



# SECTION III

## Traffic Criteria Manual

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# 1.0

## Introduction

This manual provides recommended standards for traffic related design issues. They are intended to supplement the Engineering Criteria Manual of the City of Colorado Springs and are aimed at ensuring consistent engineering design practices and providing an adequate corridor for the placement of public street infrastructure within the city limits. City Engineering will adhere to these policies as closely as possible when reviewing roadway design proposals whether it is for new development or for a City funded project. The City Engineer and his authorized representatives may grant variances from any of these policies when there are practical difficulties that prevent the application of a policy and if the granting of such variance will not be detrimental to the public safety. Flexibility will be used in the City's interpretation and application of these requirements when suitable justification is provided for alternative design solutions.

Alternative design standards may apply for projects that involve Traditional Neighborhood Design, Mixed Use Development, Small Lot PUD Development, Traffic Calming Design, and Hillside Design. The appropriate City manuals for projects involving these designs should be consulted. When the term speed is used in this manual it refers to the posted speed of the street. Design speed is typically 5 mph above the posted speed.

Traffic Impact Studies (See Appendix A) and design plans for streets in new developments and redevelopment projects must be submitted to the Engineering Development Review Division of City Engineering. Traffic Studies and plans for City funded projects must be submitted to City Engineering's Roadway Team. Some traffic studies are commissioned by the transportation section of Economic Development's Comprehensive Planning group and should be submitted directly to them.

The figures provided in this manual are illustrative only. They are not to scale and are not intended to be used for/as engineering design. For simplicity, some design elements such as sidewalks or bicycle lanes have been left off certain figures.

## 2.0

### Traffic Control Devices

The type and location of traffic control devices used on city streets must be approved by City Engineering. Traffic signals should be used where necessary, but alternate traffic control such as stop signs or roundabouts will be considered first.

When it can be shown that a particular zoning action, master plan, or development plan impacts the street system to a point that a traffic signal is warranted according to Manual on Uniform Traffic Control Devices (MUTCD) and approved by City Engineering, the developer shall be responsible for all or a portion of the signal installation. For more information about a developer's responsibility for traffic signal participation and financial assurances please reference Section 10.5 of the Subdivision Policy Manual.

## 3.0

### Access Control

#### 3.1

#### State Highways

Access onto State Highways in the City will be subject to stipulations contained in the State of Colorado, State Highway Access Code. All accesses to and from State Highways will require a permit which must be obtained from and approved by the Colorado Department of Transportation (CDOT). All accesses from new developments onto State Highways require City Engineering review.

#### 3.2

#### City Streets

The design, number, and location of access drives shall be approved by City Engineering. The number of access drives shall be a balance to allow for efficient traffic flow while providing adequate access to private property. City Engineering realizes that the adequacy of access points is a critical issue in the economic success of commercial developments and redevelopment areas. The following information is presented as a general guideline for the location of access drives to public streets.

1. **Provisions of Access** – Property owners have the right of reasonable access to the public street system. This manual provides standards for approving access to the City Street system based on the street classification. If a property cannot be served by any access point meeting these standards, City Engineering shall designate access point(s) based on traffic safety; operational needs, economic development, and conformance to as much of the requirements of these guidelines as possible. Access drives shall not be approved for parking or loading areas that require backing movements in a public street right-of-way except for single family or duplex residential uses on local streets.
2. **Restriction of Turning Movements** – Where necessary for the safe and efficient movement of traffic, City Engineering may require access drives to provide for only limited turning movements (e.g., right turns only).
3. **Number of Access Drives** – One access drive per property ownership shall be permitted which may be jointly shared with adjacent properties unless a site plan or Traffic Impact Study (TIS) approved by City Engineering shows that additional access drives are required to adequately handle driveway volumes and will not be detrimental to traffic flow. Properties with extensive street frontage may be granted more than one point of access in accordance with safe traffic engineering design and widths as referred to in **Section 5.0** and in compliance with major street access control standards.
4. **Sight Distance Requirements** – The minimum sight distance shall be provided at all access drives as shown in **Section 4.0**.



# 4.0

## Sight Distance Requirements

Sight distance is one of the most important design issues to be considered for traffic safety. Before any access to a collector or higher street classification is approved, City Engineering will review design plans for adequate sight distance at intersections.

### 4.1

#### Approach Speed

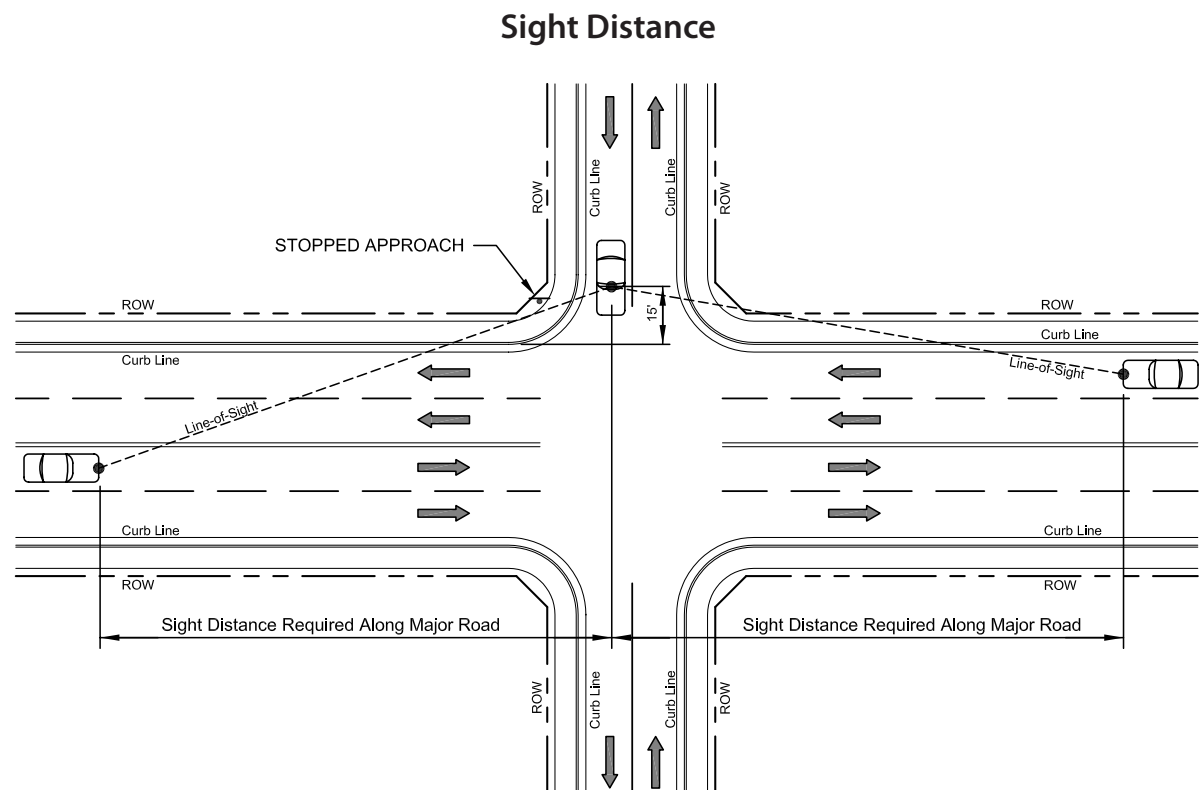
The speed used for determining minimum entering sight distance requirements is assumed to be the posted speed limit. If City Engineering has reason to believe that the operating speed is substantially different than the posted speed they can request that the 85<sup>th</sup> percentile speed be used to determine sight distance. In the case of a new facility, the design speed should be used. For modified cul-de-sacs (knuckles, eyebrows, tee turnarounds, etc) sight distance must be provided based on the expected operating speed of the location.

### 4.2

#### Horizontal Sight Distance

The distance shall be measured from the center of the approach lane at a point fifteen feet (15') behind the flow line of the intersecting street to the center of the nearest approaching traffic lane for each direction. Refer to **Figure 1**.

Figure 1



## 4.3

### Vertical Sight Distance

The distance shall be measured to allow a driver at the height of 3.5 feet to see an object 2.0 feet above the roadway at the minimum sight distance described below. For further details, refer to [A Policy on Geometric Design of Highways and Streets](#), American Association of State Highway and Transportation Officials (AASHTO) 2004, Chapter 3, "Elements of Design/Vertical Curves."

## 4.4

### Intersection Sight Distance

The minimum sight distance at all public and private street intersections or accesses, and driveways to collector streets or greater shall follow the guidelines below. At no time shall the minimum sight distance be less than the AASHTO stopping sight distance.

Table 1

Sight Distance

Speed of Thru Roadway (MPH)	Minimum Sight Distance for Stopped Vehicle (FT)	Grade Correction Distance (FT)					
		Upgrade To:			Downgrade To:		
		3%	6%	9%	3%	6%	9%
15	80	0	-5	-10	+5	+10	+20
20	115	0	-5	-10	+5	+10	+20
25	280	0	-10	-20	+10	+20	+30
30	335	0	-10	-20	+10	+20	+30
35	390	-10	-15	-25	+10	+25	+40
40	445	-10	-20	-30	+10	+30	+50
45	500	-15	-25	-30	+15	+40	+60
50	555	-20	-35	-45	+20	+50	+70

## 4.5

### Residential Driveway Sight Distance

The previous sight distance criteria does not apply to single-family back-out drives where sight distance will be provided based on location of the drivers eye when commencing the back-out maneuver. To provide sight distance from driveways to both the street and sidewalk items taller than three (3) feet should not be placed within five (5) feet of the edge of driveway. This restriction extends from the edge of street to ten (10) feet behind the back of sidewalk. This restriction includes solid surface fences and large shrubs. Utility poles, fire hydrants, openly spaced trees, and traffic devices are allowable if visual obstruction is minimal.

# 5.0

## Intersection Spacing

Each high density residential and commercial access should be separated at a minimum by a distance equal to the stopping sight distance described in the **Table of Traffic Engineering Design Standards** in **Section 15**. When deceleration or acceleration lanes are or will be required, it is desirable that the accesses be separated by a sufficient distance so that the speed change lanes including transition tapers do not overlap. Access should not be planned within the acceleration, deceleration, taper or storage lengths of other access points or intersections. Refer to **Figures 2** and **3**. The center of commercial/multi-family accesses not in alignment will normally be offset a minimum of one hundred fifty feet (150') on all local and collector streets; three hundred feet (300') on all arterials. The off-set of intersections may need to be adjusted to accommodate adequate left turn storage length.

Figure 2

Low Density Residential Driveways

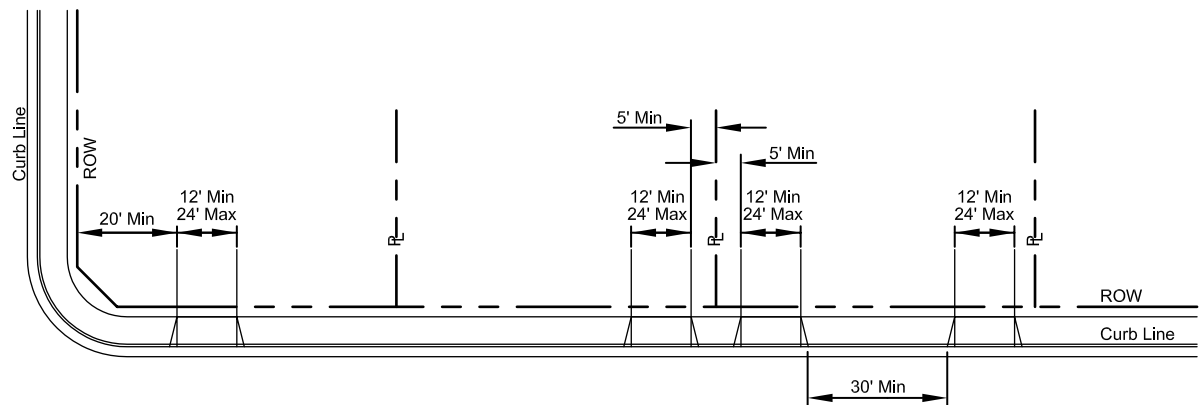
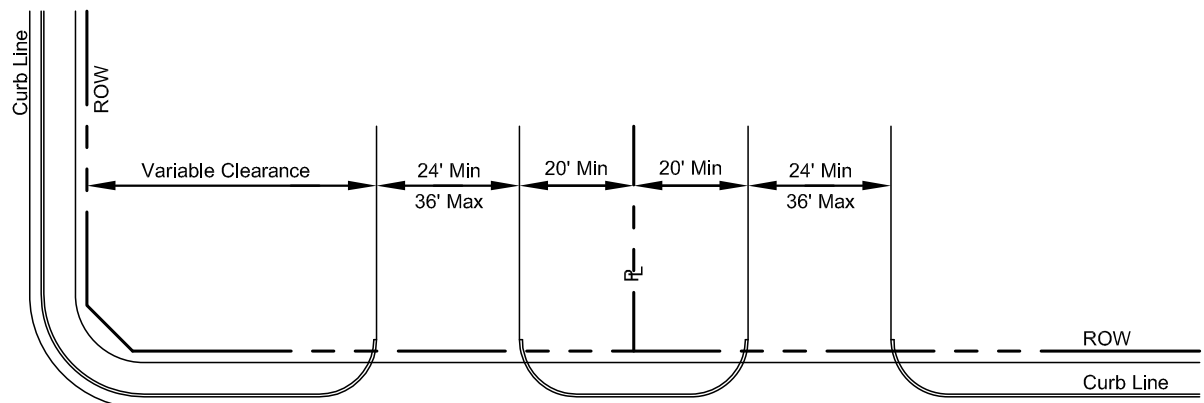


Figure 3

Multi Family Residential Driveways and Commercial Accesses



## 6.0

### Access Design

#### 6.1

##### Access Grades

Commercial or high density residential access that may be signalized in the future shall meet the grade standards for signalized City streets (See 9.0). Non signalized commercial or high density residential access drives should provide a grade of 4% or less at the street approach.

#### 6.2

##### Access Design

Commercial or high density residential access shall be a minimum of 24 feet in width. Widths greater than 36 feet must be approved by City Engineering. Driveways shall have a minimum curb return of 15 feet. Driveways intersecting principal arterials shall have a minimum curb return of 20 feet.

#### 6.3

##### Internal Circulation

Private internal traffic circulation on commercial sites is reviewed by Land Use Review at the time of development plan. EDRD reviews accesses onto the public street and related issues, but EDRD does not review private internal traffic circulation. As needed, EDRD provides support to the LUR planner or can mediate between LUR and an applicant about internal circulation issues if requested. The only exceptions are school sites. City Engineering reviews internal circulation on school sites. City Engineering supports the development plan criteria in Section 7.5.502 of the Code which asks, "Have the internal drives, external access points, and pedestrian walkways been designed to provide safe and convenient vehicular and pedestrian access within the project?"

# 7.0

## Medians

Raised medians shall be required on principal arterials and may be allowed on locals, collectors and minor arterials. All designs are subject to review and approval by City Engineering. Refer to **Figures 4, 5, and 6.**

If required by City Engineering or requested by the developer, all raised medians shall be a minimum of seventeen feet (17') in width (face of curb to face of curb). Along principal arterial designs of six lanes or more, the median width shall be no less than twenty-eight feet (28') face of curb to face of curb. Openings in existing medians must be approved by City Engineering.

The use of 3/4 intersection median design and channelized "T" intersections require a median wider than the minimum 17' median. A 22' median width is suggested where these designs are anticipated.

Median openings void of left turn lanes shall be designed in the bullet nose configuration, with allowances for pedestrian crossings. Left turn lanes shall be designed to accommodate the 20-year left turn volume based on the 95% queue of the left turn.

Figure 4

### Right-In, Right-out, Left-in Median Design

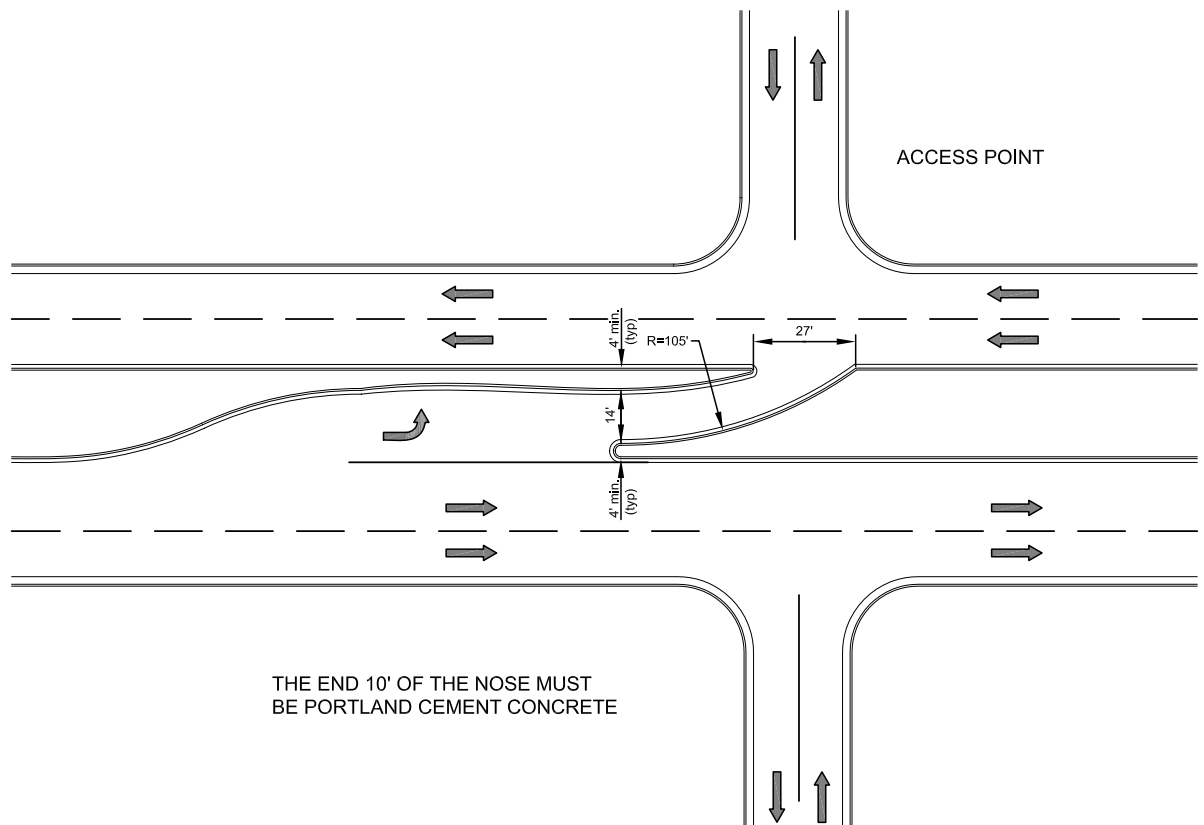


Figure 5

## Median Design to Restrict Exiting Left Turns

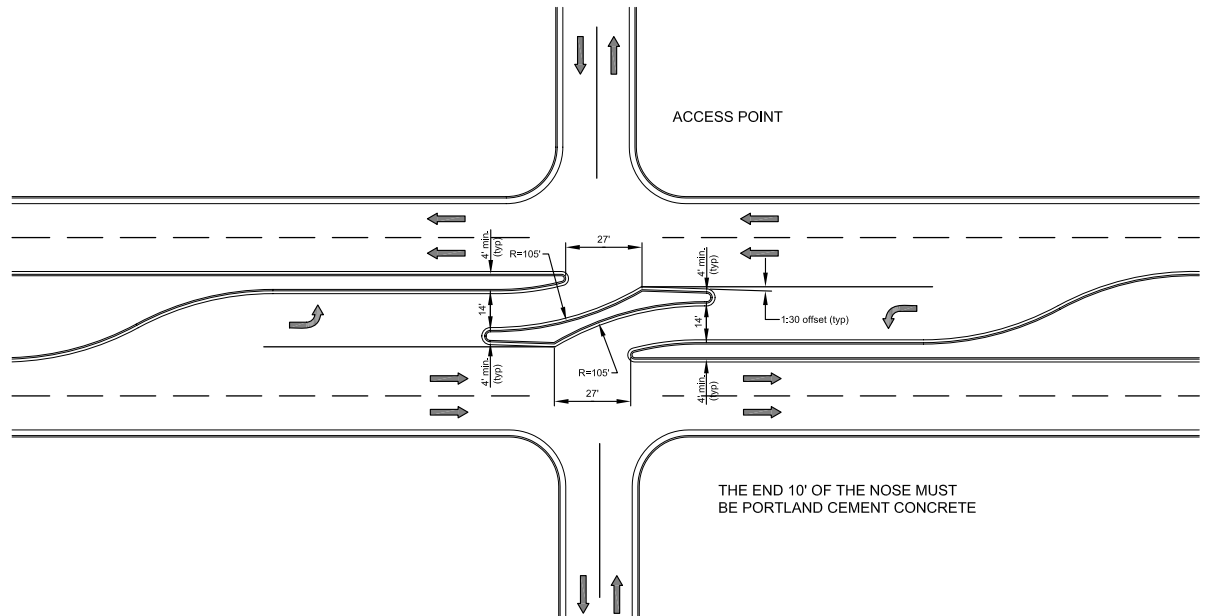
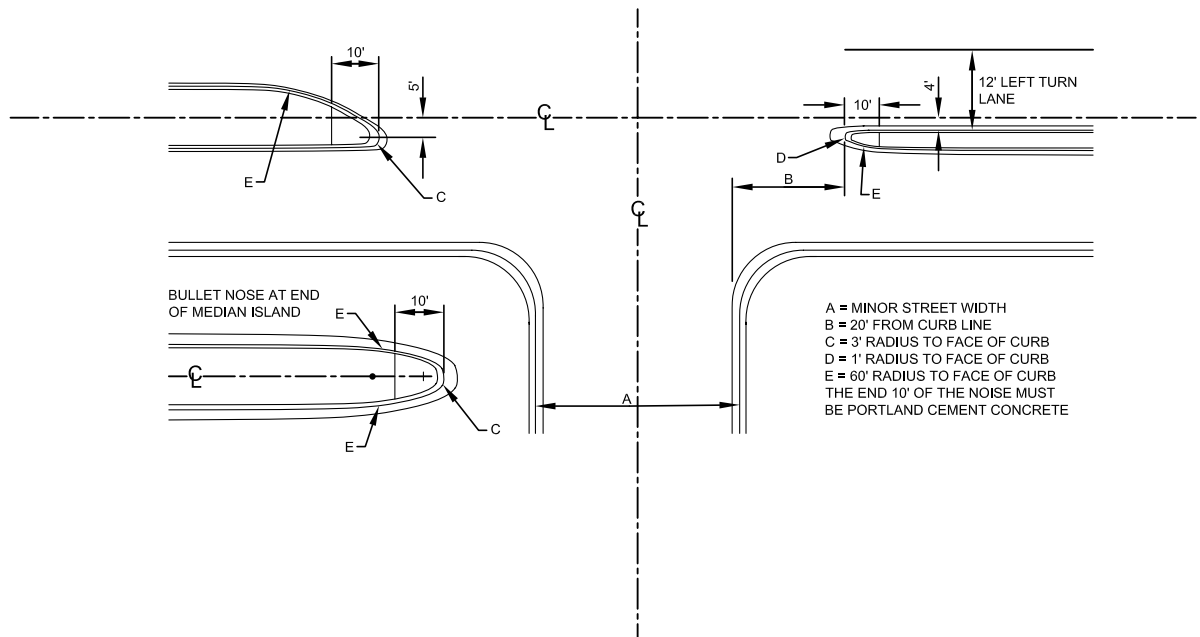


Figure 6

## Median Openings for Intersections and Median Island Ends



This sketch is for a three leg intersection. If the intersection has four legs, the left side will also have an auxiliary lane for left turns, and the median on the left side will have the same configuration as the one on the right side rotated 180 degrees.

# 8.0

## Channelization

Left or right turn lanes may be required along collector or arterial roadways if deemed necessary for the safe and efficient flow of traffic. The design of such lanes shall be based on 20-year traffic projections for that roadway. The design will consist of adequate taper lengths, deceleration or acceleration length, storage capacity, and turning geometrics. The installation costs will be required of the developer if it is determined that a major proportion of its need is created by the impact of a proposed development.

## 8.1

### Turn Channel Approaches

1. **Exclusive Turn Lane Requirements** - Exclusive left turn, right turn, and acceleration lanes shall be provided wherever left turn, right turn, or acceleration lanes are specified as being needed by an approved Traffic Impact Study (TIS). The requirements for use of turn lanes are shown in **Table 2**.

Table 2

Summary of Exclusive Turn Lane Requirements

	Left Turn Lane	Left Turn Acceleration Lane	Right Turn Lane	Right Turn Acceleration Lane
<b>Expressway</b>	A left turn lane is required for any access that allows left turn ingress movement.	A left turn acceleration lane may be required if the design would be a benefit to the safety and operation of the roadway.	A right turn lane is required for any access with a projected peak hour right turn ingress turning volume of 10 VPH or greater.	A right turn acceleration lane is required for any unsignalized access with a projected peak hour right turn egress turning volume of 10 VPH or greater for roadways with posted speeds of 50 mph or greater.
<b>Principal Arterial</b>	A left turn lane is required for an access with a projected peak hour left ingress turning volume of 10 VPH or greater.	A left turn acceleration lane may be required if it would be a benefit to the safety and operation of the roadway.	A right turn lane is required for any access with a projected peak hour right ingress turning volume of 25 VPH or greater.	A right turn acceleration lane is not required.

	Left Turn Lane	Left Turn Acceleration Lane	Right Turn Lane	Right Turn Acceleration Lane
<b>Minor Arterial</b>	A left turn lane is required for any access with a projected peak hour ingress turning volume of 25 VPH or greater.	An acceleration lane is generally not required.	A right turn lane is required for any access with a projected peak hour right turning volume of 50 VPH or greater.	An acceleration lane is not required.

*Note: Turn lane requirements on lower classification roads to be determined on a case-by-case basis depending on recommendations from a traffic impact study and approved by City Engineering.*

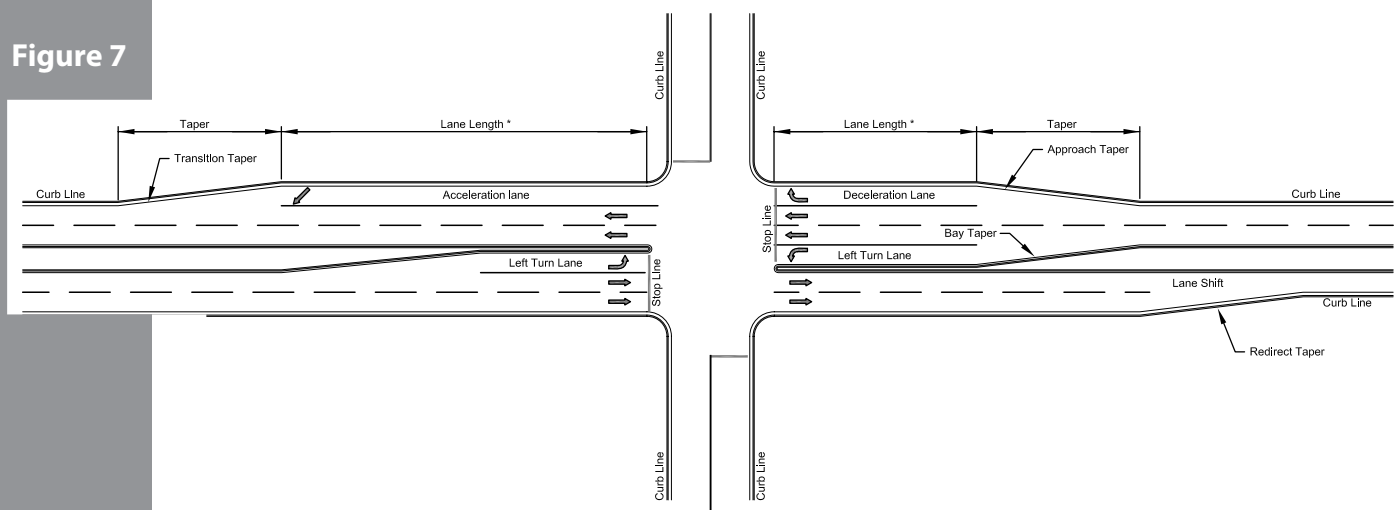
- Lane Shifts or Drops Required** - Lane shifts or drops shall be provided wherever redirection of traffic is specified as being needed by an approved signing and striping plan.
- Conflicts between Exclusive Turn Lanes** - Where two intersections have exclusive turn lanes that overlap, or the ending points of the exclusive turn lanes have less than 300 feet or one-half their length of separation (whichever is shorter) and a significant structure or topographical feature does not preclude widening, a continuous exclusive turn lane shall be established between the intersections to improve roadway consistency, safety, and to maintain edge of pavement continuity.

If restrictive topography allows only one exclusive turn lane, normally a left turn deceleration lane is given first priority. Where the travel lanes must be redirected due to the addition of a left turn lane, a pavement overlay is required.

## 8.2 Turn Lane Design

Turn lanes typically consist of a combination of several components (i.e. tapers, lane length, and storage). The use and design of these components varies based on the type of access, roadway classification, and site-specific conditions. **Figures 7 and 8** present a graphical guide to basic exclusive turn lane elements.

**Figure 7**

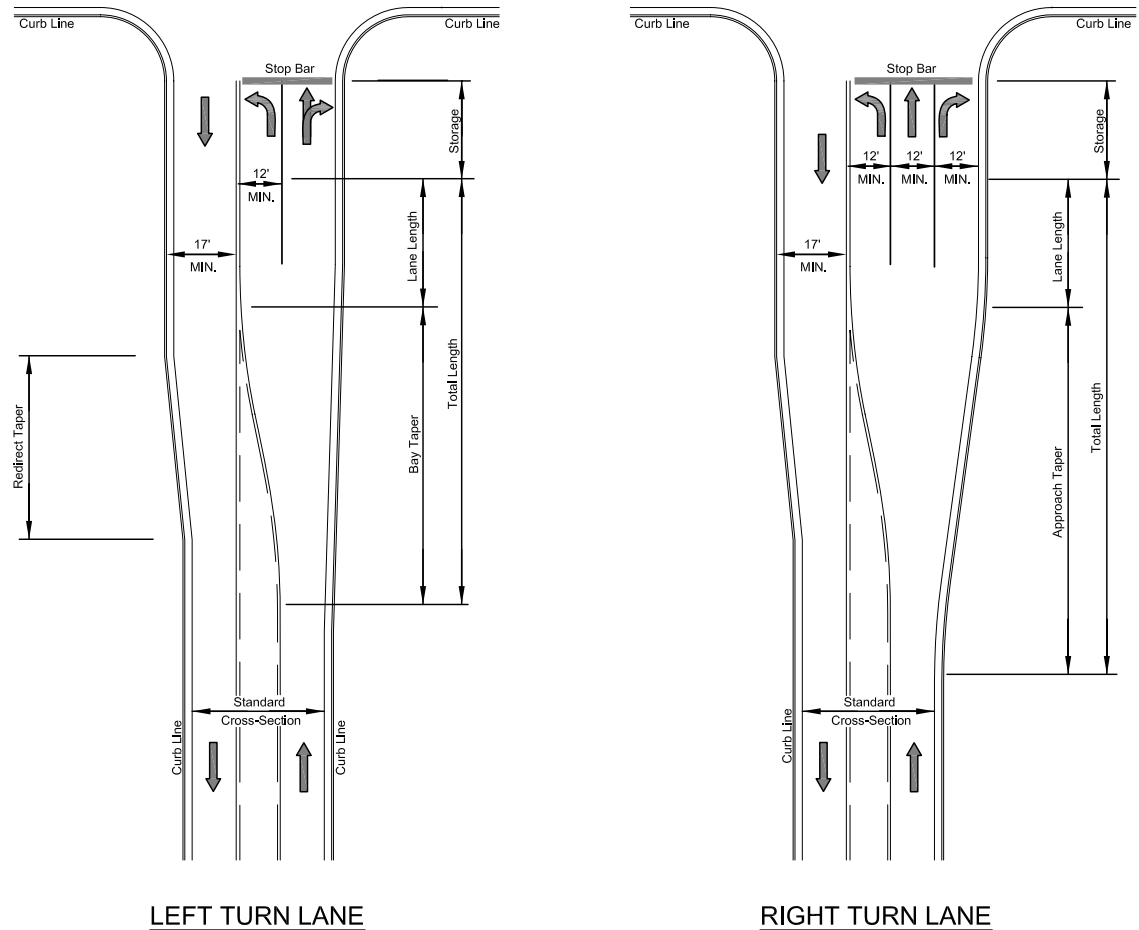




\* Additional length may be required for storage turning vehicles at potential controlled intersections.

Figure 8

## Design Elements for Left and Right Turn Lanes



NOTE: This full intersection design is asymmetrical. Left Turn and Thru Lanes must align with the opposite intersection approach.

### 1. Deceleration/Acceleration Lanes

- a. **Deceleration Length** The basis for designing a deceleration lane and taper is to provide sufficient length for a vehicle to decelerate and brake entirely outside the through traffic lanes. **Table 3** provides the required deceleration lane and taper design lengths by speed. Deceleration lane lengths shall be adjusted for a grade of 3% or more using the factors in **Table 4**. The required length allows a motorist to decelerate in gear for at least 3 seconds followed by safe braking to a complete stop. When design constraints necessitate reducing part of the deceleration length, the taper shall be reduced first and then the deceleration length. All reductions in deceleration lane length must be approved by City Engineering.

Table 3

Required Deceleration Lane and Taper Lengths

Speed (MPH)	Lane Length (feet)	Approach Taper (feet)	Total Length (feet)
25	115	120	235
30	115	120	235
35	120	140	260
40	155	160	315
45	200	180	380
50	235	200	435
60	290	240	530
70	Special Design	Special Design	Special Design

Table 4

Deceleration Lane Grade Adjustment Factors

Roadway Grade	Factors
<b>Upgrade</b>	
3% to 4.9%	0.90
5% to 7.5%	0.80
<b>Downgrade</b>	
3% to 4.9%	1.20
5% to 7.5%	1.35

- b. **Bay Tapers** For arterial streets the straight line taper should be replaced with a bay taper (asymmetrical reverse curve). The bay taper should be at least 1/3 the length of the appropriate straight line taper. The turn-off curve should be approximately twice the size of the second curve. A design detail for a bay taper is available in AASHTO, Exhibit 9-95.

- c. **Acceleration Length** The basis for designing an acceleration lane and transition taper is to provide sufficient length for a vehicle to accelerate to the appropriate speed and merge into the through traffic lanes without disrupting traffic flow. **Table 5** provides the required acceleration lane and transition taper design lengths by speed. Acceleration lane lengths in **Table 5** shall be adjusted for a grade of 3% or more using the factors in **Table 6**. Where design constraints necessitate reducing part of the acceleration lane, the taper length should be reduced first. All reductions to acceleration lanes must be approved by City Engineering.

Table 5

Design Criteria for Acceleration Lanes

Speed (MPH)	Lane Length (feet)	Straight-line Taper (feet)
40	236	12:1
45	388	13.5:1
50	580	15:1
60	930	20:1
70	1290	25:1

Table 6

Grade Adjustment Factors for Acceleration Lanes

	Speed (MPH)		
	40 to 50	60	70
<b>Upgrade</b>			
3 to 4.9%	1.3	1.5	1.7
5 to 7.5%	1.5	2.0	2.5
<b>Downgrade</b>			
3 to 4.9%	0.7	0.65	0.6
5 to 7.5%	0.6	0.55	0.5

- d. **Redirect Tapers** When constructing a roadway that will directly connect with an existing roadway of a different width, it is necessary to install a redirect taper between the two. Redirect tapers shall be used where an exclusive turn lane (drop lane), median or other redirection of vehicles is necessary and where redirection of the flow of traffic is necessary to accommodate the exclusive turn lane or median. Redirect tapers shall be installed in conformance with **Table 7**. These ratios are not to be used in the design of acceleration, deceleration, or storage lanes. If the redirect taper would result in a horizontal curve design deficiency for the through movement, the horizontal curve shall be corrected. Redirect taper should be designed as straight tapers with the beginning and ending points rounded.

Table 7

Redirect Tapers for Through Lanes

Speed (MPH)	20	25	30	35	40	45	50	55	60	65	70
Straight Taper Ratio	10:1	12.5:1	15:1	20:1	25:1	30:1	45:1	50:1	55:1	60:1	65:1

## 2. Storage Lengths for left turn lanes

The length of a left turn lane for all city streets, other than expressways, shall be based on providing adequate storage length. Deceleration length is not to be included for the left turn lane design.

The basis for designing the length of required storage is to provide sufficient length for vehicles to queue within the lane without affecting other movements. **Table 8** provides the required storage lengths for stop-controlled intersections. If City Engineering determines that meeting the required storage length is impractical or results in an unsafe condition, the minimum storage length shall be based on the mean arrival rate, but in no case shall the minimum storage length be less than 50 feet. On expressways, left turn lanes shall be designed to include the deceleration length and storage length.

Table 8

Required Storage Lengths for Stop-Controlled Intersections

DHV (VPH)	<60	61-120	121-180	181-250	>250
Storage Length (feet)	50-75	100	150	200	250 or more

*Note: At signalized intersections the left turn lane storage length shall be based on the 95% queue.*

## 9.0

### Grade at Intersections

Flat grades are preferred in all directions from an intersection, but in no case shall grades exceed four percent (4%) for a distance of at least fifty (50) feet from all curb intersections unless physical factors warrant special consideration. At signalized intersections (or intersections expected to be signalized in the future), two percent (2%) maximum grades are required for two hundred (200) feet in each direction on the approach as measured from the cross street curb line. Refer to AASHTO Standards for design of crest and sag vertical curves.

## 10.0

### Angle of Intersection, Minimum Intersection Curb Radii

Proposed streets and driveways shall intersect one another at ninety degree (90°) angles or as close to ninety degrees as is feasible; no less than eighty degrees (80°). The number of intersections along arterials shall normally not be spaced less than one-quarter mile. (A pair of offset "T" intersections shall be treated as one intersection for quarter mile spacing purposes). Intersections of local streets with arterials should be "T" intersections to reduce the number of conflicting movements at these intersections. When "T" intersections are used, the center lines of the streets not in alignment shall normally be offset a minimum of one hundred and fifty feet (150') on local streets and three hundred feet (300') on commercial locals, collectors, and arterials, unless an accepted TIS justifies a smaller separation. On arterial streets, if the left turn storage for two "T" intersections overlap, the minimum spacing shall be increased to accommodate the left turn queues. A minimum of 100' tangent prior to beginning of curve measured from the center line of the intersected street shall be maintained for all residential street intersections along a collector street. At street intersections, the minimum curb radii for standard streets are illustrated in **Table 9**. Street intersections with non-standard cross sections or not at ninety degree (90) angles will require truck turning analysis for both the wheel base and the overhang path. The truck turning analysis shall be submitted to City Engineering for review. Waivers of the minimum curb return radii will be considered on a case-by-case basis with sufficient justification and in special zone districts (TND, Mixed Use, etc.)

Table 9

Minimum Intersection Curb Radii

Type of Intersection	Curb Radii
Local – Local	15'
Local – Collector	20'
Collector – Collector	25'
Local – Arterial	25'
Collector – Arterial	30'
Arterial – Arterial	40'

# 11.0

## Installation of Curbs, Mid-block Walkways, Pedestrian Ramps, and Guardrails

### 11.1

#### Types of Curb

Curb and gutter is required on all City streets in accordance with Section 7.7.704 of the City Code. Standard Type 1, 8" vertical curb and gutter or equivalent 6" curb must be used on all Collectors, Major, and Minor Arterials. Ramp curb may be used on residential streets when drainage considerations warrant its use subject to the approval of the City Engineer. Ramp curb shall not be approved abutting multi-family, commercial, industrial, park or school land uses. In all cases the same curb type shall be used on both sides of the street.

Streets without curbs will be considered on a case-by-case basis if the proposed development is designed as a Low Impact Development (LID) and unique street cross sections help achieve the desired goal of increased storm water infiltration.

### 11.2

#### Mid-Block Walkways

City Engineering may require a concrete mid-block walkway, not less than six (6) feet in width, on local and collector streets when it is deemed necessary to provide access to schools, shopping centers, transportation facilities, or other community facilities and services.

### 11.3

#### Pedestrian Ramps

Pedestrian ramps shall be installed as required by City Engineering per City of Colorado Springs Pedestrian Ramp design detail as contained in the City of Colorado Springs City Engineering Standard Specifications as required by Ordinance (7.7.704-E3).

### 11.4

#### Guardrails

Guardrails shall be installed as required by City Engineering per AASHTO warrants and shall comply with AASHTO design guidelines.

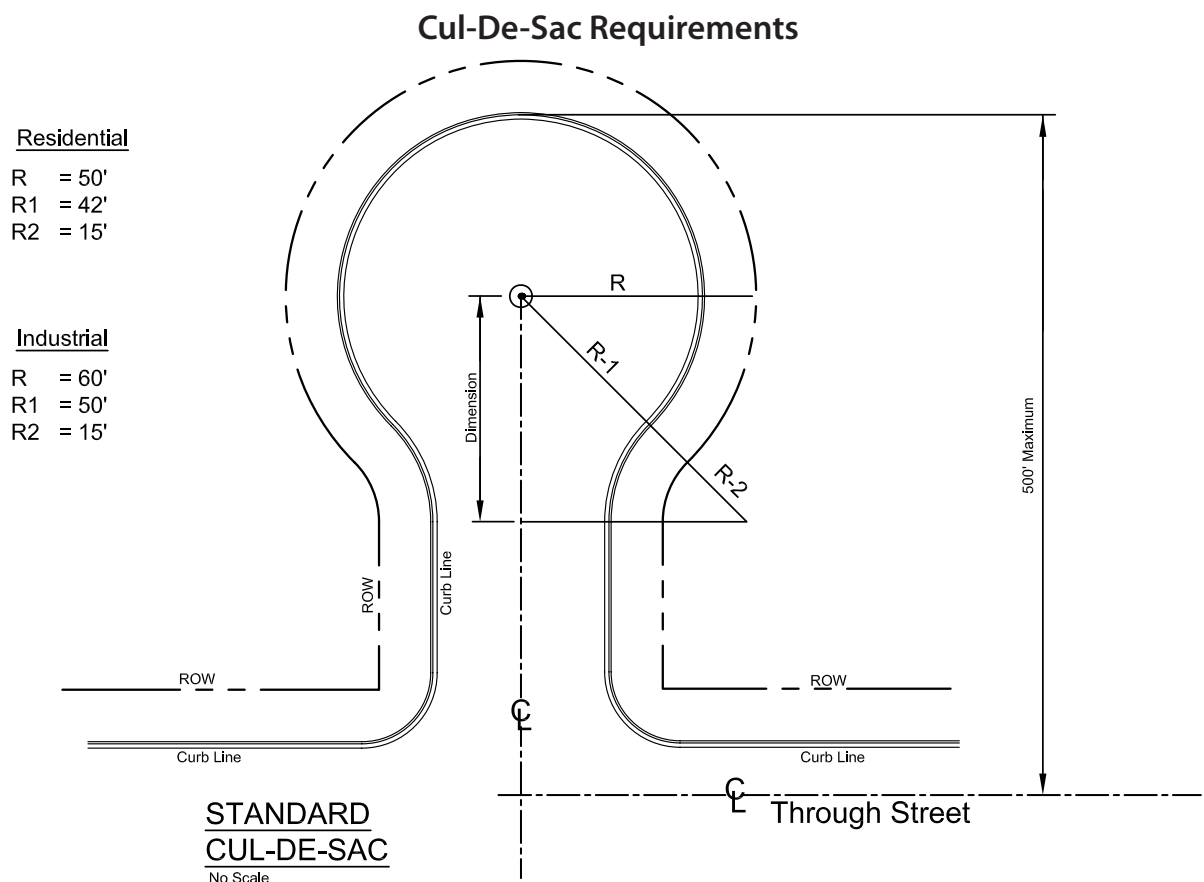
# 12.0

## Cul-De-Sac Regulations

The design and overall length of a cul-de-sac shall be determined by topography, type of development, proposed density, and other physical factors which may warrant special consideration. The overall length of a cul-de-sac street normally shall not exceed five hundred feet (500'). The cul-de-sac will generally be designed with a turn-around right-of-way radius of fifty feet (50') in residential development and sixty feet (60') in industrial development and with a radius to curb flowline of forty-two feet (42') in residential development and fifty feet (50') in industrial development, see Figure 9. Alternate cul-de-sac design geometry will be considered on a case-by-case basis with sufficient justification when design constraints exist or when LID or other special zone district goals are being incorporated in the design.

Modified cul-de-sacs (knuckles, eyebrows, tee turn-around, etc.) can be used on local streets as long as sight distance criteria contained in section 4.2 is met. For example, a knuckle design on a 90 degree (90°) curve would need to provide adequate sight distance based on a 15 mph design since that would be the expected operating speed of a vehicle making a 90 degree (90°) turn. Sight distance can be protected by additional right-of-way or providing legal restrictions for landscaping, buildings, fences, and other objects that would block a driver's view. Any restrictions for sight distance purposes shall be identified on the development plan. All cul-de-sac designs must meet Fire Code provisions for cul-de-sacs.

Figure 9



# 13.0

## Private Streets

Private streets are acceptable in new development at the discretion of the developer and subject to City review. Section 7.7.704 (C) of the City Code states that the location and design of private streets is subject to the review and approval of Traffic Engineering [administered by the Engineering Development Review Division (EDRD)] and the Fire Department. This review is done at the time of the Development Plan. EDRD approval is not required on the design plans and profiles for private streets except for intersections with a public street. Gated residential communities must use private streets. The developer must make financial arrangements for the perpetual ownership and maintenance of private streets (i.e. a homeowners' association) to include life-cycle repair and replacement of the facilities. EDRD requires that the reception number of the associated recorded documents be referenced on the final plat. City policy requires that private streets be designed structurally (i.e. pavement thickness) to meet or exceed City standards and specifications. Signing and striping of private streets must be consistent with the Manual for Uniform Traffic Control Devices (MUTCD).



# 14.0

## Street Names

### 14.1

#### Approval

Street names and numbering shall be subject to the approval of the Regional Building Department, Police Department, Fire Department (911), and City Engineering. Residential street names shall be limited to 10 letters (refer to the Addressing Ordinance 7.7.704-D).

### 14.2

#### Duplication of Names

Street names shall not duplicate nor be too closely approximated phonetically to any name of an existing City or County street in El Paso County.

### 14.3

#### Continuity of Names

Any street which is a continuation or an approximate or logical continuation of an existing dedicated street shall bear the same name as the existing street.

### 14.4

#### Small Cul-de-sacs

Small cul-de-sacs which have less than five interior lots may be omitted for name purposes when the house numbers are continuous with those of the street to which they have access.

### 14.5

#### Street Name Designations

Street name designations shall be used as follows:

1. **Boulevard or Parkway** – Shall be reserved for roadways designated on the Intermodal Transportation Plan having a median divider of sufficient size to allow for landscaping. (Example: Research Parkway)
2. **Avenue or Road** – Shall be reserved for streets of substantial continuity such as primary or secondary links of the Intermodal Transportation Plan.
3. **Street or Drive** – Shall be reserved for streets of less continuity such as local or collector streets.
4. **Court, Place, Circle, Way, Terrace or Lane** – Shall be reserved for streets with no continuity whatsoever, and contain small numbers of lots; usually cul-de-sacs
5. **Grove, Heights, Point, or View** shall be used for private streets. Private streets shall be signed by the developer per City specifications with brown background/white letters.

# 15.0

## Roadway Standards

The City of Colorado Springs uses a roadway hierarchy to provide safe and continuous travel and access. A functional classification of roadways provides the hierarchy needed to accomplish this goal. Streets are divided into categories with different design criteria to maintain and protect the primary purpose of the roadway. The roadway standards provided in this manual are to provide a standard for street sections, but variances to these sections can be requested. Roadway reductions will be considered if a lesser cross-section can be shown to adequately accommodate the projected long-term traffic volumes. The cross-sections provided in this manual are illustrative only. There are not to scale and are not intended to be used as engineering design. For simplicity, some design elements such as sidewalks or bicycle lanes have been left off certain figures. The functional classifications are described below:

### 15.1

#### Standards for Freeways

1. **Function** - Freeways permit rapid and unimpeded movement of traffic through and around the City
2. **Right-of-Way Widths** - 420 feet, minimum with frontage roads, 332 feet, minimum without frontage roads
3. **Number of Moving Lanes** - Six to eight lanes
4. **Access Conditions**
  - a. *Access* shall be grade separated
  - b. *Interchanges* shall be made with major arterial streets and freeways only
  - c. *No intersections* at grade shall be permitted
5. **Traffic Characteristics**
  - a. *No traffic* signals
  - b. *Parking* prohibited
  - c. *Bicycles* prohibited
  - d. *Two* separate one-way roadways with a dividing median strip
6. **Planning Characteristics**
  - a. *Freeways* should connect with main highways approaching and leaving the City from all directions
  - b. *Freeways* should be so aligned as to serve the major traffic generators within the City, such as the central business district, major industrial areas, regional shopping centers, etc.
  - c. *Freeways* should not bisect neighborhoods or communities but should act as boundaries between them
  - d. *Added* right-of-way is provided for landscaping, grass planting, added safety, and noise attenuation

## 15.2

### Standards for Expressways

- e. *At interchange areas:*
  1. For diamond interchanges, right-of-way should flare to 580' in width from 1000' each side of the intersection right-of-way line at the intersecting cross street.
  2. For cloverleaf interchanges, right-of-way should flare to 1300' in width from 1300' each side of the intersection right-of-way line at the intersecting cross street.
  3. For alternative interchange designs (SPUI's, flyovers, etc.) ROW requirements will be provided based on the design.
7. **Design Characteristics**
  - a. *Grades*
    1. Not less than one percent (1%) on tangents; nor more than four percent (4%)
  - b. *Cross sections*
    1. Cross sections will be determined by specific design
1. **Function** - Expressways permit rapid and relatively unimpeded movement of traffic through and around the City.
2. **Right-of-Way** - 210 feet minimum, with additional right-of-way for frontage roads, if required
3. **Number of Moving Lanes** - Four to six lanes
4. **Access Conditions**
  - a. *Access* shall be completely controlled
  - b. *Interchanges* shall be made with freeways and may be made with major arterial streets.
  - c. *Signalized* intersections are permitted with arterial streets only, preferably with one mile spacing. Signalized intersections at ½ mile locations may be allowed by City Engineering.
  - d. *Turn restricted* intersections may be allowed at half mile spacing or where they can be shown to benefit operations on the expressway.
  - e. High density or congested areas may require specific access plans.
5. **Traffic Characteristics**
  - a. *Traffic control* devices and channelization shall be provided at each intersection at grade.
  - b. *Parking* prohibited
  - c. *Two* separate one-way roadways with a dividing raised median
  - d. *Bicycles* may be permitted on the shoulder or on separated bikeways for portions of expressways.

## 6. Planning Characteristics

- a. *Expressways* should connect with main highways approaching and leaving the City from all directions.
- b. *Expressways* should be so aligned as to serve the major traffic generators within the City, such as the central business district, major employment centers, military installations, regional shopping centers, etc.
- c. *Expressways* should not bisect neighborhoods or communities but should act as boundaries between them
- d. *Added* right-of-way is provided for landscaping, grass planting, added safety, and noise attenuation
- e. *At interchange* areas:
  1. For diamond interchanges, right-of-way should flare to 580' in width from 1000' each side of the intersection right-of-way line at the intersecting cross streets
  2. For cloverleaf interchanges, right-of-way should flare to 1300' in width from 1300' each side of the intersection right-of-way line at the intersecting cross street
  3. See Freeway #3

## 7. Design Characteristics

- a. *Grades*
  1. Not less than one percent (1%) on tangents or more than four percent (4%)
- b. *Cross section*
  1. Cross sections will be determined by specific design

# 15.3

## Standards for Principal Arterial Streets

1. **Function** - Major arterial streets permit rapid and relatively unimpeded traffic movement throughout the City and carry high volumes of inter and intra traffic which connects major land use elements as well as communities with one another. Major function is to serve through traffic. The secondary function is to serve abutting property. This functional description pertains to four lane and greater facilities.
2. **Right-of-Way Width** - 107 - 142 feet
3. **Number of Moving Lanes** - Four to six lanes, with left and right turn bays. Right turn lanes shall be constructed at intersections of all arterial streets.
4. **Access Conditions**
  - a. *Intersections* and curb cuts shall be limited, as approved by City Engineering.
  - b. *Signalized intersections* shall be limited to 1/2 mile spacing unless adequate justification is provided to approve signalized intersections at other locations.
  - c. *Median* cuts will be permitted at major or significant street intersections, generally at intervals of approximately ¼ to ½ miles as approved by City Engineering.

## 5. Traffic Characteristics

- Regulation of traffic shall be accomplished by traffic control devices and channelization.
- On-street parking prohibited
- Vertical curb required with detached sidewalks
- Median shall be raised with curb and gutter (City Standard Detail D-6 and D-24)
- High density or congested areas may require specific access plans.

## 6. Planning Characteristics

- Principal arterial streets should be spaced approximately one mile apart in the suburban areas of the City to ¼ mile apart in areas of high population density and intense land usage.
- Principal arterial streets should not bisect neighborhoods, but should act as boundaries between them.
- Sidewalks shall be set back from the street.
- In general, abutting properties should not face on the roadway unless separated from it by a frontage road. Lots that directly abut the arterial shall have a minimum depth of 120 feet.
- Bicycle access shall be part of a 4' multi-use shoulder.

## 7. Design Characteristics

- Grades
  - Not less than one percent (1%) on tangents; nor more than four percent (4%). Grades of six percent (6%) may be considered for unique, short distances.
- Alignment
  - Horizontal – 1040 foot minimum radius at centerline for standard crowned cross-slopes
  - Vertical – minimum length equivalent to K value times the algebraic difference in the rate of grade.

Figure 10

### Cross Sections for Principal Arterial Streets

#### Type I (4- Lane, 107' Right-of-Way)

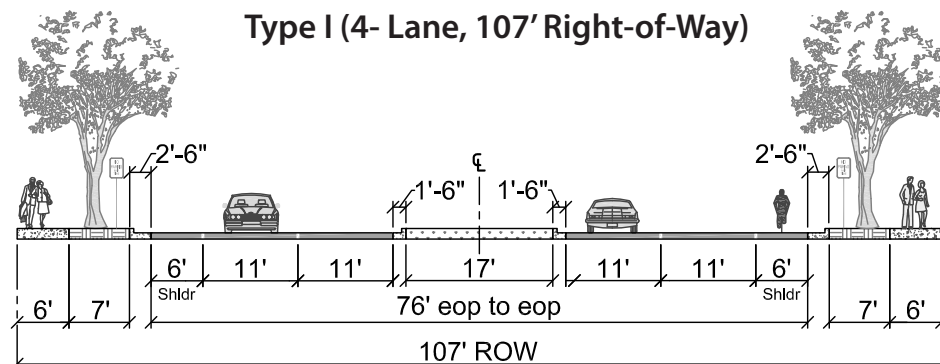
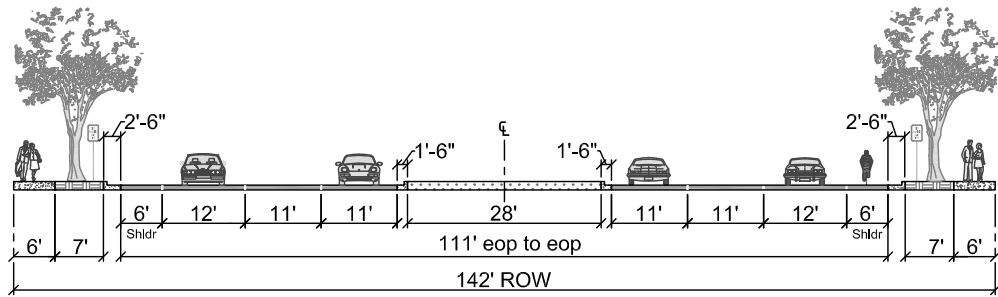


Figure 11

### Type II (6-Lane, 142' Right-of-Way)



## 15.4

### Standards for Minor Arterial Streets

1. **Function** - Minor arterial streets permit rapid and relatively unimpeded traffic movement throughout the City and carry high volumes of inter and intra-traffic which connect major land use elements.
2. **Right-of-Way Width** - 90 feet (with two 5 foot easements)
3. **Number of Moving Lanes** - Four lanes
4. **Access Conditions**
  - a. *Intersections* will generally be "T" type at grade as approved by City Engineering.
  - b. *Intersections* and curb cuts shall be limited as approved by City Engineering.
5. **Traffic Characteristics**
  - a. *Regulation* of traffic shall be accomplished by traffic control devices and channelization.
  - b. *On-street* parking prohibited
  - c. *Vertical* curbs required with detached sidewalks
  - d. *Medians* will be raised. Painted medians will be considered with adequate justifications.
6. **Planning Characteristics**
  - a. *Minor* arterial streets should be spaced approximately one mile apart in the suburban areas of the City to a few blocks apart in areas of high population density and intense land usage.
  - b. *Minor* arterial streets preferably should not bisect neighborhoods.
  - c. *Bicycle* access shall be part of a 4' multi-use shoulder.
7. **Design Characteristics**
  - a. *Grades*
    1. Not less than one percent (1%) on tangents; nor more than four percent (4%). Grades of six percent (6%) may be considered for unique, short distances.

b. *Alignment*

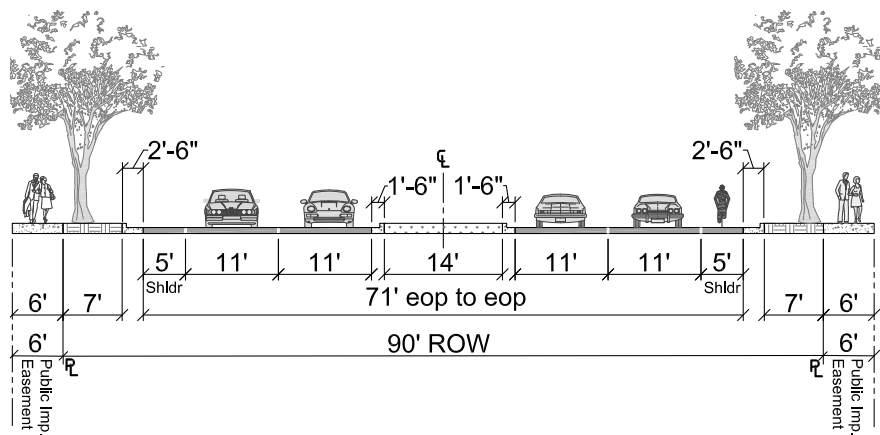
1. Horizontal – 765 foot minimum radius at centerline for standard crowned cross-slopes.
2. Vertical – minimum length equivalent to the K value times the algebraic difference approval of grades.

c. *Frequency of intersections*

1. Intersections along minor arterial streets shall be limited to as few as possible

Figure 12

Minor Arterial



15.5

Standards for Collector Streets

1. **Function** - Collector streets are designed to serve the local needs of the neighborhood and to provide direct access to non-residential, abutting properties. All traffic carried by collector streets should have an origin or a destination within the neighborhood.
2. **Right-of-Way Width** - 57 feet (no parking) to 67 feet (parking)
3. **Number of Moving Lanes**- Two lanes
4. **Access Conditions** - Direct access to residential properties is by way of curb cuts.
5. **Traffic Characteristics**
  - a. *On-street* parking is allowed on both sides of minor collector streets unless prohibited.
  - b. *Intersections* are at grade
6. **Planning Characteristics**
  - a. *Sidewalks* will be detached from vertical curbs
  - b. *Bicycle* travel can be accommodated with 14' shared lanes.
  - c. *No residential* frontage allowed on collectors with ADT greater than 2500.

## 7. Design Characteristics

### a. Grades

1. Not less than one percent (1%) on tangents; collector not more than ten percent (10%).

### b. Alignment

1. Horizontal curves – collector 335 foot minimum radius at centerline for standard crowned cross-slopes.
2. Vertical curves – A minimum length equivalent to the K value times the algebraic difference of approach grades.

### c. Frequency of intersections

1. Intersections along collector streets shall be limited to as few points as possible, while providing commercial access to abutting properties and connecting to local street system.

Figure 13

Collector (With Parking)

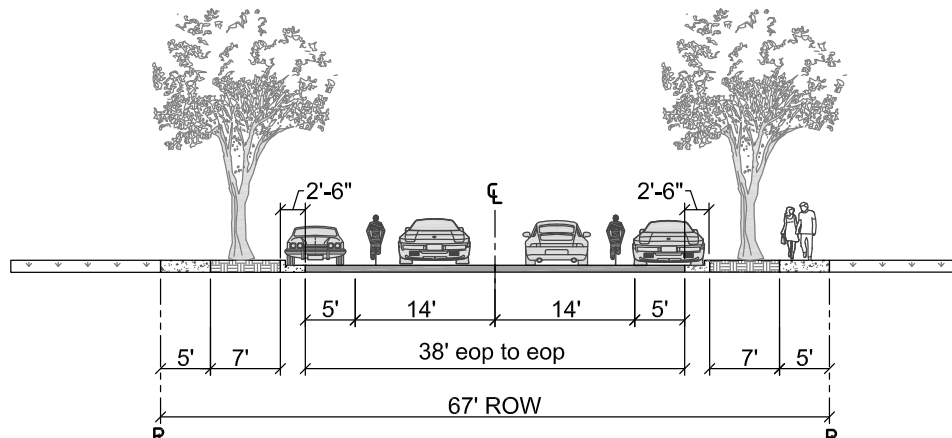
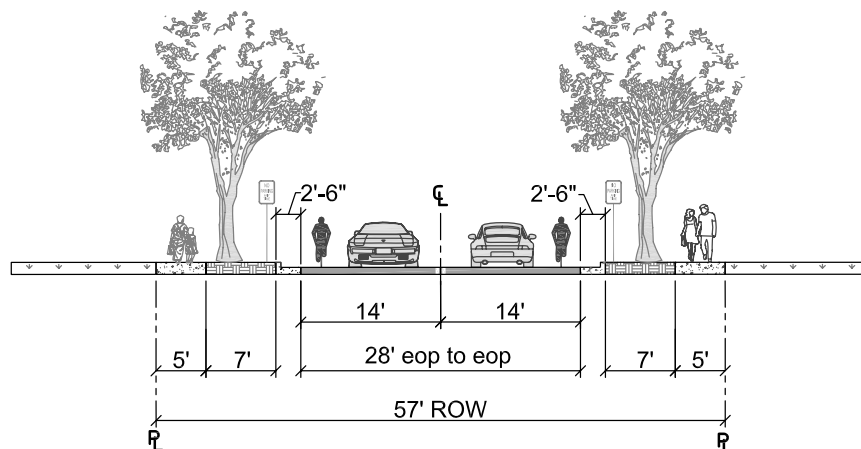


Figure 14

Collector (Without Parking)





## 15.6

### Standards for Residential Streets

1. **Function** - Designed to serve the local needs of the neighborhood and to provide direct access to abutting residential properties. All traffic carried by residential streets should have an origin or a destination within the neighborhood.
2. **Right-of-Way Width** - 50 feet minimum plus 5 foot easements on each side of right-of-way for utilities and sidewalks.
3. **Number of Moving Lanes** - Two lanes
4. **Access Conditions** - Intersections are at grade with direct access to abutting properties by way of curb cuts or ramp-type curbing.
5. **Traffic Characteristics** - On-street parking is allowed on both sides of the street
6. **Planning Characteristics**
  - a. *Residential* streets should be designed to discourage through traffic and to encourage traffic speeds of 25 mph or less. These streets should not exceed 1200 feet in length and should include geometric features at intervals of 600' maximum. Examples of features include chokers (chicanes), traffic circles, median island/barriers, cul-de-sacs, and curvatures. Design criteria for these techniques are available in the Traffic Calming Design Manual.
  - b. *In subdivision* design, residential streets are discouraged from intersections with major and secondary arterial streets.
  - c. *Sidewalks* may be detached from or attached to the curb, depending upon the type of curb.
  - d. *Bicycle* travel can be accommodated in the travel lanes due to the low volume, low speed nature of this type of roadway.
7. **Design Characteristics**
  - a. *Grades*
    1. Not less than one percent (1%) on tangents; nor more than ten percent (10%)
  - b. *Alignment*
    1. Horizontal curves – 200 foot minimum radius at centerline for standard crowned cross-slopes.
    2. Vertical curves – a minimum length equal to the K times the algebraic difference of approach grades.
  - c. *Frequency of Intersections*
    1. Intersections along residential streets shall be allowed as needed to provide connections to other local streets and collector streets.

Figure 15

### Residential (Local) Streets (Detached Sidewalk)

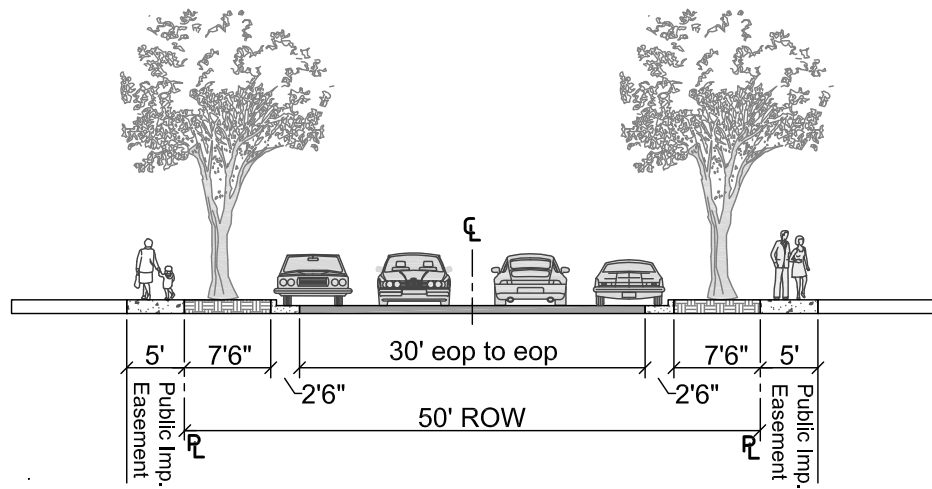
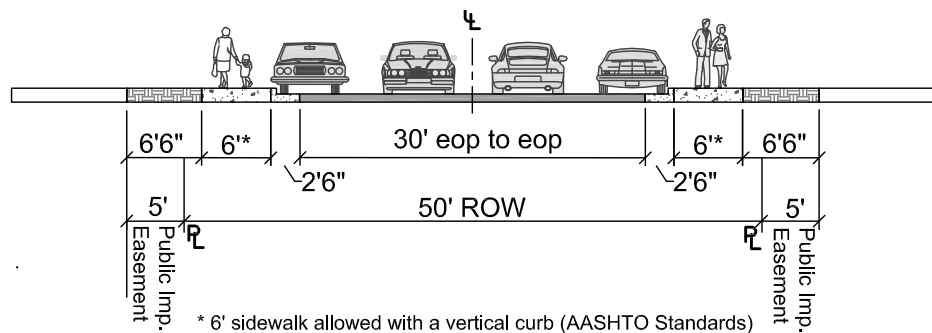


Figure 16

### Residential (Local) Streets (Attached Sidewalk)



## 15.7

### Standards for Minor Residential Streets

1. **Function** - Designed to provide direct access to abutting single-family residential properties or cul-de-sacs having a length of no greater than 500 feet. A pavement mat of 24 feet is allowed on minor residential streets which contain no more than 20 single-family lots. Any other residential street having more than 20 single-family lots must install a 28 foot pavement mat.
2. **Right-of-Way** - 47 feet minimum plus 5 foot easements on each side of right-of-way for utilities and sidewalks.
3. **Number of Moving Lanes** - Two lanes
4. **Access Conditions** - Direct access to residential properties is by way of curb cuts or by ramp type curbs.
5. **Traffic Characteristics**
  - a. *On-street* parking is allowed on one side of the street
  - b. *Intersections* are at grade

## 6. Planning Characteristics

- Minor residential streets should be designed as short loop or cul-de-sac streets only.
- Minor residential streets should not intersect major arterial streets.

## 7. Design Characteristics

### a. Grades

- Not less than one percent (1%) on tangents; nor more than ten percent (10%)

### b. Alignment

- Horizontal curves – 200 foot minimum radius at centerline for standard crowned cross-slopes.
- Vertical curves – A minimum length equivalent to the K value times the algebraic difference of the approach grades.

Figure 17

### Minor Residential (Local) Streets (Detached Sidewalk)

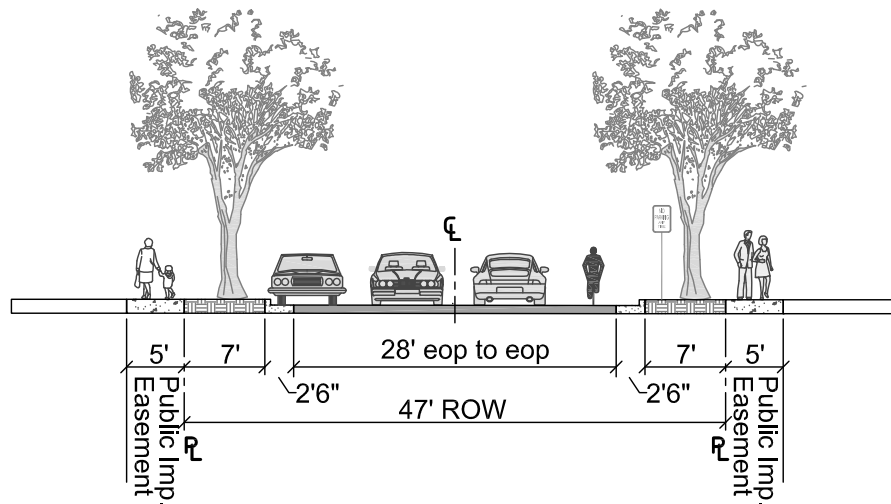
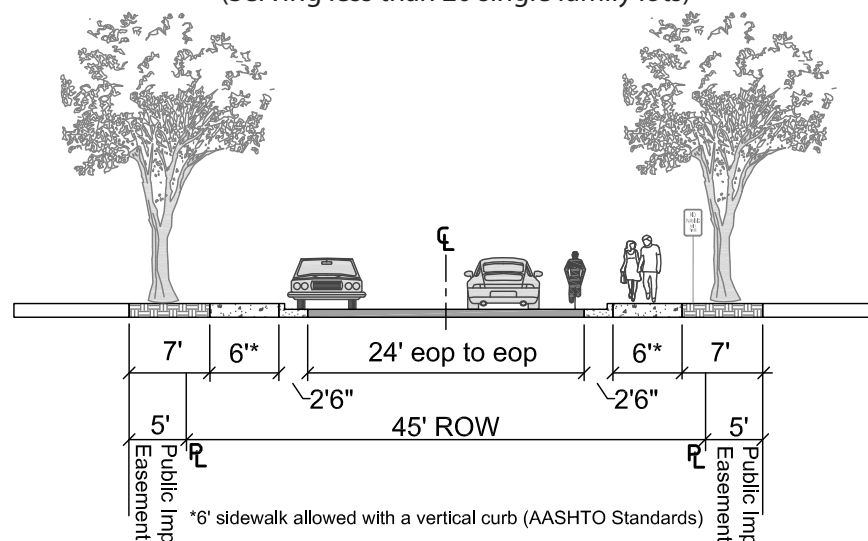


Figure 18

### Minor Residential (Local) Streets (Attached Sidewalk)

(Serving less than 20 single family lots)



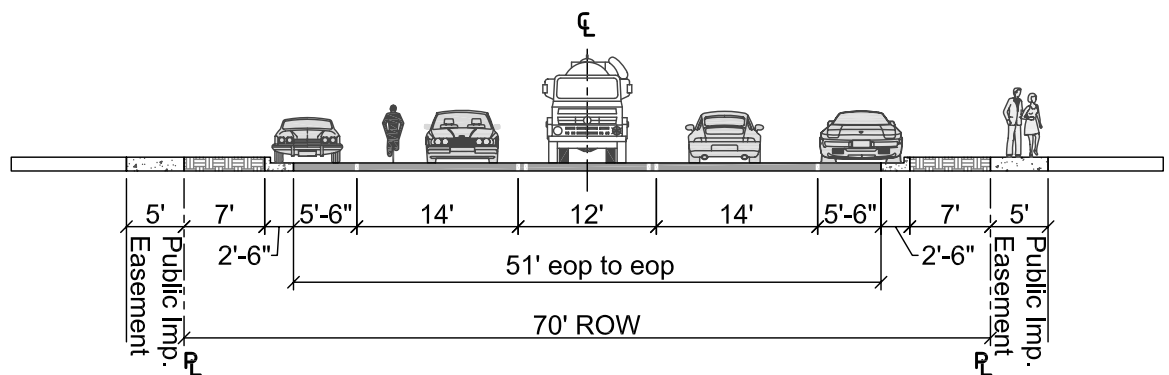
## 15.8

### Standards for Industrial Streets

1. **Function** - Industrial/ commercial streets are designed to serve facilities within industrial/ commercial areas and to connect such areas with major arterial and collector streets.
2. **Right-of-Way Width** - 70 feet (with two 5 foot easements)
3. **Number of Moving Lanes** - Two lanes to four lanes
4. **Access Conditions** - Direct access to abutting industrial/commercial properties is by way of curb cuts.
5. **Traffic Characteristics**
  - a. *On-street parking* may be permitted on both sides of the street
  - b. *Intersections* are at grade
6. **Planning Characteristics**
  - a. *Only* local industrial/commercial traffic should be encouraged on industrial streets
  - b. *Sidewalks* will be detached from the curb where required
7. **Design Characteristics**
  - a. *Grades*
    1. No less than one percent (1%) on tangents; nor more than eight percent (8%)
  - b. *Alignment*
    1. Horizontal – 335 foot minimum radius at centerline
    2. Vertical – A minimum length equivalent to the K value times the algebraic difference of the approach grades.
  - c. *Frequency of Intersections*
    1. Intersections along industrial/ commercial streets shall be limited to as few as possible, while connecting to the collector street system and providing access to local land uses.

Figure 19

### Industrial Streets



## 15.9

### Standards for Alleys

1. **Function** - Designed to provide access to abutting property at rear lot lines.
2. **Right-of-Way Widths** - 20 foot (Residential)/ 25 foot (Commercial)
3. **Number of Moving Lanes** - Two lanes
4. **Access Conditions**
  - a. *Provide access to abutting property at rear of lots*
5. **Traffic Characteristics**
  - a. *Normally alleys shall intersect at perpendicular angles with streets*
  - b. *No parking shall be permitted*
6. **Planning Characteristics**
  - a. *Alleys shall be open at both ends*
  - b. *Normally alleys shall not intersect with collector streets or arterial streets.*
7. **Design Characteristics**
  - a. *Grade*
    1. Not less than one percent (1%) on tangents; nor more than ten percent (10%)
8. **Alley Drainage**

Alley surfaces may be designed to drain in three ways.

  - Concrete V-shaped. The entire alley must be concrete. Concrete pans down the center of asphalt alleys are not permitted.
  - Asphalt crowned with valley gutters on each side, or
  - Asphalt cross-sloped with a valley gutter on the low side.

Flow spread in alleys shall be confined to the right-of-way at reasonable depths. Storm flows in alleys shall be limited to the flows generated from the rear of the lots adjoining the alley. Alley flows shall not cross the intersecting streets into another alley but shall be captured or diverted at the intersecting street. For more information about alley design reference is made to the design manuals for Traditional Neighborhood and Mixed Use Development.

Figure 20

### Residential Alleys

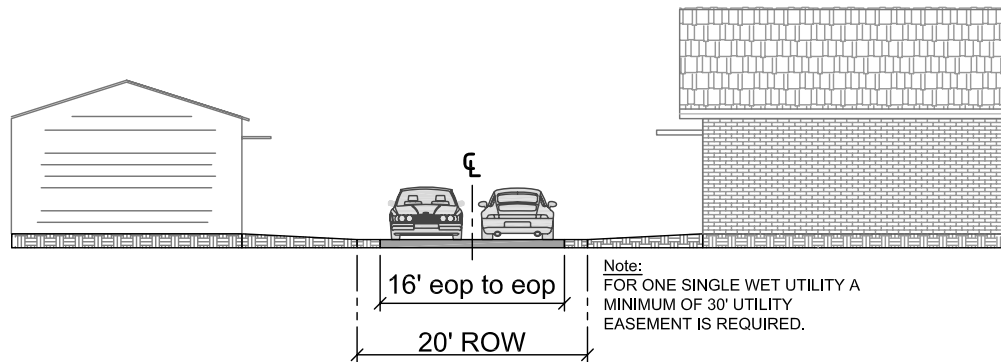
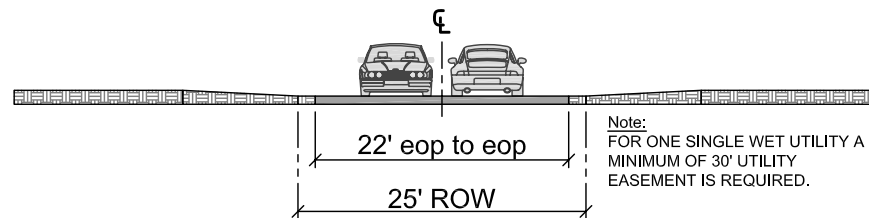


Figure 21

### Commercial Alleys



# 16.0

## Table of Traffic Engineering Design Standards

### Traffic Engineering Design Standards (Freeways, Expressways and Arterials)

Design Element	Functional Classification				
	Freeway	Expressway	Principal Arterial Type 2 (6 lane)	Principal Arterial Type 1 (4 lane)	Minor Arterial
Speeds (1)	65	55	45	45	40
Design ADT	85,000-100,000	60,000-85,000	25,000-60,000	10,000-25,000	5,000-25,000
Trip Length	Over 5 miles	Over 5 miles	1-2 miles	1-2 miles	Over 1 mile
Corridor ROW Width	332'-420'	210'	142'	107'	90' w/ (2) 5' easements
Roadway Width (pavement mat)	Var. Width	2-50' pavement mat	2-40' pavement mat	2-28' pavement mat	69'
# of Lanes	6-8	4-6	6	4	4
Lane Widths	12'	12'	11'	11'	11'
Shoulder Width	12'	10'	4'	4'	4'
Median	Var. Width	Raised 28'	Raised 28'	Raised 17'	Raised 17'
Sidewalk Requirement (placement)	N/A	N/A	Detached 6'	Detached 6'	Detached 6'
Bicycle Accommodation	N/A	N/A	6' Multi-Use Shoulder	6' Multi-Use Shoulder	5' Multi-Use Shoulder
Tree lawn Width	N/A	N/A	7'	7'	7'
Parking	No	No	No	No	No
Access	Full Control	Full Control	Full Control	Full Control	Full Control
Design Vehicle	WB 67	WB 67	WB 67	WB 67	WB 50
Signalized Intersection Frequency	N/A	1 mile	½ mile	½ mile	½ mile
Unsignalized Intersection Frequency	1 mile	N/A	¼ mile	¼ mile	600'
Vertical Alignment	Refer to Vertical Curve Design in AASHTO Geometric Design of Highways and Streets				
Horizontal Alignment Radius	N/A	N/A	1045'	1040'	765'
Grade (min-max)	1%-4%	1%-4%	1%-4%	1%-4%	1%-4%
Intersection Grade	Grade Separ.	1% min	1% min	1% min	1% min
Intersection Sight Distance	775'	665'	500'	500'	445'
Stopping Sight Distance (2)	730'	570'	360'	360'	305'

### Traffic Engineering Design Standards (Collector, Residential [Local], Public Alley, and Industrial)

Design Element					
	Collector	Residential (Local)	Minor Residential (Local)	Public Alley	Industrial
Speeds (1)	30	25	25	15	30
Design ADT	1,500-5,000	300-1,500	50-300	50-300	<10,000
Trip Length	1 mile	Local	Local	Local	Truck Local
Maximum Uninterrupted Facility Length	¼ mile	600'	300'	Adjacent Street Length	1 mile
Corridor ROW Width	57' (no parking) 67' (parking)	50' w/ (2) 5' easements	47' w/ (2) 5' easements	20' Residential 25' Commercial	70' w/ (2) 5' easements
Roadway Width (pavement mat)	28' (no parking) 38' (parking)	30'	24' (<21 Lots) 28' (>20 Lots)	16' Residential 22' Commercial	51'
# of Lanes	2	2	2	2	3
Lane Widths	14' w/ shared bike	9'	N/A	N/A	14' w/shared bike w/12' ctl
Shoulder Width	N/A	N/A	N/A	N/A	N/A
Median	N/A	N/A	N/A	N/A	N/A
Sidewalk Requirement (placement)	Detached 5'	Attached 6' vert. curb/ Detached 5' others	Attached 6' vert. curb/ Detached 5' others	N/A	Detached 5'
Bicycle Accommodation	On street w/ shared lane	On street w/ shared lane	On street w/ shared lane		On street w/ shared lane
Tree lawn Width	7'	7'-6"	7'	N/A	7'
Parking	Allowed	Two Sides	One-side parking only	No	Two sides
Access	Partial Control	Partial Control	Partial Control	N/A	Partial Control
Design Vehicle	WB 40	SU 30	SU 30	N/A	WB 67
Signalized Intersection Frequency	N/A	N/A	N/A	N/A	½ mile
Un-signalized Intersection Frequency	600'	300' max	300' max	½ adjacent street length	600'



Design Element					
	Collector	Residential (Local)	Minor Residential (Local)	Public Alley	Industrial
Vertical Alignment	Refer to Vertical Curve Design in AASHTO Geometric Design of Highways and Streets				
Horizontal Alignment Radius	335'	200'	200'	85'	335'
Grade (min-max)	1%-10%	1%-10%	1%-10%	1%-10%	1%-8%
Intersection Grade	1%-3%	1%-4%	1%-4%	1%-4%	1%-3%
Intersection Sight Distance	335'	280'	280'	170'	335'
Stopping Sight Distance (2)	200'	155'	155'	80'	200'

*Note: Alternate design standards may apply when Traditional Neighborhood, Mixed Use, Hillside, or Low-Impact Development are used.*

*(1) Speed refers to the anticipated posted speed. The design speed is 5 mph greater than the posted speed.*

*(2) For level terrain only.*

# 17.0

## Transit Services

On arterial streets that are a designated bus route, developers will need to work with Mountain Metropolitan Transit to determine the appropriate location of bus stops and bus turnouts. Bus turnouts are to be considered on Arterial streets where there is no on-street parking, a high volume of vehicular traffic, and posted speeds are 40 mph or greater. Bus bays, open bus bays, and queue jumper bus bays are all acceptable designs for bus turnouts. The general guidelines and standard details for bus turnouts are available from Mountain Metropolitan Transit.

# 18.0

## Definitions, Abbreviations, and Acronyms

**AASHTO** – American Association of State Highway and Transportation Officials

**Accesses** – Commercial entrances and exits.

**ADT** – Average Daily Traffic

**Algebraic Difference in Grades (%)** – The number derived by subtracting the approach and departing tangent grades (%) of a curve.

**Asymmetrical Reverse Curve** – Opposing curves of the same radius.

**CDOT** – Colorado Department Of Transportation

**Design Speed** – Safe and comfortable driving speed. Usually 5 MPH over the posted speed.

**DHV** – Design Hour Volume

**Driveways** – Residential entrances and exits.

**F<sub>c</sub>** – Face of Curb

**K Value** – The length of a vertical curve divided by the algebraic difference of approach grades.

**MPH** – Miles per hour

**Posted Speed** – The speed limit placed on the signs next to the roadway.

**TIS** – Traffic Impact Study

**VPH** – Vehicles Per Hour

# 19.0

## References

- A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials (AASHTO) 5<sup>th</sup> Edition, 2004
- A Policy on Geometric Design of Rural Highways, AASHTO, 2004
- Transportation and Traffic Engineering Handbook, Institute of Transportation Engineers (ITE), 1999
- Urban Transportation Operations – Training Design of Urban Streets, U.S. Department of Transportation Federal Highway Administration (USDOT – FHWA), 1982
- A Survey of Urban Arterial Design Standards, Institute for Municipal Engineering – American Public Works Association (APWA), 1969
- Subdivision Policy Manual, City of Colorado Springs, 1980 Update
- Manual on Uniform Traffic Control Devices, USDOT – FHWA, 2003
- Guidelines for Driveway Design and Location, ITE, 1985
- Guidelines for Urban Major Street Design, ITE, 1985
- Residential Streets, Urban Land Institute (ULI), National Association of Home Builders (NAHB), American Society of Civil Engineers (ASCE), 1977
- Trip Generation, 7<sup>th</sup> Edition, ITE, 2003
- 2010 Pavement Design Manual, Colorado Department of Transportation (CDOT)

# Appendix A

## Traffic Impact Study Guidelines for Development Projects

### Purpose

The purpose of these guidelines is to provide a uniform methodology for the traffic engineering consultants to use in conducting traffic impact studies for proposed development projects. The compliance of these guidelines will result in the timely review by City Engineering and reduced revisions.

A traffic impact study (TIS) will be required for a proposed non-residential development with a peak hour trip generation of over 100 vehicles, or any proposed residential development with 150 or more dwelling units. The forecast volume shall be based on trip generation rates contained in the latest edition of the Trip Generation Manual published by the Institute of Transportation Engineers (ITE) or other rates as approved by City Engineering.

All TISs for new subdivision development shall be submitted to the Engineering Development Review Division (EDRD) of City Engineering. EDRD will return review comments to the preparer. When the review process is complete and the TIS is ready for approval, EDRD requires two copies be submitted for City signature. Additional copies can be submitted and will be returned to the engineer. These copies shall be properly certified, signed, sealed, and dated by the registered professional engineer responsible for the report. The signature block for EDRD shall read *This Traffic Impact Study is hereby accepted by City Engineering* with a line for the EDRD reviewer's signature and date. Following EDRD approval of the TIS a scanned PDF version of the record approved report and plans must be received by EDRD prior to recording the Final Plat.

The following types of submittals which exceed the trip generation/ dwelling unit criteria will require a TIS:

1. A master plan or development plan submittal.
2. Any rezoning application.
3. A preliminary map or final plat if the property has already been rezoned for the proposed use and no traffic study was required for the rezoning, or the original traffic study is more than two years old.
4. Prior to issuance of a building permit, if the property has already been zoned/ platted and no previous traffic study less than two years old exists.
5. For a State Highway Access Permit, if:
  - a. *Site* access is required off a State Highway prior to issuing a building permit.
  - b. *Additional* access off a State Highway to an existing use is being requested.
  - c. Any change of use affecting access from the State Highway.
6. For an application for annexation into the City.
7. The applicant will be required to submit a new traffic study if, after submitting the original traffic study, the land use intensity and traffic generation is increased by more than 15%.
8. Other conditions as determined by City Engineering.
9. City Engineering may require other memos, letters, analyses, or other documentation to address specific traffic issues at staff discretion.

The traffic study shall be conducted by a professional engineer registered in the State of Colorado with adequate experience in traffic engineering and/ or transportation planning.

## Methodologies

The study shall be conducted using the following methodologies.

The preparer of the traffic study shall meet with City Engineering. At this meeting, the following items will be addressed:

- Establishment of the study area
- Identification of the analysis periods (AM, PM, Weekend) to be studied
- The forecast years (opening year and horizon year)
- Trip generation assumptions
- Methodology to obtain trip distribution and assignment assumptions
- Identification of high accident locations or operational deficiencies to be addressed as part of the study

It is recommended that the applicant submit the completed forecasts of background traffic, project trip generation, trip distribution, and trip assignment to City Engineering for review prior to the full traffic analysis.

Impacts of the development on the existing and proposed roadway network shall be identified. Intersection traffic analyses (including project driveways) shall be conducted using the operational methodologies described in the latest edition of the Highway Capacity Manual (HCM).

Traffic analysis conducted using Synchro or other computer software products shall use the following settings unless otherwise approved by City Engineering:

- Peak Hour Factor (PHF): 0.88 Rural; 0.92 Urban
- Cycle Length: between 60 seconds and 120 seconds; higher and lower cycle lengths require prior approval by City Engineering.
- Yellow Time: 3.0 seconds minimum; follow ITE guidelines
- All-Red Time: 2.0 seconds
- The City recognizes the HCM level of service (LOS) as the nationally accepted standard for LOS. HCM reports shall be used for LOS results in Synchro, not Synchro's own LOS calculations.

LOS figures should show the LOS results for each intersection approach as well as the overall intersection LOS.

Mid-block traffic analyses shall be based on volume to capacity ratios using the following capacity values:

Roadway Classification	ADT
Principal Arterials (8 Lane)	65,000
Principal Arterials (6 Lane)	50,000
Principal Arterials (4 Lane)	25,000
Minor Arterials	25,000
Major Collectors	10,000
Minor Collectors	3,500
Local	1,500
Minor Local	300
Industrial-Commercial	10,000
Frontage Road	5,000

Mid-block analysis shall be used only where intersection analysis does not adequately address capacity concerns. At locations where the "with project" scenario analyses indicate intersection approach LOS D will be exceeded and/ or midblock LOS C will be exceeded, the study shall identify mitigation measures or explain why mitigation is not needed. The mitigation measures shall include improvements that will provide LOS D or better at intersection approaches and LOS C or better at midblock locations. The mitigation measures shall be presented with drawings to clearly show the existing and proposed improvements.

The need for new traffic signals shall be evaluated using the warrants in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD). No new traffic signals should be proposed that cannot be justified using MUTCD traffic signal warrants. Traffic progression is of paramount importance. All potential signalized intersections should be planned for ½ mile intervals. All other locations to be considered shall meet the following criteria:

- The progression pattern calculation shall use a cycle length between 60 and 120 seconds. Efficiency (e) equals Bandwidth (BW) in that direction in seconds divided by the cycle length (C) in seconds and multiplied by 100 to obtain a percent.  $e = BW/C \times 100$ . A minimum efficiency of 30% shall be achieved. Those intersections, which would reduce the progression efficiency to below 30% if a signal were installed, shall remain unsignalized and have turning movement limited by driveway design or median islands.
- Submittal of a time/space diagram with acceptable through bands, cycle lengths, and progression speeds.
- In areas that may affect established complex computerized progressions any deviation from existing conditions shall be thoroughly addressed and approved by City Engineering prior to approval.
- The green time allowed to the cross street shall be considered no less than the time that is required for a pedestrian to cross the mainline at four feet per second.

Weave analyses for potentially affected locations may be required for the study. This analysis should be conducted using HCM methodologies and/or micro-simulation modeling by an approved micro-simulation model.

## **Traffic Study Format**

Specific requirements will vary depending on the site location. However, all traffic studies shall contain, as a minimum, the following information. See the "Required Figures and Tables Matrix" to determine the required exhibits.

### **1.0 Introduction**

- % Purpose of the report
- % Study objectives

### **2.0 Area Conditions**

- % Study Area Land Use
  - Existing land uses on the site and in the vicinity
  - Existing zoning on the site
  - Approved future development on other sites in the vicinity
- % Site Accessibility
  - Area roadway system
    - Existing – with current roadway classification designation
    - Future – Intermodal Transportation Plan (ITP) designation



- Traffic volumes and conditions
  - If practical, all reported counts should be actual counts and not based on factored peak hour sampling. Latest available counts from the City and/or CDOT may be acceptable if taken within a reasonable time (typically 2 years).
  - Peak Hour Factor (PHF) for existing conditions. LOS analysis can match recorded counts
  - Describe any existing high accident locations in the study area
- Transit service
- Existing relevant transportation system management and/ or Traffic Demand Management (TDM) programs (if any)
- Other as applicable

### 3.0 Proposed Development

% Description of the size of the parcel, general terrain features, and the location

% Vicinity map showing the site in relation to the surrounding transportation system

% Site plan showing proposed project

- Description of each proposed land use including the unit size (area, # of workers, etc.)
- Phasing (if any) and construction timing

% Sight distance exhibits for proposed project access locations

- Sight distance should be based on speed line of sight as described elsewhere in City guidelines
- If vertical alignment impacts sight distance, then the exhibit should include a vertical profile demonstrating that vertical curves do not interfere with the access line of sight, or appropriate field data.
- If sight distance is not an issue; explain the rationale within the text of the report.

### 4.0 Projected Traffic

% Site traffic

- Trip generation table – Should follow ITE, Trip Generation guidelines on when to use average rates and when to use equations. The peak hour of adjacent street traffic should be used when available. Also, include ITE or other reference materials in the appendix of the report for any trip rates used and/ or trip reduction factors used.
- Trip Distribution – May need multiple trip distributions depending on project phasing and timing of surrounding roadway network build-out
- Modal split (if appropriate)
- Pass-by traffic should not exceed 10% of adjacent street traffic during the peak hour.
- Trip assignment

% Background traffic

- Opening year(s) – Use combination of latest Pikes Peak Area Council of Governments (PPACG) model, other adjacent traffic studies, existing counts, National Cooperative Highway Research Program Report (NCHRP) 255 methodology, and interpolation to determine
- Horizon year – Needs to match latest PPACG travel demand model horizon year

% Total traffic

- Opening year(s) – Sum of site traffic and background traffic
- Horizon year – Same as above

5.0 Traffic analysis

% Existing conditions (without project) – if not already presented in Section 2.0

% Opening year(s)

- Without project
- With project

% Horizon year

- Without project
- With project

6.0 Equivalent Single Axle Loads (ESAL) Projections

% If needed to provide a detailed pavement design, ESAL projections should be developed using the technique provided in the CDOT Pavement Design Manual

7.0 Findings and conclusions with PE certification and City signature blocks.

% Site access

% Accident trends and causes

% Traffic impacts

% Parking – discuss if proposed parking meets City requirements and if not, how the shortage will be accommodated. If reciprocal and/or shared parking is contemplated, a parking accumulation study for existing facilities similar to proposed uses will be necessary.

8.0 Recommendations

% Site access/ circulation plan

% Improvements – An additional LOS analysis to demonstrate that proposed improvements will mitigate the impacts

- Can include access turn restrictions as well as access speed change lanes. If speed change lanes (acceleration/ deceleration lanes into and out of project accesses) are proposed, depict graphically demonstrating how proposed speed change lane conforms to City's guidelines and/ or queues produced from LOS analysis (whichever is greater)

9.0 Appendix

% In addition to the tables/figures shown in the attached "Required Figures and Tables Matrix" which can be included in either the appendix or within the text of the report, the following items need to be included in the appendix of the report

- Traffic counts
- Trip generation sources – either ITE or other accepted source
- Forecast calculations/ data
  - Include PPACG or other source data and calculations on how opening year and horizon year background forecasts were determined
- LOS Analyses (for all scenarios studied)
  - Intersections
  - Roadways
  - Queues
  - Weaves
- Parking
  - Counts
  - Calculations

### Required Figures and Tables Matrix

Table or Figure	Description
Vicinity Map	Area map showing site location and area of influence. Include existing roadway system showing major and minor streets adjacent to site and site boundaries.
Site Development Plan	Plan showing the proposed development under study including access locations, building sizes, and land use zones.
Site Land Use Table	Table describing the different site land uses, the describing unit (area, workers, etc...) and the ITE trip generation code.
Site Traffic Generation Table	Table showing the estimated daily trips and A.M. and P.M. peak hour (or weekend) trips generated by each component of the proposed development. Peak hour trips must be shown separately for inbound and outbound directions. ITE Land Use code used should be displayed.
Internal Capture Table	Table showing trip reductions for internal capture of a multi-use development.
Pass-by Trip Table and Figure	Table showing the pass-by trip reduction and figure showing the turning movements of the pass-by vehicles entering and exiting the site.
Trip Distribution and Assignment Figure	Map or table showing (by percentages) the portion of site traffic approaching and departing the area on each roadway; may differ by land use within multi-use development.
Average Daily Traffic Volume Figure	Daily volumes on roads in the study area.

AM and PM Peak Hour Turning Volume Figure	Peak hour turning volumes at each location critical to site access or serving major traffic volumes through the study area.
Lane Geometry Figure	Exhibit showing travel lanes and movements at each location shown on the turning volume figure.
Level of Service Figure	Levels of service computed for each turning movement, approach, intersection and roadway in the study area.
Queue Length	Scaled drawing showing queue lengths or table comparing queue length to storage length and access spacing.

*Note: The above tables and graphs may be combined as long as the information is understandable.*

## Appendix B

### Standard Utility Locations

This appendix, which will define the standard utility and storm sewer placement in the various street classifications, is *still under consideration*.

## Appendix C

### Roundabout Design Guide

# 1.0

## Introduction to Roundabout Design Guide

Roundabouts are a safe and efficient form of traffic control, which can be used at many of the same locations as traffic signals or stop controls. Based on US and international studies, roundabouts reduce accidents for motor vehicles and pedestrians and, due to the slower speeds and the reduced angles, the severity of accidents are less, with fewer injuries. Because of the advantages of roundabouts, it is the policy of the City to use roundabouts as a substitute for other types of intersection control, including intersections with no control, 2-way or all-way stop. They should be used instead of a traffic signal at all locations where a roundabout is shown to operate as well or better than a signal wherever the roundabout can be constructed to meet these standards. Roundabouts are allowed on local streets, minor and major collectors, minor and principal arterials, but are limited to no more than two approach lanes.

Standards included herein will be used, along with engineering judgment and information from other sources, for the design of all roundabouts within the City of Colorado Springs, and for the review of designs by city staff and private consultants. Where conflicting standards exist, this design guide shall govern.

When designing roundabouts, there are several characteristics that can be standardized, such as signing and marking; while others must be adapted within the design standards to fit the demands of the location, such as approach angles and right of way restrictions. This design guide has been created to allow engineers the flexibility to design a roundabout to fit a particular site, while still maintaining consistency with other roundabouts citywide to enhance driver expectancy.

All roundabout designs will require a two step process: a preliminary design initially submitted that meets design criteria listed under both general design criteria and specific/ geometric design elements as noted, and upon approval of the overall preliminary design, a final design showing all construction details and any phased construction signing and marking.

## 2.0

### General Design Criteria

#### 2.1

#### Appropriate Roadways / Locations

Roundabouts should be used where physical conditions such as approach grades and adequate right of way allow. They are limited to use on a roadway with four or fewer through lanes resulting in no more than two approach lanes. They are not appropriate when the capacity requires more than two circulating lanes. Roundabouts are also not appropriate if the use of a roundabout is expected to produce greater vehicle delay or increased difficulty for pedestrians.

Design of the approach road and roundabout must provide adequate visibility of the roundabout from a distance that will allow approaching drivers to see the roundabout, both daytime and nighttime. This decision sight distance (DSD) is the minimum distance required that which will allow deceleration from the 85% travel speed (or posted speed limit, whichever is greater) to the maximum entry speed of 20 MPH (single lane) or 25 MPH (multilane) without exceeding a deceleration rate of  $10'/s/s$ . This is generally the same distance as the "intersection sight distance" noted in AASHTO standards, variable by approach speed.

#### 2.2

#### Approach and Circulatory Speeds

The centerlines of the approaching roadways should generally meet near the center of the roundabout, with some offset allowed as long as the fastest path criteria are met. However, roundabouts offset significantly from this criteria will create a difficult design, with the fastest path requiring artificial restrictions or difficult to traverse approaches. This can result in vehicles crossing lanes and/or failing to follow the lane lines on the approach or exit. Roundabouts may have three, four or five approaches. Approach roadways may be single lane, single lane with a flare out to provide an added lane at the circulating roadway (used to provide a left-only lane), single lane with a by-pass right turn lane, or two lanes without added lane. The configuration is based on the turning movement volumes.

The approach roadway section includes the roadway from the point where traffic is traveling at the speed limit to the yield point where the entering vehicles enter the inscribed circle (see figure 1 for explanation of the roundabout elements). This section extends to the limits of the decision sight distance (Exhibit 3-3, Section 3 AASHTO Geometric Design of Highways & Streets, 2001, avoidance maneuver B – Stop on urban roadway).

The central island shall be visible from the intersection decision sight distance both day and night without the installation of any lighting that would distract or shine directly at any vehicle operators. The minimum distance varies with the roadway classification, but generally is the same as approaching any other intersection listed in the intersection standards. The distance where the driver should be able to tell they are approaching a roundabout ranges from 450' prior to the yield point for a local roadway to 750' for a higher speed arterial.

## 2.3

Approach speeds calculated at 50' and 150' prior to the yield point or entrance to the circulating roadway are critical to the safe operation of the roundabout. The design should meet the maximum desirable approach speed of 20 MPH (single lane) or 25 MPH (multilane) at 50'; and 5 MPH faster than entry speed at the 150' point. Actual operating speed maximums are controlled by the "fastest path" as noted in Figure II, which are the radii measured along the vehicle path, not along the curb flowlines. Reverse curves, landscaping, roadway narrowing, and other forms of psychological speed reduction may be required where approach speeds are high.

Design speed limitations and their respective radii through the roundabout are shown on Figure II, included in Section 3.0 – Specific / Geometric Design Elements, identified as R1, R2, R3, R4, and R5. The maximum radius and respective speeds at various locations on the travel path through the roundabout are critical to the safe operation of the roundabout. Curb and gutter, splitter islands, and the central island placement control the fastest vehicle path, but are not the same radii. In addition to the overall speed limitation for operation, the maximum speed differential between any two parts of the traveled path is 12 MPH to reduce the potential for rear-end accidents for vehicles turning left or exiting.

All alignment parameters, including sight distance restrictions for landscaping shall be included in the preliminary design drawings. See Figure III for sight distance restrictions.

### Design Vehicle

All roundabouts shall be designed to allow single passenger cars, pickups, SU trucks and city bus operation without the use of a truck apron. Larger trucks will require the use of a truck apron, especially on single lane roundabouts. A moving van, fire truck, and/ or WB 50 truck shall be used to check for the ability to navigate the roundabout using truck aprons, but without striking any of the outside curbs, signs, utility structures, or splitter islands.

Operation of all roundabouts shall be checked using the turning characteristics for the design vehicles in the following chart, except for state highways, or arterials near industrial areas, other areas of high truck usage, or along established truck routes, where a WB 67 truck shall apply. The turning trucks may be required to use a truck apron meeting these standards, but without causing any damage to any part of the roundabout. Generally, a multilane roundabout will not need a truck apron, as larger vehicles will use both lanes.

Road Classification	Circulatory Lanes	Design Vehicle	Roundabout Type
Local	1	SU	Single lane
Collector	1	WB 40	Single lane
Minor Arterial	1	WB 50	Single lane
Minor Arterial	2	WB 50	Multilane
Major Arterial	2	WB 50	Multilane
Areas noted above, regardless of class	1-2	WB 67	Single or multilane



The use of either vehicle turning templates, or plot from Autoturn software is allowed. All preliminary design drawings must include this turning path.

## 2.4 Pedestrian/Bicycles

All roundabouts shall be designed to allow pedestrian crossings whenever sidewalks are existing or planned at the intersection. Pedestrian crossings shall be marked and signed whenever 20 year projected pedestrian usage is equal to or exceeds 20 pedestrians per hour at any time of the day. Marked and signed crosswalks are also required for all roundabout crossings on a school route or bordering a park, shopping area, or other area where pedestrian activity is expected. Lighting shall be designed to illuminate the pedestrian area without backlighting persons within the crosswalk.

In areas of unusually high pedestrian usage, supplemental active warning devices may be required, such as flashing beacons or LED supplemented signage. The warning devices may be activated either manually by the user or automatically by any approved detection/ actuation technology. Where blind pedestrians are expected, the flashing beacons must be activated manually by the use of a tactile or sound emitting push button.

If the roundabout is on a street with bicycle lanes or a roadway with designated or planned bicycle lanes, the approach shall allow for the connection from the bicycle lane to the sidewalk, allowing the bicyclist the choice to either "claim the lane" and proceed through the roundabout as a vehicle, or exit the roadway prior to the roundabout onto the sidewalk and use the pedestrian facilities. The roadway should be reduced in width at the point where the bicycle lane exits from the roadway.

See Figure IV for details of construction, signing and marking for pedestrians and bicyclists. Details of marking and signing shall be included in the final design.

## 2.5 Design Software

The appropriate design software shall be used to ensure proper design and capacity. Local street or minor collector intersections, where the roundabout is used for aesthetics or speed control, and volumes are low do not require a capacity analysis. Other classifications may require some analysis by either AASidra or Rodel to analyze the roundabout in comparison with other traffic control devices. For capacity analysis or design variables on major collectors, minor or principal arterials, the use of Rodel software is required.

All preliminary designs shall be accompanied by AM and PM peak hour turning move counts for existing (or development opening) volumes and for a 20 year projection, including the electronic file from Rodel when required. Where the roundabout is near a school, shopping center, or other major traffic generator, the peak hour for local traffic with the traffic generator fully developed shall be used.

## 2.6

### Utilities & Drainage

Design of underground and overhead utilities shall be included on the final design. Design of water, sewer, electric, and gas lines shall meet the appropriate Colorado Springs Utility (CSU) standards. Street lighting shall follow CSU standards for pole, light fixture, and type of lighting. Lighting shall be designed to illuminate any pedestrians within the crosswalks without causing a backlight effect. Lighting shall be situated to help the driver identify the general shape of the intersection and to highlight conflict points or areas of entry, and exit from beyond the stopping sight distance as identified in Figure III.

The following drainage standards apply to roundabouts:

1. **Drainage** shall comply with the City Drainage Criteria Manual. Roundabouts should be generally designed to slope away from the central island with drainage inlets located on the outer curb line. Placement of any inlets shall include consideration of the wheel path traveling through the roundabout with the desirable location between the entrance and exit, not along the roundabout entrance, the central island, the exit, or the splitter islands. Inlets within the roundabout shall be constructed with a 6 inch curb height and no extension of the gutter pan. An alternate to the standard City inlet design, such as the CDOT Type R inlet, is allowed to meet this criterion.
2. **If the** 8 inch curb height is used with the standard City inlet design, the inlet must be located outside of the roundabout and approaches to limit influence on the drivers' path through the roundabout. All inlet gutter sections will be limited in width to 24 inches from lip to flowline.

## 2.7

### Landscaping

Landscaping is an important part of the design, especially in the center island to provide visual awareness of the roundabout. Landscaping designs must consider pedestrian and vehicle safety, providing year around amenities for the roundabout users without causing any sight distance problems, especially on approach to pedestrian crossings.

All final designs shall include a landscaping design sheet identifying plant types, height from the top of the mature plant to the roadway surface, including the height of planter area, and minimum pruning height for the lower branches of any trees to be planted. See Figure II for areas where height is restricted for sight distance reasons. Within the central island, outside of the required stopping sight distance line, the use of larger materials is encouraged to improve the driver's perception of the roundabout location and shape. Avoid distracting displays, such as signs, intricate sculptures or animated items or glare from lights that could increase the potential for accidents.

## 2.8

### Other

Other design criteria include, but are not limited to:

1. **The exit** of the roundabout should be no smaller than the entry and include transition to the full width cross-section, including any on-street parking.

2. **Transit** stops should be located downstream of the roundabout clear of the exit area, and built with a pullout, or they may be combined with the on-street parking area.
3. **Prior** to submitting the preliminary design, a pre-design meeting is recommended with City Engineering to identify any unusual or location-specific design criteria or design elements or other issues unique to the location.

# 3.0

## Specific/ Geometric Design Elements

### 3.1

## Approach Roadway

The approach roadway design elements include curb alignment, median width and transition, approach flare, crosswalk location, horizontal and vertical alignment of the approach lane(s), intersection and stopping sight distance calculations, approach speed, fastest path radii, and other associated elements identified in Figures I thru VI.

Minimum / maximum standards include the following:

Fastest Path		Single Lane		Multilane Roundabout	
		R Max	Speed (MPH)	R Max	Speed (MPH)
R1	Entry	86-99'	20	152-178'	25
R2	Circulating	99-116'	20	178-210'	25
R3	Exit	152-178'	25	152-178'	25
R4	Left turn	99-116'	15	178-210'	25
R4	Minimum*	18-20'	10	33-37'	13
R5	Right turn	152-178'	20	152-178'	25

*\*R4 has a minimum requirement to reduce rear end accidents caused by excessive speed differential*

*Note – radii are given as a range for various super elevation rates from 0% to 4%, positive for R1, R3 & R5, and negative for R2 and R4.*

*Calculations for each specific roadway segment and corresponding cross slope should follow AASHTO Geometric Design of Highways & Streets, 2001 or later*

Maximum approach grade	2% for 200' on minor and principal arterials 4% for 100' on minor and major collectors 4% for 50' on local streets
Approach Decision Sight Distance ("DSD" on figure WW)	375' for 25 MPH or less 450' for 30 MPH 525' for 35 MPH 600' for 40 MPH 675' for 45 MPH 750' for 50 MPH

*Note – Approach Decision Sight Distance, DSD, is the distance at which the driver is aware of the change in alignment caused specifically by the roundabout. If the required DSD is not available due to topographic limitations, advance warning signs will be required. Vertical alignment must be checked as well as horizontal alignment for restrictions to DSD.*

Minimum Approach Tangent (approach centerline to yield line)	300' on principal arterial 200' on minor arterial 100' on all collectors 50' on local access
Min. distance to nearest access (distance from splitter island)	600' on principal arterial 300' on minor arterial 100' on all collectors 30' on local access

## 3.2 Circulating Roadway

The circulating roadway, that portion of the roundabout between the central island and the inscribed circle is the portion of the roadway used by vehicular traffic. The inscribed circle of the roundabout, which encloses the circulating roadway, shall be large enough to accommodate all road users without exceeding the fastest path maximum radii. Generally, the design of the inscribed circle will be from 130' to 200' for multilane roundabouts, and from 80' to 130' for single lane roundabouts. The outside edge of the circulating roadway is within and generally the same size as the inscribed circle.

The circulating roadway shall be from 1.0 to 1.2 times the approach roadway width at the entry to the roundabout. Super-elevation for the circulatory road should generally be no greater than -0.02, although a super-elevation of up to -0.04 may be approved if conditions warrant. Adverse super elevation is preferred for the circulatory road as it provides a smoother transition for motorists, better drainage, and helps keep speeds to an acceptable level.

Roundabouts may be designed and built in stages, with the initial size of the inscribed circle large enough for a multilane roundabout, with an oversized central island that restricts the circulating roadway to one lane. In this case, it is likely that a truck apron will be needed.

Bypass lanes should be avoided if possible, due to the difficulty for pedestrians (especially sight impaired) to safely cross three roadways instead of the usual two in other roundabouts. If the capacity analysis with Rodel indicates that the existing and shorter range projected volumes will operate at level D or better, the roundabout should be built without a bypass. If the 20 year projected volumes show the need for a bypass, adequate right of way shall be included to accommodate the future expansion and the bypass will be built when the operating LOS exceeds level C.

## 3.3 Sight Distance

Stopping Sight Distance (SSD) is the distance between the hazard and the approaching driver, measured along the vehicle path. It is used to assess safety for vehicle to vehicle and vehicle to pedestrian or bicycle hazards. Every conflict point at the intersection must be checked, based on vehicle speed near the conflict area for obstructions of the required visibility area – see Figure III.

SSD for the approach and yield at the roundabout are based on AASHTO standards for urban roadways, Section 9 of the 2001 geometric design manual, Case A for sight distance to the left, and Section 3, Ex 3-1 for SSD relating to pedestrians. Horizontal and vertical alignment must be checked.

Stopping Sight Distance	15 MPH	80'
	20 MPH	115
	25 MPH	155
	30 MPH	200
	35 MPH	250
	40 MPH	305
	45 MPH	360

### 3.4 Splitter Islands

Splitter islands provide proper deflection of vehicular traffic for speed control and pedestrian refuge area. They are required on all roundabouts, with paint only allowed as an option on mini-roundabouts and 6" high mountable curb on all other roundabouts. They shall be a minimum of 50' long (measured from the outside edge of the circulator road) if there is a pedestrian crossing. The alignment of the splitter island should incorporate a tangent extension of the splitter island flowline meeting the outside flowline of the central island. See Figure V

Splitter islands where crosswalks exist or are projected shall have a minimum 6'x6' pedestrian refuge (an 8'x8' refuge is preferable). Crosswalks should be 25' from the yield line for single lane roundabouts, and 45 – 50' for multilane roundabouts. On multilane approaches, the crosswalks should be radial to the traveled way to improve visibility for pedestrians.

The curb face along the circulating roadway should be offset from the traveled way a distance of 3' on the approach side next to the circulating roadway tapering to 1.5' at the intersection of the entry and the approach. Island nose radii shall meet the dimensions as shown in Figure V.

### 3.5 Central Island

Central islands are the most visible part of the roundabout for approaching vehicles and establish the shape and size of the roundabout. Their size is critical to the correct operation of the roundabout.

Central island diameter for a multilane roundabout should be designed for each case to assure that the deflection for entering vehicles results in meeting the maximum fastest path requirements. Generally, the central island diameter will be between 65' and 135' for a multilane roundabout and between 50' and 100' for a single lane roundabout.

Required truck aprons shall not exceed -0.08 super elevations. They shall be constructed with a 4" high mountable curb sloped back at a 60 degree angle and rounded at the top, with 12" spill gutter for new roundabouts. Key-in curb only without gutter pan will be allowed for retrofit of existing intersections for the central island with drainage away from the curb.

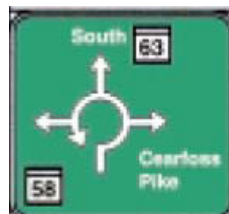
## 3.6

### Signing and Marking

Truck aprons should be constructed of concrete, contrasting in texture and color from the road, easy to maintain, and able to withstand loads of turning trucks (i.e. minimum 6" decorative, contrasting concrete, such as exposed aggregate, colored, and/ or patterned concrete, etc.). Brick, cobblestone, or other individually placed paving materials are not allowed.

Elevation drawings of the central island shall be included with the preliminary plans for review. The central island, not including any truck apron, shall be a minimum of 2' above the surrounding roadway outside of the sight distance restricted areas, and shall be of contrasting texture and colors to the roadway and the background. They shall be designed for low maintenance (restrict the use of sod or other high maintenance surfaces).

1. **Signing** - See Figure IV for sign locations. All signs shall conform to Manual on Uniform Traffic Control Devices (MUTCD) as modified by the latest recommended roundabout signing standards and by these design standards.
  - a. *Advance* roundabout warning signs with advisory speed plaques are required whenever topography or driver distraction precludes adequate advance visibility of the roundabout – see Approach Decision Sight Distance in paragraph 3.1 for distances. They may also be used temporarily or permanently whenever a roundabout is modified or a new roundabout constructed as a retrofit to an existing intersection.
  - b. *Yield* signs shall be placed on the right side of the road at the point where vehicles are to yield when entering the roundabout. Supplemental yield signing in the splitter island may be required due to alignment or sight distance problems where a single yield is not adequate. Supplemental signs noting "To Traffic in Circle" may be required to be added to the yield signs on multilane roundabouts. "YIELD" pavement marking may be required where field observation warrants.
  - c. *Lane* assignment signs depicting the lanes maneuvering around the roundabout (as in the following figure) shall be provided on all multi-lane approaches.
    1. Note – this sign to be replaced with the new sign with "Roundabout" at the top in Black/Yellow, and "Left Lane" and "Right Lane" below the symbols. Also, examples of signs with only one turn at a "T" intersection will be given, and a sign for a single lane entry with an auxiliary left turn lane on the flared approach.
  - d. *Street* name signs with a minimum of 6" lettering shall be placed on the splitter islands oriented toward traffic on the circulatory roadway. Flag type signs indicating the exit street name are required for arterials on any multilane roundabout.
  - e. *Advanced* directional guidance signs (as depicted in the following figure) shall be used as noted in the intersection guidelines.





- f. See paragraph 2.4 for required pedestrian crossings. Pedestrian signage is required where pedestrian usage meets minimum requirements. All marking, signing, and supplemental warning devices shall meet MUTCD standards as modified and shown in the detail drawings in this design guide.
2. **Marking** - All pavement markings shall conform to MUTCD as modified by the latest recommended roundabout guidelines and these design standards.
  - a. Lane use pavement markings, including arrows and solid or dashed lines shall be used on all multilane roundabouts. See Figure IV for their correct placement.
  - b. Yield triangles shall be used to mark the location at which drivers must yield to circulating traffic. The yield markings shall be curved along the outline of the circulatory road and shall have triangles oriented toward approaching drivers as depicted in the following figure. Supplemental "YIELD" pavement marking may be required where field observations indicate a significant number of vehicles do not yield.
  - c. Yellow edge lines shall be placed along the left edge of the approach roadway along the edge of the splitter islands if the splitter island is installed within a painted median. For multilane roundabouts only, yellow edge lines are required around the central island, and white edge lines are required along the right side of the splitter island outlining the circulating roadway.
  - d. Pedestrian crossings should be marked with ladder style markings consisting of 2' x 8' markings.
  - e. Retroreflective raised pavement markers (RRPM) may be required on the central island and splitter islands where sight distance and/ or lighting indicates improved warning is needed for nighttime operation.

### 3.7 Landscaping Design Elements

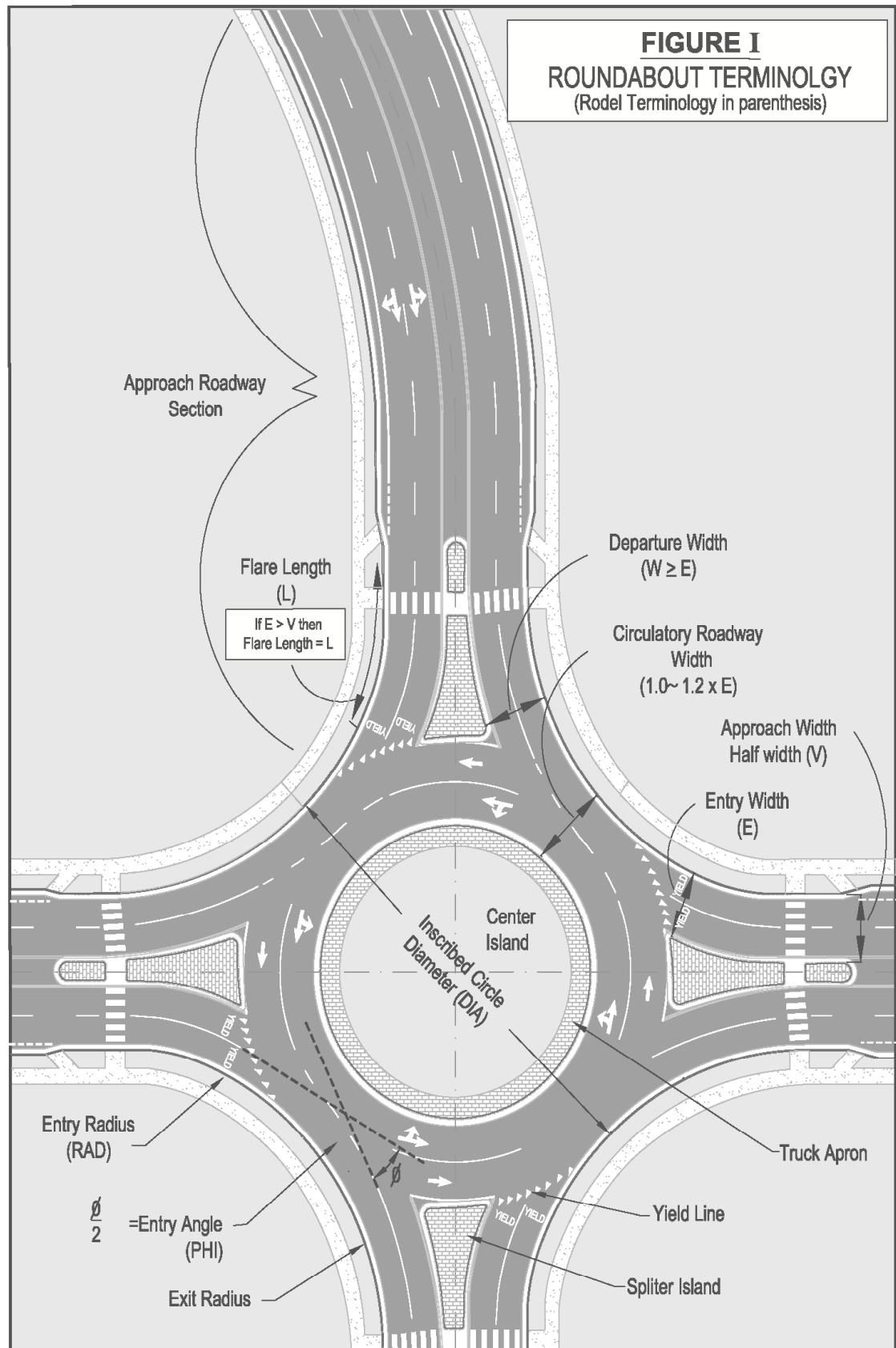
Splitter islands shall be hardscape or contain low level vegetation with a maximum height of the curb, splitter island structure, and landscaping, at maturity, of 30" above the roadway (see Figure III).

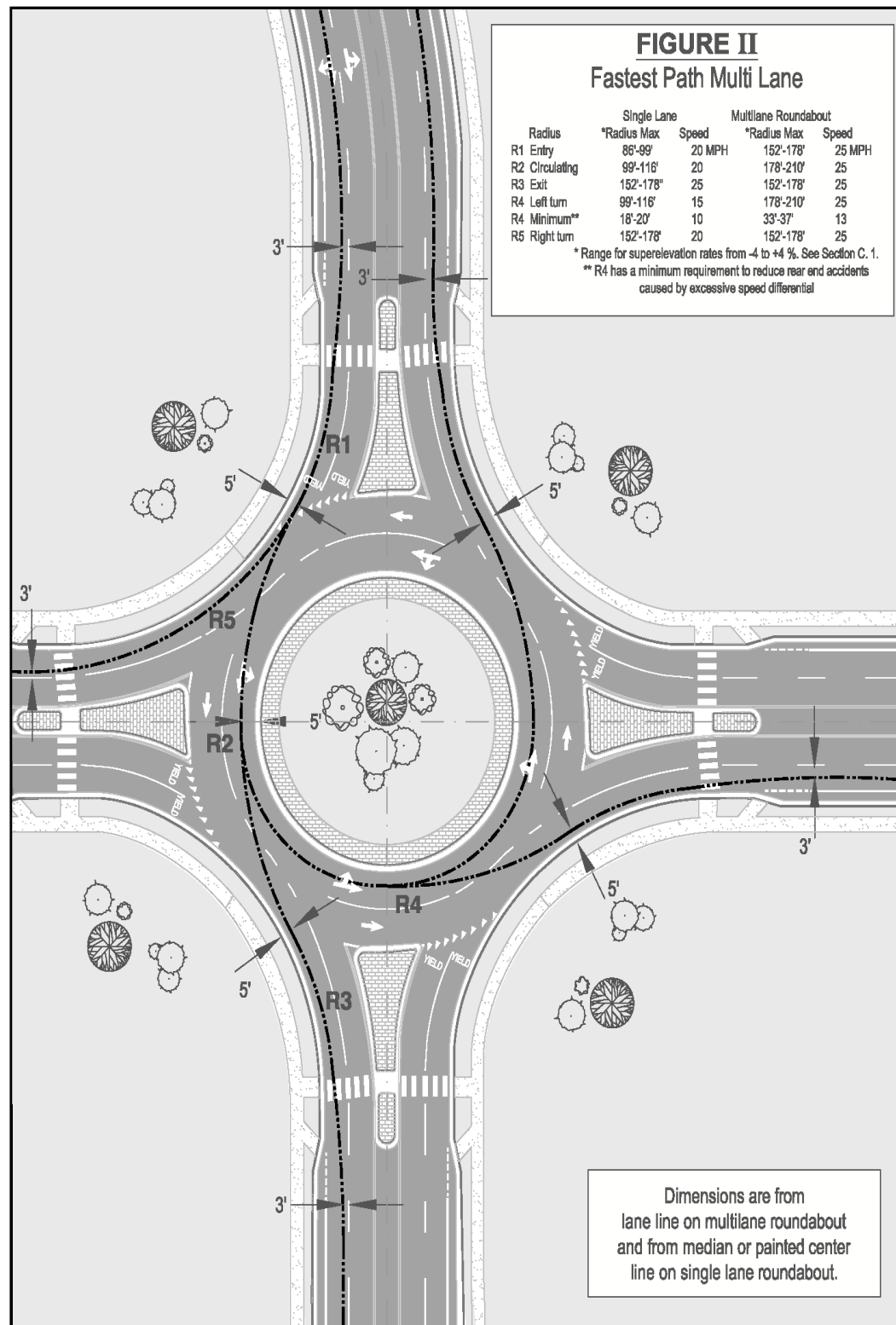
The central island should contain vertical features outside of the stopping sight distance restriction area, visible to approaching traffic both day and night, to reduce approach speeds.

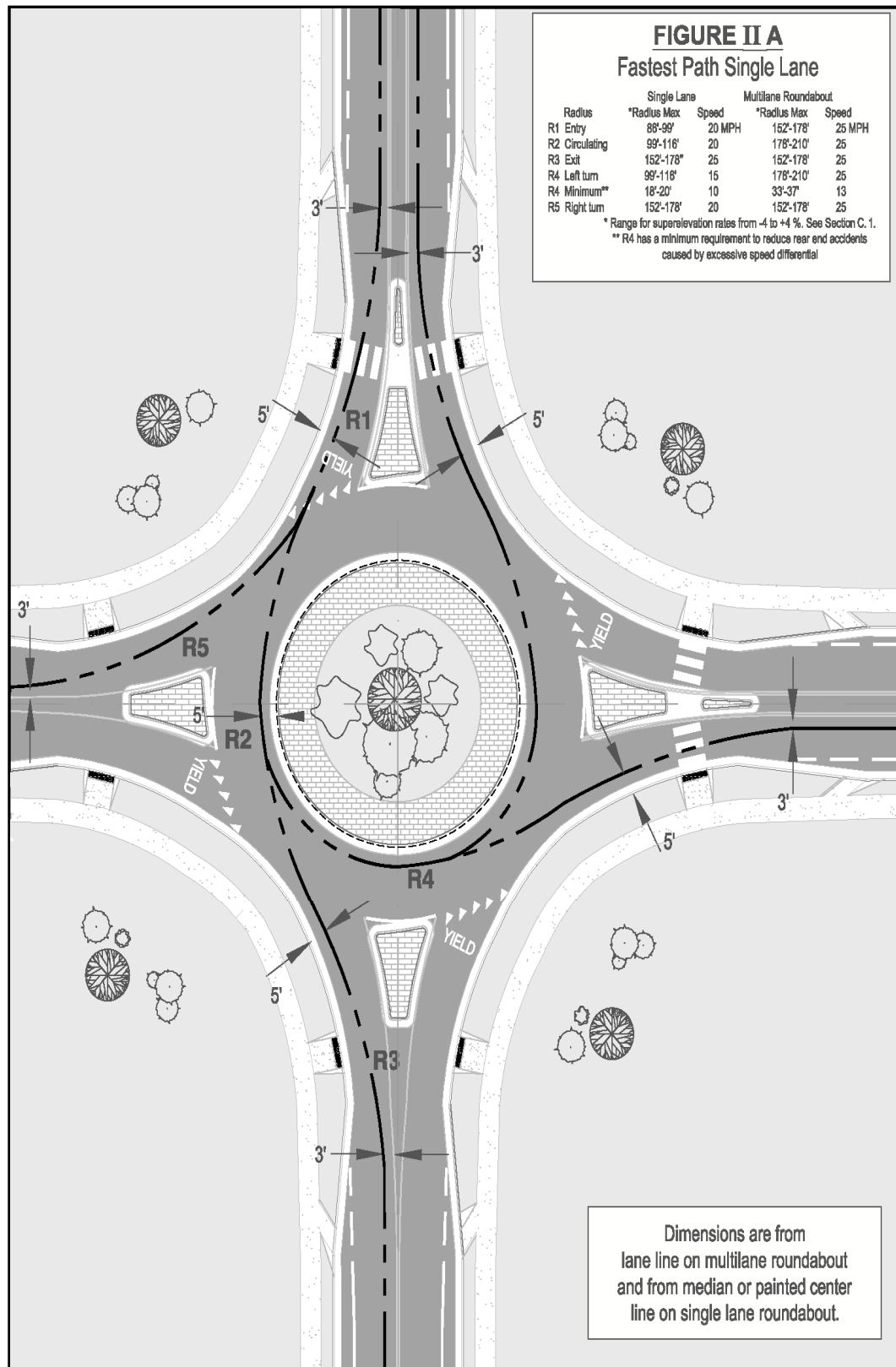
New roundabouts with landscaping shall have a maintenance agreement with the City Parks Department, providing for maintenance, or they shall have guaranteed funding for maintenance of the landscaping by private organizations (i.e. homeowners associations, property management agencies, etc.). Retrofit roundabouts shall have low-maintenance landscaping or a maintenance agreement similar to new roundabouts.

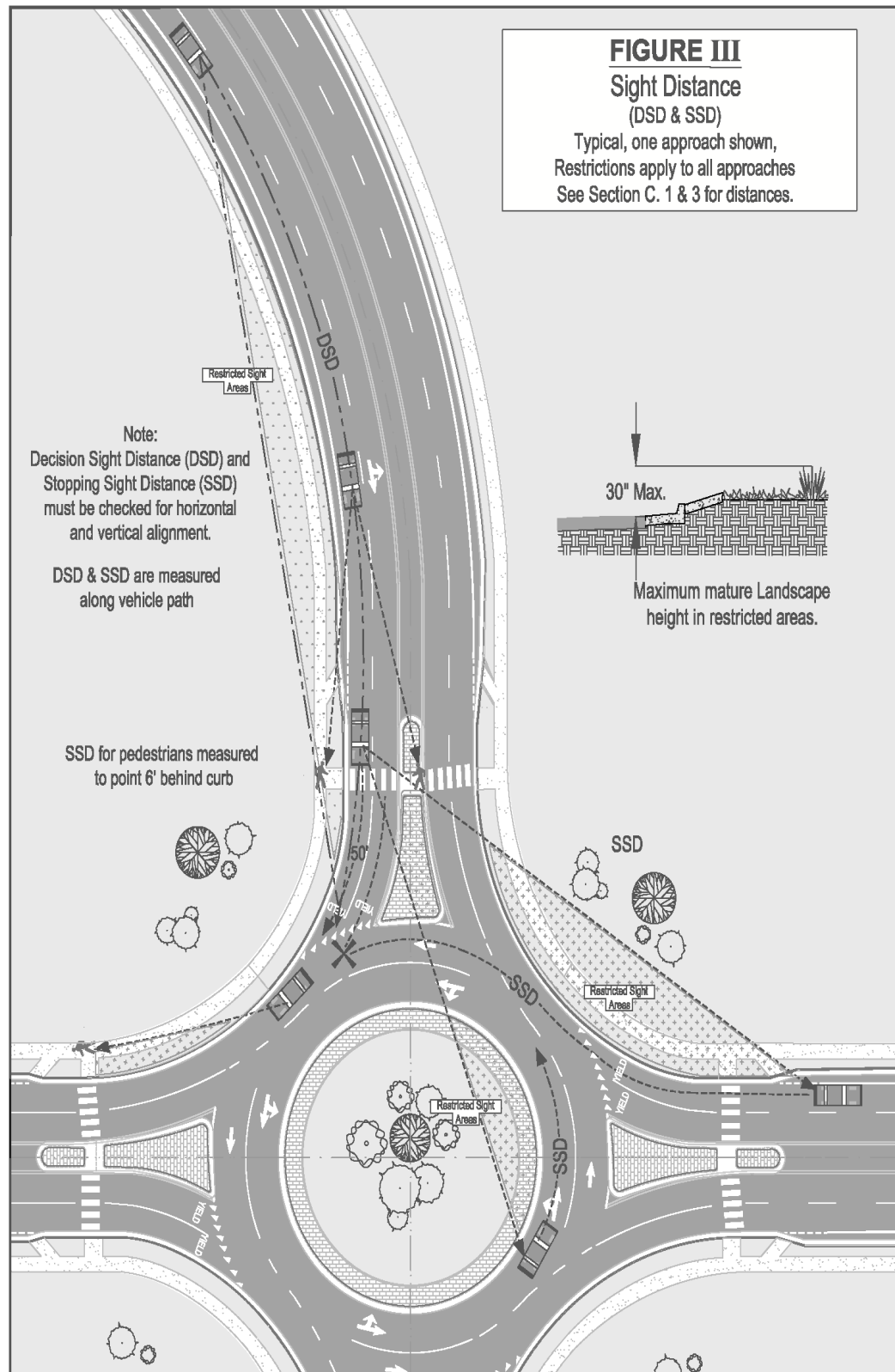
Landscaping and design elements shall be aesthetically pleasing, shall fit within the context of the surrounding area, shall not distract drivers, and shall not interfere with pedestrian safety.

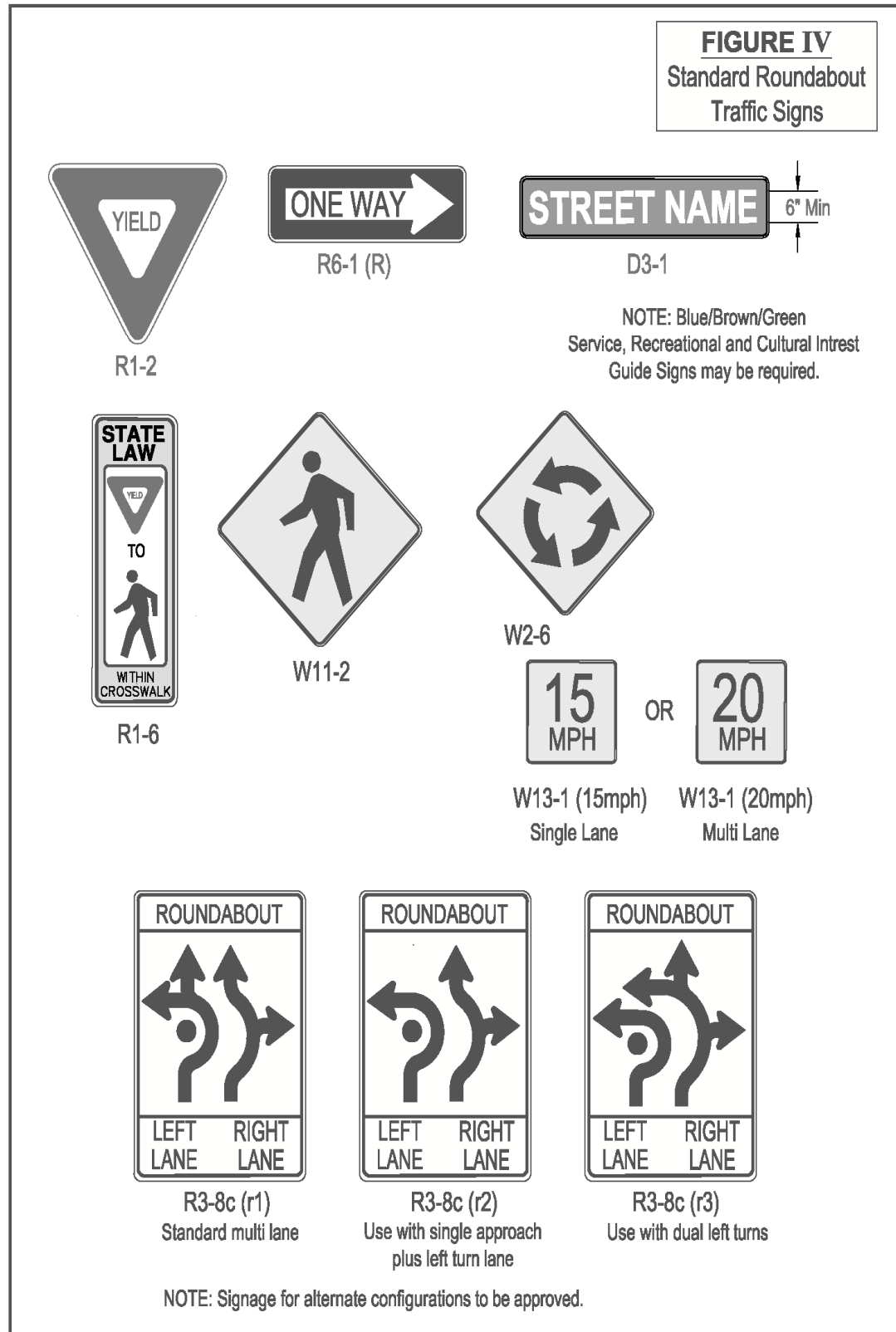


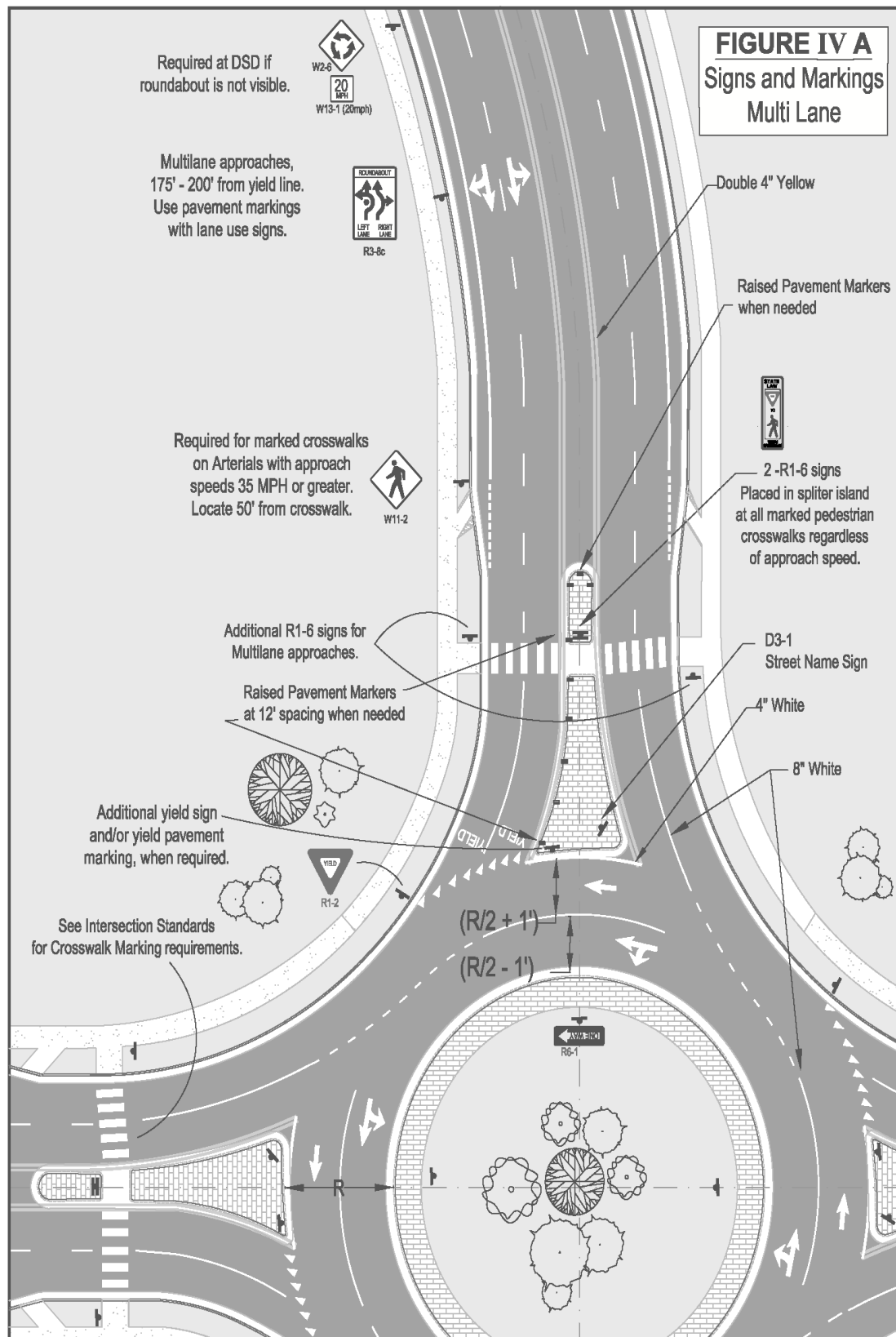


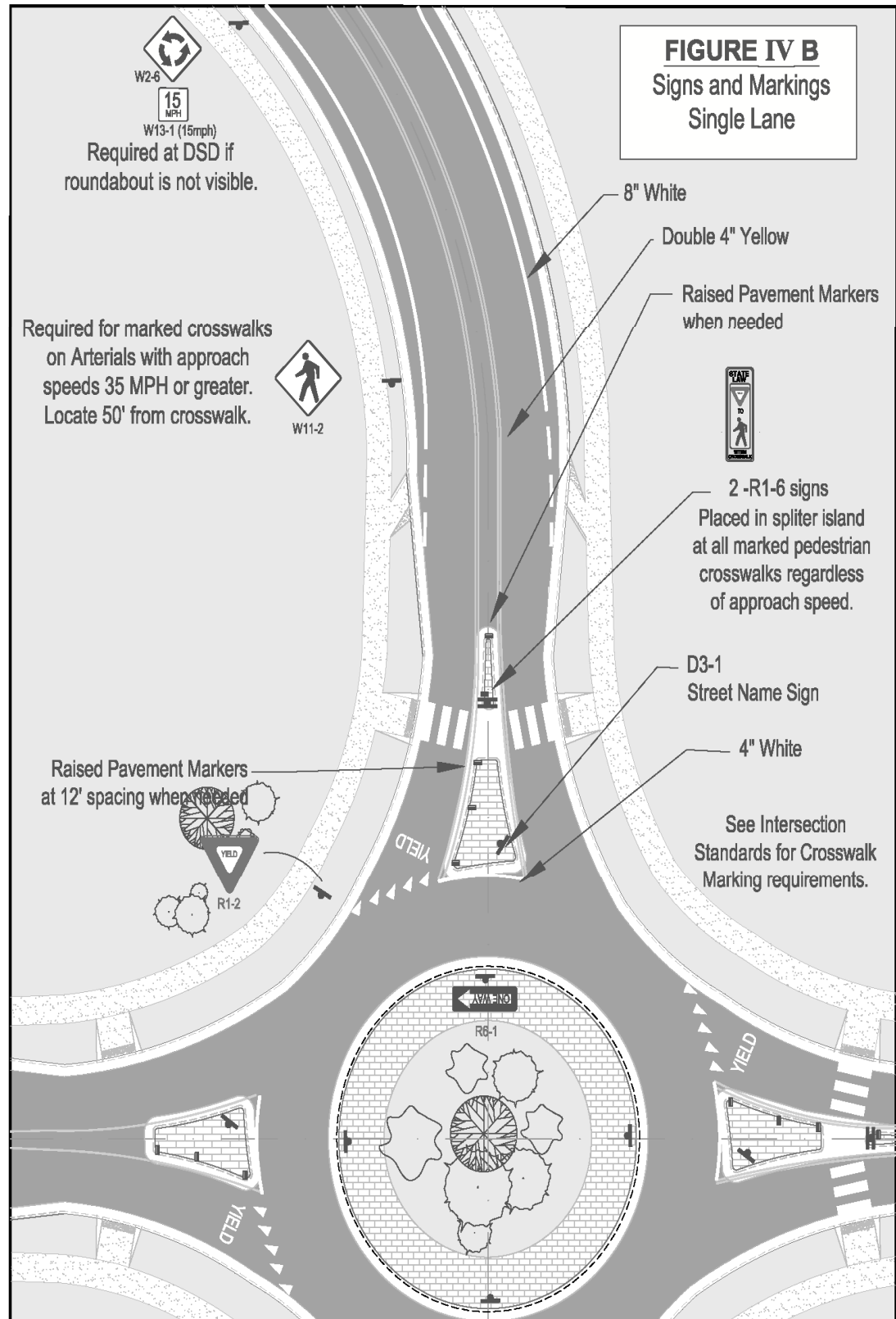


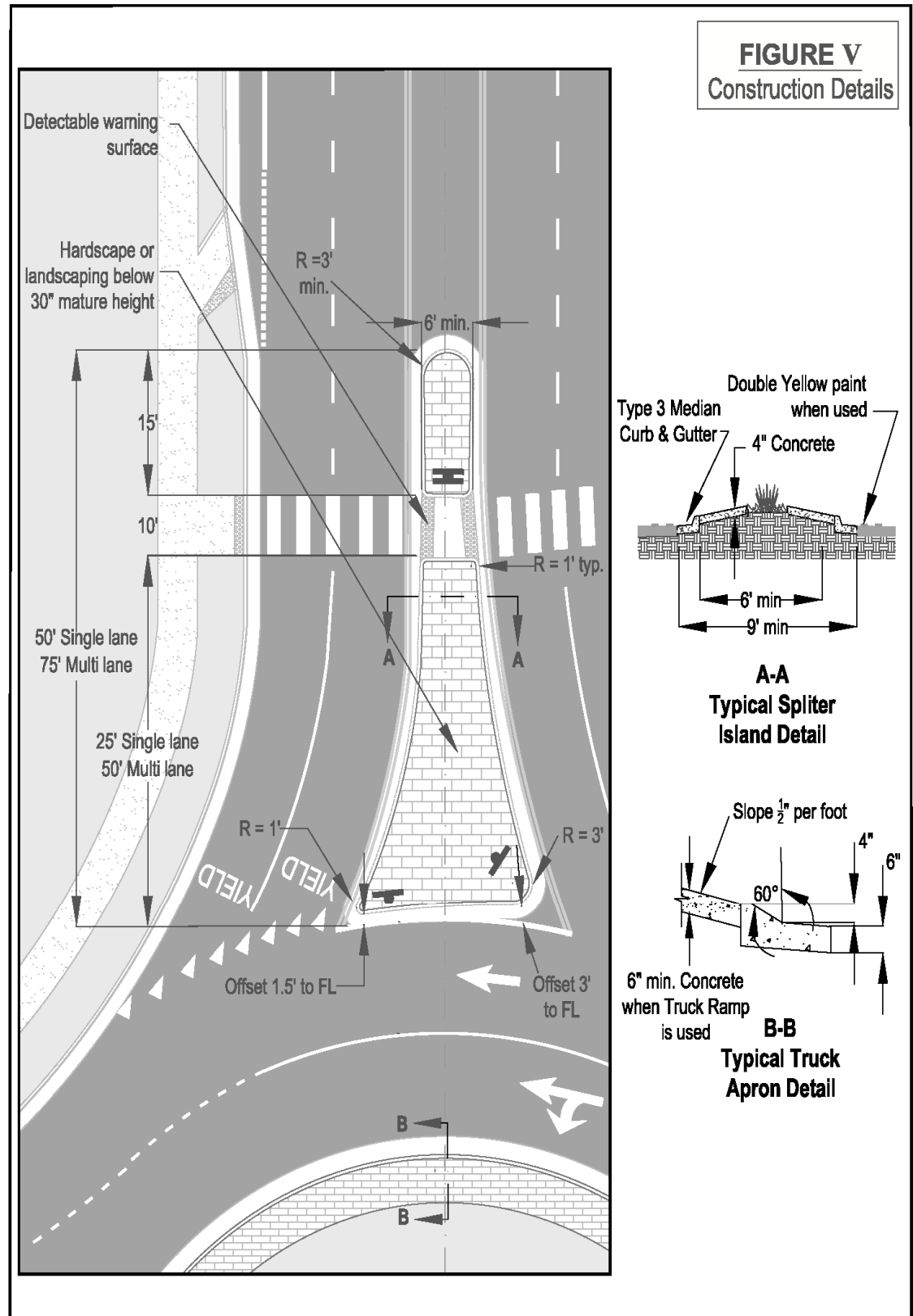






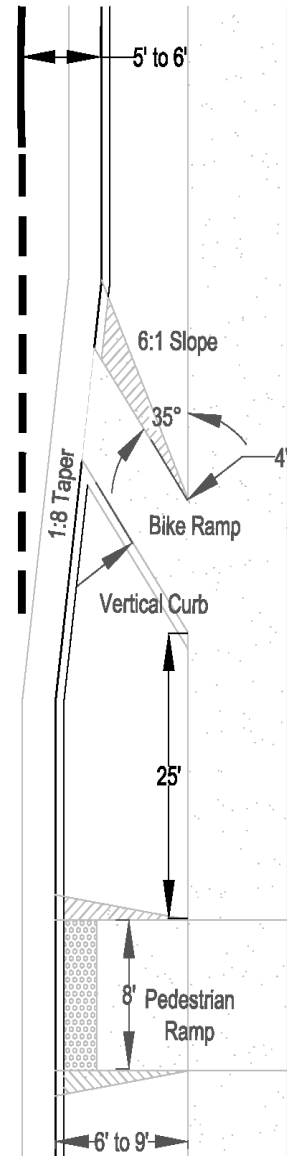
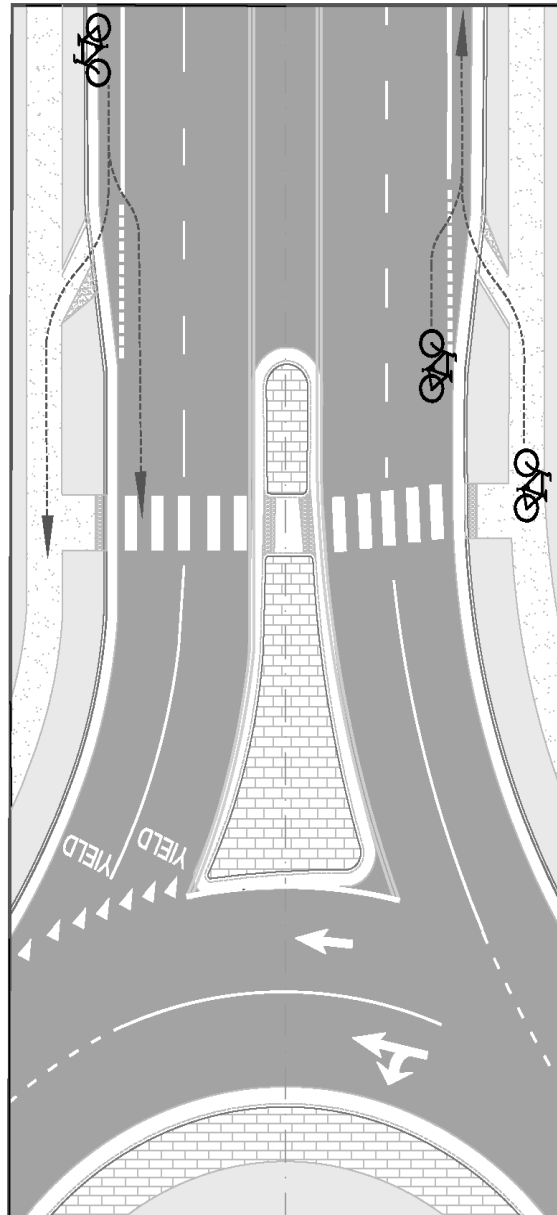








**FIGURE VI**  
Bicycle Path and Ramp Detail



## 4.0

### Definitions

**Central Island** – the raised area in the center of a roundabout around which traffic circulates

**Fastest Path Radius** – the minimum radius on the fastest through path around the central island measured 5' from any flowline

**Circulating Volume** – the total volume in a given period of time on the circulatory roadway immediately prior to an exit

**Circulatory Roadway Width** – the width between the outer flowline of the circulatory roadway and the central island, not including the width of any apron

**Deflection** – the change in trajectory of a vehicle imposed by geometric features of the roadway

**Departure Width** – the width of the roadway used by departing traffic downstream of the roundabout. The departure width is typically no more than the total roadway width

**Decision Sight Distance** – from AASHTO Geometric Design manual, Section 3, the distance from the intersection where the driver recognizes that they are approaching an obstacle that will require a maneuver or stop

**Design Vehicle** – the largest vehicle that can reasonably be anticipated to use a facility

**Entry Flare** – the widening of an approach to provide additional capacity at the yield line and storage

**Entry Path Radius** – the minimum radius on the fastest through path prior to the yield line, measured 5' from any flowline, noted as R1

**Entry Radius** – the minimum radius of curvature of the outside or right curb at the entry

**Entry Speed** – the speed a vehicle is traveling at as it crosses the yield line

**Entry Width** – the width of the entry where it meets the inscribed circle, measured perpendicularly from the right edge of the entry to the intersection point of the left edge line and the inscribed circle

**Exit Path Radius** – the minimum radius on the fastest through path into the exit, measured 5' from any flowline, noted as R3

**Exit Radius** – the minimum radius of curvature of the outside right curb at the exit

**Exit Width** – the width of the exit where it meets the inscribed circle, measured perpendicularly from the right edge of the exit to the intersection point of the left edge line and the inscribed circle

**Inscribed Circle** – the circle forming the outer edge of the circulatory roadway used to define the size of a roundabout, measured between the outer edges of the circulating roadway. It is the diameter of the largest circle that can be inscribed within the outline of the intersection

**Multilane Roundabout** – a roundabout that has at least one entry with two or more lanes, and a circulatory roadway that can accommodate more than one vehicle traveling side-by-side

**Right-Turn Bypass Lane** – a lane provided adjacent to, but separated from, the circulatory roadway, that allows right-turning movements to bypass the roundabout. Also known as a right-turn slip lane

**Roundabout** – an intersection with 3 or more approach legs, generally circular in shape where continuous flow of traffic is allowed through the use of the yield and merge maneuvers

**Sight Triangle** – an area required to be free of obstructions to enable visibility between conflicting movements

**Single-Lane Roundabout** – a roundabout that has single lanes on all entries and one circulatory lane

**Splitter Island** – a raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic, and provide storage space for pedestrians crossing that intersection approach in two stages

**Stopping Sight Distance** – the distance measured along the centerline of travel on a roadway required for a driver using the sight triangle or sight line to perceive and react to an object in the roadway and to brake to a complete stop before reaching that object

**Truck Apron** – a raised, colored and/or textured concrete surface next to the outside curb of the central island designed to allow large trucks to turn with their rear wheels leaving the roadway and riding up onto the apron area

**Two-Stage Crossing** – a process in which pedestrians cross a roadway by crossing one direction of traffic at a time, waiting in a pedestrian refuge between the two traffic streams if necessary before completing the crossing