

***SUBDIVISION AND DEVELOPMENT***

***STREET STANDARDS***



***PIMA COUNTY***

***APRIL 5, 2005***

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## **1. INTRODUCTION**

### **1.1. PURPOSE**

These standards have been adopted by the Pima County Board of Supervisors to guide land use planners and design engineers in the preparation of subdivision plats, development plans and improvement plans consistent with national standards and local policies and procedures.

The requirements set forth herein are intended to provide for the construction of roadway systems that can handle vehicular, pedestrian and bicycle traffic safely and efficiently, both within the subdivision and at the interface with the existing roadway network.

### **1.2. APPLICATION**

These standards apply to all roadway construction, reconstruction or rehabilitation related to residential or commercial subdivisions or developments within unincorporated Pima County. Both public and private roadways are subject to this regulation, as these roadways are traveled by the general public regardless of whether the responsibility for safety, control and maintenance of the roadway is public or private.

### **1.3. LIST OF REFERENCES**

Many of the standards presented in this manual are based on state-of-the- practice references published by several national, state and local agencies and organizations. For items not covered herein, the engineer shall design in accordance with those references.

The list of references included below (and at the end of each chapter) presents the most current version of the references (at the time the manual was developed). The user should always refer to the latest version of such publications.

- American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets, Washington D.C., 2001.
- American Association of State Highway and Transportation Officials. Roadside Design Guide, Washington D.C., 2002.
- Arizona Department of Transportation, Materials Preliminary Engineering and Design Manual, Third Edition, Phoenix, 1989.
- Arizona Department of Transportation. Policies, Guidelines and Procedures, Section 240 Traffic Impact Analyses, Phoenix, 2000.
- Arizona Department of Transportation. Standard Drawings - Structures Section, Phoenix, 1992.
- City of Tucson. Development Standards, Tucson, 2000.
- City of Tucson. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona, October 1989.
- Federal Highway Administration. Manual on Uniform Traffic Control Devices, Washington D.C., 2003.
- Florida Department of Transportation. Site Impact Handbook, Tallahassee, Florida, 1997.
- Institute of Transportation Engineers. Manual of Transportation Engineering Studies, Prentice-Hall, Englewood Cliffs NJ, 1994.

- Institute of Transportation Engineers. Trip Generation, 7th edition, Washington D.C., 2003.
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- Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.
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- Pima County Department of Transportation. Environmentally Sensitive Roadway Design Guidelines, Tucson, 2002.
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- Pima County Department of Transportation. Signing Manual, Tucson, 2002.
- Pima County. Commercial Design Manual, Tucson, June 2003.
- Pima County Flood Control District. Drainage and Channel Design Standards for Local Drainage, Tucson, 1984.
- Pima County. Major Streets and Scenic Routes Plan, Tucson, 2002.
- Pima County. Ordinance 1999-FC1: Floodplain and Erosion Hazard Management Ordinance, Tucson, 1999.
- Pima County. Pima County Code, Tucson, 2003.
- Transportation Research Board. Highway Capacity Manual, National Research Council, Washington D.C., 2000.
- U.S. Department of Transportation, Federal Highway Administration. Highway Functional Classification: Concepts, Criteria and Procedures, Washington D.C., 1989.

- U.S. Department of Transportation, Federal Highway Administration. Manual on Uniform Traffic Control Devices, Millennium Edition, Washington D.C., 2000.
- United States Department of Justice. ADA Standards for Accessible Design, Washington D.C., 1994.

## **2. CRITERIA FOR DEVELOPMENT CLASSIFICATION**

The set of design standards that apply to each development varies depending on the intended use of the development. Therefore, before using this manual, it is important to classify the proposed development into one of the categories defined in the introduction. This chapter presents the criteria used to classify each development (in part or as a whole) as rural residential, urban residential or commercial/industrial.

It is strongly recommended that developers and design engineers meet with all Pima County Department of Transportation divisions involved and the Flood Control District to discuss the proposed project prior to submittal of a development plan or subdivision plat. This is of critical importance if the development meets any of the following three criteria:

- The proposed project will have direct access to major streets and routes.
- The project will produce an Average Daily Traffic of 1,000 vehicles or more. For residential subdivisions, this is equivalent to 100 residential units.
- The project will include off-site improvements.

This type of meeting will also provide an opportunity for the Department of Transportation to coordinate the development with other Capital Improvement Projects (CIP) in the vicinity of the project, and it will help design engineers better prepare their submittal and reduce project review time. The Engineer shall call the Development Review Division Manager at 740-6586 to schedule this meeting.

There will be cases in which a development cannot be clearly classified into the categories presented here. If that is the case, Pima County Development Services and the Department of Transportation will determine the classification of the proposed development based on the prevailing conditions and applicable criteria. Note also that certain developments may encompass both residential and commercial uses. In those cases, the residential portion of the development must follow the residential standards and the commercial portion must follow the standards for commercial developments. Mixed-use developments (e.g. commercial

and residential developments) with common vehicular, pedestrian and/or bike access must meet both commercial and residential standards for the area of shared use. Modifications to the design parameters may be made based on the findings from a Traffic Impact Analysis.

## **2.1. RESIDENTIAL SUBDIVISIONS**

As a general rule, residential subdivisions are those where property is used for dwellings regardless of the zoning classification. The exceptions to the rule are condominiums, apartments and other multi-family residences because of their similarity with commercial and industrial developments in terms of access lanes and parking, among other elements. Therefore, condominiums, apartments and other multi-family residences shall follow the commercial development standards presented in this manual.

Based on criteria such as development density, drainage patterns and environmental preservation, this manual recognizes two main types of residential subdivisions: urban and rural. The features of each type of subdivision, as well as the criteria for categorizing residential subdivisions as rural or urban is discussed here and illustrated below in Figure 2.1.

Besides the two main types of residential subdivisions, Pima County recognizes a special type of subdivision referred to as a “conservation subdivision”. Conservation subdivisions promote the establishment of conservation natural areas and, where possible and practicable, support interconnected, continuous, and integrated open space systems within an area, particularly when located adjacent to public preserves. In order to achieve the goal of conservation, a special set of street standards has been developed for conservation subdivisions. Those standards are discussed in Chapter 6. However, their use is restricted to subdivisions that comply with Section 18.09.100 of the *Pima County Code*<sup>1</sup>.

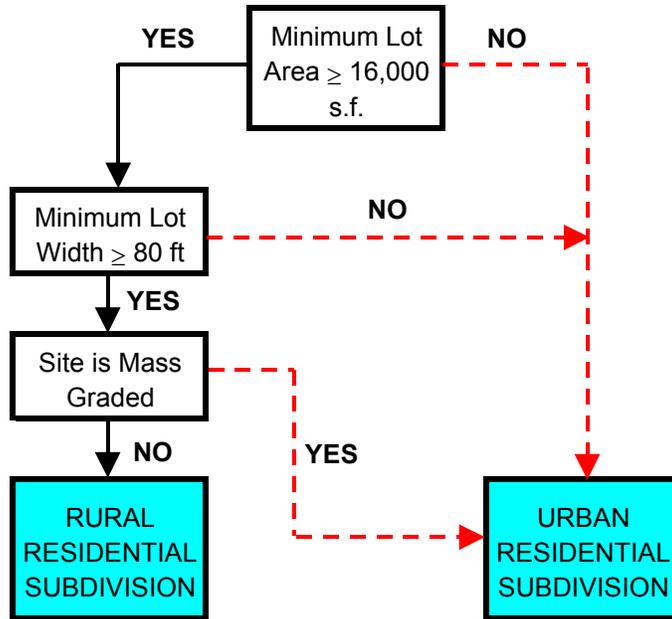


Figure 2.1. Flowchart for Residential Subdivision Classification.

### 2.1.1. Rural Residential Subdivisions

Rural residential subdivisions are characterized by relatively large lots, considerably spaced driveways (low driveway density) and minimal disturbance to the natural environment in terms of grading, drainage patterns, wildlife and native vegetation. A residential subdivision shall be classified as rural for the purpose of this manual if it meets all of the following three conditions:

- The minimum lot size is at least 16,000 s.f.  
AND
- The minimum lot width is at least 80 ft. Lot width is defined in Section 18.03.020 of the *Pima County Code*<sup>1</sup>.  
AND
- The subdivision is not mass graded. Mass grading is the process of grading the subdivision streets and lots or building pads at the same time. A subdivision is not mass graded if individual grading permits are obtained for each lot as part of the building permit process.

### **2.1.2. Urban Residential Subdivisions**

The lots in urban residential subdivisions are generally smaller than in rural subdivisions. In addition, driveways are more closely spaced (high driveway density) and there are significant changes to the natural environment in terms of grading, drainage patterns, wildlife and native vegetation. In general, residential subdivisions that are not classified as rural shall be classified as urban. Specifically, a residential subdivision shall be categorized as urban for the purpose of this manual if it meets at least one of the following conditions:

- The minimum lot size is less than 16,000 s.f.  
OR
- The minimum lot width is less than 80 ft. Lot width is defined in Section 18.03.020 of the *Pima County Code*<sup>1</sup>.  
OR
- The subdivision is mass graded. Mass grading is the process of grading the subdivision streets and lots or building pads at the same time.

### **2.2. COMMERCIAL AND INDUSTRIAL SUBDIVISIONS**

In general, any subdivision whose intended use is not residential dwelling shall be considered a commercial or industrial subdivision for the purpose of this manual, and shall follow the commercial and industrial subdivision street standards presented in Chapter 7.

### **2.3. COMMERCIAL AND INDUSTRIAL DEVELOPMENTS**

The development of any parcel of land for commercial, industrial, or any other non-residential use shall follow the commercial development standards included in

Chapter 8 of this manual. Condominiums, apartments and other multi-family residences must also be treated as commercial developments.

## **REFERENCES**

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<sup>1</sup> Pima County. Pima County Code, Tucson, 2003.

### 3. DESIGN ELEMENTS COMMON TO ALL DEVELOPMENT TYPES

Although several design elements depend on the type of subdivision being developed (urban, rural or commercial), there are several elements that are common to all types of subdivisions. Among those are the layout of the internal street network, the traffic operations and safety performance measures to be met, the criteria for on- and off-site improvements, and the geometric and pavement design standards. This chapter addresses all of the above mentioned elements that are common to all subdivisions.

#### 3.1. SITE LAYOUT

In order to provide an acceptable street layout for a subdivision, the designer must ensure that vehicular, pedestrian and bicycle traffic can be handled safely and efficiently, both within the subdivision and at the interface with the existing roadway network. This can be accomplished by incorporating the concept of functional classification in the design and by performing an applicable traffic impact study.

##### 3.1.1. Functional Classification

Functional classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide<sup>1</sup>. The major street functional categories are freeways, arterial, collectors and local streets. Each of these street categories have different characteristics in two areas: the amount of *mobility* they provide and how restrictive or permissive they are in terms of providing *access* to land.

Freeways provide mobility for large traffic volumes at high speeds but have limited access points. Arterial streets can also accommodate large traffic volumes but have more points of access than freeways. Collector roadways normally offer a balanced combination of mobility and access, while local roads emphasize the access to land

but handle low traffic volumes. The relationship between access and mobility provided by the different functional classes is illustrated in Figure 3.1.

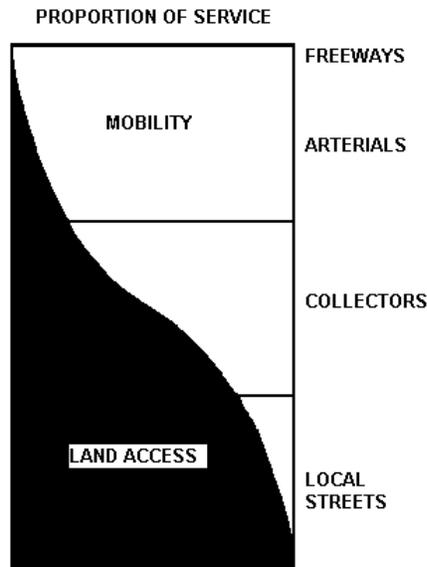


Figure 3.1. Access - mobility relationship by functional class (Modified from AASHTO<sup>2</sup>)

A typical vehicle trip involves travel in all or most of the functional categories presented here. In a home-to-work trip, a person normally leaves his/her driveway and enters a local road for a short distance until reaching a collector roadway. From there, he/she joins the arterial street network until reaching the vicinity of his/her destination. At that point the reverse process starts, going from the arterial to a collector and then to a local street. Figure 3.2 shows a portion of an urban street network and the functional classification of every street

Generally, even for large subdivisions, only collector and local streets are required to handle the traffic generated by the development. Therefore, this manual only addresses the design elements and characteristics of collectors and local streets. However, there may be subdivisions that because of their size or other unique conditions may require improvements to, or the construction of an arterial roadway. In those cases, the need for the arterial must be determined by the Traffic Impact Study and the design parameters must follow those in the *Pima County Roadway Design Manual*<sup>3</sup>, including the *Environmentally Sensitive Roadway Design Guidelines*, if applicable.

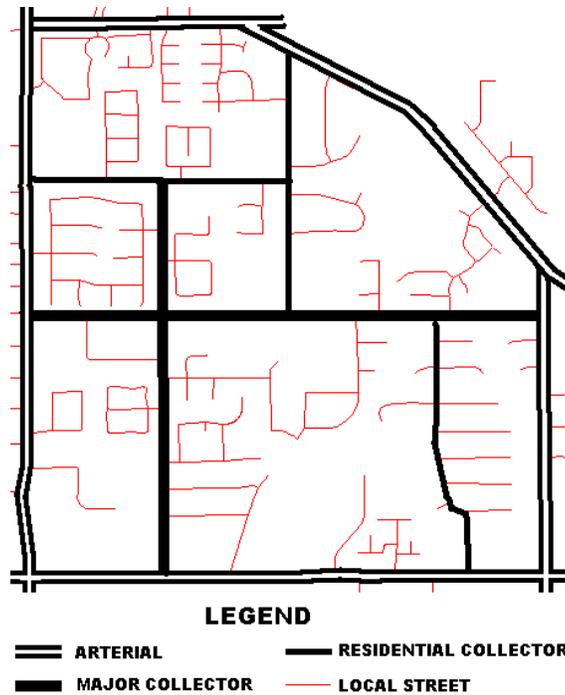


Figure 3.2. Layout of a typical urban street network

This manual recognizes two types of collectors: residential collectors and major collectors. Descriptions of the attributes of local streets and of each collector type are presented in the following sections. Those descriptions are intended to guide the designer in the selection of the appropriate type of street.

Table 3.1 characterizes the types of streets discussed here based on traffic volume, design speed, access to property, roadway terminus, access density, system continuity and segment length. Segment length is the distance between consecutive breaks in the roadway alignment. The following elements create breaks in the alignment:

- Knuckles. All knuckles shall have an intersection angle ( $\Delta$ ) between  $60^{\circ}$  and  $120^{\circ}$  and shall conform to the criteria presented in Details 3.1-1 and 3.1-2.
- Sharp horizontal curves. Curves with an intersection angle ( $\Delta$ ) greater than  $60^{\circ}$  and a radius not exceeding 300 feet are considered sharp curves.
- Traffic circles. The design of all traffic circles shall conform to the dimensions presented in Detail 3.2.

In special cases, variations to the design parameters may be requested by following the modification process defined in Chapter 9, “Administration of the Standards.”

**3.1.1.1. Local Streets**

Local streets are generally two lane undivided roadways that provide direct access to residences, business and other abutting properties; therefore, the access density (access points per unit of distance) is high. Service to through traffic movement is discouraged in local streets. Because they are only intended to serve local traffic, the maximum segment length for local streets shall be ¼ mile. Local streets should connect to another local street or a collector at the origin, and end at another local street or at a turnaround (e.g. a cul-de-sac). The design Average Daily Traffic (ADT) shall not exceed 1,000 vehicles per day and the design speed shall be 25 mph.

**3.1.1.2. Residential Collectors**

Residential collectors provide a combination of mobility and land access within residential neighborhoods. In the outbound direction, residential collectors consolidate the traffic flow from the local streets and direct it to major collectors or arterials. Inbound, residential collectors help distribute the traffic to the local streets. The design ADT for local collector shall be between 1,000 and 2,500 vehicles per day. Direct access to property is not desirable because of safety considerations. If direct access to property is not allowed, the segment length shall range from ¼ mile to 1 mile and the design speed shall be 30 mph. However, if direct access to property is provided, the maximum segment length shall be limited to ¼ mile and the design speed shall be 25 mph.

**3.1.1.3. Major Collectors**

Major collectors provide connectivity from large subdivisions to the arterial roadway system. They are normally situated at mid-section locations and are between 1 and 3 miles in length. Major collectors are designed to serve volumes from 2,500 to 10,000 vehicles per day and shall have a minimum design speed of 40 mph. Given the level of mobility that they provide (in terms of volumes and speed), direct access to adjacent property shall not be provided and the access density must be low.

Table 3.1. Summary of Design Attributes by Functional Class

Parameter	Local Street	Residential Collector	Major Collector
<b>MANDATORY CRITERIA</b>			
Volume (veh/day)	< 1,000	1,000 - 2,500	2,500 - 10,000
Segment Length (mi)	<¼	¼ - 1	1 – 3
Design Speed (mph)	25	25-30	40
Direct Access to Property	Yes	No*	No
<b>RECOMMENDED CRITERIA</b>			
Major Terminus	Collector or local street	Arterial or major collector	Arterial
Minor Terminus	Local street or turnaround	Residential collector or Local street	Arterial, residential or major collector
System Continuity	Low	Medium	High

\* Direct access to property can be provided if the maximum segment length is limited to 1/4 mile AND the design speed is 25 mph

### 3.1.2. Traffic Impact Studies (TIS)

In order for Pima County to operate and maintain the roadway network as safely and efficiently as possible, it is necessary to evaluate the impact of development-generated traffic. Such impact can be identified by conducting a Traffic Impact Study (TIS). The objectives of this section are two-fold:

1. To establish the conditions that determine the need for a TIS.
2. To establish the minimum requirements for a TIS in terms of study area, study horizon and study contents.

#### 3.1.2.1. Determining the need for a TIS

A TIS prepared by a registered Professional Engineer is required for any subdivision or commercial development which generates 100 or more gross trips during the morning or afternoon peak hour of the generator. Table 3.2 shows the thresholds that would trigger the need for a TIS for some of the most common uses. For uses not included in the table, the number of trips generated shall be calculated using the latest edition of *Trip Generation*<sup>4</sup>, from the Institute of Transportation Engineers.

Table 3.2. Thresholds for requiring Traffic Impact Studies

ITE Code	LAND USE	UNIT	PEAK HR TRIPS/UNIT	THRESHOLD
<b>RESIDENTIAL</b>				
210	Single Family	DU	1.02	100 DU
230	Condominium/Townhomes	DU	0.54	185 DU
220	Apartments	DU	0.67	150 DU
240	Mobile Home	DU	0.58	175 DU
416	RV Park	SPACE	0.48	210 SPACES
250	Retirement Community	DU	0.34	295 DU
<b>COMMERCIAL AND INDUSTRIAL</b>				
911	Walk-in Bank	1,000 SF	42.02	2,500 SF
912	Drive-in Bank	1,000 SF	51.23	2,000 SF
820	Shopping Center	1,000 SF	4.97	21,000 SF
850	Supermarket (Grocery Store)	1,000 SF	12.25	8,000 SF
851	24-Hour Convenience Store	1,000 SF	65.24	1,500 SF
861	Discount Club	1,000 SF	6.46	16,000 SF
890	Furniture Store	1,000 SF	0.92	109,000 SF
812	Lumber Store	1,000 SF	8.38	12,000 SF
816	Hardware/Paint Store	1,000 SF	11.18	9,000 SF
841	New Car Sales	1,000 SF	2.97	34,000 SF
840	Vehicle Repair (Automobile Care Center)	1,000 SF	4.01	25,000 SF
844	Gas Station	PUMP	16.18	7 PUMPS
430	Golf Course	HOLES	4.59	22 HOLES
492	Racquet Club	COURT	4.66	22 COURTS
493	Health Club	1,000 SF	4.30	24,000 SF
831	Quality Restaurant	1,000 SF	10.82	10,000 SF
832	Sit Down High Turnover Restaurant	1,000 SF	19.38	5,000 SF
834	Fast Food (with drive-thru)	1,000 SF	72.74	1,500 SF
110	General Light Industrial	1,000 SF	1.08	93,000 SF
120	General Heavy Industrial	1,000 SF	0.68	147,000 SF
130	Industrial Park	1,000 SF	0.92	109,000 SF
150	Warehousing	1,000 SF	0.61	164,000 SF
<b>OFFICES</b>				
710	General Office Building	1,000 SF	1.56	65,000 SF
750	Office Park	1,000 SF	1.74	58,000 SF
770	Business Parks	1,000 SF	1.43	70,000 SF
760	Research & Development Center	1,000 SF	1.24	81,000 SF
730	Government Office	1,000 SF	11.03	10,000 SF
720	Medical-Dental Office Buildings	1,000 SF	4.36	23,000 SF
<b>INSTITUTIONAL</b>				
520	Elementary school	STUDENTS	0.30	335 STUDENTS
522	Middle/Junior High School	STUDENTS	0.46	220 STUDENTS
530	High School	STUDENTS	0.46	220 STUDENTS
565	Day Care Center	STUDENTS	0.86	120 STUDENTS
560	Church	1,000 SF	9.49	11,000 SF

DU: Dwelling Units

SF: Square Feet Gross Floor/Leasable Area

Example: Medical office building, 15,000 SF

Peak hour trip rate: 4.36 trips/1,000 SF

Trip Generation: 15,000 SF x (4.36 trips / 1,000 SF) = 65 trips in the peak hour

A TIS can also be required by Pima County, even if the proposed development generates less than 100 trips in the peak hour, if there are any current traffic concerns in the local area (such as an offset intersection, or high accident rates), or if there are other traffic specific problems that may be aggravated by the proposed development.

### **3.1.2.2. Categories for TIS**

Based on the size and phasing of the proposed development, the following categories of TIS have been established:

- a) CATEGORY I. Small developments which generate 100 or more peak hour trips but less than 500 trips during the morning or afternoon peak hour.
- b) CATEGORY II. Moderate size developments which generate 500 or more peak hour trips but less than 1,000 trips during the morning or afternoon peak hour.
- c) CATEGORY III. Large single-phase developments which generate 1,000 or more trips during the morning or afternoon peak hour.
- d) CATEGORY IV. Large multi-phase developments which generate 1,000 or more trips during the morning or afternoon peak hour.

### **3.1.2.3. Scope**

The level of detail needed for a TIS depends on the size of the development and its phasing. However, every TIS must address elements such as the study area, the study horizon, data collection requirements, capacity analysis, among others. Those elements are discussed here.

- a) STUDY AREA. The minimum study area shall be determined by project type and size in accordance with the criteria in Table 3.3. The study area for the proposed development shall include traffic signal controlled intersections, site access drives and major unsignalized intersections to ensure their operation and level of service are adequately assessed. Unsignalized intersections where at least one of the intersecting streets is a collector or arterial are considered major unsignalized intersections. The extent of the study area may

be either enlarged or decreased depending on special conditions as determined by the County Traffic Engineer.

b) STUDY HORIZON. The study horizon years shall be determined by project type and size in accordance with the criteria in Table 3.3.

Table 3.3. Summary of design attributes by functional class (Modified from <sup>5</sup> and <sup>6</sup>)

Study Category	Development/Subdivision Characteristics	Study Horizons (a)	Minimum Study Area (b)
I	Small development 100-499 peak hour trips	1. Opening year	1. Site access drives 2. All signalized intersections and/or major unsignalized intersections within 1/4 mile
II	Moderate development 500-999 peak hour trips	1. Opening year 2. 5 years after opening	1. Site access drives 2. All signalized intersections and/or major unsignalized intersections within 1/2 mile
III	Large single-phase development ≥1000 peak hour trips	1. Opening year 2. 5 years after opening 3. 20 years after opening	1. Site access drives 2. All signalized intersections and/or major unsignalized intersections within 1 mile
IV	Large multi-phase development ≥1000 peak hour trips	1. Opening year of each phase 2. 5 years after build-out 3. 20 years after build-out	1. Site access drives 2. All signalized intersections and/or major unsignalized intersections within 1 mile

a. Assume full occupancy and build-out for single phase developments

b. An enlarged study area may be required as discussed in 3.1.2.3. a)

c) ANALYSIS TIME PERIOD. Both the morning and afternoon weekday peak hours need to be analyzed. If the proposed project is expected to generate no trips or a very low number of trips during either the morning or evening peak periods the requirement to analyze such period may be waived by the County Traffic Engineer. If the peak traffic hour in the study area occurs during a time period other than the normal peak travel periods, these peak hours must also be analyzed.

d) DATA COLLECTION REQUIREMENTS. All data is to be collected in accordance with the latest edition of the *ITE Manual of Transportation Engineering Studies*<sup>7</sup> or as directed by the County Traffic Engineer, if not specifically covered in the ITE Manual.

Turning movement counts shall be obtained for all existing cross-street intersections to be analyzed during the morning and afternoon peak periods. Available turning movement counts may be extrapolated a maximum of three years with concurrence of the County Traffic Engineer.

The current and projected daily traffic volumes shall be presented in the report. Available daily count data may be obtained from Pima County Department of Transportation and extrapolated a maximum of three years with the concurrence of the County Traffic Engineer. Where daily count data are not available, mechanical counts may be required at the County Traffic Engineer's discretion.

Roadway geometric information shall be obtained for all streets in the study area. This includes: roadway width, number of lanes, turning lanes, vertical grade, location of nearby driveways, and lane configuration at intersections. The location and type of traffic controls shall also be identified.

If appropriate, traffic volumes should be adjusted to account for seasonal variations. The use of seasonal adjustment factors should be approved by the County Traffic Engineer.

- e) TRIP GENERATION. The latest edition of ITE's *Trip Generation* shall be used for selecting trip generation rates. The guidelines contained in *Trip Generation* shall be used to determine whether the average trip generation rate or equation should be used. Other rates may be used with the approval of the County Traffic Engineer in cases where *Trip Generation* does not include trip rates for a specific land use category, or includes only limited data, or where local trip rates have been shown to differ from the ITE rates.
  
- f) TRIP DISTRIBUTION AND ASSIGNMENT. Projected trips shall be distributed and added to the projected non-site traffic on the roadway network. The

projected traffic volume must be shown for all roadways internal to the subdivision and for all other roadways within the study area. The specific assumptions and data sources used in deriving trip distribution and assignment shall be documented in the study.

- g) CAPACITY ANALYSIS. Level of Service (LOS) shall be computed for signalized and major unsignalized intersections as identified in Table 3.2, in accordance with the latest edition of the *Highway Capacity Manual*<sup>8</sup>. For rural highways where the signalized intersections are more than 1 mile apart, the level of service on the highway shall be estimated in accordance with the latest edition of the *Highway Capacity Manual*.

While the use of the operational methodologies presented in the *Highway Capacity Manual*<sup>8</sup> is always desirable, analyses using the planning method are acceptable for dimensioning of new facilities.

- h) TRAFFIC SIGNAL NEEDS. An analysis of traffic signal needs shall be conducted for all arterial/arterial, arterial/major collector and major collector/major collector intersections within the study area for the opening year. Signal need evaluations must determine if an intersection meets the signal warrants included in the latest edition of *the Manual on Uniform Traffic Control Devices (MUTCD)*<sup>9</sup>. If the warrants are not met for the opening year, they should be evaluated 5 years after opening for categories II, III and IV Traffic Impact Studies.

- i) ACCIDENT ANALYSIS. An analysis of three-year accident data within the study area shall be conducted to determine if the level of safety (in terms of accident rates and severity index) needs improvement due to the addition of site traffic. Pima County's Traffic Engineering Division maintains Countywide and segment/intersection specific accident data that can serve as baseline for the analysis.

- j) QUEUING ANALYSIS. A queuing analysis shall be conducted for all turn lanes under stop or signal control within the study area to ensure that the expected queues can be accommodated in the storage length provided. Although there are several methods for estimating queue length, the following equations may be used <sup>2</sup>:

For signalized intersections (for every cycle):

$$Queue\ length\ (ft) = 2 \cdot \left( 25 \frac{ft}{veh} \right) \cdot \left( \frac{Volume\ (veh / hr)}{Cycles\ per\ hour} \right)$$

For unsignalized intersections (for a 2 minute period):

$$Queue\ length\ (ft) = \left( 25 \frac{ft}{veh} \right) \cdot \left( \frac{Volume\ (veh / hr)}{30} \right)$$

- k) IMPROVEMENT ANALYSIS. The roadways and intersections within the study area shall be analyzed with and without the proposed development to identify any projected impacts in regard to level of service and safety.

The minimum design requirements for all intersections and roadway segments shall be LOS D with no intersection through lane movement falling below LOS D and no intersection turning movement falling below LOS E. If the TIS shows that the impact of a development will bring the LOS below those thresholds during the study horizon, mitigation alternatives to improve the LOS to at least those thresholds must be analyzed as part of the study. Common mitigation alternatives include capacity improvements, travel demand management and provision of alternative modes.

If the performance of the existing intersection or roadway is already below those thresholds (e.g. below LOS D for through movements) the study must find alternatives to at least maintain the existing performance. The TIS must also evaluate the need for turning lanes on all major unsignalized intersections using the criteria presented in Section 3.1.3.

- I) ALTERNATIVE MODES. In cases where pedestrian, transit, bicycle, golf cart or equestrian activity should be expected, the TIS must identify any conflict points between vehicles and any other mode. In those cases the study must also make recommendations to facilitate the operation of alternative modes and ensure the safety of their users, especially at the interface with the vehicular network.

Pima Association of Governments (PAG) and its member jurisdictions have developed and adopted the *Regional Plan for Bicycling*<sup>10</sup> and the *Regional Pedestrian Plan*<sup>11</sup>. Pima County has also adopted the *Eastern Pima County Trail System Master Plan*. Recommendations related to alternate modes should be in harmony with the goals of the plans, especially in relation to the planning, design, construction and maintenance of bicycle and pedestrian facilities. Particular attention should be paid to:

- Ensuring connectivity of pedestrian and bicycle systems.
- Providing safe non-motorized access to school for school children.

#### **3.1.2.4. Sample table of contents for TIS**

The following table of contents can be used as a template for most Traffic Impact Studies. The table of contents may be modified to better fit the needs of the particular study, but the TIS should at least address the points presented in Section 3.1.2.3 (Scope).

#### **1. INTRODUCTION AND SUMMARY**

*a. Purpose of report and study objectives*

*b. Executive Summary*

- *Site location and study area*
- *Development description*
- *Principal findings*
- *Conclusions/Recommendations*

#### **2. PROPOSED DEVELOPMENT (Site and Nearby)**

*a. Site location*

*b. Land use and intensity*

*c. Site plan (must be legible)*

- *Access geometrics*

*d. Development phasing and timing*

### **3. STUDY AREA CONDITIONS**

- a. Study area
  - Area of significant traffic impact
  - Influence area
- b. Land use
  - Existing land use
  - Anticipated future development
- c. Site accessibility
  - Existing and future area roadway system
  - Site circulation

### **4. ANALYSIS OF EXISTING CONDITIONS**

- a. Physical characteristics
  - Roadway characteristics
  - Traffic control devices
  - Transit service
  - Pedestrian/bicycle facilities
  - Existing transportation demand management
- b. Traffic volumes
  - Daily, morning and afternoon peak periods, and others as required
- c. Level of service
  - Morning peak hour, afternoon peak hour, and others as required
- d. Safety related deficiencies
- e. Data sources

### **5. PROJECTED TRAFFIC**

- a. Site traffic forecasting (each horizon year)
  - Trip generation
  - Mode split (if applicable)
  - Pass-by traffic (if applicable)
  - Trip distribution
  - Trip assignment
- b. Non-site traffic forecasting (each horizon year)
  - Projections of non-site traffic
- c. Total traffic (each horizon year)

### **6. TRAFFIC AND IMPROVEMENT ANALYSIS**

- a. Site access
- b. Level of service analysis
  - Without project including programmed improvements (each horizon year)
  - With project including programmed improvements (each horizon year)
- c. Roadway improvements
  - Improvements by PCDOT or others to accommodate non-site traffic
  - Additional alternative improvements to accommodate site traffic

- d. *Traffic safety*
  - *Sight distance*
  - *Acceleration/deceleration lanes, auxiliary lanes*
  - *Adequacy of location and design of driveway access*
- e. *Alternative modes considerations*
  - *Vehicle/pedestrian conflict points*
  - *Vehicle/bicycle conflict points*
  - *Vehicle/Golf Cart*
- f. *Traffic control needs*
- h. *Traffic signal needs (base plus 5-year horizon)*
- i. *Transportation demand management*

## **8. CONCLUSIONS**

## **9. RECOMMENDATIONS**

- a. *Roadway improvements*
  - *Phasing*
- b. *Site access*
- c. *Internal site circulation*
- d. *Transportation demand management actions (if appropriate)*
- e. *Other*

## **10. APPENDICES**

- a. *Traffic counts*
- b. *Capacity analyses worksheets*
- c. *Traffic signal needs studies*
- d. *Queuing Analysis*
- e. *Accident data summaries*

## **11. FIGURES AND TABLES**

- a. *Site location*
- b. *Site plan*
- c. *Existing transportation system*
- d. *Existing daily volumes*
- e. *Existing peak hour turning volumes*
- f. *Future transportation system*
- g. *Estimated site traffic generation (daily and peak period)*
- h. *Directional distribution of site traffic (daily and peak period)*
- i. *Site traffic (peak period)*
- j. *Non-site traffic (peak period)*
- k. *Total future traffic (daily and peak period)*
- l. *Projected levels of service*
- m. *Recommended improvements*

### 3.1.3. Auxiliary Lanes

In order for the internal subdivision streets and the adjacent existing roadways to operate safely and efficiently, it is necessary to evaluate the need for channelization of traffic movements, especially at major unsignalized intersections. The warrants outlined here shall be followed for unsignalized intersections that provide access to new subdivisions or developments and for major unsignalized intersections internal to the subdivision or development. The warrants apply both to subdivisions and developments that require a TIS, and to those that do not.

#### 3.1.3.1. Left Turn Lane Warrants

The methodology presented here applies to all subdivision or development access points where a left turn must be executed from a two-lane roadway to enter the subdivision. The intent is to identify locations where lack of left turn lanes presents a potential safety concern.

The need for an exclusive left turn lane can be determined from Table 3.4 if the following parameters are known:

- ADT: The two-way average daily traffic on the roadway from which the left turn is executed. If a TIS for the subdivision is not available, ADT can be obtained from the Pima County Traffic Engineering division or from the Pima Association of Governments.
- LT: Number of left turns in the peak hour. If a TIS for the subdivision is not available, the number of left turns can be estimated based on the number of trips generated by the subdivision or development in the peak hour (using the trip generation rate from *Trip Generation*<sup>4</sup> or Table 3.2) divided by the number of access points where left turns are (or will be) permitted, as shown in the following equation:

$$LT = \frac{0.5 \cdot \text{Trip Generation}_{P.H.}}{\text{Access Pts}}$$

For residential subdivisions the equation simplifies to:

$$LT = \frac{0.5 \cdot \text{Dwelling Units}}{\text{Access Pts}}$$

- Posted Speed: The posted speed limit on the roadway from which the left turn is executed.

Table 3.4 shows the maximum number of left turn movements allowed in the peak hour without a dedicated left turn lane. If those values are exceeded for any ADT and speed combination, a left turn lane shall be provided.

An exclusive left turn lane will also be required regardless of the size of the subdivision or development, if an access point to the subdivision is located in an area where sufficient stopping sight distance is not provided on the major roadway. If the roadway shoulders or any pedestrian or bicycle facilities are affected by the addition of a left turn lane they must be replaced. The storage length required for the lane must comply with the requirements in the *Pima County Pavement Marking Design Manual*<sup>12</sup>.

Table 3.4. Maximum left turn volume in the peak hour without a left turn lane (modified from IHSDM<sup>13</sup>)

Posted Speed (mph)	ADT (2-way)			
	<2,500	2,500-5,000	5,000-10,000	>10,000
≤ 35	75	50	30	15
40-50	75	40	20	10
≥ 55	75	30	10	5

### 3.1.3.2. Right Turn Lane Warrants

The methodology presented here applies to all subdivision or development access points where a right turn must be executed from a collector or arterial to enter the

subdivision. The intent is to identify locations where the lack of right turn lanes presents a potential safety concern.

The need for an exclusive right turn lane can be determined from Table 3.5 if the following parameters are known:

- ADT: The bi-directional average daily traffic on the roadway from which the right turn is executed. If a TIS for the subdivision is not available, ADT can be obtained from the Pima County Traffic Engineering division or from the Pima Association of Governments.
- RT: Number of right turns in the peak hour. If a TIS for the subdivision is not available, the number of right turns can be estimated based on the number of trips generated by the subdivision or development in the peak hour (using the trip generation rate from *Trip Generation*<sup>4</sup> or Table 3.2) divided by the number of access points where right turns are (or will be) permitted, as shown in the equation below:

$$RT = \frac{0.5 \cdot \text{Trip Generation}_{p.H.}}{\text{Access Pts}}$$

For residential subdivisions the equation simplifies to:

$$RT = \frac{0.5 \cdot \text{Dwelling Units}}{\text{Access Pts}}$$

Table 3.5 shows the maximum number of right turn movements allowed in the peak hour without a dedicated right turn lane. If those values are exceeded, a right turn lane shall be provided.

Table 3.5. Peak Hour Volume Warrant for Right Turn Lanes (modified from IHSDM<sup>13</sup>)

ADT (2-way)	Max. Peak Hour Right Turn Volume (w/o RT Lane)
2,500-5,000	100
5,000-10,000	70
>10,000	40

**3.1.3.3. Auxiliary Lanes Sample Calculation**

Given the following information, determine the need for dedicated left turn and right turn lanes:

- Turns made from a 2 lane collector roadway
- Posted speed: 45 mph
- ADT on collector roadway: 8,000 veh/day
- 150 single-family residences
- 2 Access points

To calculate LT and RT

$$LT = RT = \frac{0.5 \cdot 150}{2} = 38$$

To evaluate need for left turn lane

Reading in Table 3.4 for ADT between 5,000 and 10,000 and posted speed of 45, the maximum number of left turns allowed in the peak hour is 20.

Since LT (38) > 20, a left turn lane IS warranted (at each access point).

To evaluate need for right turn lane

Reading in Table 3.5 for ADT between 5,000 and 10,000 and posted speed of 45, the maximum number of right turns allowed in the peak hour is 70.

Since RT (38) < 70, a right turn lane IS NOT warranted.

### **3.1.4. Dead-end streets and Cul-de-sacs**

A dead-end street is a single street that comes to an end without any other streets intersecting it. Cul-de-sacs are the turnaround areas at the end of a dead-end street, including those designed with a radius (or bulbhead), T-shaped and Y-shaped. Different types of cul-de-sacs are illustrated in Details 3.3 to 3.6.

All permanent dead-end streets shall be designed with an adequate turn around area at the dead-end. This turnaround area may not be required on dead-end streets less than 150 feet in length if public services, such as fire, refuse, school buses, delivery and repair vehicles, and postal service can be provided without the use of the street. The length of a dead-end street is the distance from the centerline of the last connecting street to the end of the pavement.

There is no restriction on the maximum length of a dead-end street. However, turn around areas must be provided at least every 1,320 feet (see Detail 3.8). Designers should also check fire district(s) regulations for dead-end streets, as some fire departments may have more strict requirements.

Bulbhead cul-de-sacs (see Details 3.3 and 3.4) are preferred for turnarounds because of their overall efficiency and maintainability. The paved turnaround radius shall be a minimum of 42 feet measured to the edge of pavement or back of wedge curb. The turnaround right-of-way radius shall be a minimum of 50 feet. The maximum slope in cul-de-sac areas shall be 8% in any direction. Pedestrian paths connecting cul-de-sacs to nearby pedestrian facilities such as sidewalks and trails should be provided to improve the connectivity of the pedestrian network.

T-shaped and Y-shaped turnarounds may be used for dead-end streets with a projected ADT of 140 vehicles or less.

Improvements to existing dead-end streets on abutting properties may be required during rezoning or subdivision platting. The purpose of these improvements shall be to allow proper through connection of streets. Through connections may require that the developer remove abandoned cul-de-sac pavement on the abutting property (see Detail 3.7) and that the full pavement section be carried to property line.

Where temporary turnarounds are designed for future extension to abutting properties, a note shall appear on the final plat listing the street name and indicating the temporary nature of the turnaround.

Bulbhead cul-de-sacs may contain landscaping within the center area provided that 1) the radius to the edge of pavement is a maximum of 18 feet; (2) the cul-de-sac is large enough to allow the passage of the design vehicle and its wheelpaths within the paved area, and; (3) are not proposed to be future through streets. Detail 3.5 illustrates this condition.

Pima County shall not be responsible for maintaining cul-de-sac landscaping. License agreements and approval from Pima County Department of Transportation shall be required prior to the approval of improvement plans that include new landscaping within the right-of-way.

### **3.1.5. Raised Medians and Median Islands**

Medians serve a variety of functions, such as, separating opposing traffic, providing storage for turning vehicles, minimizing headlight glare and providing width for future lanes. Raised medians should not be used on extended sections of two-lane roadways because they may cause operational and safety problems. If a median is used, it must be designed in accordance with the *Pima County Roadway Design Manual*<sup>3</sup>.

Median Islands are short sections of medians used primarily at intersections or crossings. Median islands are used in subdivision streets (generally at the access drives) for aesthetics, to protect pedestrians and to channelize intersection movements. The design of any median shall meet the following criteria:

- The width of median islands shall be measured from edge of pavement to edge of pavement.
- On local streets and residential collectors, the minimum median island width shall be 4 feet. On major collectors, the minimum median island width shall be 20 feet.
- The maximum median island width for all street classes shall be 24 feet.
- Landscaping placed in the median island shall not interfere with the stopping sight distance lines as described in Section 3.2.2.4, nor shall it fall within the sight visibility triangles of an intersection, as described in Section 3.2.4.2.
- For turning lanes, the turn bay opening and the storage length shall be designed following the Pima County *Pavement Marking Design Manual*<sup>12</sup>.
- Lane shifts at intersections are not allowed. Therefore, if a median island is provided on only one of two opposing intersection approaches, sufficient tapers shall be provided on the undivided approach to ensure proper alignment of lane markers. Taper rates and length shall meet the requirements of the Pima County *Pavement Marking Design Manual*<sup>12</sup>.
- Placement of “Do Not Enter” signs may be requested by Pima County based on specific project conditions.
- At locations where pedestrian traffic is expected across a median island, a pedestrian refuge area must be provided. Refuge areas shall be at least 6 feet wide.

### **3.1.6. Intersection Lighting**

Street lighting contributes to improve the safety of locations with potential vehicle or pedestrian conflicts. Street lighting shall be installed at intersections that provide

access to or are internal to a subdivision or development or adjacent to it, when they meet one or more of the following criteria:

- One of the intersecting streets is a major collector or arterial.
- The intersection is signalized or is scheduled to be signalized within five years of the opening of the subdivision or development. The Traffic Engineering Division of the Pima County Department of Transportation keeps the signalization schedule for the County.
- Situations where horizontal or vertical curvature of the roadway, channelization or other factors, constitute a confusing or unsatisfactory condition that may be improved with lighting.
- Intersections with significant pedestrian crossing volumes.

The installation of poles, luminaries, conduit, wiring, circuits and all other street lighting elements shall be done in accordance with Pima County's *Standard Details for Public Improvements*<sup>14</sup> and *Standard Specifications for Public Improvements*<sup>15</sup>. Upon satisfactory testing, Pima County shall receive ownership of, and will maintain all street lights installed within public right-of-way.

### **3.1.7. Gated Entries**

Gated entrances shall only be allowed in subdivisions where all streets are privately maintained, and shall meet the following requirements:

- Stopping locations (keypads, card-readers, guard shack, etc.) shall be set back at least 50 feet from the right-of-way of the cross street to avoid interfering with through traffic and to provide protection for entering vehicles. If a TIS is performed for the subdivision, it shall include a queuing analysis for the gated entry to ensure sufficient storage capacity (measured from the right-of-way line).
- The minimum width of the vehicular gate must be 26-foot clear opening width to allow for entrance and egress. If an island separates the two directions of travel, a minimum 14-foot entrance in each direction shall be permissible.

- Any equipment or obstructions (such as keypads or card-readers) shall be installed in the curbside area.
- The design of the entrance shall allow vehicles that do not go past the gate to turnaround without interfering with other traffic. The minimum turnaround radius shall be 42 feet.

### **3.1.8. External Vehicular Access**

The following provisions shall apply to external vehicular access to subdivisions and developments.

- All residential subdivisions and commercial or industrial developments shall provide separate, legal, all-weather, paved access directly to the nearest arterial or collector highway. The developer shall be responsible for the cost of connecting the internal subdivision streets to the existing public roadway network.
- Access shall not be allowed through the existing local streets of adjacent properties where the zoning differs or if the access would impose detrimental impacts on adjacent properties.
- Individual direct access for residential units fronting on major collectors and arterials shall not be permitted in single family detached residential subdivisions. Paved all-weather access to the units shall be provided by internal subdivision streets having a minimum number of intersections with the highway.
- When a frontage road is determined necessary by the County Engineer, a commercial or industrial development fronting on an arterial or major collector shall be required to construct a frontage road contiguous to and generally paralleling the major street, to intercept, collect and distribute traffic desiring to cross, enter or leave the major street.
- Commercial and industrial developments shall not be allowed access through any residentially zoned area.

- Residentially zoned areas of CR-3 or higher density shall not be allowed access through residential areas zoned CR-2 or lower density.
- All off-site roadway improvements shall meet the requirements of the Pima County *Roadway Design Manual*<sup>3</sup>, including the *Environmentally Sensitive Roadway Design Guidelines*<sup>16</sup> (when the improvements are located on Environmentally Sensitive Land).

### **3.1.9. Street Signing**

The signing of all subdivision and development streets shall comply with the requirements in the *Manual on Uniform Traffic Control Devices (MUTCD)*<sup>9</sup> and the *Pima County Signing Manual*<sup>17</sup>

## **3.2. GEOMETRIC ELEMENTS**

Geometric design of residential (both urban and rural) and commercial subdivisions shall be in accordance with the following criteria. Geometric standards not specifically included in this manual shall conform to the latest edition of *A Policy on Geometric Design of Highways and Streets*<sup>2</sup> published by the American Association of State Highway and Transportation Officials (AASHTO).

### **3.2.1. Design Controls**

The two main roadway design controls are design speed and the design vehicle. The minimum design speed for local streets, residential collectors and major collectors are summarized in Table 3.6. In cases where the design speed exceeds 40 mph, the *Pima County Roadway Design Manual*, and *A Policy on Geometric Design of Highways and Streets* shall be used for roadway design.

A 20-mph design speed can be used for local streets in mountainous terrain. A street section is considered to be in mountainous terrain if it traverses areas with terrain slopes of 15% or greater, which are both longer than 50 feet when measured

in any horizontal direction, and higher than 7.5 feet when measured vertically. Residential and major collectors in mountainous terrain must still meet the criteria in Table 3.6.

Table 3.6. Design Controls for Geometric Design

	Local Street	Residential Collector	Major Collector
Design Speed (mph)	25	25-30	40
Design Vehicle*	WB-40	WB-40	WB-50

\* The characteristics of the design vehicles are elaborated in AASHTO<sup>2</sup>

The minimum design vehicles for the various classes of subdivision streets are also presented in Table 3.6. Non-residential subdivisions and parking area access lanes (PAAL) shall be designed for the largest vehicle anticipated to use the facility.

### 3.2.2. Horizontal Alignment

#### 3.2.2.1. General Design Considerations

When designing the horizontal alignment of a roadway, the following considerations must be taken into account:

- The design of horizontal and vertical alignments should be well coordinated to avoid undesirable driver reactions.
- Compound circular curves should be avoided. In special cases where topography or right-of-way constraints require the use of compound curves, the radius of the flatter curve should not exceed 1.5 times the radius of the sharper curve. Broken-back curves (two curves in the same direction with a short tangent between them) should also be avoided.
- When superelevation is used in reverse curves, a minimum tangent separation of at least 4/3 of the longer of the two superelevation runoff lengths shall be used.
- Roadways must not approach intersections in a horizontal curve. A tangent section of at least 25 feet, measured from the nearest right-of-way line of the cross street, must be provided on all intersection approaches where at least one of the intersecting streets is a collector or arterial. If both intersecting roadways

are local streets, a tangent section must be provided between the right-of-way line of the cross street and the intersection of the centerlines. Detail 3.9 illustrates this requirement.

- An angle point is acceptable for breaks in tangent alignment of less than 1°08'.

### 3.2.2.2. Horizontal Curves

The minimum centerline radius for a circular horizontal curve is given by the following equation:

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

where:  
 V: Design speed (mph)  
 f: Side friction factor  
 e: Superelevation rate (ft/ft)  
 R: Radius of curve (ft)

The limiting side friction values for various design speeds are given in Table 3.7. Those values are based on the design for low-speed urban streets included in *A Policy on Geometric Design of Highways and Streets*<sup>2</sup>. Table 3.7 also provides the minimum centerline curve radius for cases when a normal crown is used (assuming e=-0.02) and for cases when the maximum superelevation is used (e=0.04). If a different superelevation is required, the equation provided must be used to determine the minimum curve radius.

Table 3.7. Limiting Side Friction Values and Minimum Curve Radius

Design Speed (mph)	20	25	30	35	40
Maximum f	0.300	0.252	0.221	0.197	0.178
R <sub>min</sub> (ft) with e=-0.02 (ft/ft)	95	180	300	460	675
R <sub>min</sub> (ft) with e= 0.04 (ft/ft)	80	145	230	345	490

When two tangents of a local street are connected by a curve of less than the minimum radius, a “knuckle” or “eyebrow” design as the one shown in Detail 3.1 must be used.

**3.2.2.3. Superelevation**

Superelevation is not generally used in local streets, but it is often used for collector roadways. The maximum superelevation rate allowed shall be 0.04 (4%). All superelevation transitions, including the tangent runout and the superelevation runoff, must be designed in accordance with the principles defined in *AASHTO, A Policy on Geometric Design of Highways and Streets*<sup>2</sup>.

**3.2.2.4. Stopping Sight Distance**

The sight distance available to drivers across the inside of horizontal curves is an important element in the design and review of a horizontal alignment. Stopping sight distance is a function of design speed and grade. The minimum stopping sight distance for level ground (grades up to 2%) and for downgrades up to 6% are presented in Table 3.8.

Table 3.8. Stopping Sight Distance

Design Speed (mph)	20	25	30	35	40
Stopping sight distance (ft) – Grades ≤ 2%	115	155	200	250	305
Stopping sight distance (ft) – Grades ≤ 6%	120	165	215	270	335

In downgrades greater than 6%, the stopping sight distance must be computed using the following equation from *A Policy on Geometric Design of Highways and Streets*<sup>2</sup>:

$$d = 3.675 \cdot V + \frac{V^2}{10.435 \pm 30 \cdot G}$$

where:

d: Stopping sight distance (ft)

V: Design speed (mph)

G: Grade (ft/ft)

When sight obstructions such as walls, cut slopes, buildings, and continuous median barriers exist on the inside of curves, the distance to the obstruction from the center of the nearest travel lane must be checked. This distance, M, is termed the middle

ordinate of the curve. Guidelines for the middle ordinate are given in *AASHTO, A Policy on Geometric Design of Highways and Streets*<sup>2</sup>, based on the stopping sight distance that must be provided.

### 3.2.3. Vertical Alignment

#### 3.2.3.1. General Design Considerations

When designing the vertical alignment of a roadway, the following considerations must be taken into account:

- A smooth grade line with longer tangent grades and fewer vertical curves should be considered.
- Two vertical curves in the same direction separated by short sections of tangent grade (broken-back grade lines) should be avoided.
- When designing long upgrades, place the flattest grades at the top of the hill to increase the safety at the crest of the hill.
- Avoid hidden dip profiles or roller coaster profiles.
- Investigate drainage at the top of the crest to create positive drainage flow and verify that no ponding occurs at the bottom of a sag curve.

#### 3.2.3.2. Grades

The longitudinal grades allowed in local and collector roadways are intended to provide maintainable operating speeds and efficient drainage. The grades allowed for subdivision roadways are shown in Table 3.9.

Table 3.9. Allowable grades for subdivision streets

Street Class	Grade
Driveways (within public right-of-way)	14.0%
Local Street – Max. grade	10.0%
Collectors (Residential and Major) – Max Grade	8.0%
All Streets – Min. Grade	0.5%

In mountainous terrain (see definition in Section 3.2.1), grades of up to 15% for local streets and up to 12% for collectors (residential and major) may be allowed if a proper request is filed in accordance with Chapter 9, “Administration of the Standards.”

### **3.2.3.3. Stopping Sight Distance**

The provision of adequate stopping sight distance along the entire length of the curve is the primary design control for crest and sag vertical curves. Stopping sight distance is a function of design speed and approach grade. The stopping sight distance required for vertical curves must be calculated using the criteria presented in Section 3.2.2.4.

### **3.2.3.4. Vertical Curves**

Vertical curves are used to accommodate changes in the profile of the terrain. Grade breaks in the profile of 1% or less do not require a vertical curve. Adequate stopping sight distance and pleasing aesthetics must be provided in all vertical curves. Vertical curves should generally be as long as possible to provide for the safest possible roadway. However, in mountainous terrain (see definition in Section 3.2.1), a minimum length vertical curve may be needed to reduce excavation.

The minimum length of vertical curve shall be determined by the greater of the following two criteria:

- For Comfort: Input the design speed into the following equation:

$$L = 3 \cdot V$$

where:

L: Length of vertical curve (ft)

V: Design speed (mph)

- For stopping sight distance: Input the stopping sight distance into the equations in Table 3.10 derived from *A Policy on Geometric Design of Highways and Streets*<sup>2</sup>.

Table 3.10. Minimum length of vertical curves based on stopping sight distance

	Crest Curves	Sag Curves
S<L	$L = \frac{A \cdot S^2}{2158}$	$L = \frac{A \cdot S^2}{400 + 3.5 \cdot S}$
S>L	$L = 2 \cdot S - \frac{2158}{A}$	$L = 2 \cdot S - \frac{400 + 3.5 \cdot S}{A}$

where:

L = length of vertical curve (ft)

S = sight distance (ft)

A = algebraic difference in grades (%)

Alternatively, the minimum curve length for stopping sight distance can be calculated based on the rate of vertical curvature and the difference in grades, as shown in the equation below. The values of K that provide adequate sight distance for a given design speed are presented in Table 3.11. Note that both procedures described here yield the same minimum curve length.

where:

$L = K \cdot A$  L = length of vertical curve (ft)

K = rate of vertical curvature (ft/%)

A = algebraic difference in grades (%)

Table 3.11. Minimum rate of vertical curvature (K) for crest and sag vertical curves

Design Speed (mph)	20	25	30	35	40
K <sub>min</sub> (Crest Curves)	7	12	19	29	44
K <sub>min</sub> (Sag Curves)	17	26	37	49	64

Also, in order to ensure proper drainage, the rate of vertical curvature (K) shall not exceed 167. If K is larger than 167, drainage conditions must be studied.

### **3.2.3.5. Coordination of Vertical and Horizontal Alignments**

The combined effect of vertical and horizontal alignments along a given section of roadway is an important factor to consider. The following considerations should be addressed when considering roadways with both horizontal and vertical curves within the same stretch of roadway:

- Design for middle of the range values for both vertical and horizontal alignments instead of sacrificing one alignment to optimize the other.
- Crest vertical curves should not immediately proceed or be located within sharp horizontal curves.
- Sharp horizontal curvature near the low point in a sag vertical curve should be avoided.
- Horizontal and vertical curves should be as flat as possible when entering or exiting an intersection to ensure necessary sight distances are obtained.

### **3.2.4. Intersections**

The goal of intersection design should be to provide layouts that allow for safe and efficient crossing, merging and diverging of conflicting vehicle streams. These conflicts can significantly be reduced through the provision of adequate sight distance and efficient traffic control devices.

#### **3.2.4.1. Intersection Alignment**

The alignments for the legs of an intersection must take into consideration the following points:

- The centerlines of intersecting local to local and local to collector streets shall have an angle of intersection as close to ninety (90) degrees as is practical. In no case will an angle of intersection be less than seventy-five (75) degrees.

- Right-of-way lines at the corners of street intersections will be rounded with a curve radius of twenty-five (25) feet or greater, or with comparable cutoffs or chords. The radii must be adjusted at skewed intersections to provide sufficient curvature. In all cases, adequate sight distances shall be maintained.
- Intersections shall have a minimum return radius of forty (40) feet for arterials or major collectors, and twenty-five (25) feet for local streets or residential collectors, except when acceleration or deceleration lanes are used. Radii larger than forty (40) feet shall not be used for any street without approval from Pima County. Excessively large radii create increased travelway dimensions that may lead to unsafe conditions for pedestrians. Uncurbed intersections shall utilize concrete header curb throughout the intersection to prevent pavement raveling. When acceleration or deceleration lanes are present, curve radii may be reduced to twenty-five (25) feet.
- Intersections should be located along tangent sections of roadway. In no case shall an intersection be located on or near the inside of a sharp curve.
- Intersections with more than four (4) entering approaches shall not be used.
- Roadways must not approach intersections in a horizontal curve. A tangent section of at least 25 feet, measured from the nearest right-of-way line of the cross street, must be provided on all intersection approaches involving at least one collector or arterial roadway. If both intersecting roadways are local streets, a tangent section must be provided between the right-of-way line of the cross street and the intersection of the centerlines (see Detail 3.9).
- Consecutive intersections on the same or opposite sides of a street shall be offset a minimum of 150 feet from adjacent edges of pavement, as shown in Figure 3.3.

- Landing areas are required for all stopped conditions. The maximum allowable grade for this landing area (in unsignalized intersections) shall be 3% (6% in mountainous terrain) and this grade must extend at least 20 feet in each direction from the outside edge of the traveled way of the intersecting street.

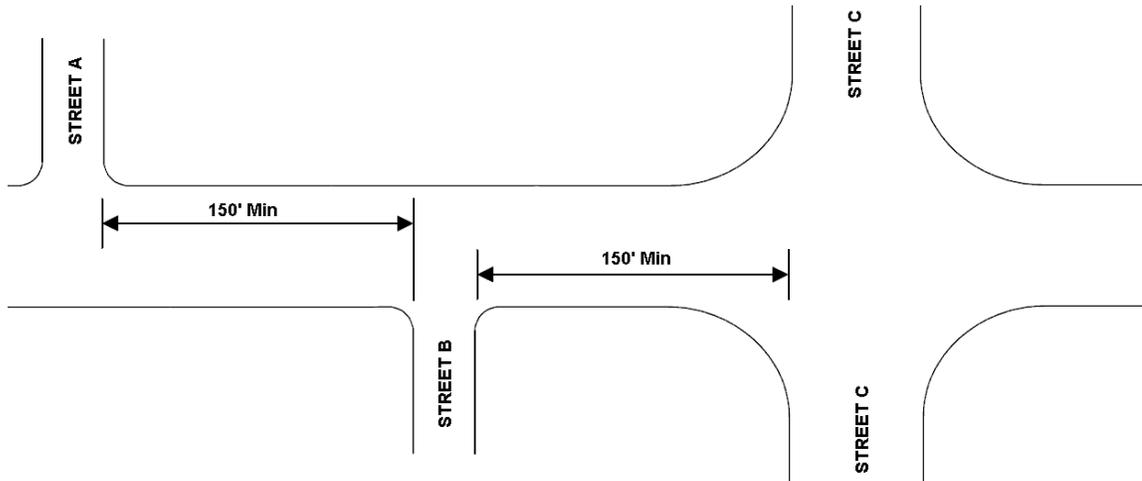


Figure 3.3. Minimum intersection offsets

### 3.2.4.2. Intersection Sight Distance

Clear line of sight shall be maintained along all streets and driveways to provide for the safety of motorists, pedestrians and bicyclists. Sight visibility triangles depend on the following factors: type of intersection control, type of movement, lane configuration, design speed, approach grade and design vehicle.

Table 3.12 illustrates the left (near) side and right (far) side requirements for the most common case; intersections with stop control on the minor road (see Detail 3.10). The values in the table assume that the major street is undivided, the design vehicle is a passenger car (for gap acceptance purposes) and the approach grade is 3% or less. In all other cases the sight visibility triangles shall be determined following the procedure included in the latest edition of *A Policy on Geometric Design of Highways and Streets*<sup>2</sup>.

The left and right side distance requirements of sight triangles along a horizontal curve shall be measured along a chord as opposed to along the arc (See Detail 3.11).

On streets with one-way traffic and streets with two-way traffic separated by raised median islands (i.e. no opening), only the near side sight visibility triangle is required. However, a pedestrian visibility triangle shall be maintained in place of the far side triangle (see Detail 3.12).

Table 3.12. Minimum Sight Distance Triangle Requirements

MAJOR STREET Design Speed of Major Street (mph)	TWO-LANE ROAD		THREE AND FOUR LANE UNDIVIDED		FIVE LANE UNDIVIDED	
	Left Side Requirement (ft)	Right Side Requirement (ft)	Left Side Requirement (ft)	Right Side Requirement (ft)	Left Side Requirement (ft)	Right Side Requirement (ft)
20	140	95	150	75	165	60
25	180	120	195	95	205	80
30	220	145	235	115	250	95
35	260	170	280	135	295	110
40	300	195	320	155	340	130
45	340	220	360	175	385	145
50	380	245	405	190	430	160
55	420	270	445	210	475	175
60	455	295	485	230	520	195

**NOTES:**

1. Assumptions: stop control in minor street, undivided roadway, passenger car and grade of 3% or less.
2. The sight distances presented in the table are equivalent to those developed by ASSHTO. However, they are **measured to the edge of pavement** (see Detail 3.10) instead of to the center of the lane (as done by AASHTO).

The sight lines of the sight triangles shall supercede standard building setback lines where the sight lines require a greater setback distance. Sight visibility triangles shall be depicted to scale on all plats, development plans and landscape plans. The area within the sight triangle must be entirely enclosed within the right-of-way, or within an easement. Restrictive notes pertinent to sight visibility triangles may be required on plats, development plans and landscape plans. No improvements over 30 inches in height relative to the adjacent roadways shall be located within the sight visibility triangles.

### **3.2.5. Traffic Calming**

The goal of traffic calming is to improve the street safety and overall quality of life in residential neighborhoods by reducing vehicle speeds and the volume of cut-through traffic. Traffic calming can be achieved through the utilization of operational measures, design features and sometimes, physical barriers.

This manual has been developed in such a way that the goals of traffic calming should be achieved by a combination of appropriate geometric design criteria, functional classification and traffic parameters. Therefore, the need for physical barriers such as speed humps or chokers is not anticipated.

In the case of unique field conditions, physical barriers and other traffic calming devices may be used if a proper request is filed and approved in accordance with Chapter 9, "Administration of the Standards."

### **3.3. PAVEMENT DESIGN**

These pavement design standards apply to all public or private local and collector street improvement projects designed as part of a development, including off-site improvements. Each development that involves street construction shall submit for approval a pavement design report containing the following information for each street:

- A tabulation of results of soil subgrade tests.
- Projected average daily traffic (ADT).
- 18-kip Equivalent Single Axle Loads (ESAL) used.
- Structural numbers (SN).
- Pavement thickness.

Pavement structure design must be performed following the process outlined in *Materials Preliminary Engineering and Design Manual*<sup>18</sup>, published by the Arizona Department of Transportation. An overview of the process for flexible pavement design is provided here along with parameters appropriate for Pima County. Based on the 20 year projected ADT, the following ESAL's will be accepted for pavement design:

Table 3.13. Accepted ESAL's for Pavement Design

20 year ADT	ESAL
<500	40,000
500-1000	70,000
1000-1500	100,000
1500-2500	150,000

When the projected 20 year ADT exceeds 2500, or when the engineer desires to calculate his own ESAL's, complete calculations, including a breakdown of the traffic by vehicle type, shall be included in the pavement design report. The ESAL calculations shall be based on the 20-year design period and the ESAL factors shown in Table 3.14. The ESAL factors for TS, TT and TST vary depending on the design year according to regression equations developed by FHWA. As an example, for pavement designed for the 2005-2025 period, the median year of the design would be 2015, and "Yr" (see Table 3.14) would be 115 based on the difference between 2015 and the year 1900.

Table 3.14. ESAL Calculation Factors

Vehicle Type		ESAL Factor
Passenger Cars	P	.0008
Buses	BUS	.2500
Light Truck	LT	.0100
Medium Truck	MT	.4000
Tractor Semi-trailer	TS	$-0.98126 + 0.02771 \times \text{Yr}$
Truck-Trailer	TT	$-0.22238 + 0.02041 \times \text{Yr}$
Tractor Semi-trailer Trailer	TST	$-1.44956 + 0.04182 \times \text{Yr}$

Yr = Median year of the design period - 1900

The percentage of total traffic assumed in the design lane shall be 50% for two lane roadways and 45% for four lane roadways.

Subgrade sampling and testing for public or private roadways shall be accomplished in accordance with standard ADOT procedures and the results tabulated in the pavement design report. Soil support values shall be calculated in accordance with the ADOT *Materials Preliminary Engineering and Design Manual*<sup>18</sup> and the selection of a design soil support value shall be fully documented in the pavement design report.

Weighted structural numbers shall be calculated using the design soil support value, the appropriate ESAL, and a Seasonal Variation Factor (SVF). The SVF for the Tucson area is 1.7, for areas outside of Tucson, Figure 202.02-1 and Table 202.02-4 of *Materials Preliminary Engineering and Design Manual*<sup>18</sup> must be consulted. The structural coefficients to be used for various pavement structure courses are shown in Table 3.15.

Table 3.15. Structural coefficients for pavement structure courses

Material	Structural coefficient
Asphalt Rubber Asphaltic Concrete (ARAC)	0.55 <sup>a</sup>
Asphaltic Concrete (AC)	0.44
Cement or bituminous treated base	0.28
Cement or bituminous subgrade	0.23
Aggregate Base (AB)	0.12 <sup>b</sup>

<sup>a</sup> Only 2" of ARAC may use a coefficient of 0.55. The coefficient for thickness in excess of 2" shall be 0.44.

<sup>b</sup> The value of AB should be adjusted by a drainage coefficient of 0.92 for projects in the Tucson area. This results in a value of 0.11. Table 202.02-7 of *Materials Preliminary Engineering and Design Manual*<sup>18</sup> should be consulted for projects in other areas.

The minimum terminal serviceability index (Pt) for design of local streets shall be 2.4, for all collectors the minimum terminal serviceability index shall be 2.6. The minimum weighted structural numbers and pavement sections by roadway classification are presented in Table 3.16.

Table 3.16. Minimum Weighted Structural Numbers and pavement sections

Street Classification	Minimum SN	Minimum AC	Minimum AB
Local Streets	1.49	2.5"	4.0"
Residential Collectors	1.75	3.0"	4.0"
Major Collectors	1.98	3.0"	6.0"

Subbase material should be of significantly better quality than native soil. Subbase may not be used as part of the pavement section when the subgrade soil has an R-value of 30 or greater. In addition, when subbase material is used, the thickness of the subbase may not be more than 1.5 times the combined thickness of the asphalt and aggregate base courses. The layer coefficient for material, which meets minimum Pima County standards for subbase, is 0.05. If better quality material is used, a larger layer coefficient may be used in accordance with Figure 203.00-3 of *Materials Preliminary Engineering and Design Manual*<sup>18</sup>. Cement or bituminous treatment of the subgrade can be considered in lieu of removing and replacing poor native soil. The minimum thickness of these courses is 6 inches.

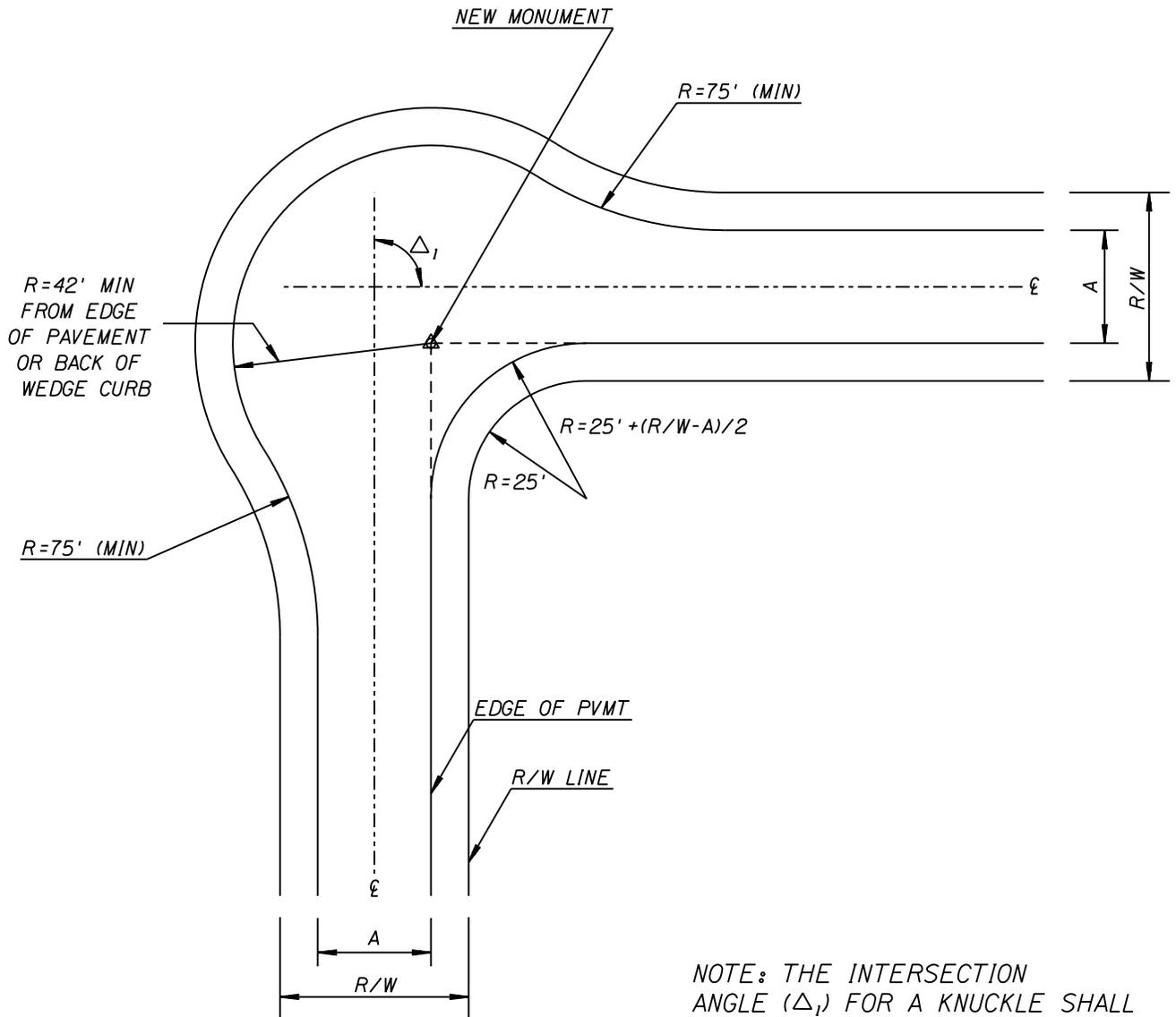
If the minimum thickness of the AC and AB courses together does not provide the necessary SN, increasing the thickness of AC is preferable to specifying deeper sections of AB. This is particularly true if utilities are impacted and driveways must be maintained to adjacent properties during construction.

When existing streets are widened, the new pavement section shall either match the existing pavement section or meet minimum thickness as required in Table 3.16, whichever is greater. Upon completion of a pavement widening, the complete cross section may be required to receive a chip seal coat, slurry seal, microsurfacing or asphaltic concrete overlay, at the discretion of Pima County, for the entire length of the pavement widening.

When through streets are designed which may ultimately connect to future developments, pavement design shall accommodate future wheel loads to account for use of the roadway as a haul-road.

## **REFERENCES**

- <sup>1</sup> U.S. Department of Transportation, Federal Highway Administration. Highway Functional Classification: Concepts, Criteria and Procedures, Washington D.C., 1989.
- <sup>2</sup> American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets, Washington D.C., 2001.
- <sup>3</sup> Pima County Department of Transportation. Roadway Design Manual, Tucson, 2003.
- <sup>4</sup> Institute of Transportation Engineers. Trip Generation, 7<sup>th</sup> edition, Washington D.C., 2003.
- <sup>5</sup> Arizona Department of Transportation. Policies, Guidelines and Procedures, Section 240 Traffic Impact Analyses, Phoenix, 2000.
- <sup>6</sup> Maricopa County Department of Transportation. MCDOT Traffic Impact Procedures, 2000.
- <sup>7</sup> Institute of Transportation Engineers. Manual of Transportation Engineering Studies, Prentice-Hall, Englewood Cliffs NJ, 1994.
- <sup>8</sup> Transportation Research Board. Highway Capacity Manual, National Research Council, Washington D.C., 2000.
- <sup>9</sup> U.S. Department of Transportation, Federal Highway Administration. Manual on Uniform Traffic Control Devices, Washington D.C., 2003.
- <sup>10</sup> Pima Association of Governments. Regional Plan for Bicycling, Tucson, 2000.
- <sup>11</sup> Pima Association of Governments. Regional Pedestrian Plan, Tucson, 2000.
- <sup>12</sup> Pima County Department of Transportation. Pavement Markings Design Manual, Tucson, 2002.
- <sup>13</sup> Kindler, C.E. et al. IHSDM Intersection diagnostic Review Model. Federal Highway Administration Report No. FHWA-RD-02-045, Washington D.C., 2003.
- <sup>14</sup> Pima County Department of Transportation. Standard Details for Public Improvements, Tucson, 2003.
- <sup>15</sup> Pima County Department of Transportation. Standard Specifications for Public Improvements, Tucson, 2003.
- <sup>16</sup> Pima County Department of Transportation. Environmentally Sensitive Roadway Design Guidelines, Tucson, 2002.
- <sup>17</sup> Pima County Department of Transportation. Signing Manual, Tucson, 2002.
- <sup>18</sup> Arizona Department of Transportation, Materials Preliminary Engineering and Design Manual, Third Edition, Phoenix, 1989.



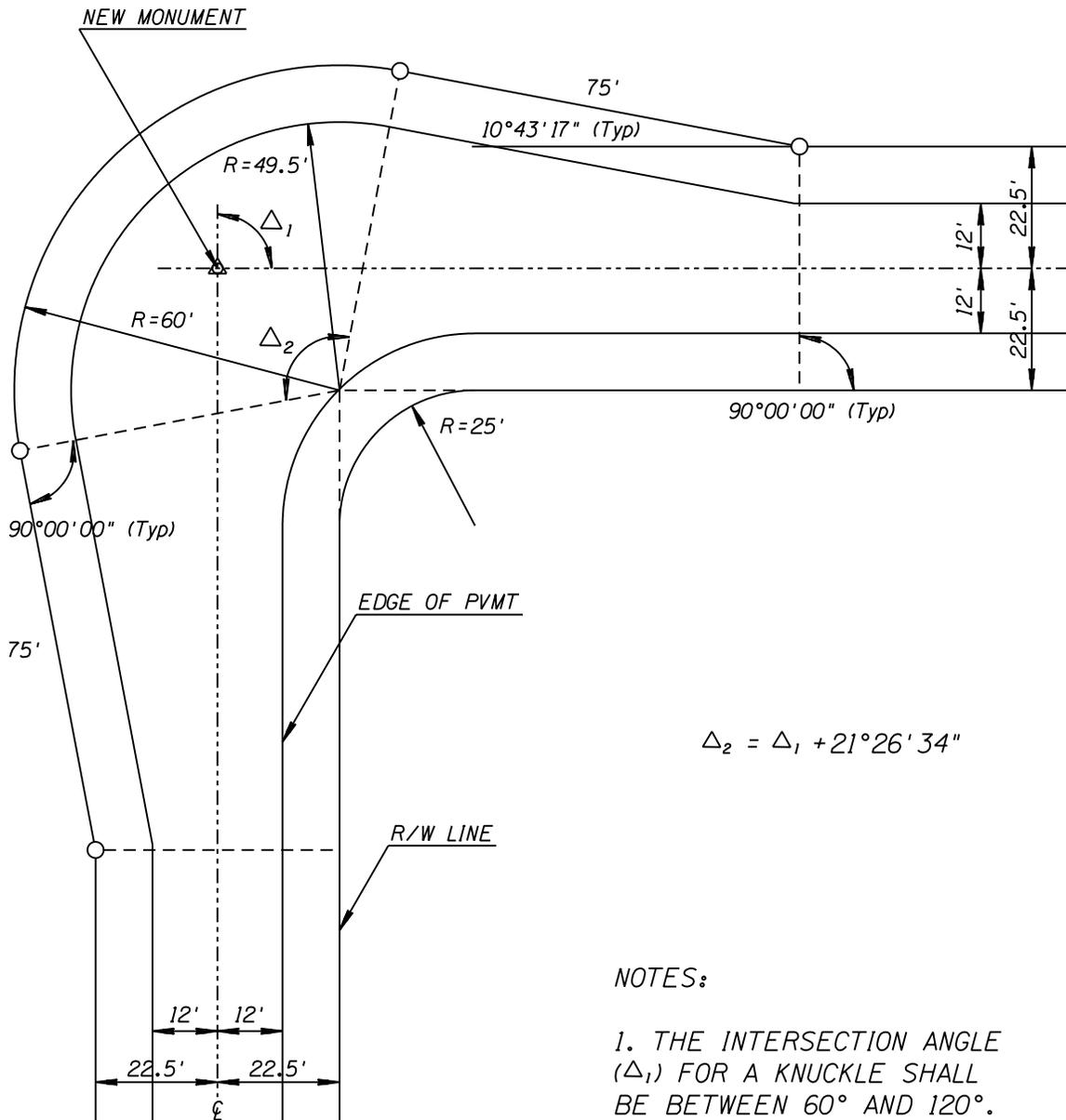
NOTE: THE INTERSECTION ANGLE ( $\Delta_1$ ) FOR A KNUCKLE SHALL BE BETWEEN 60° AND 120°.

DETAIL 3.1-1

KNUCKLE DESIGN  
ALTERNATE 1



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



$$\Delta_2 = \Delta_1 + 21^\circ 26' 34''$$

NOTES:

1. THE INTERSECTION ANGLE ( $\Delta_1$ ) FOR A KNUCKLE SHALL BE BETWEEN  $60^\circ$  AND  $120^\circ$ .

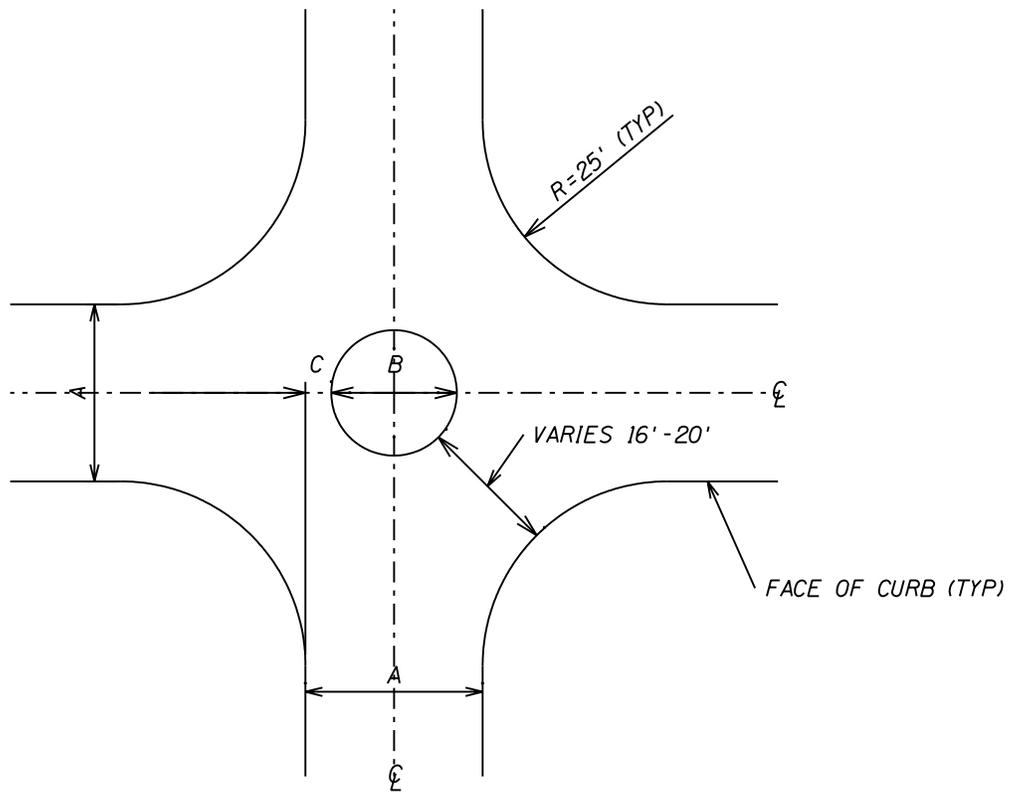
2. THIS KNUCKLE IS TO BE USED ONLY WITH 45' R/W.

DETAIL 3.1-2

KNUCKLE DESIGN  
ALTERNATE 2



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



INTERSECTION DIAGRAM

A STREET WIDTH	B CIRCLE DIAMETER	C
24'	17'	3.5'
30'	24'	3.0'
32'	27'	2.5'
36'	33'	1.5'
40'	38'	1.0'

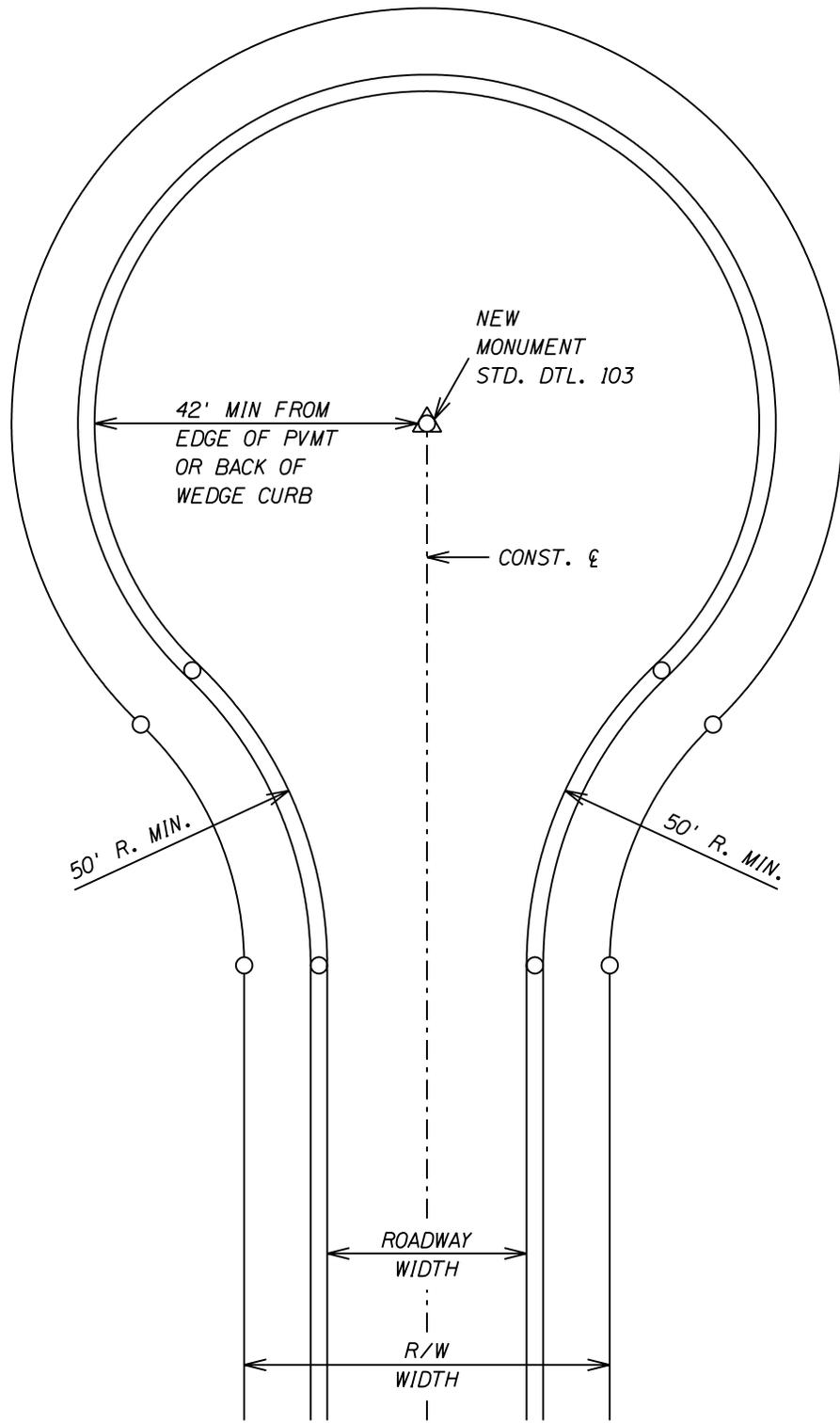
LANDSCAPING/VEGETATION INSTALLED BY THE DEVELOPER/HOMEOWNER'S ASSOCIATION SHALL BE UNDER 30" IN HEIGHT AND SHALL NOT BE MAINTAINED BY PIMA COUNTY. A LICENSE AGREEMENT MUST BE EXECUTED AND APPROVED BY THE DEPARTMENT OF TRANSPORTATION PRIOR TO CONSTRUCTION.

DETAIL 3.2

TYPICAL  
TRAFFIC CIRCLE  
DESIGN



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

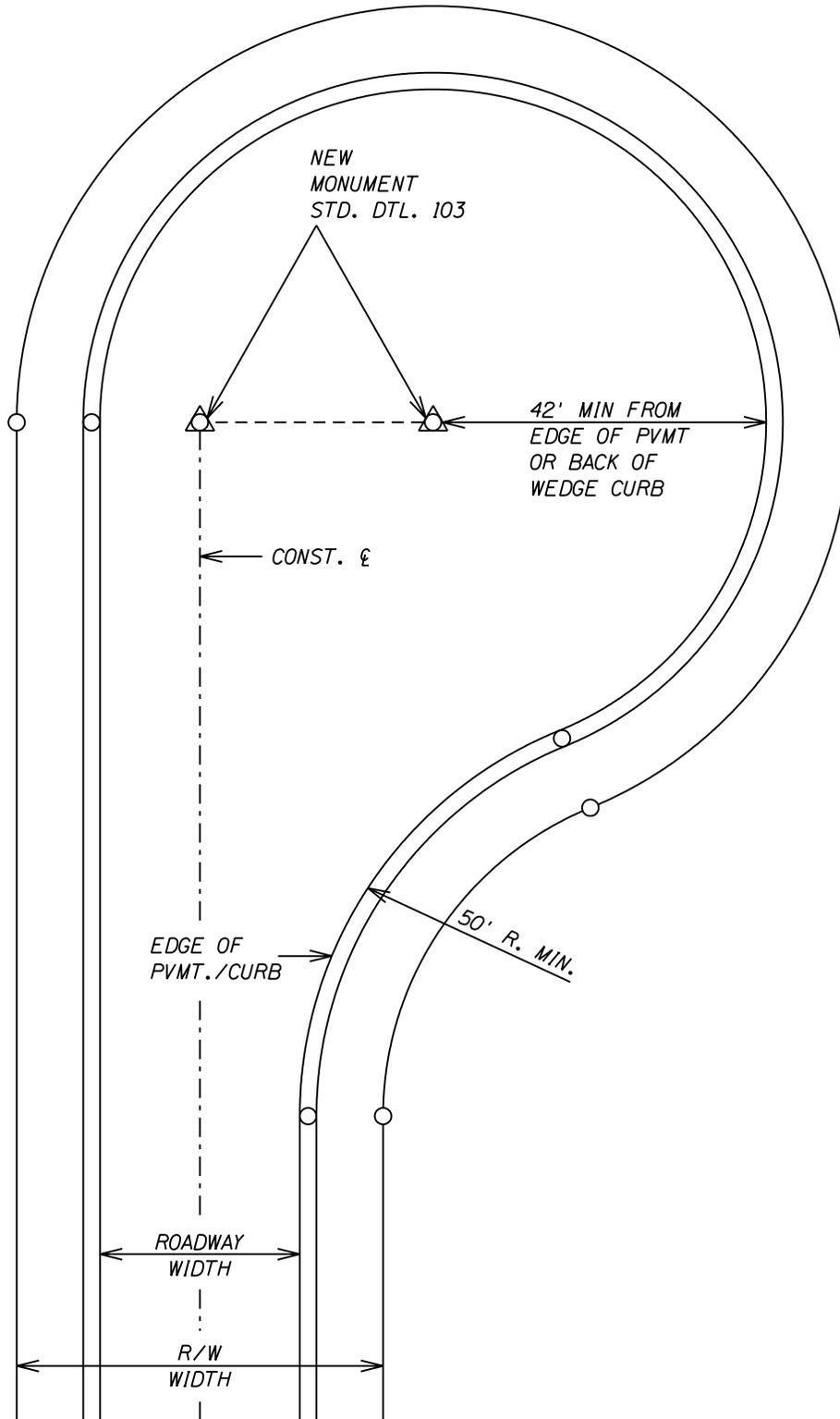


DETAIL 3.3

STANDARD CUL-de-SAC



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

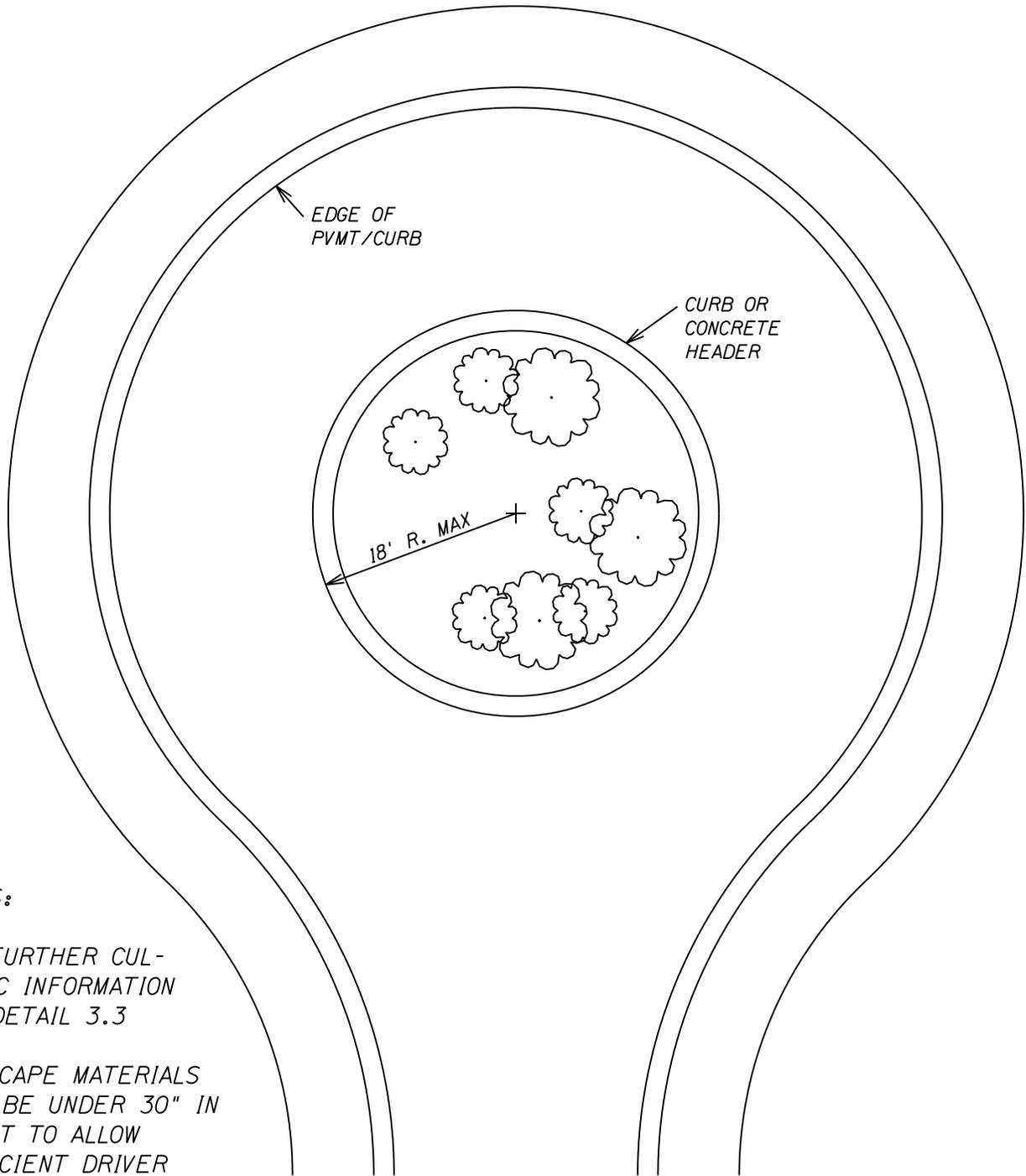


DETAIL 3.4

OFFSET CUL-de-SAC



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



**NOTES:**

FOR FURTHER CUL-de-SAC INFORMATION SEE DETAIL 3.3

LANDSCAPE MATERIALS MUST BE UNDER 30" IN HEIGHT TO ALLOW SUFFICIENT DRIVER VISIBILITY.

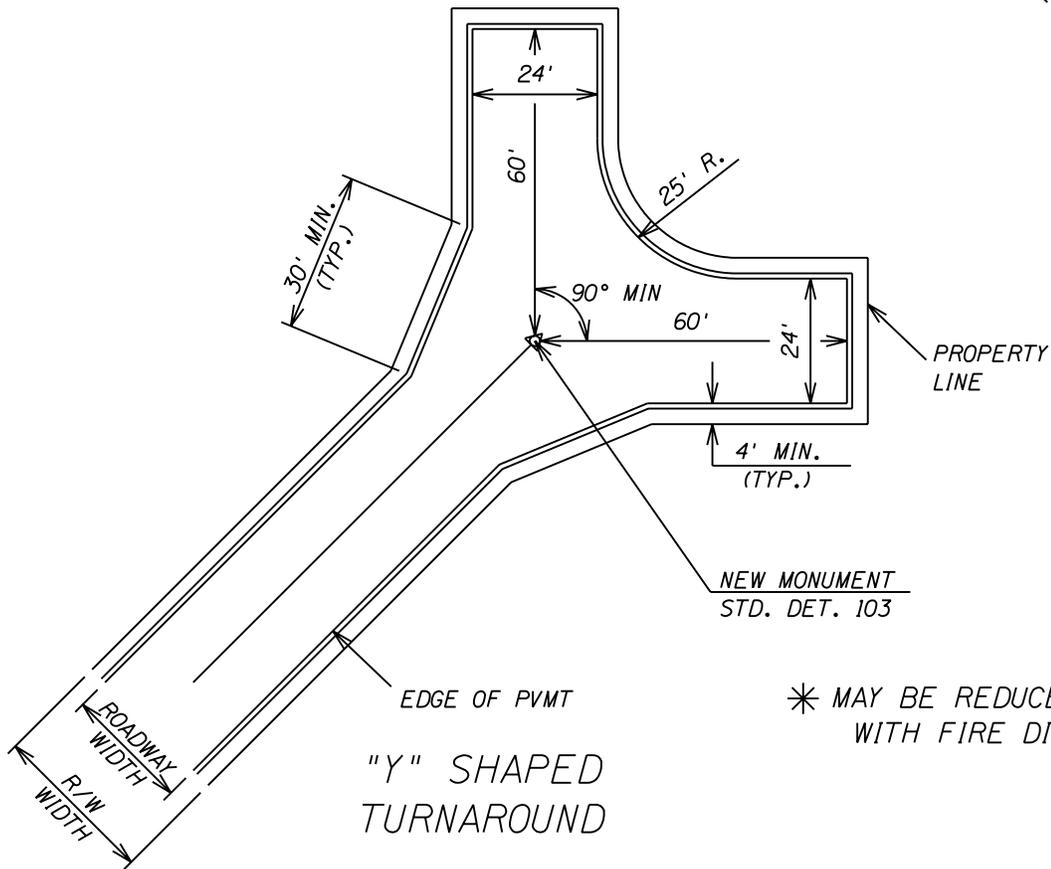
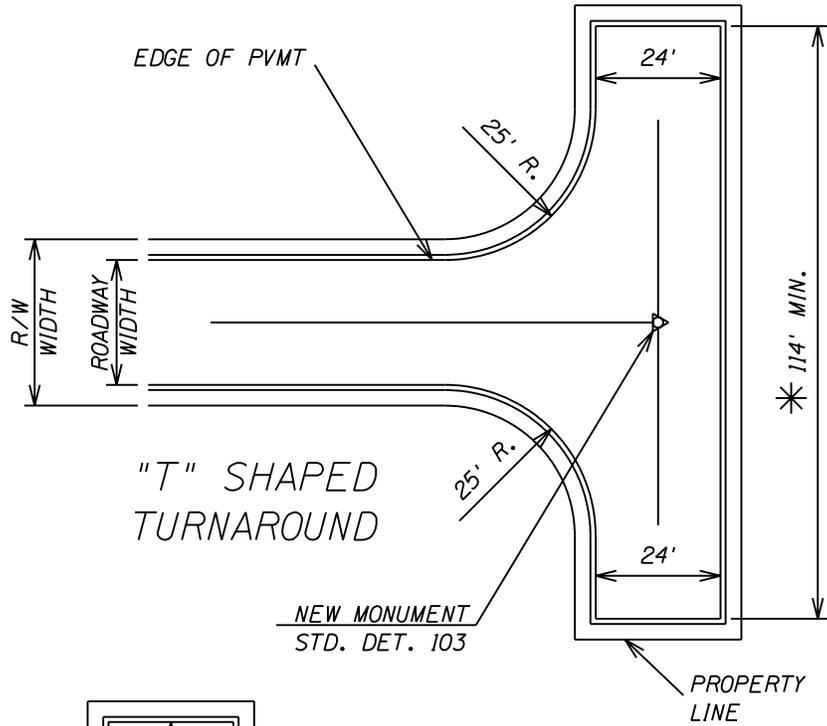
LANDSCAPING/VEGETATION INSTALLED BY THE DEVELOPER/HOMEOWNER'S ASSOCIATION SHALL NOT BE MAINTAINED BY PIMA COUNTY. A LICENSE AGREEMENT MUST BE EXECUTED AND APPROVED BY THE DEPARTMENT OF TRANSPORTATION PRIOR TO CONSTRUCTION.

DETAIL 3.5

CUL-de-SAC  
LANDSCAPING DETAIL



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



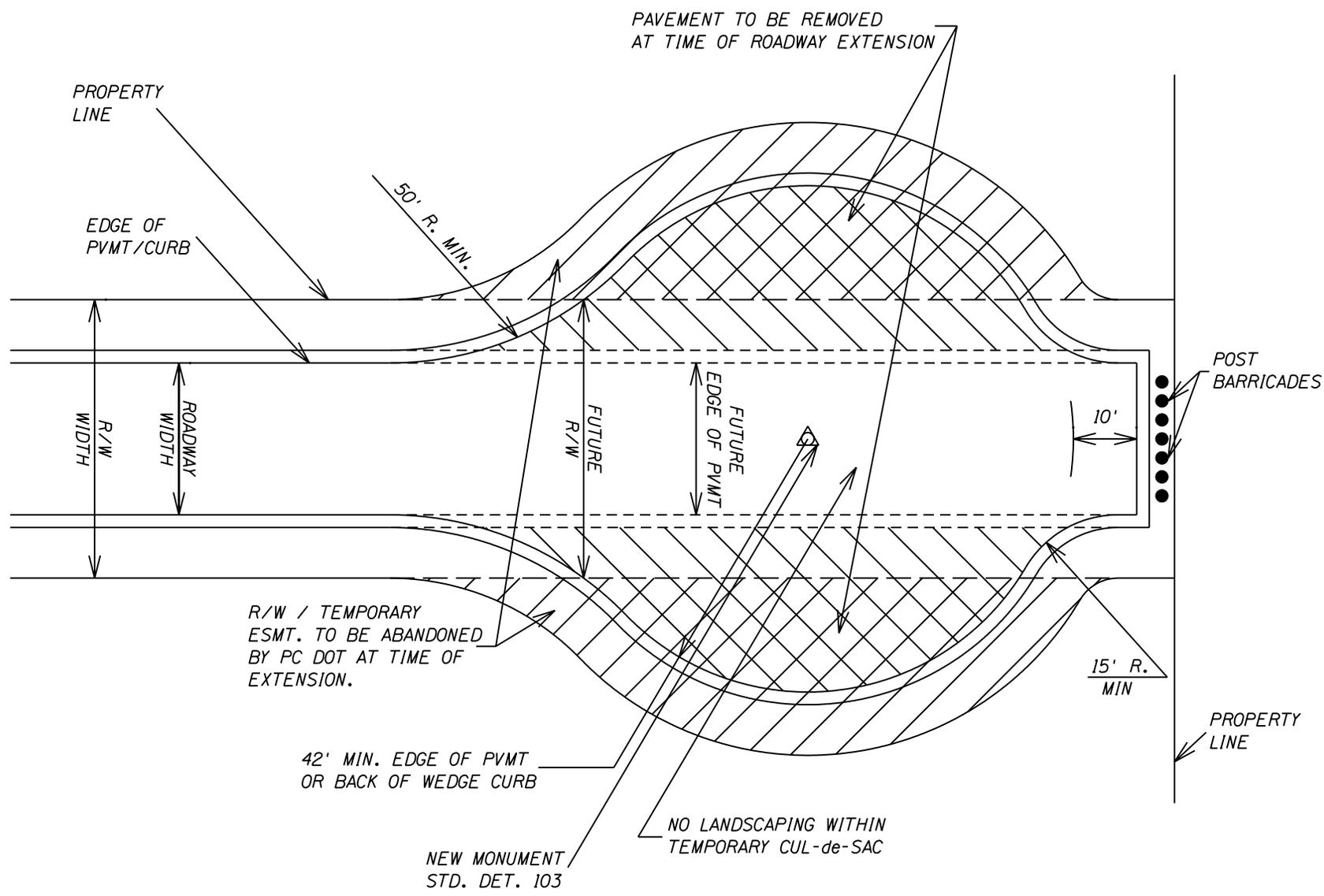
\* MAY BE REDUCED IN ACCORDANCE WITH FIRE DISTRICT CRITERIA

DETAIL 3.6

TURNAROUNDS



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

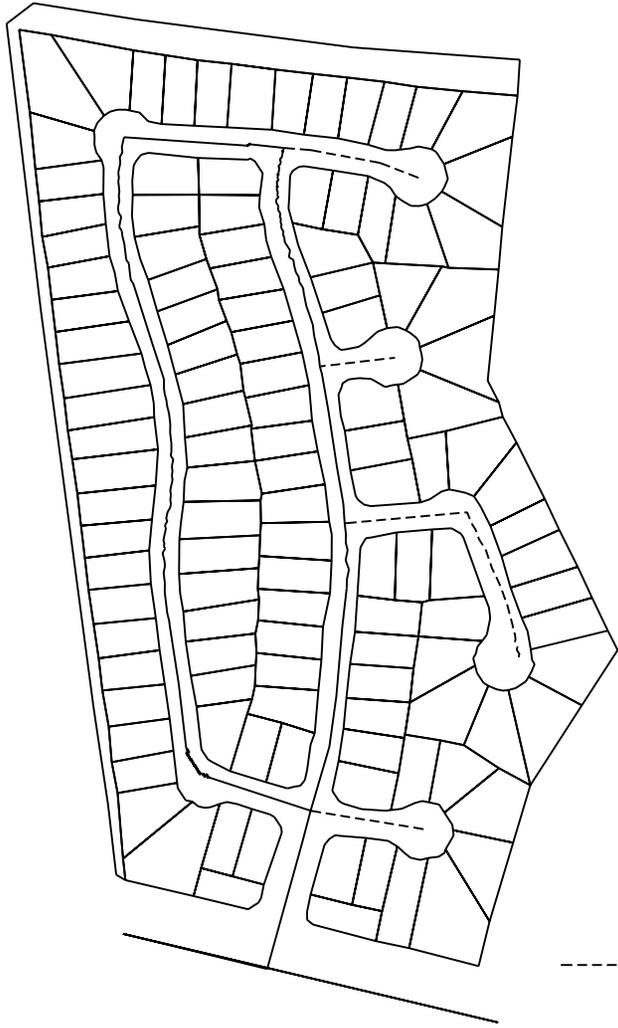


DETAIL 3.7

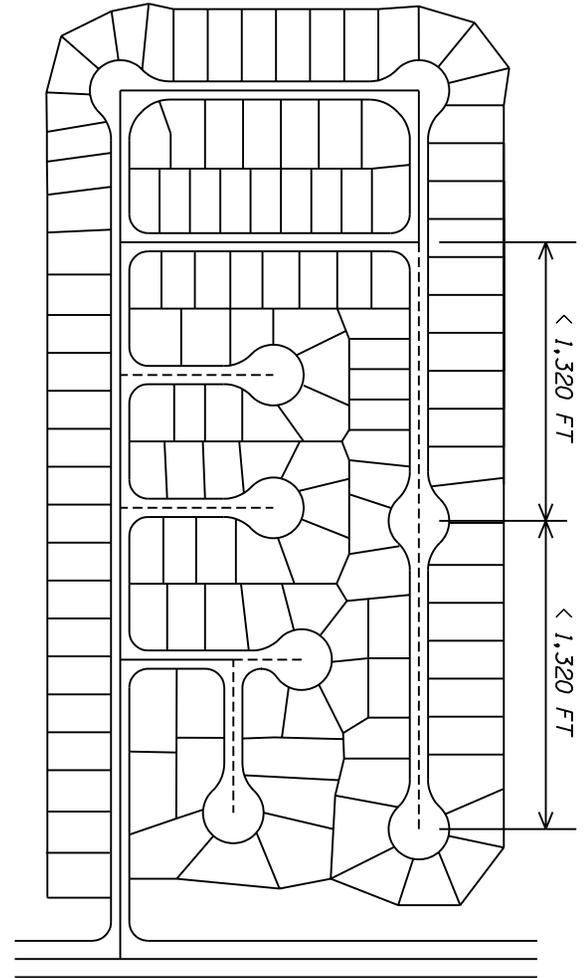
TEMPORARY CUL-de-SAC



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



----- LENGTH OF DEAD-END STREET



NOTE:  
SIGNING OF DEAD-END STREETS MUST BE APPROVED  
BY PIMA COUNTY TRAFFIC ENGINEERING DIVISION

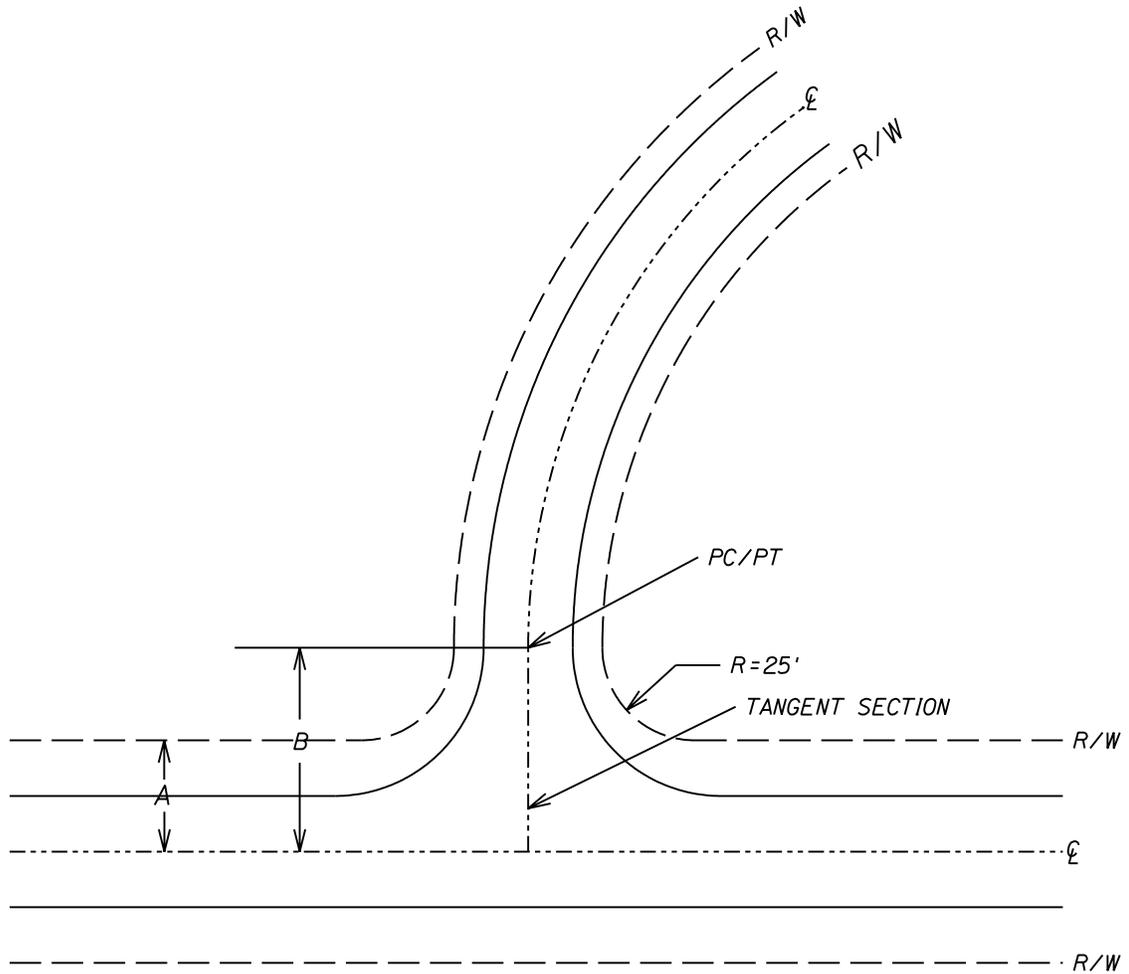
NOT TO SCALE

DETAIL 3.8

DEAD-END STREET  
MEASUREMENT  
AND DETAIL



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



INTERSECTION DIAGRAM

INTERSECTION	B
1 OR MORE COLL./ART.	A + 25'
2 LOCAL STREETS	A

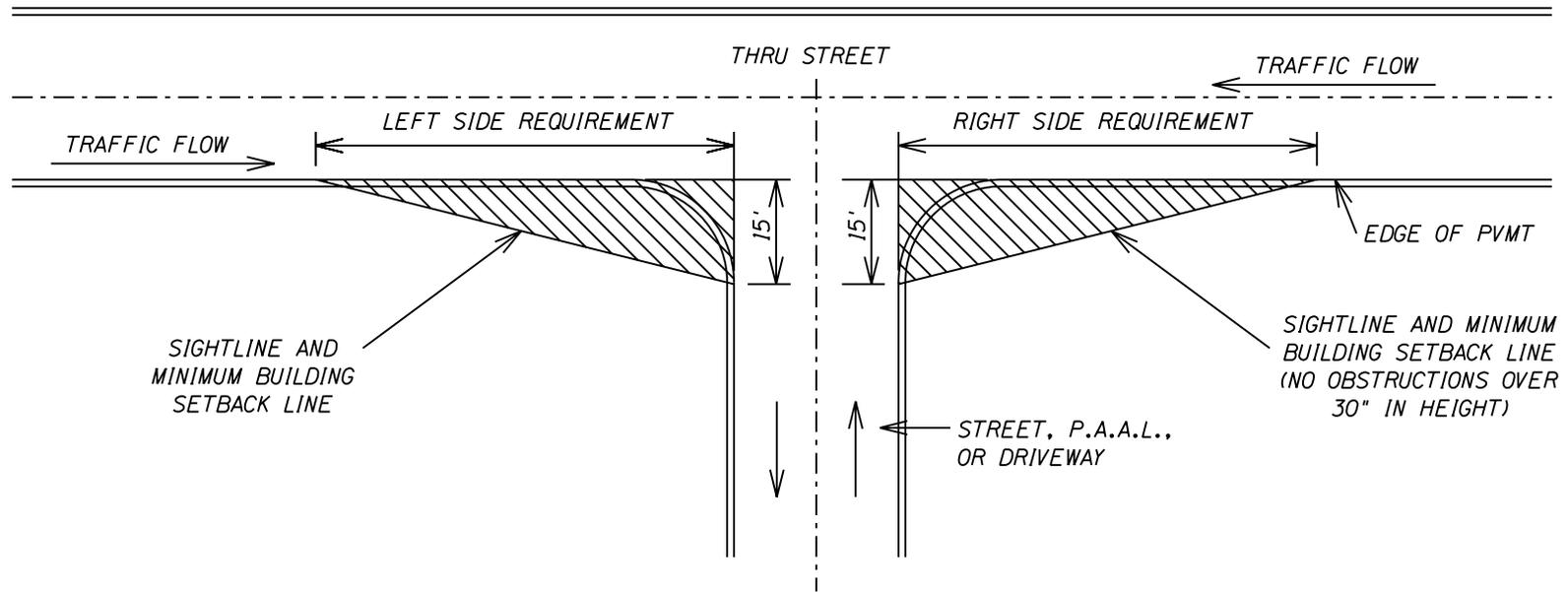
IN ALL CASES, ROADWAY CENTERLINES  
MUST BE TANGENT AT THE EXTENSION  
OF THE RIGHT-OF-WAY LINE

DETAIL 3.9

MINIMUM TANGENT  
SECTION AT  
INTERSECTIONS



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



DESIGN SPEED OF MAJOR STREET (mph)	TWO-LANE ROAD		THREE- AND FOUR-LANE UNDIVIDED		FIVE-LANE UNDIVIDED	
	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)
20	140	95	150	75	165	60
25	180	120	195	95	205	80
30	220	145	235	115	250	95
35	260	170	280	135	295	110
40	300	195	320	155	340	130
45	340	220	360	175	385	145
50	380	245	405	190	430	160
55	420	270	445	210	475	175
60	455	295	485	230	520	195

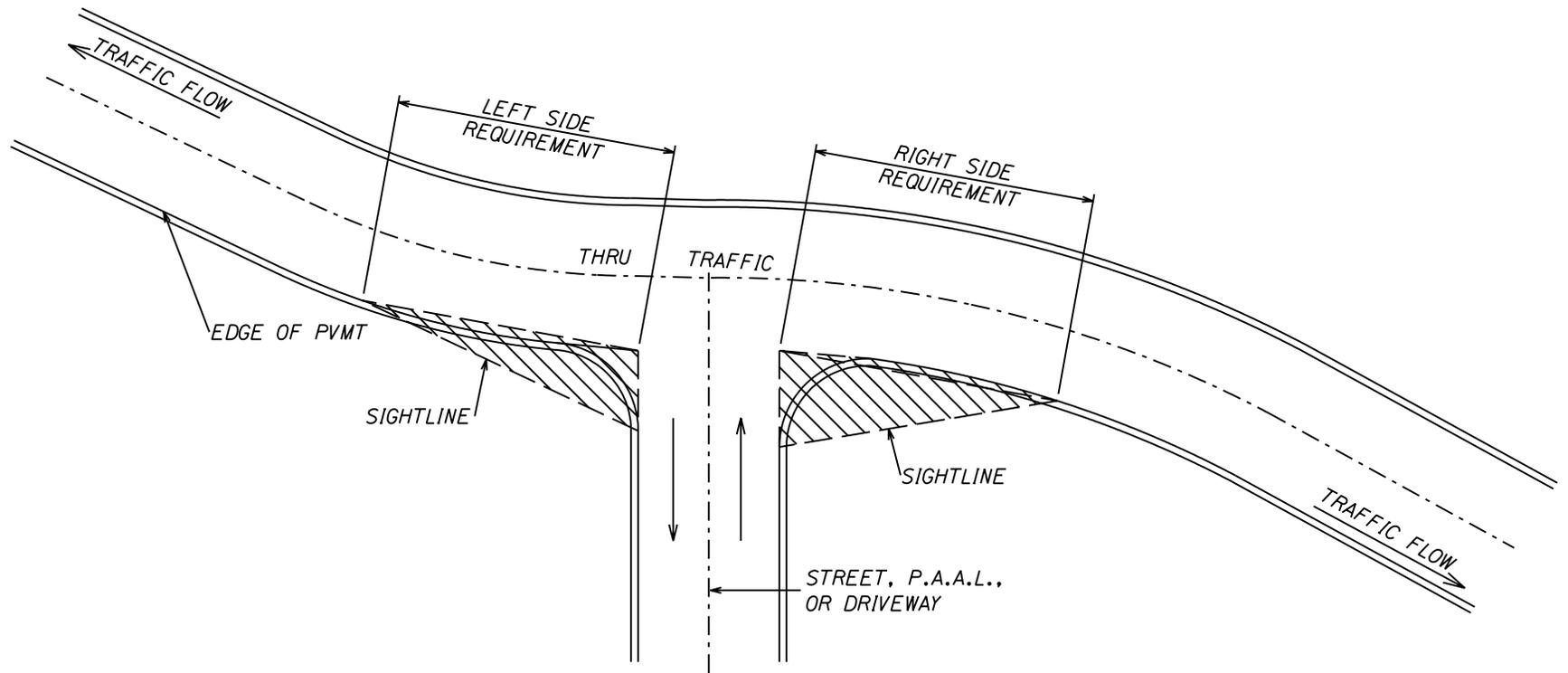
NOTE: THE SIGHT DISTANCES SHOWN ARE MEASURED FROM EDGE OF PAVEMENT TO EDGE OF PAVEMENT

DETAIL 3.10

TYPICAL  
SIGHT DISTANCE  
TRIANGLES



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



DESIGN SPEED OF MAJOR STREET (mph)	TWO-LANE ROAD		THREE- AND FOUR-LANE UNDIVIDED		FIVE-LANE UNDIVIDED	
	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)	LEFT (NEAR) SIDE REQUIREMENT (ft)	RIGHT (FAR) SIDE REQUIREMENT (ft)
20	140	95	150	75	165	60
25	180	120	195	95	205	80
30	220	145	235	115	250	95
35	260	170	280	135	295	110
40	300	195	320	155	340	130
45	340	220	360	175	385	145
50	380	245	405	190	430	160
55	420	270	445	210	475	175
60	455	295	485	230	520	195

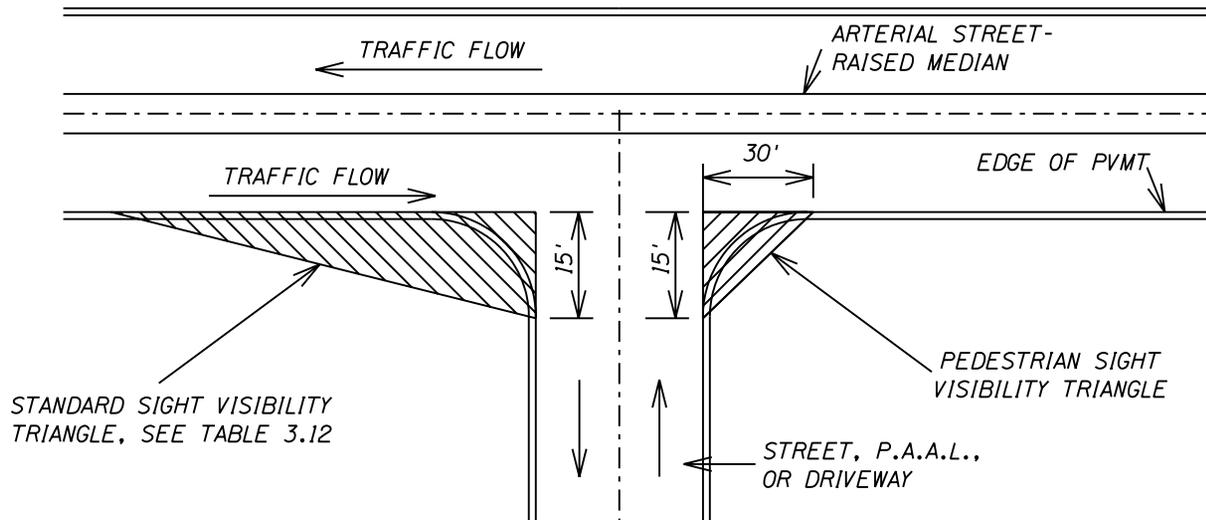
NOTE: THE SIGHT DISTANCES SHOWN ARE MEASURED FROM EDGE OF PAVEMENT TO EDGE OF PAVEMENT

DETAIL 3.11

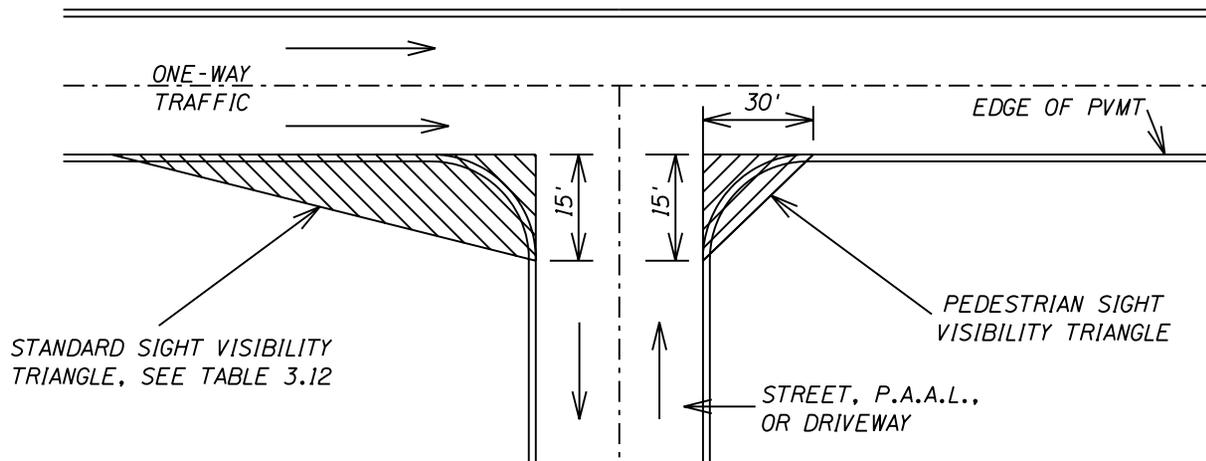
## CURVILINEAR ROADWAY SIGHT DISTANCE TRIANGLES



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



NOTE: THE SIGHT DISTANCES SHOWN ARE MEASURED FROM EDGE OF PAVEMENT TO EDGE OF PAVEMENT



NOTE: THE SIGHT DISTANCES SHOWN ARE MEASURED FROM EDGE OF PAVEMENT TO EDGE OF PAVEMENT

DETAIL 3.12

PEDESTRIAN SIGHT DISTANCE TRIANGLE



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

## 4. URBAN RESIDENTIAL SUBDIVISIONS

Before using this chapter verify that the subdivision meets the requirements outlined in section 2.1.2 for urban residential subdivisions.

The design standards covered in this chapter are applicable to urban residential subdivisions only. Urban residential subdivisions must also comply with the design standards defined in Chapter 3, “Design elements common to all development types.”

### 4.1. CROSS SECTIONAL ELEMENTS

The cross section of a street consists of several elements in the roadway and in the roadside. A discussion of these elements and their relation to each street functional class is provided in the first two parts of this section (Roadway and Roadside). The third part of the section introduces typical cross sections for each of the street functional classes defined in Chapter 3.

#### 4.1.1. Roadway

The roadway is the portion of the cross section that is intended for vehicular use, including bike lanes and any shoulders provided. However, since all streets in urban subdivisions must be curbed, shoulders shall not be required. The roadway elements used in urban residential subdivisions must meet the following criteria:

- The minimum lane width for vehicular travel lanes for local streets shall be 12 feet if wedge curb is used and 14 feet if vertical curb is used. In order to control speeds in residential areas, the total pavement width of a local street shall not exceed 30 feet.

- All residential collectors shall have a minimum lane width of 14 feet. On-street parking shall not be allowed on residential or major collectors.
- All major collector streets shall have 6-foot bike lanes on both sides (measured from the edge of the travel lane to the face of curb).
- Major collector streets shall have a two way left turn lane to allow vehicles to turn without interfering with the through-moving vehicles. The minimum width of the two way left turn lane shall be 12 feet. Additional dedicated turning lanes may be required on residential and major collectors in the vicinity of intersections. The need for additional turning lanes shall be defined based on the criteria in Section 3.1.3 and on the Traffic Impact Study (if available). The minimum width of a turning lane shall be 12 feet.
- The roadway cross slope shall range from 1% to 3% for all street classes (2% cross slope is standard). The cross slope allowed in superelevated horizontal curves is discussed in Section 3.2.3.3. Inverted crowns are not acceptable for urban residential subdivision streets.
- Major collectors shall be striped according to the Pima County *Pavement Marking Design Manual*<sup>1</sup>. Pima County may also require pavement markings for residential collectors and/or local streets when deemed necessary.

Table 4.1 summarizes the minimum dimensions of roadway elements based on street classification.

Table 4.1. Standard element dimensions for urban residential streets

	Local Street	Residential Collector	Major Collector
Travel lanes	12'	14'	12'
Two way left turn lane	Not required	Not required	12'
Turning lanes	Not required	12' (See Sect 3.1.3)	12' (See Sect 3.1.3)
Bike lanes	Not required	Not required	6'
Cross slope	1% - 3%	1% - 3%	1% - 3%

#### 4.1.2. Roadside

The roadside includes all street elements beyond the edge of pavement. This section addresses the following roadside elements: curbs, sidewalks, side slopes, horizontal clearance to obstructions, traffic barriers, handrails, right-of-way, utilities and driveways. Design criteria for medians are discussed in Section 3.1.5.

##### 4.1.2.1. Curb

Curbing shall be required on all urban subdivision streets. For local streets, either wedge curb or vertical curb can be used as shown in Details 4.1 and 4.2. Residential and major collectors must utilize vertical curb to emphasize the separation between vehicular and pedestrian traffic.

At the intersections of two local streets, the minimum curb radius shall be 25 feet along the face of curb. The curb radius of intersections involving at least one collector roadway (residential or major), must be designed to accommodate the turning movement of the design vehicle specified in Table 3.6.

Curb access ramps shall be provided at all curb returns and shall be designed according to Pima County's *Standard Details for Public Improvements*<sup>2</sup>.

##### 4.1.2.2. Sidewalk

Sidewalks shall be required on both sides of all streets within urban residential subdivisions. Connectivity of pedestrian facilities is required within all subdivisions. A

4-foot or wider clear area can be used in lieu of sidewalks along the non-lot side of a single loaded street if a proper request is filed and approved in accordance with Chapter 9, "Administration of the Standards." In cases where pedestrian traffic is extremely unlikely and sidewalks will not be provided, authorization may be granted if a proper request is filed and approved in accordance with Chapter 9, "Administration of the Standards." Sidewalks shall be of Portland cement concrete and shall be constructed according to Pima County's *Standard Details for Public Improvements*<sup>2</sup>.

The area between the back of curb and the roadside edge of the sidewalk is the curbway. When wedge curb is used for local streets, the minimum curbway width shall be 3 feet and the minimum sidewalk width shall be 4 feet. In no case can the sidewalk be adjacent to a wedge curb. Local streets designed with vertical curb may have the sidewalk adjacent to the curb if the sidewalk is at least 5 feet wide.

All residential and major collectors must have a minimum curbway of 3 feet with a sidewalk at least 5 feet wide.

A maintenance space between the sidewalk and the lot property line shall be provided for sidewalks maintained by Pima County and must be 1 foot or greater depending on grade differentials and available right-of-way.

No irrigation systems will be permitted within the curbway. Neighborhood postal units shall be designed and located in such a manner as not to present a hazard to the motoring public or pedestrians.

#### **4.1.2.3. Side Slopes**

All cut and fill slopes shall be constructed in accordance with the Grading Standards, chapter 18.81 of the *Pima County Code*<sup>3</sup>, and *AASHTO A Policy on Geometric Design of Highways and Streets*<sup>4</sup>. Cut and fill slopes over 2 feet in height shall be revegetated or stabilized as shown in Table 4.2. All revegetated areas, as well as

the method of irrigation and maintenance responsibility until final stabilization must be clearly identified in the landscape plans.

Table 4.2. Treatment methods for cut-fill slopes over 2 feet in height

Cut of Fill Slope (H:V)	Treatment
3:1 or less steep	Revegetate
Steeper than 3:1 to 2:1	Rock rip-rap with filter fabric
Steeper than 2:1	Grouted rip-rap or retaining structure

Alternative methods of stabilization may be allowed if certified as stable by a registered geotechnical engineer, and a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” Terracing may be done as provided in the *Grading Standards of the Pima County Code*<sup>3</sup>.

All cut and fill channel slopes and stabilization methods shall be constructed in accordance with the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup> by the Pima County Flood Control District.

**4.1.2.4. Horizontal Clearance to Obstructions**

Typical clear zone requirements do not apply to low-speed curbed roadways in urban environments. However, a minimum clearance of 1 foot should be provided between the back of curb and all obstructions<sup>4</sup>.

**4.1.2.5. Traffic Barriers**

Guardrails and other traffic barriers are effectively roadside obstacles. In consequence, a significant number of crashes with guardrails produce injuries. The proximity of guardrail to the traveled way often also increases accident rates. Therefore, guardrail should only be installed where the potential consequences of departure from the roadway (in terms of accident severity and frequency) are extremely severe.

Because of their design speeds, barriers are generally not required for local streets or residential collectors. However, engineering judgement must be exercised by the designer to determine the need for barriers under exceptional circumstances. Figure 4.1 presents the risk warrant for embankment recommended in AASHTO's *Roadside Design Guide*<sup>5</sup>. Barriers are warranted for conditions falling above the warrant line in the figure.

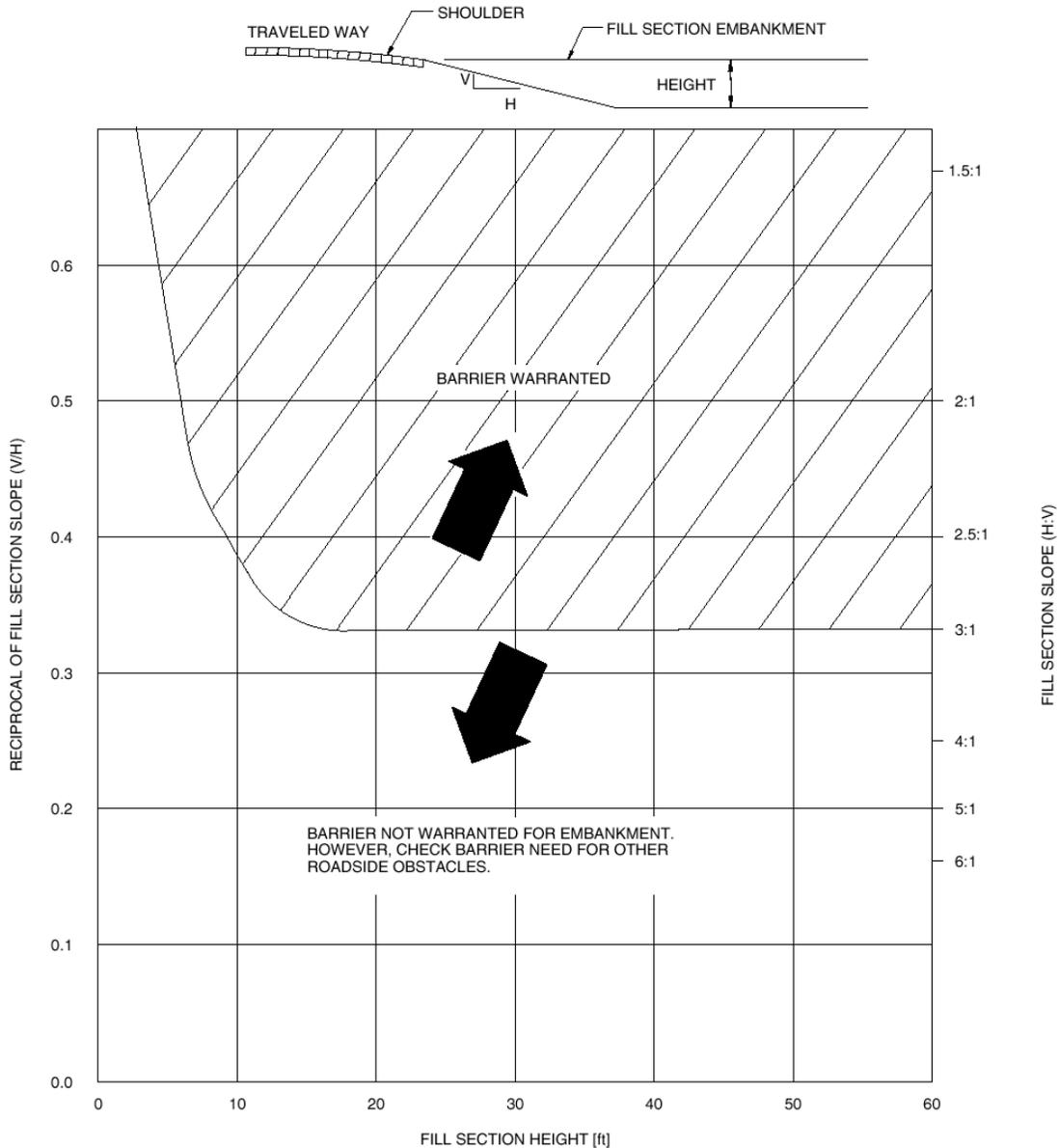


Figure 4.1. Barrier risk warrant for embankments (from AASHTO<sup>5</sup>)

When a barrier is used, it must be placed where the non-recoverable slope or obstruction begins to keep it as far as possible from the traveled way. The minimum spacing allowed from the edge of the traveled way to the face of the barrier shall be 4 feet. Barriers must be installed in accordance with current ADOT standard Specifications and Drawings.

Post barricades are an acceptable treatment for roadways that dead-end into drainage channels.

**4.1.2.6. Handrails**

Handrails shall be installed for protection of pedestrians whenever slopes are steeper than 2:1 (H:V) within 3 feet of the sidewalk and the embankment height is 3 feet or greater. The design engineer may determine that differences in elevation between the sidewalk and nearby terrain under other circumstances may also warrant the installation of handrail. Handrail shall be built in accordance with Pima County's *Standard Details for Public Improvements*<sup>2</sup>

**4.1.2.7. Right-of-way**

Right-of-way must be wide enough to encompass all cross sectional elements. The minimum right-of-way required for each of the applicable street functional classes is shown in Table 4.3. However, the following additional provisions are made in regards to right-of-way:

*Table 4.3. Minimum right-of-way requirements by functional class*

Street Class	Right-of-Way
Local street	45'
Residential collector - No property access	48'
Residential collector - Property access allowed	60'
Major collector	90'-120'

- In no case shall the travel lanes, medians, shoulders, curbs or sidewalks be located in easements. Easements may be granted in lieu of right-of-way for certain cross section elements such as utilities, sewers and slopes. Such easements must specifically grant right of entry to Pima County to allow proper maintenance of the facilities located within the easement and to enable remedy from hazards to the public so as to assure public safety.
- Collector street right-of-way shall be of sufficient width to accommodate the ultimate pavement section required for the projected design year traffic. Additional rights-of-way may be required by the Department of Transportation at intersections identified on the Pima County *Major Streets and Scenic Routes Plan*<sup>6</sup> or intersections of other collectors where it is deemed necessary to provide sufficient width for turning lanes, sight visibility and other design and safety considerations.
- When it is determined by Pima County that, in the public interest and for the health, welfare, or safety of same, vehicular access to or from a development or subdivision at a particular location should be prohibited, a 1 foot wide Vehicle Access Control Easement (VACE) shall be granted to the public.
- Supplemental right-of-way may be required at all intersections where standard right-of-way widths are unable to completely enclose the sight distance triangles. If right-of-way is not granted for sight distance, an easement in a common area will be required restricting the use within the sight distance triangles (see Section 3.2.4.2). In no case shall any part of the sight distance triangles fall within an individual lot.

#### **4.1.2.8. Utilities**

With the exception of minor service extensions to individual parcels, all longitudinal utility facilities (including sanitary sewers and telecommunications) between service points to individual parcels shall be located within the street right-of-way. Strip

easements may be used along streets in lieu of right-of-way if for utility purposes and for other uses compatible with utility needs (subject to utility company approval). Access between the street and the private property shall not be denied.

All sanitary sewer facilities shall be provided in accordance with the current Pima County *Standard Specifications for Public Improvements*<sup>7</sup> and the *Standard Details for Public Improvements*<sup>2</sup>. All services shall be provided or stubbed out to existing or planned parcels with all new street construction to avoid the need to remove and replace new pavement.

#### **4.1.2.9. Driveways**

Driveways providing access to subdivision lots shall comply with the following standards:

- The lot frontage shall be at least 30 feet in order to allow room for the driveway and the installation of utilities.
- If parking is designed to be in the lot driveways, at least 20 feet of driveway length shall be provided between the back of the sidewalk and the garage opening to ensure that vehicles parked in the driveway do not block the sidewalk.
- Common drives shall serve a maximum of four lots and shall be limited to a maximum of 150 feet in length to facilitate the provision of municipal services such as fire and trash pick-up.

#### **4.1.3. Typical Cross Sections**

As has been discussed throughout this Chapter, the need for certain cross sectional elements and their dimensions depend on the functional classification of the street. Typical cross sections for each applicable street class are presented here.

#### **4.1.3.1. Local Streets**

There are two alternative minimum cross sections for local streets. The first alternative (see Detail 4.1) has 12-foot travel lanes, wedge curb, 3-foot curbway and 4-foot sidewalk on each side. If vertical curb is used the lanes must be 14 feet wide and the sidewalk must be 5 feet wide (if the 3-foot curbway is not provided). This scenario corresponds to the second alternative (see Detail 4.2).

#### **4.1.3.2. Residential Collectors**

Residential collectors handle larger traffic volumes than local streets and are also allowed longer tangent sections. To ensure the safety of pedestrians it is necessary to provide clear separation between the roadway and the sidewalk. Therefore, the utilization of wedge curb is not allowed in residential collectors. Vertical curb, with a 3-foot curbway and 5-foot sidewalk must be provided in all cases.

When direct access to property is allowed from residential collectors, the number of vehicular conflict points increases due to the higher access density. To improve drivers sight visibility, a 60-foot right-of-way must be provided. If direct access to property is not allowed, a 48-foot right-of-way is sufficient. The typical cross section for this street class is shown in Detail 4.3

#### **4.1.3.3. Major Collectors**

Clear separation between vehicular and pedestrian traffic is required in major collector streets because of traffic volumes and speed considerations. Therefore, vertical curb and a 3-foot curbway must be provided. Also, because of traffic volumes, a two way left turn lane must be included in the cross section. The typical section for a major collector is illustrated in Detail 4.4.

### **4.2. DRAINAGE**

Roadways are frequently subjected to flooding either by runoff transported along the street or at drainage crossings. The following standards have been developed to

reduce the hazards associated with storm runoff along or across a roadway and to ensure the safety of roadway users. Field and topographic conditions should be considered in conjunction with these standards, and engineering judgement should be exercised in all cases to minimize adverse effects to adjoining property while maintaining traffic safety.

In order to analyze drainage patterns and impacts, a drainage report shall be prepared by a registered Professional Engineer for any subdivision construction or street improvement. The report must be reviewed and approved by the Pima County Flood Control District.

All proposed drainage improvements must conform to the requirements of the Federal Emergency Management Agency (FEMA), the *Pima County Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup> and the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup> by Pima County Flood Control District.

#### **4.2.1. Urban Street Drainage**

The provisions made in regards to urban drainage along streets are discussed below and summarized in Table 4.4.

- Where curbs are provided, street drainage should not exceed 50 cubic feet per second (cfs) and in no case shall the street flows exceed 100 cfs.
- On major and residential collector streets, a minimum 10-foot pavement width must be kept clear of flowing or ponded water in each direction of travel during the 10-year storm.
- On local streets, the runoff from a 10-year storm must be contained between the curbs of the street.
- On both collectors and local streets, the 100-year discharge must be contained within the right-of-way and cannot exceed 10 feet per second in velocity.

- Should the 10-year discharge water surface elevation exceed the top of the curb, storm sewers or other treatments shall be provided to keep the water between the curbs.
- The minimum pipe size for storm sewers shall be 18 inches.

Table 4.4. Design criteria for longitudinal street drainage

Parameter	Design Standard
Maximum street runoff (cfs)	100
10-year storm containment - Local streets	Between curbs
10-year storm - Minimum width clear of water (collectors)	10 ft per direction
100-year storm containment	Within R/W
Minimum storm sewer pipe diameter (in)	18

Drainage conveyed within the street shall only be discharged from the street right-of-way into drainage easements as provided by the plat. A drainage easement will be required whenever any natural watercourse has been altered to such a degree as to need a constructed channel cross-section and periodic maintenance; or if through development, storm runoff is concentrated to such a degree as to require a defined channel. Drainage is generally conveyed by using curb openings, scuppers or catch basins that discharge into channels or storm drain systems. These treatments are discussed in the following sections.

#### 4.2.1.1. Curb Openings

Curb openings used for drainage shall be fitted with outlet aprons and shall have a maximum length of 10 feet. The curb elevation must transition from the normal reveal to the level of the opening at a rate of 12:1 (see Detail 4.5). Also, to avoid frequent changes in sidewalk elevation and pedestrian discomfort, curb openings must be spaced a minimum of 150 feet (from centerline to centerline). Roadway curb openings and drainage inlets shall be fitted with appropriate barricades as necessary. Table 4.5 presents the design standards for curb openings.

Should the design require greater conveyance than can be provided by curb openings, then scuppers, catch basins or other drainage structures must be used.

Table 4.5. Design standards for curb openings

Parameter	Design Standard
Maximum length (ft)	10
Curb transition slope	12:1
Minimum spacing (ft)	150

#### 4.2.1.2. Scuppers

Scuppers are structures used to drain flow under a sidewalk, generally between a paved area and a drainageway. They are generally a viable alternative for locations where curb openings can not accommodate the design flow. Scuppers must be designed to accommodate the 100-year storm. The containment limits requirements defined in Section 4.2.1 for the 10 and 100-year storms must also be met.

The Pima County *Standard Details for Public Improvements*<sup>2</sup> provides several design alternatives for sidewalk scuppers. The design shown in Detail 4.6 can also be used.

#### 4.2.1.3. Catch Basins

Catch basins are structures used to drain the pavement into storm drain systems. Catch basins must be designed to accommodate the 100-year storm. The containment limit requirements defined in Section 4.2.1 for the 10 and 100-year storms must also be met. The Pima County *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>, the *Roadway Design Manual*<sup>10</sup> and the *Standard Details for Public Improvements*<sup>2</sup> provide guidance in the design of catch basins. In areas where pedestrian or bicycle traffic is expected, the design, installation and location of catch basins should be done in such a way as to minimize potential hazards to pedestrian and bicyclists.

#### **4.2.2. Cross Drainage**

In urban subdivisions storm drainage across the roadway must be handled by culverts or by culvert and at-grade crossing combinations, depending on the design period. The specific design criteria for those treatments are discussed in this section. For more details, refer to the *Drainage and Channel Design Standard for Local Drainage*<sup>9</sup>.

Regardless of the cross drainage treatment used, emergency vehicles and other vehicles must be able to safely access the subdivision in flooding situations. Therefore, at least one paved, permanent all-weather access shall be provided to each lot. The maximum flow depth over the roadway for all-weather access shall be as defined in the *Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup>, Section 16-36.060 or any revisions of the ordinance.

The Pima County *Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup> prohibits diversion of flow from one basin to another. Flood limits and depths shall be kept unchanged where flows of 50 cfs or greater exit onto adjacent property, unless an improved channel or other measures to prevent flood damage are provided. Drainage easements shall be provided within the subdivision for cross-drainage.

##### **4.2.2.1. Culverts**

Culvert structures shall be required at all drainage crossings in urban subdivisions. In local streets the culverts shall be designed to at least handle the 10-year flow under the roadway. Culverts across residential collectors shall convey at least the 25-year flow under the roadway. Culverts across major collectors shall convey at least the 50-year flow under the roadway or, if possible, the 100-year flow under the roadway. Whenever a culvert is designed for less than the 100-year event, the excess flow during that event shall be contained within a dip with a flow depth of less than 12 inches. If the roadway is all-weather access, the flow depth shall not exceed the requirements defined in the *Floodplain and Erosion Hazard Management*

Ordinance<sup>8</sup>. Table 4.6 summarizes the minimum design flow requirements for culverts.

Table 4.6. Minimum design flow for culverts

Street Class	Minimum Culvert Requirements
Local Street	Q <sub>10</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Residential Collector	Q <sub>25</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Major Collector	Q <sub>50</sub> (Q <sub>100</sub> if possible) under roadway , Q <sub>100</sub> contained within dip*

\* If roadway is an all-weather access, the maximum flow depth shall be in compliance with the Pima County Floodplain and Erosion Hazard Management Ordinance<sup>8</sup>

In addition to the specific requirements described above, any culverts constructed for an urban subdivision must meet the following criteria:

- Pipe culverts shall have a minimum diameter of 18 inches.
- Reinforced Concrete Pipes (RCP), Corrugated Metal Pipes (CMP), High Density Polyethylene pipes (HDPE) and Spiral Rib Pipe (SRP) are acceptable for pipe culverts. Pipes made of other materials will require approval from Pima County.
- Headwalls shall be required at inlets for pipes greater than 30 inches in diameter, multiple pipe culverts and Reinforced Concrete Box Culverts (RCBC). For channels in supercritical flow, flared end walls and headwalls shall be required.
- Reinforced Concrete Box Culverts (RCBC) shall be at least 4 feet in height and shall be structurally designed according to Arizona Department of Transportation's (ADOT) *Standard Drawings – Structures Section*<sup>11</sup> or by a licensed structural engineer.
- Erosion protection must be provided at the culvert outlets according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>. Erosion protection design compares the outlet velocity to the natural stream velocity. When outlet velocity exceeds 10 feet per second, wired-tied rip rap shall be required to provide for uniform spreading of the flow and to protect against scour. If the length of protection needed to reduce flow velocity becomes excessive, another form of protection should be used.

- The velocity at the culvert outlet shall be greater than 3 feet per second to reduce culvert maintenance needs.
- All culverts with headwalls shall extend 10 feet beyond the edge of the travel lane to protect errant vehicles and pedestrians. Where culverts cannot be extended 10 feet beyond the edge of the travel lane, guardrails or other suitable traffic barriers must be used as discussed in Section 4.1.2.5.
- Handrail must be provided at all culverts in the vicinity of pedestrian traffic.

#### **4.2.2.2. At-Grade Crossings**

At-grade crossings shall only be used to supplement culverts during certain rainfall events (see section 4.2.2.1).

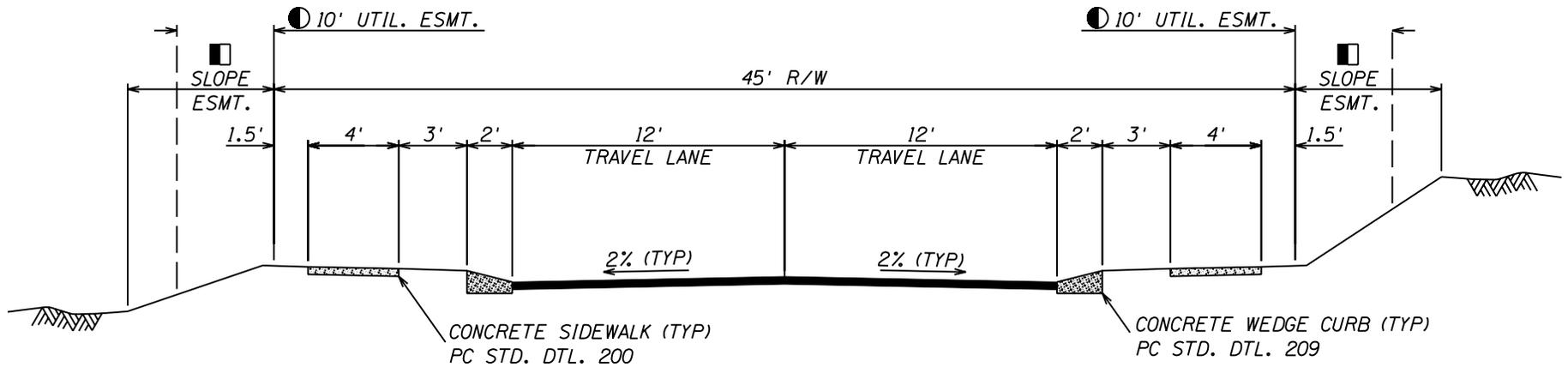
Post barricades shall be placed at all at-grade crossings. In addition, at-grade crossings in which the transverse flow during the 100-year event is less than or equal to 50 cfs, shall at least be fitted with 6-inch by 12-inch concrete headers. If the 100-year flow is greater than 50 cfs, cut-off walls must be constructed. Cut-off walls shall be designed 1 foot deeper than the scour determined by the use of the approved general and local scour equations or 70% of the maximum depth of scour. However, in no case shall the cut-off wall depth be less than 2 feet upstream and 3 feet downstream. Sliding and overturning moments may need to be analyzed for at-grade crossings protected by cut-off walls deeper than 6 feet. Concrete headers and cut-off walls must extend to the limits of the developed 100-year flow width.

In order to improve safety, aesthetics and to reduce maintenance, all at-grade crossings needed shall be designed to be self-cleaning. This can be accomplished by providing a 4% superelevation at the at-grade crossing, by installing a sediment trap, or by other means with the approval of Pima County. Erosion protection must be provided at the culvert outlets of at-grade crossings according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>, and as specified in section 4.2.2.1 of this manual.

## **REFERENCES**

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- <sup>1</sup> Pima County Department of Transportation. Pavement Marking Design Manual, Tucson, 2002.
- <sup>2</sup> Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.
- <sup>3</sup> Pima County. Pima County Code, Tucson, 2003.
- <sup>4</sup> American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets, Washington D.C., 2001.
- <sup>5</sup> American Association of State Highway and Transportation Officials. Roadside Design Guide, Washington D.C., 2002.
- <sup>6</sup> Pima County. Major Streets and Scenic Routes Plan, Tucson, 2002.
- <sup>7</sup> Pima County and City of Tucson. Standard Specifications for Public Improvements, Tucson, 2003.
- <sup>8</sup> Pima County. Ordinance 1999-FC1: Floodplain and Erosion Hazard Management Ordinance, Tucson.
- <sup>9</sup> Pima County. Drainage and Channel Design Standards for Local Drainage, Tucson, 1984.
- <sup>10</sup> Pima County Department of Transportation. Roadway Design Manual, Tucson, 2003.
- <sup>11</sup> Arizona Department of Transportation. Standard Drawings - Structures Section, Phoenix, 1992.



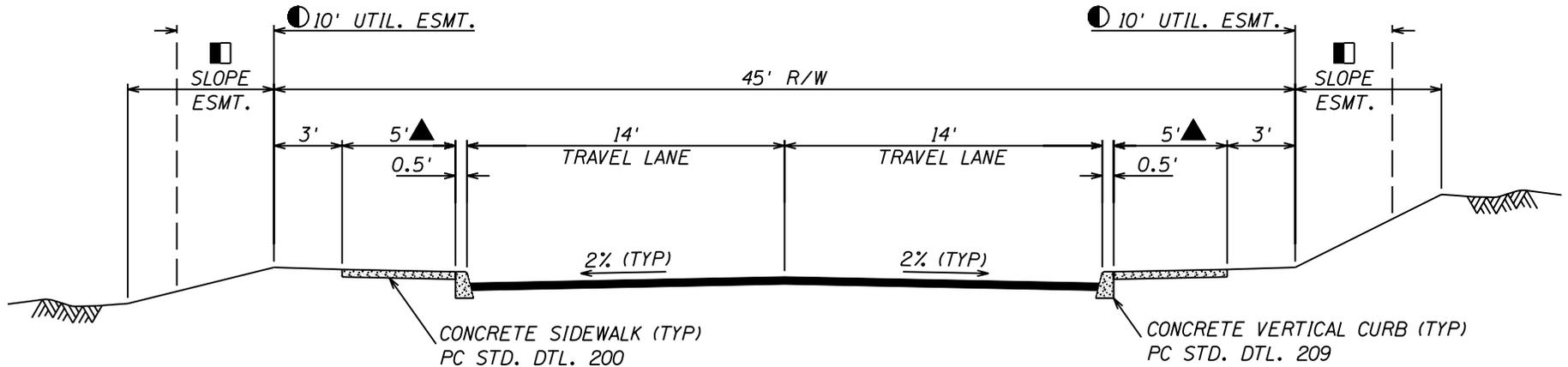
- OR AS DETERMINED BY UTILITY COMPANIES
- WHERE APPLICABLE

DETAIL 4.1

LOCAL STREET  
 URBAN RESIDENTIAL SUBDIVISION  
 ALTERNATIVE 1  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION



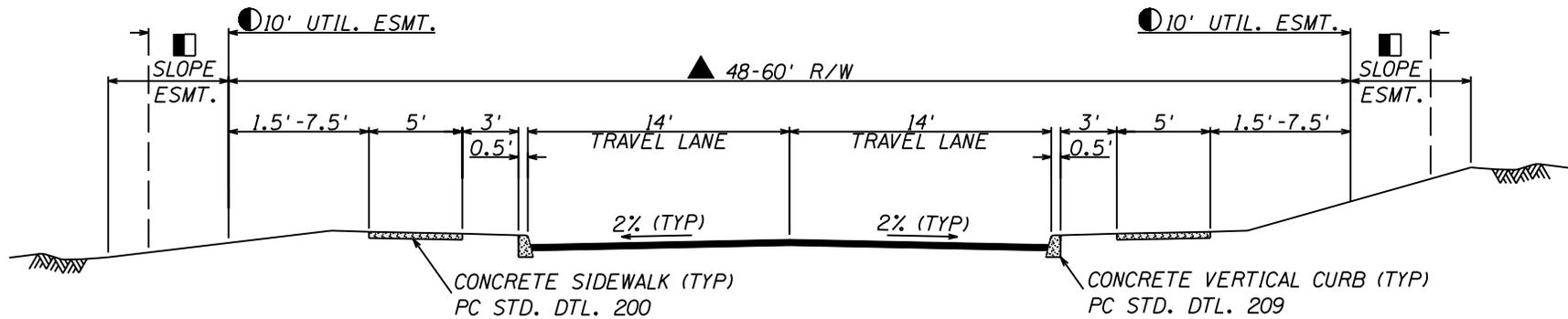
- OR AS DETERMINED BY UTILITY COMPANIES
- WHERE APPLICABLE
- ▲ THE USE OF A 4' SIDEWALK WITH A 3' CURBWAY IS ALSO ALLOWED

DETAIL 4.2

LOCAL STREET  
 URBAN RESIDENTIAL SUBDIVISION  
 ALTERNATIVE 2  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION



● OR AS DETERMINED  
BY UTILITY COMPANIES

■ WHERE APPLICABLE

▲ 48' R/W IF DIRECT ACCESS TO INDIVIDUAL PROPERTY IS NOT PERMITTED  
60' R/W IF DIRECT ACCESS TO INDIVIDUAL PROPERTY IS PERMITTED

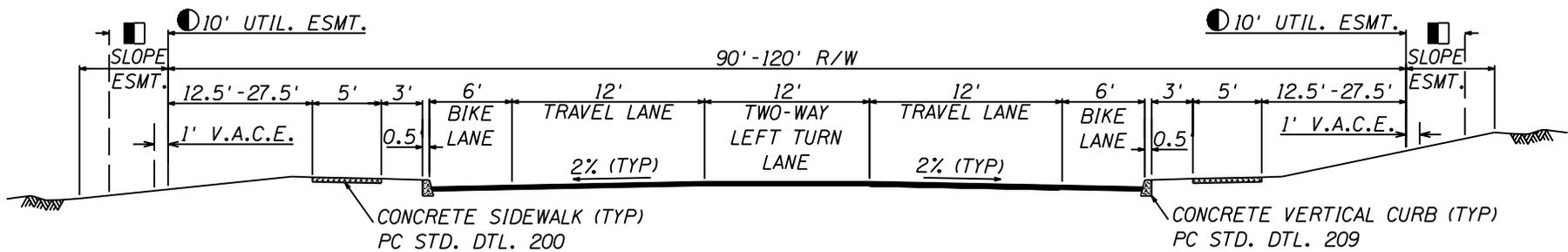
NOTE: NO PARKING ALLOWED

DETAIL 4.3

RESIDENTIAL COLLECTOR  
URBAN RESIDENTIAL SUBDIVISION  
(See Table 3.1 for Street Classification)



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



● OR AS DETERMINED BY UTILITY COMPANIES

■ WHERE APPLICABLE

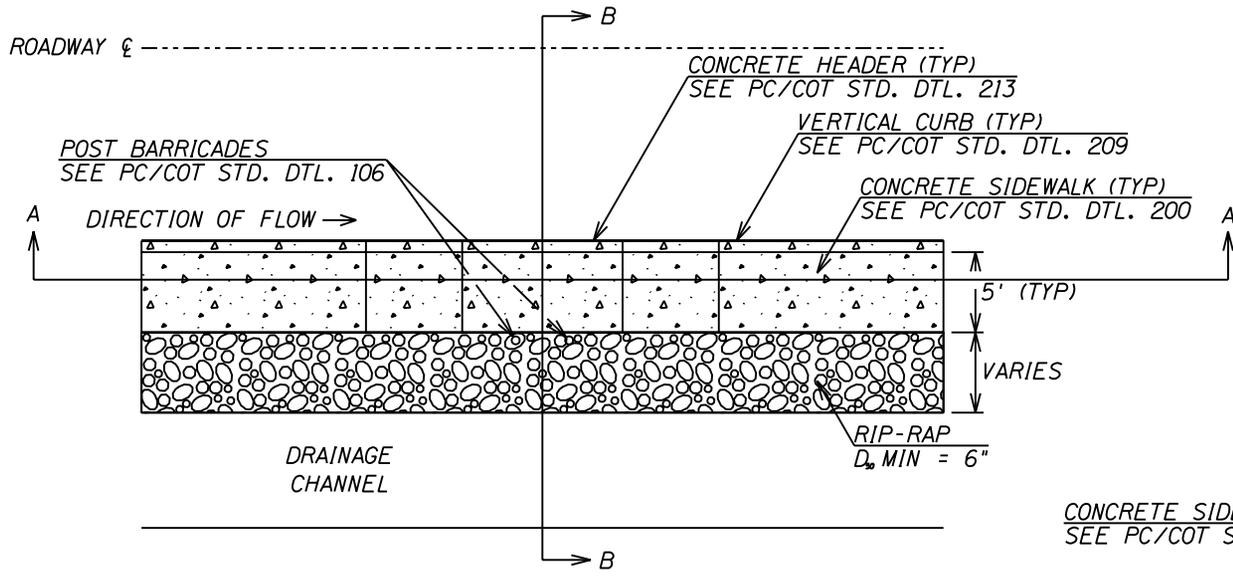
NOTE: NO PARKING ALLOWED

DETAIL 4.4

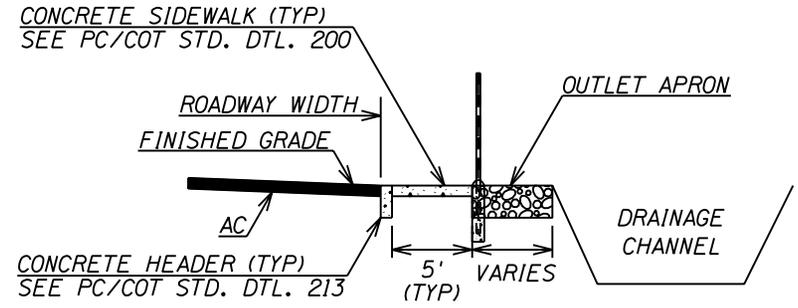
MAJOR COLLECTOR  
 URBAN RESIDENTIAL SUBDIVISION  
 (See Table 3.1 for Street Classification)



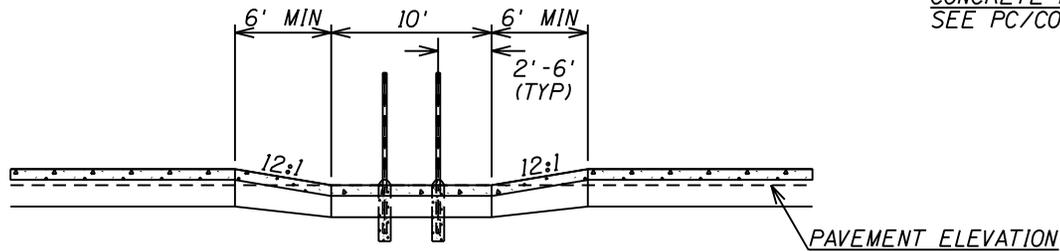
PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION



PLAN VIEW



SECTION B-B



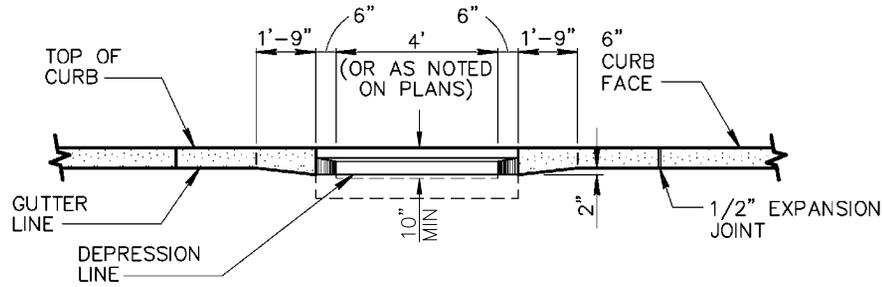
SECTION A-A

DETAIL 4.5

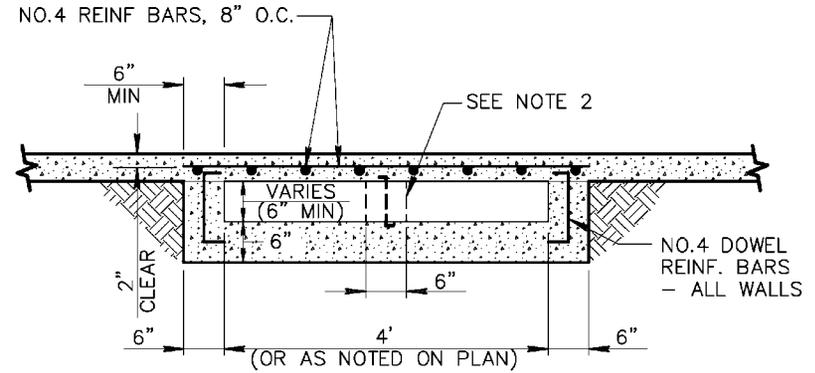
CURB OPENING DETAIL



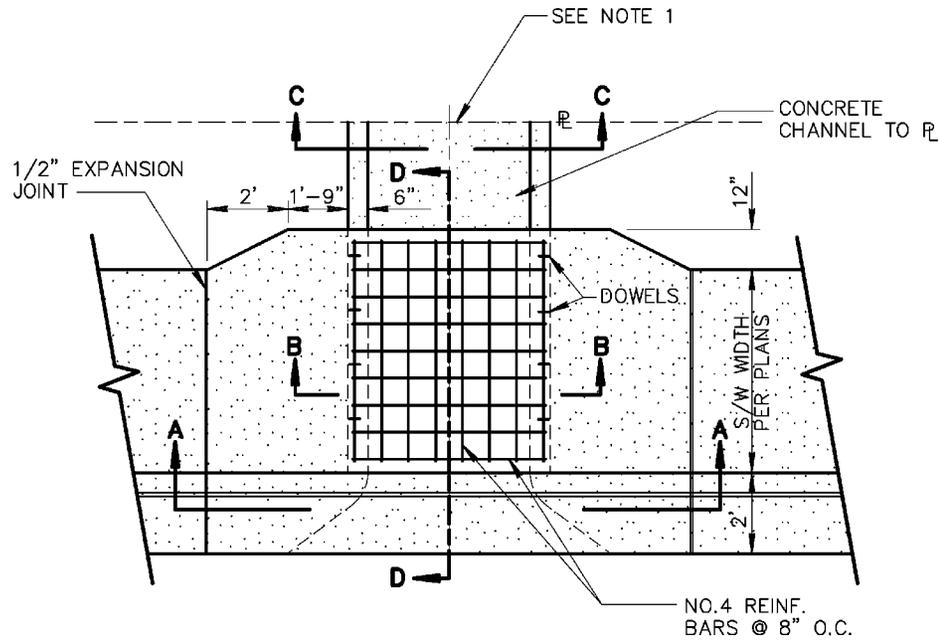
PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



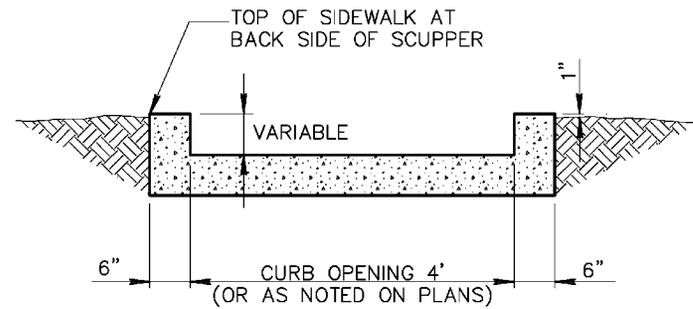
**SECTION A-A**



**SECTION B-B**



**SCUPPER PLAN VIEW**



**SECTION C-C  
SPILLWAY**

**NOTE:**

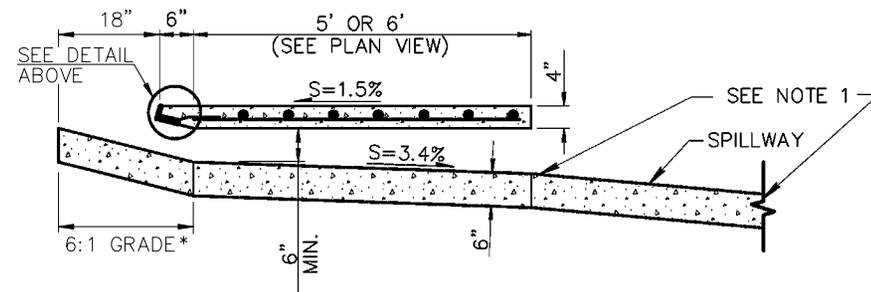
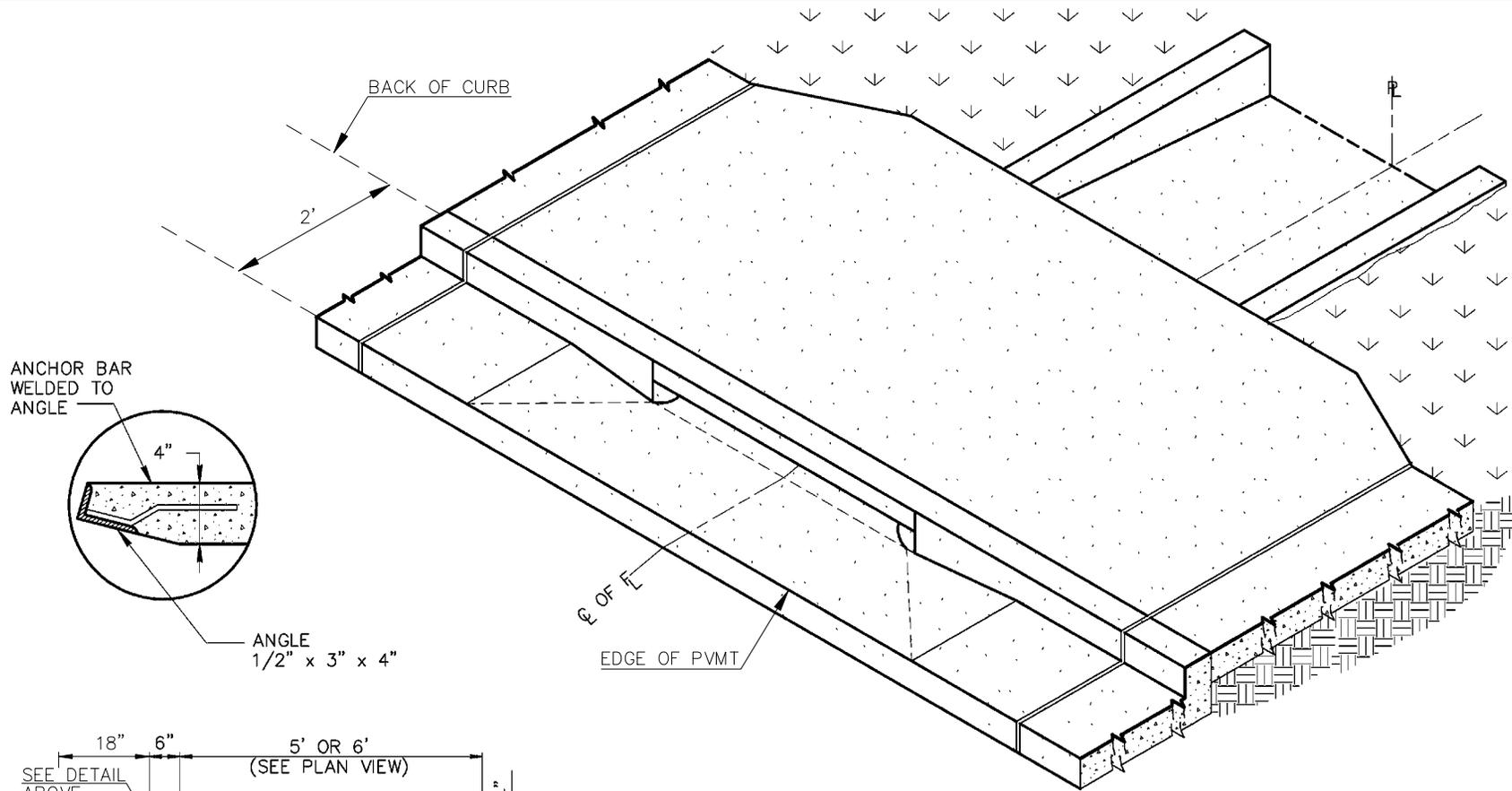
1. UNLESS OTHERWISE NOTED CONCRETE SHALL BE CLASS 'B'.
2. A CENTER WALL SHALL BE INSTALLED IN SCUPPERS WIDER THAN 4' OR IF MORE THAN 1 SCUPPER IS BUILT IN SERIES.

*DETAIL 4.6-1*

*SIDEWALK SCUPPER DESIGN*



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



**SECTION D-D**

- NOTE:**
1. TRANSITION TO SPILLWAY/CHANNEL AS PER APPROVED PLANS.
  2. A CENTER WALL SHALL BE INSTALLED IN SCUPPERS WIDER THAN 4' OR IF MORE THAN 1 SCUPPER IS BUILT IN SERIES.
  3. EXPANSION JOINT FILLER SHALL BE 1/2" BITUMINOUS TYPE PREFORMED EXPANSION JOINT FILLER, A.S.T.M. D-1751.
  4. UNLESS OTHERWISE NOTED CONCRETE SHALL BE CLASS 'B'.
  5. CAPACITY CALCULATIONS SHALL BE BASED ON ORIFICE FLOW.

\*A 2:1 MAX GRADE CAN BE USED BETWEEN 18" AND 24" FROM EDGE OF PVMT,

*DETAIL 4.6-2*

*SIDEWALK SCUPPER DESIGN*



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

## 5. RURAL RESIDENTIAL SUBDIVISIONS

Before using this chapter verify that the subdivision meets the requirements outlined in section 2.1.1 for rural residential subdivisions.

The design standards covered in this chapter are applicable to rural residential subdivisions only. Rural residential subdivisions must also comply with the design standards defined in Chapter 3, “Design Elements Common to all Development Types.”

### 5.1. CROSS SECTIONAL ELEMENTS

The cross section of a street consists of several elements in the roadway and in the roadside. A discussion of these elements and their relation to each street functional class is provided in the first two parts of this section (Roadway and Roadside). The third part of the section introduces typical cross sections for each of the street functional classes defined in Chapter 3.

#### 5.1.1. Roadway

The roadway is the portion of the cross section that is intended for vehicular use, including bike lanes and any shoulders provided. The roadway elements used in rural residential subdivisions must meet the following criteria:

- The minimum lane width for vehicular travel lanes shall be 12 feet for both local streets and collectors.
- Dedicated turning lanes may be required on residential and major collectors in the vicinity of intersections. The need for turning lanes shall be defined based on the criteria in Section 3.1.3 and on the Traffic Impact Study (if available). The minimum width of a turning lane shall be 12 feet.

- The roadway cross slope shall range from 1% to 3% for all street classes (2% cross slope is standard). The cross slope allowed in superelevated horizontal curves is discussed in Section 3.2.3.3. Inverted crowns are not acceptable for rural residential subdivision streets.
- Local streets shall have a minimum 4-foot graded shoulder. Residential and major collectors shall have at least a 10-foot shoulder (6 feet paved and 4 feet graded). Shoulders shall be kept free of obstructions such as raised driveways, culverts, utilities, mailboxes, etc.
- The cross slope of the shoulder shall match that of the travel lanes, unless approval is obtained from Pima County due to topography and/or drainage considerations.
- Residential and major collectors shall be striped according to the Pima County *Pavement Marking Design Manual*<sup>1</sup>. Pima County may also require pavement markings for residential collectors and/or local streets when deemed necessary.

Table 5.1 summarizes the standard dimensions of roadway elements based on street classification.

Table 5.1. Standard element dimensions for rural residential streets

	Local Street	Residential Collector	Major Collector
Travel lanes	12'	12'	12'
Paved shoulder	Not required	6'	6'
Graded shoulder	4'	4'	4'
Turning lanes	Not required	12' (See Sect 3.1.3)	12' (See Sect 3.1.3)
Cross slope	1% - 3%	1% - 3%	1% - 3%

**5.1.2. Roadside**

The roadside includes all street elements beyond the edge of pavement. This section addresses the following roadside elements: side slopes, horizontal clearance

to obstructions, channels, traffic barriers, handrails, right-of-way, utilities and driveways. Design criteria for medians are discussed in Section 3.1.5. Except for the use of concrete headers at the return radius of intersections or at drainage crossings, curb shall not be used for rural subdivision streets unless a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” Any areas where curbs are used must meet the roadway and drainage design requirements of Chapter 4, “Urban Residential Subdivisions”.

**5.1.2.1. Side Slopes**

All cut and fill slopes shall be constructed in accordance with the Grading Standards, chapter 18.81 of the *Pima County Code*<sup>2</sup>, and *AASHTO A Policy on Geometric Design of Highways and Streets*<sup>3</sup>. Cut and fill slopes over 2 feet in height shall be revegetated or stabilized as shown in Table 5.2. All revegetated areas, as well as the method of irrigation and maintenance responsibility until final stabilization must be clearly identified in the landscape plans.

*Table 5.2. Treatment methods for cut- fill slopes over 2 feet in height*

<b>Cut of Fill Slope (H:V)</b>	<b>Treatment</b>
3:1 or less steep	Revegetate
Steeper than 3:1 to 2:1	Rock rip-rap with filter fabric
Steeper than 2:1	Grouted rip-rap or retaining structure

Alternative methods of stabilization may be allowed if certified as stable by a registered geotechnical engineer, and a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” Terracing may be done as provided in the *Grading Standards of the Pima County Code*<sup>2</sup>.

All cut and fill channel slopes and stabilization methods shall be constructed in accordance with the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup> by the Pima County Flood Control District.

### 5.1.2.2. Horizontal Clearance to Obstructions

In order to reduce the frequency and severity of crashes with natural and man-made roadside obstacles, an unobstructed, relatively flat area must be provided beyond the edge of the traveled way for the recovery of errant vehicles. AASHTO refers to this area as “clear zone”. The clear zone shall be measured from the edge of the outermost travel lane and shall be contained entirely within the right-of-way.

The clear zone that must be provided on a roadway is a function of the design speed, the traffic volume and the clear zone cross slope. However, the functional classification used in this manual already accounts for design speed and traffic volume. Therefore, clear zone requirements for subdivisions can be determined based on functional classification and cross slope only.

Clear zone cross slopes flatter than or equal to 6:1 (H:V) are preferred because they provide comfortable recovery. However, slopes up to 4:1 are considered recoverable and are allowed. Clear zone slopes between 4:1 and 3:1 are traversable but not recoverable and must extend beyond the toe of the slope as discussed in the *Roadside Design Guide*<sup>4</sup>. Table 5.3 presents the clear zone requirements for rural residential subdivision streets based on cross slope and functional classification.

Table 5.3. Clear zone requirements (from AASHTO Roadside Design Guide<sup>4</sup>)

Foreslope of Backslope (H:V)	Local Street	Residential Collector	Major Collector
6:1 or flatter	10'	12'	14'
Steeper than 6:1 to 4:1	12'	14'	16'

When a sufficient clear zone cannot be provided, a traffic barrier (see section 5.1.2.4) shall be constructed. Any reduction to the width requirements presented in Table 5.3, or the preservation or installation of objects within the clear zone without construction of a barrier, shall require the approval of Pima County. The County may require an engineering study to assess the safety implications of such condition in order to approve it.

### **5.1.2.3. Roadside Channels and Ditches**

Roadside channels or ditches shall not be constructed within the shoulder area of any roadway. Ditches or channels shall not be constructed within the right-of-way unless:

- The design flow can be handled by the channel or ditch without interfering with the safe operation of the roadway, and
- The ditch or channel meets the clear zone requirements defined in AASHTO's *Roadside Design Guide*<sup>4</sup> (Section 3.2.4 in the 2002 edition) and all applicable sections of these standards.

Drainage swales within the right-of-way that carry roadway runoff shall only be acceptable where velocities are less than 4 feet per second (or where appropriate protection is provided), and where driveway access is restricted or controlled to prevent ponding, diversion of flow or other conflicts. Additional criteria is provided in *Drainage and Channel Design Standards for Local Drainage*<sup>5</sup> by Pima County Flood Control District

### **5.1.2.4. Traffic Barriers**

Guardrails and other traffic barriers are effectively roadside obstacles. In consequence, a significant number of crashes with guardrails produce injuries. The proximity of guardrail to the traveled way often also increases accident rates. Therefore, guardrail should only be installed where the potential consequences of departure from the roadway (in terms of accident severity and frequency) are extremely severe.

Figure 5.1 presents the risk warrant for embankment recommended in AASHTO's *Roadside Design Guide*<sup>4</sup>. Barriers are warranted for conditions falling above the warrant line in the figure.

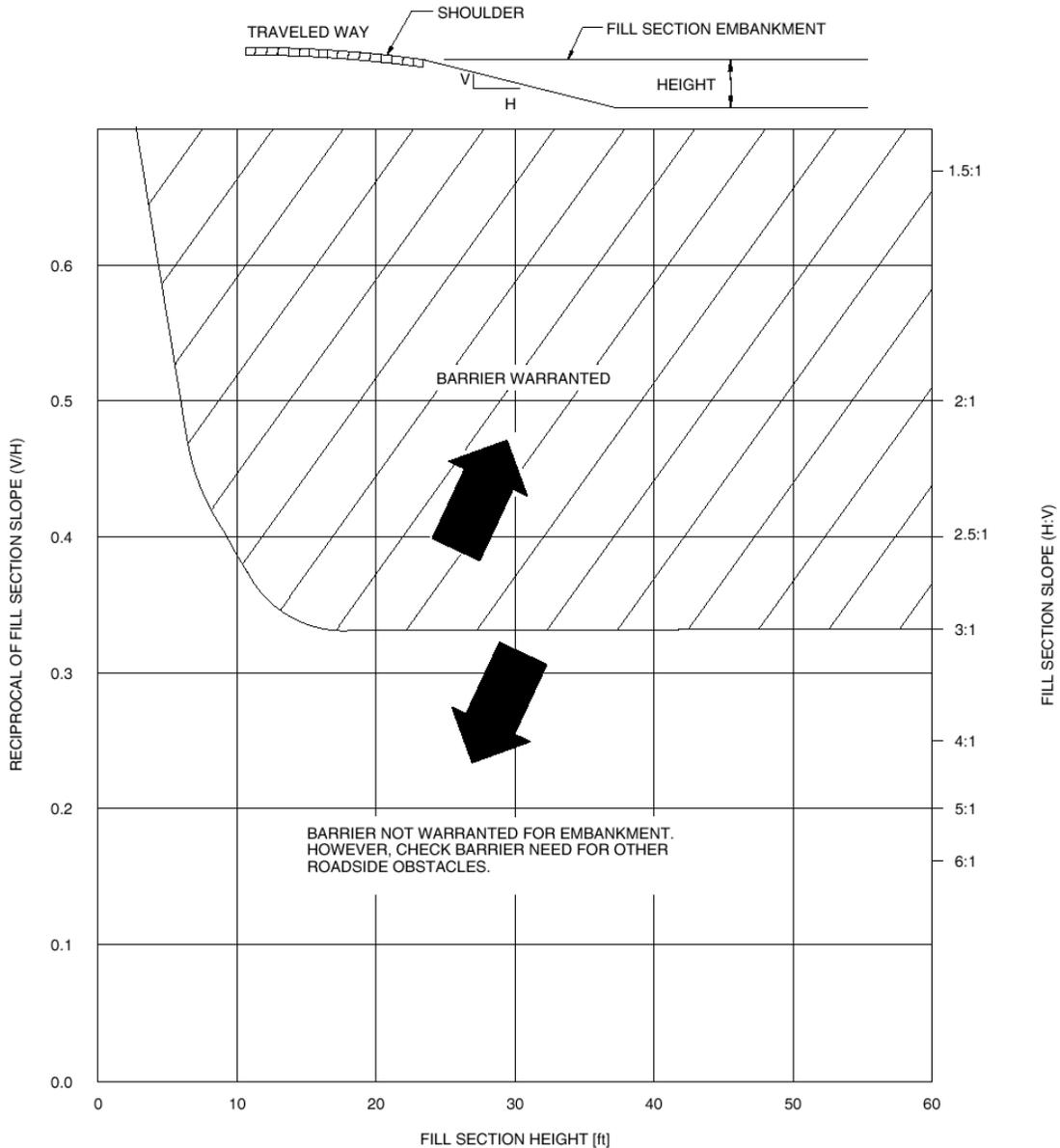


Figure 5.1. Barrier risk warrant for embankments (from AASHTO<sup>4</sup>)

When a barrier is used, it must be placed where the non-recoverable slope or obstruction begins to keep it as far as possible from the traveled way. The minimum spacing allowed from the edge of the traveled way to the face of the barrier shall be

4 feet. Barriers must be installed in accordance with current ADOT standard Specifications and Drawings.

Post barricades are an acceptable treatment for roadways that dead-end into drainage channels.

**5.1.2.5. Handrails**

Handrails shall be installed for protection of pedestrians whenever slopes are steeper than 2:1 (H:V) within 3 feet of the walkway and the embankment height is 3 feet or greater. The design engineer may determine that differences in elevation between the walkway and nearby terrain under other circumstances may also warrant the installation of handrail. Handrail shall be built in accordance with Pima County's *Standard Details for Public Improvements*<sup>6</sup>.

**5.1.2.6. Right-of-way**

Right-of-way must be wide enough to encompass all cross sectional elements. The minimum right-of-way required for each of the applicable street functional classes is shown in Table 5.4. However, the following additional provisions are made in regards to right-of-way:

*Table 5.4. Minimum right-of-way requirements by functional class*

Street Class	Right-of-Way
Local street	45'
Residential collector - No property access	50'
Residential collector - Property access allowed	60'
Major collector	90'-120'

- In no case shall the travel lanes, medians, or shoulders be located in easements. Easements may be granted in lieu of right-of-way for certain cross section elements such as utilities, sewers and slopes. Such easements must specifically grant right of entry to Pima County to allow proper maintenance of the facilities

located within the easement and to enable remedy from hazards to the public so as to assure public safety.

- Collector street right-of-way shall be of sufficient width to accommodate the ultimate pavement section required for the projected design year traffic. Additional rights-of-way may be required by the Pima County Department of Transportation at intersections identified on the Pima County *Major Streets and Scenic Routes Plan*<sup>7</sup> or intersections of other collectors where it is deemed necessary to provide sufficient width for turning lanes, sight visibility and other design and safety considerations.
- When Pima County determines that, in the public interest and for the health, welfare, or safety of same, vehicular access to or from a development or subdivision at a particular location should be prohibited, a 1-foot Vehicle Access Control Easement (VACE) shall be granted to the public.
- Supplemental right-of-way may be required at all intersections where standard right-of-way widths are unable to completely enclose the sight distance triangles. If right-of-way is not granted for sight distance, an easement will be required restricting the use within the sight distance triangles (see Section 3.2.4.2).

#### **5.1.2.7. Utilities**

With the exception of minor service extensions to individual parcels, all longitudinal utility facilities (including sanitary sewers and telecommunications) between service points to individual parcels shall be located within the street right-of-way. Strip easements may be used along streets in lieu of right-of-way if for utility purposes and for other uses compatible with utility needs (subject to utility company approval). Access between the street and the private property shall not be denied.

All sanitary sewer facilities shall be provided in accordance with the current Pima County *Standard Details for Public Improvements*<sup>8</sup> and the *Standard Specifications*

for *Public Improvements*<sup>9</sup>. All services shall be provided or stubbed out to existing or planned parcels with all new street construction to avoid the need to remove and replace new pavement.

#### **5.1.2.8. Driveways**

Driveways providing access to subdivision lots shall comply with the following standards:

- The lot frontage shall be at least 30 feet in order to allow room for the driveway and the installation of utilities.
- Common drives shall serve a maximum of four lots and shall be limited to a maximum of 150 feet in length to facilitate the provision of municipal services such as fire and trash pick-up.
- Driveways shall not obstruct roadside flow and shall maintain grade with the roadway shoulder and roadside channel or ditch, if provided.

#### **5.1.3. Typical Cross Sections**

As has been discussed throughout this Chapter, the need for certain cross sectional elements and their dimensions depend on the functional classification of the street. Typical cross sections for each applicable street class are presented here.

##### **5.1.3.1. Local Streets**

The standard cross section of a rural local street includes two 12-foot travel lanes and 4-foot graded shoulders in a minimum 45-foot right-of-way. Slope easements are required when the existing ground elevation cannot be matched within the right-of-way. Detail 5.1 depicts the standard cross section for rural local streets.

##### **5.1.3.2. Residential Collectors**

Residential collectors handle larger traffic volumes than local streets and are also allowed longer tangent sections. Therefore, paved shoulders shall be constructed to provide better operating conditions. Residential collectors shall have 12-foot travel

lanes and 10-foot shoulders (6 feet paved and 4 feet graded). When direct access to property is allowed from residential collectors, the number of vehicular conflict points increases due to the higher access density. To improve drivers sight visibility, a 60-foot right-of-way must be provided. If direct access to property is not allowed, a 50-foot right-of-way is sufficient. The typical cross section for this street class is shown in Detail 5.2.

### **5.1.3.3. Major Collectors**

Major collectors shall have 12-foot travel lanes and 10-foot shoulders (6 feet paved and 4 feet graded). Right-of-way shall be enough to accommodate future improvements such as turning lanes or additional travel lanes. The typical section for a major collector is illustrated in Detail 5.3.

## **5.2. DRAINAGE**

Roadways are frequently subjected to flooding either by runoff transported along the street or at drainage crossings. Roadside drainage is especially critical for rural roadways where curbing is not provided to control and direct flow. If curbing is provided, refer to the criteria in Section 4.2.

The following standards have been developed to reduce the hazards associated with storm runoff along or across a roadway and to ensure the safety of roadway users. Field and topographic conditions should be considered in conjunction with these standards, and engineering judgement should be exercised in all cases to minimize adverse effects to adjoining property while maintaining traffic safety.

In order to analyze drainage patterns and impacts, a drainage report shall be prepared by a registered Professional Engineer for any subdivision construction or street improvement. The report must be reviewed and approved by the Pima County Flood Control District.

All proposed drainage improvements must conform to the requirements of the Federal Emergency Management Agency (FEMA), the *Pima County Floodplain and Erosion Hazard Management Ordinance*<sup>10</sup> and the *Drainage and Channel Design Standards for Local Drainage*<sup>11</sup> by Pima County Flood Control District.

### **5.2.1. Longitudinal Drainage Channels**

The primary function of drainage channels is to collect surface runoff from the roadway and areas that drain to the right-of-way and convey the accumulated runoff to acceptable outlet points. Channel design should consider two elements:

- Hydraulic design: To ensure that channels are able to convey the design runoff, they shall be designed in conformance with the *Drainage and Channel Design Standards for Local Drainage*<sup>10</sup> prepared by Pima County Flood Control District.
- Effect on roadside: Channels shall be designed as to minimize their impact on the roadside and shall not be constructed within the shoulder area of any roadway (see Section 5.1.2.3). AASHTO's *Roadside Design Guide*<sup>4</sup> (Section 3.2.4 in the 2002 edition) defines preferred foreslopes and backslopes for basic ditch configurations.

A drainage easement will be required whenever any natural watercourse has been altered to such a degree as to need a constructed channel cross-section and periodic maintenance; or if through development, storm runoff is concentrated to such a degree as to require a defined channel.

### **5.2.2. Cross Drainage**

Storm drainage across the roadway is generally achieved by the use of at-grade crossings, culverts or a combination of both. The design criteria for each of those treatments are discussed in this section.

Regardless of the cross drainage treatment used, emergency vehicles and other vehicles must be able to safely access the subdivision in flooding situations. Therefore, at least one paved, permanent all-weather access shall be provided to each lot. The maximum flow depth over the roadway for all-weather access shall be as defined in the *Floodplain and Erosion Hazard Management Ordinance*<sup>9</sup>, Section 16-36.060 or any revisions of the ordinance.

The Pima County *Floodplain and Erosion Hazard Management Ordinance*<sup>9</sup> prohibits diversion of flow from one basin to another. Flood limits and depths shall be kept unchanged unless an improved channel or other measures to prevent flood damage are provided.

#### **5.2.2.1. Rural At-Grade Crossings**

At-grade crossings are acceptable in rural subdivisions because of the low frequency of stream flow, provided that the 100-year flow traversing the roadway is less than 500 cfs and all-weather criteria are met.

At-grade crossings in which the transverse flow during the 100-year event is less than or equal to 50 cfs, shall at least be fitted with 6-inch by 12-inch concrete headers.

If the 100-year flow ranges from 50 to 500 cfs, cut-off walls shall be installed to maintain the integrity of the roadway pavement. Cut-off walls shall be designed 1 foot deeper than the scour determined by the use of the approved general and local scour equations or 70% of the maximum depth of scour. However, in no case shall the cut-off wall depth be less than 2 feet upstream and 3 feet downstream. Sliding and overturning moments may need to be analyzed for at-grade crossings protected by cut-off walls deeper than 6 feet. Cut-off walls shall be placed at least 4 feet from the upstream and downstream edge of pavement lines. The pavement shall be widened to the upstream and downstream cut-off walls. Concrete headers and cut-off walls must extend the developed 100-year flow width.

If the flow rate of the 100-year event exceeds 500 cfs, or the 100-year event will cross the road at a depth greater than one foot, a culvert or a culvert dip section combination shall be used to guarantee that the drainage over the roadway meets all-weather access criteria. These design thresholds are illustrated in Table 5.5.

Table 5.5. Design thresholds for dip sections

100-year peak flow	Minimum treatment
≤ 50 cfs	Concrete headers
50-500 cfs	Cut-off walls
≥ 500 cfs	Culvert or Culvert + dip section

In order to improve safety, aesthetics and to reduce maintenance, all at-grade crossings needed shall be designed to be self-cleaning. This can be accomplished by providing a 4% superelevation at the at-grade crossing, by installing a sediment trap, or by other means if a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” Erosion protection must be provided at the culvert outlets of at-grade crossings according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>10</sup>, and as specified in section 5.2.2.2 of this manual.

**5.2.2.2. Culverts**

Culvert structures shall be used where the cross flow cannot be handled with an at-grade crossing, or where project conditions require handling the flow under the roadway.

In local streets the culverts shall be designed to at least handle the 10-year flow under the roadway. Culverts across residential collectors shall convey at least the 25-year flow under the roadway. Culverts across major collectors shall convey at least the 50-year flow under the roadway or, if possible, the 100-year flow under the roadway. During the 100-year event, the excess flow (if any) shall be contained

within a dip with a flow depth of less than 12 inches. If the roadway is all-weather access, the flow depth shall not exceed the requirements defined in the *Floodplain and Erosion Hazard Management Ordinance*<sup>9</sup>, Section 16-36.060. Table 5.6 summarizes the minimum design flow requirements for culverts.

Table 5.6. Minimum design flow for culverts

Street Class	Minimum Culvert Requirements
Local Street	Q <sub>10</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Residential Collector	Q <sub>25</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Major Collector	Q <sub>50</sub> (Q <sub>100</sub> if possible) under roadway , Q <sub>100</sub> contained within dip*

\* If roadway is an all-weather access, the maximum flow depth shall be in compliance with the Pima County Floodplain and Erosion Hazard Management Ordinance<sup>8</sup>

In addition to the requirements described above, any culverts constructed for a rural subdivision must meet the following criteria:

- Pipe culverts shall have a minimum diameter of 18 inches.
- Reinforced Concrete Pipes (RCP), Corrugated Metal Pipes (CMP), High Density Polyethylene pipes (HDPE) and Spiral Rib Pipe (SRP) are acceptable for pipe culverts. Pipes made of other materials will require approval from Pima County.
- Headwalls shall be required at inlets for pipes greater than 30 inches in diameter, multiple pipe culverts and Reinforced Concrete Box Culverts (RCBC). For channels in supercritical flow, flared end walls and headwalls shall be required.
- Reinforced Concrete Box Culverts (RCBC) shall be at least 4 feet in height and shall be structurally designed according to Arizona Department of Transportation’s (ADOT) *Standard Drawings – Structures Section*<sup>12</sup> or by a licensed structural engineer.
- Erosion protection must be provided at the culvert outlets according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>10</sup>. Erosion protection design compares the outlet velocity to the natural stream velocity. When outlet velocity exceeds 10 feet per second, wired-tied rip rap shall be required to provide for uniform spreading of the flow and to protect

against scour. If the length of protection needed to reduce flow velocity becomes excessive, another form of protection should be used.

- The velocity at the culvert outlet shall be greater than 3 feet per second to reduce culvert maintenance needs.
- All culverts with headwalls shall extend to the clear zone to protect errant vehicles and pedestrians. Where culverts cannot be extended to the clear zone, guardrails or other suitable traffic barriers must be used as discussed in Section 5.1.2.4.

## **REFERENCES**

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<sup>1</sup> Pima County Department of Transportation. Pavement Marking Design Manual, Tucson, 2002.

<sup>2</sup> Pima County. Pima County Code, Tucson, 2003.

<sup>3</sup> American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets, Washington D.C., 2001.

<sup>4</sup> American Association of State Highway and Transportation Officials. Roadside Design Guide, Washington D.C., 2002.

<sup>5</sup> Pima County Drainage and Channel Design Standards for Local Drainage, Tucson, 1984.

<sup>6</sup> Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.

<sup>7</sup> Pima County. Major Streets and Scenic Routes Plan, Tucson, 2002.

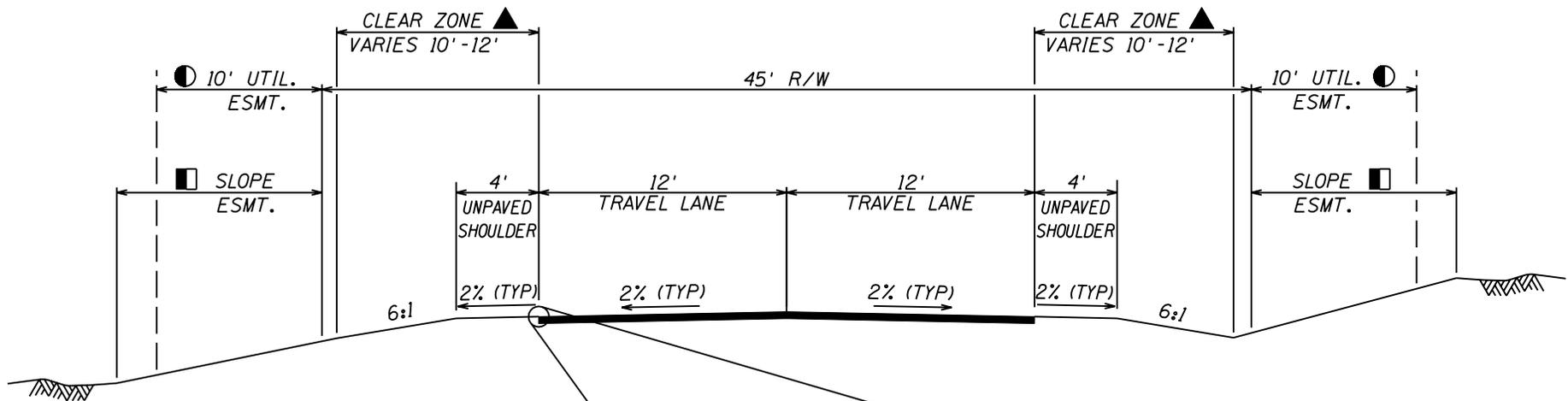
<sup>8</sup> Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.

<sup>9</sup> Pima County and City of Tucson. Standard Specifications for Public Improvements, Tucson, 2003.

<sup>10</sup> Pima County. Ordinance 1999-FC1: Floodplain and Erosion Hazard Management Ordinance, Tucson, 1999.

<sup>11</sup> Pima County Drainage and Channel Design Standards for Local Drainage, Tucson, 1984.

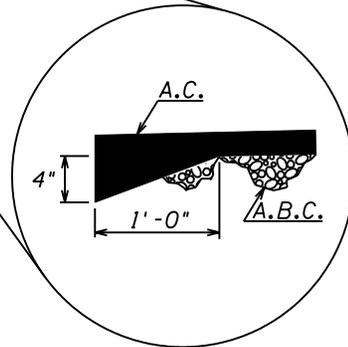
<sup>12</sup> Arizona Department of Transportation. Standard Drawings - Structures Section, Phoenix, 1992.



● OR AS DETERMINED BY UTILITY COMPANIES

■ WHERE APPLICABLE

▲ SEE TABLE 5.3

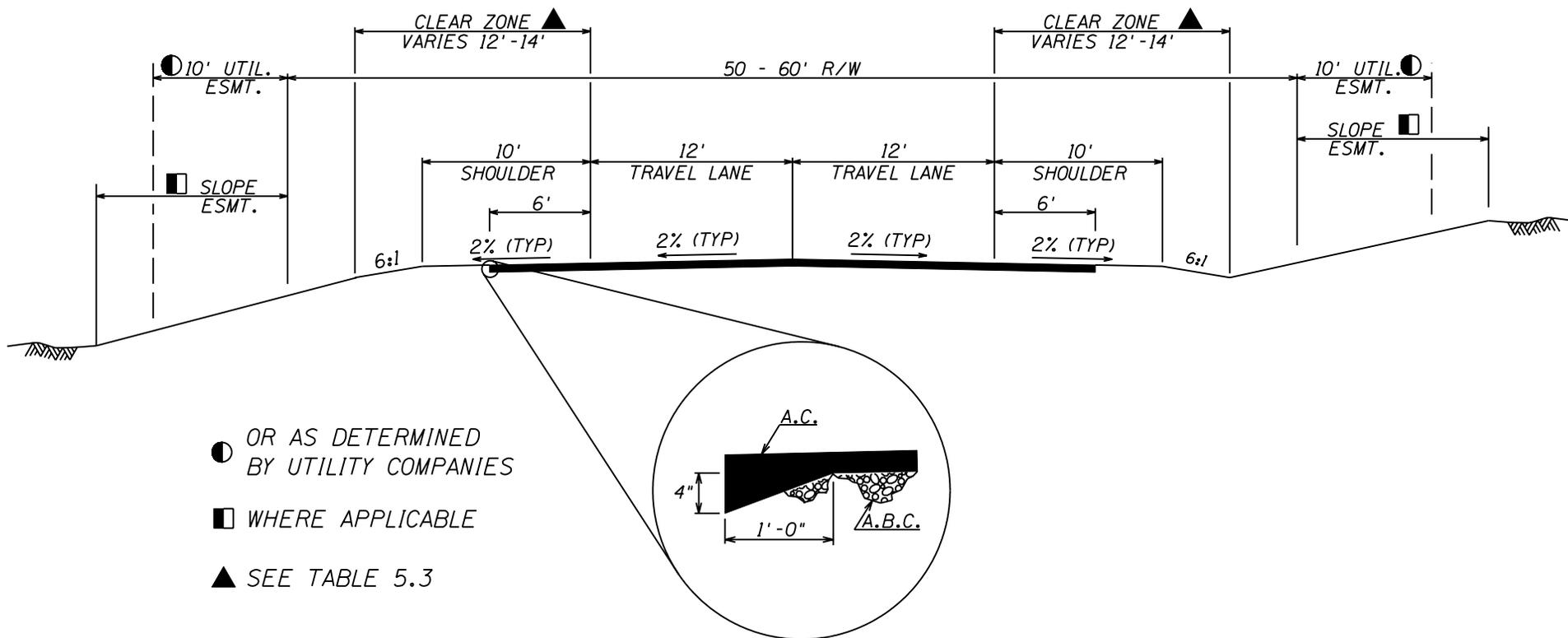


DETAIL 5.1

LOCAL STREET  
RURAL RESIDENTIAL SUBDIVISION  
(See Table 3.1 for Street Classification)



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION



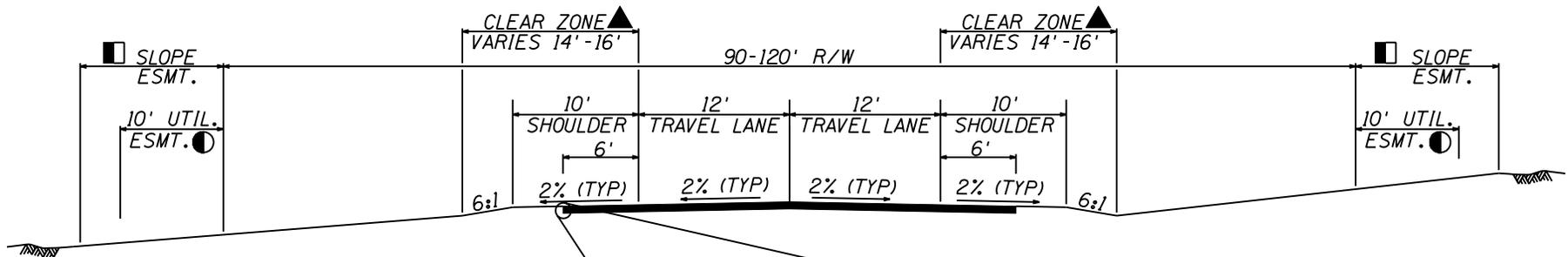
NOTE: NO PARKING ALLOWED

DETAIL 5.2

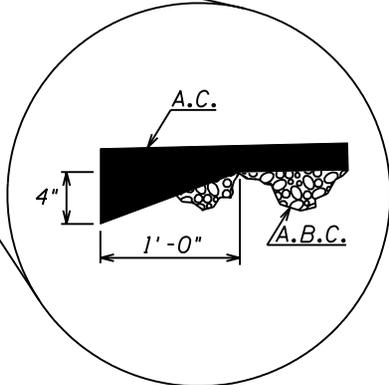
RESIDENTIAL COLLECTOR  
 RURAL RESIDENTIAL SUBDIVISION  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION



- OR AS DETERMINED BY UTILITY COMPANIES
- ▣ WHERE APPLICABLE
- ▲ SEE TABLE 5.3



NOTE: NO PARKING ALLOWED

DETAIL 5.3

MAJOR COLLECTOR  
 RURAL RESIDENTIAL SUBDIVISION  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION

## 6. CONSERVATION SUBDIVISIONS

Conservation Subdivisions promote the establishment of conservation natural areas and, where possible and practicable, support interconnected, continuous, and integrated open space systems within an area, particularly when located contiguous to public preserves. The goal of conservation site planning is to protect conservation features such as designated peaks and ridges, riparian areas, native plants and plant communities, areas near public preserves, wildlife habitat areas, biological corridors, and sites of archaeological and cultural value.

In order to achieve the goal of conservation, a special set of street standards has been developed. These standards are related to street layout, geometric features, cross sections and drainage, among other areas. Their use is restricted to subdivisions that comply with Section 18.09.100 of the *Pima County Code*<sup>1</sup>.

For standards not discussed in this chapter, Conservation Subdivisions shall comply with the requirements for rural residential subdivisions, described in Chapter 5. However, Pima County may request that the standards for urban residential subdivisions be followed when the minimum lot size, lot width or the type of grading fall within the criteria defined in Section 2.1 for urban residential subdivisions. This is a direct consequence of the increased local access density created by clustered designs. If an urban street section is used, the design criteria presented in this chapter do not apply.

### 6.1. VERTICAL ALIGNMENT

If a Conservation Subdivision is in mountainous terrain (see definition in Section 3.2.1) sustained local street gradients may be up to 15%, with up to 18% allowed for shorter transition sections.

## **6.2. CROSS SECTIONAL ELEMENTS**

In Conservation Subdivisions, vehicular travel lanes for local streets and residential collectors are to be a minimum of ten (10) feet in width. The minimum shoulder width for these street classes shall be 4 feet. The typical cross section of a local street in a Conservation Subdivision is shown in Detail 6.1.

## **6.3. CURBS AND SIDEWALKS**

Curbs are generally not considered appropriate for Conservation Subdivisions because they restrain roadway drainage and control access to abutting properties. However, curbs should be used when the characteristics of the subdivision meet the criteria of urban residential subdivisions, as defined in Section 2.1 (in terms of lot size, width and type of grading). Sidewalks shall be provided wherever curb is used.

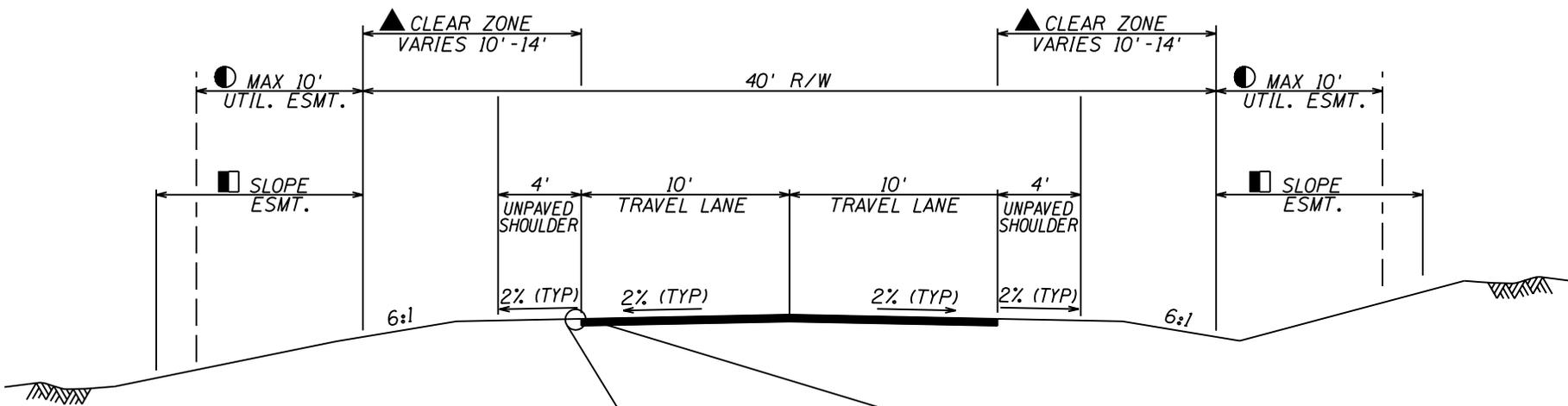
## **6.4. ALL-WEATHER CROSSINGS**

All-weather access to lots in Conservation Subdivisions will be required unless the requirement is waived in accordance with section 16.36.060 of the Pima County Code<sup>1</sup>. Where all-weather access standards are not met, the access deficiencies shall be noted in the property deed and/or subdivision plat, (ARS 32-2185.02 and 11.809 E.). All street crossings in areas of concentrated flow shall have headers or cut-off walls and comply with all other requirements specified in Section 5.2.2.1 for at-grade crossings.

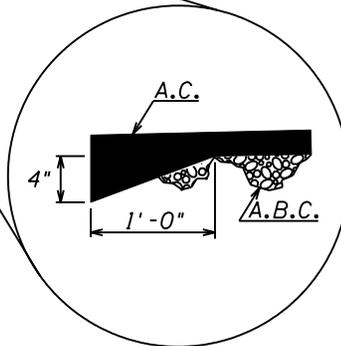
## **REFERENCES**

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<sup>1</sup> Pima County. Pima County Code, Tucson, 2003.



- WHERE NEEDED
- ▣ WHERE APPLICABLE
- ▲ SEE TABLE 5.3



NOTE: NO PARKING ALLOWED

DETAIL 6.1

LOCAL STREET  
 RESIDENTIAL COLLECTOR  
 IN CONSERVATION SUBDIVISION  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION

## 7. COMMERCIAL AND INDUSTRIAL SUBDIVISIONS

Before using this chapter verify that the subdivision meets the requirements outlined in section 2.2 for commercial and industrial subdivisions.

The design standards covered in this chapter are only applicable to industrial or commercial parcels subdivided for future individual development (see Chapter 2 for definition). The standards in this chapter do not apply to parcels that submit a single development plan (this case is covered in Chapter 8). Commercial and industrial subdivisions shall also comply with the design standards defined in Chapter 3, “Design elements common to all development types.”

### 7.1. CROSS SECTIONAL ELEMENTS

The cross section of a street consists of several elements in the roadway and in the roadside. A discussion of these elements and their relation to each street functional class is provided in the first two parts of this section (Roadway and Roadside). The third part of the section introduces typical cross sections for each of the street functional classes defined in Chapter 3.

#### 7.1.1. Roadway

The roadway is the portion of the cross section that is intended for vehicular use, including bike lanes and any shoulders provided. The roadway elements used in commercial and industrial subdivisions must meet the following criteria:

- The minimum lane width for vehicular travel lanes on local and collector streets shall be 12 feet.
- On-street parking shall not be allowed on any street within commercial or industrial subdivisions.

- Collector streets shall have a two way left turn lane to allow vehicles to turn without interfering with the through-moving vehicles. The minimum width of the two way left turn lane shall be 12 feet.
- All local and collector streets shall have 6-foot paved shoulders on both sides (measured from the edge of the travel lane to the face of curb).
- Dedicated turning lanes may be required on collectors in the vicinity of intersections. The need for turning lanes shall be defined based on the criteria in Section 3.1.3 and on the Traffic Impact Study (if available). The minimum width of a turning lane shall be 12 feet.
- The roadway cross slope shall range from 1% to 3% for all street classes (2% cross slope is standard). The cross slope allowed in superelevated horizontal curves is discussed in Section 3.2.3.3. Inverted crowns are not acceptable.
- All collectors shall be striped according to the Pima County *Pavement Marking Design Manual*<sup>1</sup>. Pima County may also require pavement markings for local streets when deemed necessary.

Table 7.1 summarizes the minimum dimensions of roadway elements based on street classification.

Table 7.1. Standard element dimensions for commercial and industrial subdivision streets

	Local Street	Collector
Travel lanes	12'	12'
Two way left turn lane	Not required	12'
Turning lanes	Not required	12' (See Sect. 3.1.3)
Paved Shoulders	6'	6'
Cross slope	1% - 3%	1% - 3%

## **7.1.2. Roadside**

The roadside includes all street elements beyond the edge of pavement. This section addresses the following roadside elements: curbs, sidewalks, side slopes, horizontal clearance to obstructions, traffic barriers, handrails, right-of-way and utilities. Design criteria for medians are discussed in Section 3.1.5.

### **7.1.2.1. Curb**

Vertical curb shall be required on all streets to delineate the edge of the roadway, regardless of project location.

At the intersections of two local streets, the minimum curb radius shall be 25 feet along the face of curb. The curb radius of intersections involving at least one collector roadway must be designed to accommodate the turning movement of the design vehicle specified in Table 3.6. Excessive curb radius shall be avoided, as they are detrimental to pedestrian traffic and complicate sign placement.

Curb access ramps shall be provided at all curb returns and shall be designed according to Pima County's *Standard Details for Public Improvements*<sup>2</sup>.

### **7.1.2.2. Sidewalk**

Sidewalks shall be required on both sides of all streets within commercial or industrial subdivisions. Connectivity of pedestrian facilities is required within all subdivisions. A 4-foot or wider clear area can be used in lieu of sidewalks along the non-lot side of a single loaded street if a proper request is filed and approved in accordance with Chapter 9, "Administration of the Standards." Sidewalks shall be of Portland cement concrete and shall be constructed according to Pima County's *Standard Details for Public Improvements*<sup>2</sup>.

Collector street sidewalks shall be a minimum of 5 feet in width and shall incorporate a 3-foot curbway between the back of curb and the roadside edge of the sidewalk.

Sidewalks in local streets can be designed with or without curbway. If a curbway is provided, its minimum width shall be 3 feet and the sidewalk shall be 5 feet in width. If the sidewalk is placed adjacent to the back of curb, the minimum sidewalk width shall be 6 feet.

A maintenance space between the sidewalk and the lot property line shall be provided for sidewalks maintained by Pima County and must be 1 foot or greater depending on grade differentials and available right-of-way.

**7.1.2.3. Side Slopes**

All cut and fill slopes shall be constructed in accordance with the Grading Standards, chapter 18.81 of the *Pima County Code*<sup>3</sup>, and *AASHTO A Policy on Geometric Design of Highways and Streets*<sup>4</sup>. Cut and fill slopes over 2 feet in height shall be revegetated or stabilized as shown in Table 7.2. All revegetated areas must be clearly identified in the landscape plans. All revegetated areas, as well as the method of irrigation and maintenance responsibility until final stabilization must be clearly identified in the landscape plans.

Table 7.2. Treatment methods for cut-fill slopes over 2 feet in height

Cut of Fill Slope (H:V)	Treatment
3:1 or less steep	Revegetate
Steeper than 3:1 to 2:1	Rock rip-rap with filter fabric
Steeper than 2:1	Grouted rip-rap or retaining structure

Alternative methods of stabilization may be allowed if certified as stable by a registered geotechnical engineer, and a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” Terracing may be done as provided in the *Grading Standards of the Pima County Code*<sup>3</sup>.

All cut and fill channel slopes and stabilization methods shall be constructed in accordance with the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup> by the Pima County Flood Control District.

#### **7.1.2.4. Horizontal Clearance to Obstructions**

Typical clear zone requirements do not apply to low-speed curbed roadways. However, a minimum clearance of 1 foot should be provided between the back of curb and all obstructions<sup>4</sup>. A 3-foot clearance to roadside objects should be provided near turning radii at intersections and driveways to keep the overhang of a truck from striking and object.

#### **7.1.2.5. Traffic Barriers**

Guardrails and other traffic barriers are effectively roadside obstacles. In consequence, a significant number of crashes with guardrails produce injuries. The proximity of guardrail to the traveled way often also increases accident rates. Therefore, guardrail should only be installed where the potential consequences of departure from the roadway (in terms of accident severity and frequency) are extremely severe.

Because of their design speeds, barriers are generally not required for local streets. However, engineering judgement must be exercised by the designer to determine the need for barriers under exceptional circumstances. Figure 7.1 presents the risk warrant for embankment recommended in AASHTO's *Roadside Design Guide*<sup>5</sup>. Barriers are warranted for conditions falling above the warrant line in the figure.

When a barrier is used, it must be placed where the non-recoverable slope or obstruction begins to keep it as far as possible from the traveled way. The minimum spacing allowed from the edge of the traveled way to face of the barrier shall be 4 feet. Barriers must be installed in accordance with current ADOT standard Specifications and Drawings.

Post barricades are an acceptable treatment for roadways that dead-end into drainage channels.

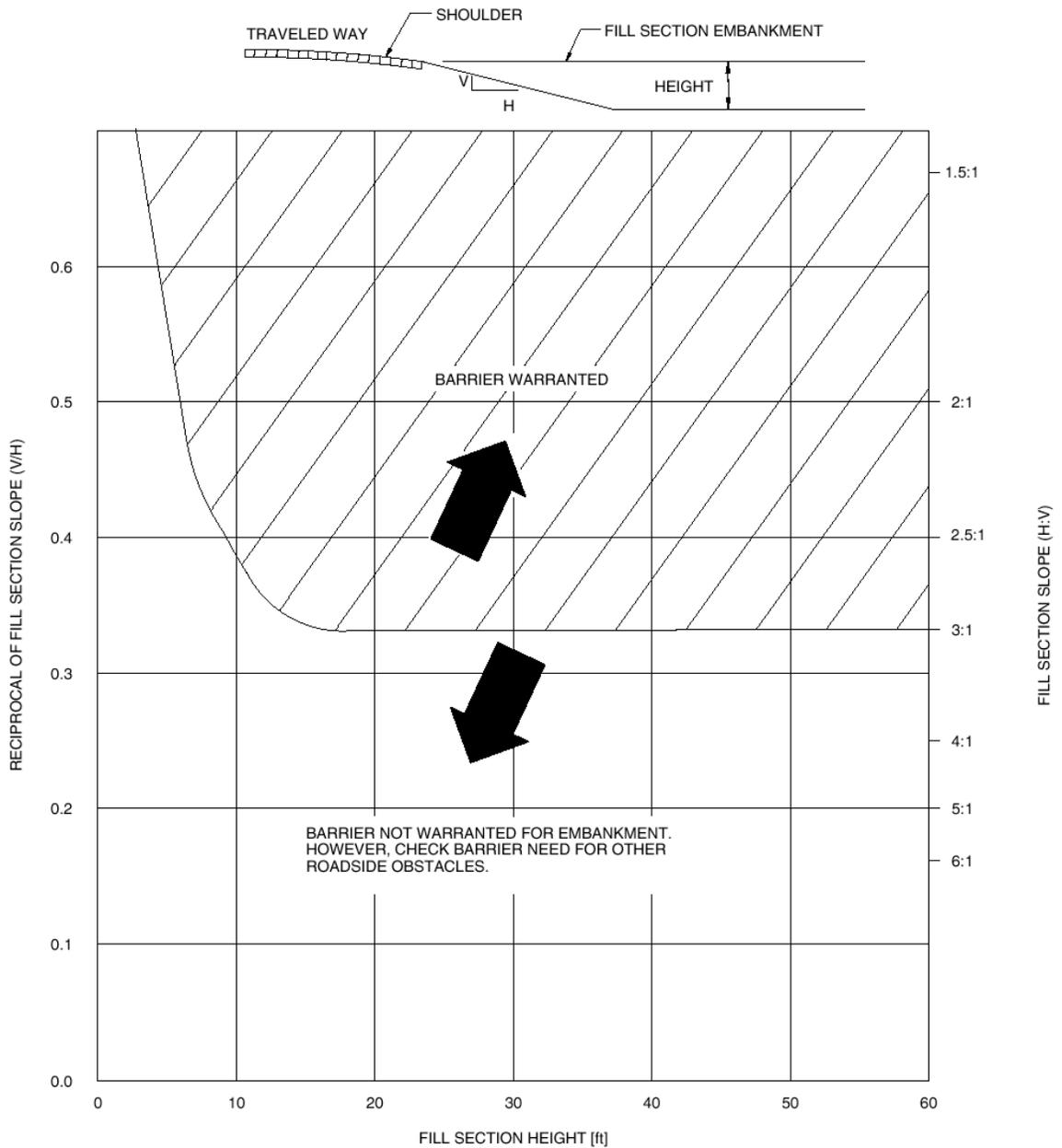


Figure 7.1. Barrier risk warrant for embankments (from AASHTO<sup>5</sup>)

**7.1.2.6. Handrails**

Handrails shall be installed for protection of pedestrians whenever slopes are steeper than 2:1 (H:V) within 3 feet of the sidewalk and the embankment height is 3

feet or greater. The design engineer may determine that differences in elevation between the sidewalk and nearby terrain under other circumstances may also warrant the installation of handrail. Handrail shall be built in accordance with Pima County's *Standard Details for Public Improvements*<sup>2</sup>.

**7.1.2.7. Right-of-way**

Right-of-way must be wide enough to encompass all cross sectional elements. The minimum right-of-way required for each of the applicable street functional classes is shown in Table 7.3. However, the following additional provisions are made in regards to right-of-way:

- In no case shall the travel lanes, medians, shoulders, curbs or sidewalks be located in easements. Easements may be granted in lieu of right-of-way for certain cross section elements such as utilities, sewers and slopes. Such easements must specifically grant right of entry to Pima County to allow proper maintenance of the facilities located within the easement and to enable remedy from hazards to the public so as to assure public safety.

*Table 7.3. Minimum right-of-way requirements by functional class*

Street Class	Right-of-Way
Local street	55'
Collector	68'

- Collector street right-of-way shall be of sufficient width to accommodate the ultimate pavement section required for the projected design year traffic. Additional rights-of-way may be required by the Department of Transportation at intersections identified on the Pima County *Major Streets and Scenic Routes Plan*<sup>6</sup> or intersections of other collectors where it is deemed necessary to provide sufficient width for turning lanes, sight visibility and other design and safety considerations.

- When it is determined by Pima County that, in the public interest and for the health, welfare, or safety of same, vehicular access to or from a development or subdivision at a particular location should be prohibited, a 1 foot wide Vehicle Access Control Easement (VACE) shall be granted to the public.
- Supplemental right-of-way may be required at all intersections where standard right-of-way widths are unable to completely enclose the sight distance triangles. If right-of-way is not granted for sight distance, an easement will be required restricting the use within the sight distance triangles (see Section 3.2.4.2).

#### **7.1.2.8. Utilities**

With the exception of minor service extensions to individual lots, all longitudinal utility facilities (including sanitary sewers and telecommunications) between service points to individual parcels shall be located within the street right-of-way. Strip easements may be used along streets in lieu of providing right-of-way if they are either for utility purposes or for other uses compatible with utility needs (subject to utility company approval). Access between the street and the private property shall not be denied.

All sanitary sewer facilities shall be provided in accordance with the current Pima County *Standard Details for Public Improvements*<sup>2</sup> and the *Standard Specifications for Public Improvements*<sup>7</sup>. All services shall be provided or stubbed out to existing or planned parcels with all new street construction to avoid the need to remove and replace new pavement.

#### **7.1.3. Typical Cross Sections**

As has been discussed throughout this Chapter, the need for certain cross sectional elements and their dimensions depends on the functional classification of the street. Typical cross sections for each applicable street class are presented in this section and graphically represented in Details 7.1 and 7.2.

**7.1.3.1. Local Streets**

Local streets shall have 12-foot travel lanes and 6-foot shoulders. The sidewalk can be 5-foot wide if a 3-foot curbway is provided, or 6-foot wide if it is placed adjacent to the vertical curb. The typical cross section for this street class is shown in Detail 7.1.

**7.1.3.2. Collectors**

Collector streets as discussed here include both minor (residential) collectors and major collectors. Collectors shall have 12-foot travel lanes and 6-foot shoulders. Also, because of traffic volume considerations, a two way left turn lane must be included in the cross section unless authorization to use a two-lane section is obtained from Pima County. Vertical curb and a 3-foot or wider curbway must be provided between the roadway and the sidewalk to ensure clear separation between vehicular and pedestrian traffic. The typical section for a major collector is illustrated in Detail 7.2.

**7.2. DRAINAGE**

Roadways are frequently subjected to flooding either by runoff transported along the street or at drainage crossings. The following standards have been developed to reduce the hazards associated with storm runoff along or across a roadway and to ensure the safety of roadway users. Field and topographic conditions should be considered in conjunction with these standards, and engineering judgement should be exercised in all cases to minimize adverse effects to adjoining property while maintaining traffic safety.

In order to analyze drainage patterns and impacts, a drainage report shall be prepared by a registered Professional Engineer for any subdivision construction or street improvement. The report must be reviewed and approved by the Pima County Flood Control District.

All proposed drainage improvements must conform to the requirements of the Federal Emergency Management Agency (FEMA), the *Pima County Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup> and the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup> by Pima County Flood Control District.

### 7.2.1. Street Drainage

The provisions made in regards to drainage along streets are discussed below and summarized in Table 7.4.

- Where curbs are provided, street drainage should not exceed 50 cubic feet per second (cfs) and in no case shall the street flows exceed 100 cfs.
- On collector streets, a minimum 10-foot pavement width must be kept clear of flowing or ponded water in each direction during the 10-year storm.
- On local streets, the runoff from a 10-year storm must be contained between the curbs of the street.
- On both collectors and local streets, the 100-year discharge must be contained within the right-of-way.
- Should the 10-year discharge water surface elevation exceed the top of the curb, storm sewers or other treatments shall be provided to keep the water between the curbs.
- The minimum pipe size for storm sewers shall be 18 inches.

Table 7.4. Design criteria for longitudinal street drainage

Parameter	Design Standard
Maximum street runoff (cfs)	100
10-year storm containment - Local streets	Between curbs
10-year storm - Minimum width clear of water (collectors)	10 ft per direction
100-year storm containment	Within R/W
Minimum storm sewer pipe diameter (in)	18

Drainage conveyed within the street shall only be discharged from the street right-of-way into drainage easements as provided by the plat. A drainage easement will be required whenever any natural watercourse has been altered to such a degree as to need a constructed channel cross-section and periodic maintenance; or if through development, storm runoff is concentrated to such a degree as to require a defined channel. Drainage is generally conveyed by using curb openings, scuppers or catch basins that discharge into channels or storm drain systems. These treatments are discussed in the following sections.

**7.2.1.1. Curb Openings**

Curb openings used for drainage shall be fitted with outlet aprons and shall have a maximum length of 10 feet. The curb elevation must transition from the normal reveal to the level of the opening at a rate of 12:1 (see Detail 4.5). Also, to avoid frequent changes in sidewalk elevation and pedestrian discomfort, curb openings must be spaced a minimum of 150 feet (from centerline to centerline). Roadway curb openings and drainage inlets shall be fitted with appropriate barricades as necessary. Table 7.5 presents the design standards for curb openings.

*Table 7.5. Design standards for curb openings*

<b>Parameter</b>	<b>Design Standard</b>
Maximum length (ft)	10
Curb transition slope	12:1
Minimum spacing (ft)	150

Should the design require greater conveyance than can be provided by curb openings, then scuppers, catch basins or other drainage structures must be used.

**7.2.1.2. Scuppers**

Scuppers are structures used to drain flow under a sidewalk, generally between a paved area and a drainageway. They are generally a viable alternative for locations where curb openings can not accommodate the design flow. Scuppers must be

designed to accommodate the 100-year storm. The containment limits requirements defined in Section 7.2.1 for the 10 and 100-year storms must also be met.

The Pima County *Standard Details for Public Improvements*<sup>2</sup> provides a detail for sidewalk scuppers. The design shown in Detail 4.6, modified from the *Uniform Standard Details for Public Works Construction*<sup>10</sup> (Maricopa Association of Governments) can also be used.

### **7.2.1.3. Catch Basins**

Catch basins are structures used to drain the pavement into storm drain systems. Catch basins must be designed to accommodate the 100-year storm. The containment limits requirements defined in Section 7.2.1 for the 10 and 100-year storms must also be met. The Pima County *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>, the *Roadway Design Manual*<sup>11</sup> and the *Standard Details for Public Improvements*<sup>2</sup> provide guidance in the design of catch basins. In areas where pedestrian or bicycle traffic is expected, the design, installation and location of catch basins should be done in such a way as to minimize potential hazards to pedestrian and bicyclists.

### **7.2.2. Cross Drainage**

In commercial and industrial subdivisions, storm drainage across the roadway must be handled by culverts or by culvert and at-grade crossing combinations, depending on the design period. The design criteria for those treatments are discussed in this section. The specific design criteria for those treatments are discussed in this section. For more details, refer to the *Drainage and Channel Design Standard for Local Drainage*<sup>9</sup>.

Regardless of the cross drainage treatment used, emergency vehicles and other vehicles must be able to safely access the subdivision in flooding situations. Therefore, at least one paved, permanent all-weather access shall be provided to

each lot. The maximum flow depth over the roadway for all-weather access shall be as defined in the *Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup>, Section 16-36.060 or any revisions of the ordinance.

The Pima County *Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup> prohibits diversion of flow from one basin to another. Flood limits and depths shall be kept unchanged where flows of 50 cfs or greater exit onto adjacent property, unless an improved channel or other measures to prevent flood damage are provided. Drainage easements shall be provided within the subdivision for cross-drainage.

**7.2.2.1. Culverts**

Culvert structures shall be required at all drainage crossings in commercial and industrial subdivisions. In local streets the culverts shall be designed to at least handle the 10-year flow under the roadway. Culverts across minor collectors shall convey at least the 25-year flow under the roadway. Culverts across major collectors shall convey at least the 50-year flow under the roadway or, if possible, the 100-year flow under the roadway. Whenever a culvert is designed for less than the 100-year event, the excess flow during that event shall be contained within a dip with a flow depth of less than 12 inches. If the roadway is all-weather access, the flow depth shall not exceed the requirements defined in the *Floodplain and Erosion Hazard Management Ordinance*<sup>8</sup>. Table 7.6 summarizes the minimum design flow requirements for culverts.

Table 7.6. Minimum design flow for culverts

Street Class	Minimum Culvert Requirements
Local Street	Q <sub>10</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Minor Collector	Q <sub>25</sub> under roadway, Q <sub>100</sub> less than 1 foot* in depth within dip
Major Collector	Q <sub>50</sub> (Q <sub>100</sub> if possible) under roadway , Q <sub>100</sub> contained within dip*

\* If roadway is an all-weather access, the maximum flow depth shall be in compliance with the Pima County Floodplain and Erosion Hazard Management Ordinance<sup>8</sup>

In addition to the requirements described above, any culverts constructed for a commercial or industrial subdivision must meet the following criteria:

- Pipe culverts shall have a minimum diameter of 18 inches.
- Reinforced Concrete Pipes (RCP), Corrugated Metal Pipes (CMP), High Density Polyethylene pipes (HDPE) and Spiral Rib Pipe (SRP) are acceptable for pipe culverts. Pipes made of other materials will require approval from Pima County.
- Headwalls shall be required at inlets for pipes greater than 30 inches in diameter, multiple pipe culverts and Reinforced Concrete Box Culverts (RCBC). For channels in supercritical flow, flared end walls and headwalls shall be required.
- Reinforced Concrete Box Culverts (RCBC) shall be at least 4 feet in height and shall be structurally designed according to Arizona Department of Transportation's (ADOT) *Standard Drawings – Structures Section*<sup>12</sup> or by a licensed structural engineer.
- Erosion protection must be provided at the culvert outlets according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>. Erosion protection design compares the outlet velocity to the natural stream velocity. When outlet velocity exceeds 10 feet per second, wired-tied rip rap shall be required to provide for uniform spreading of the flow and to protect against scour. If the length of protection needed to reduce flow velocity becomes excessive, another form of protection should be used.
- The velocity at the culvert outlet shall be greater than 3 feet per second to reduce culvert maintenance needs.
- All culverts with headwalls shall extend 10 feet beyond the edge of the travel lane to protect errant vehicles and pedestrians. Where culverts cannot be extended 10 feet beyond the edge of the travel lane, guardrails or other suitable traffic barriers must be used as discussed in Section 7.1.2.5.
- Handrail must be provided at all culverts in the vicinity of pedestrian traffic.

### **7.2.2.2. At-Grade Crossings**

At-grade crossings shall only be used to supplement culverts during certain rainfall events (see section 7.2.2.1).

Post barricades shall be placed at all at-grade crossings. In addition, at-grade crossings in which the transverse flow during the 100-year event is less than or equal to 50 cfs, shall at least be fitted with 6-inch by 12-inch concrete headers. If the 100-year flow is greater than 50 cfs, cut-off walls must be constructed. Cut-off walls shall be designed 1 foot deeper than the scour determined by the use of the approved general and local scour equations or 70% of the maximum depth of scour. However, in no case shall the cut-off wall depth be less than 2 feet upstream and 3 feet downstream. Sliding and overturning moments may need to be analyzed for at-grade crossings protected by cut-off walls deeper than 6 feet. Concrete headers and cut-off walls must extend the developed 100-year flow width.

In order to improve safety, aesthetics and to reduce maintenance, all at-grade crossings needed shall be designed to be self-cleaning. This can be accomplished by providing a 4% superelevation at the at-grade crossing, by installing a sediment trap, or by other means with the approval of Pima County. Erosion protection must be provided at the culvert outlets of at-grade crossings according to the requirements of the *Drainage and Channel Design Standards for Local Drainage*<sup>9</sup>, and as specified in section 7.2.2.1 of this manual.

## **REFERENCES**

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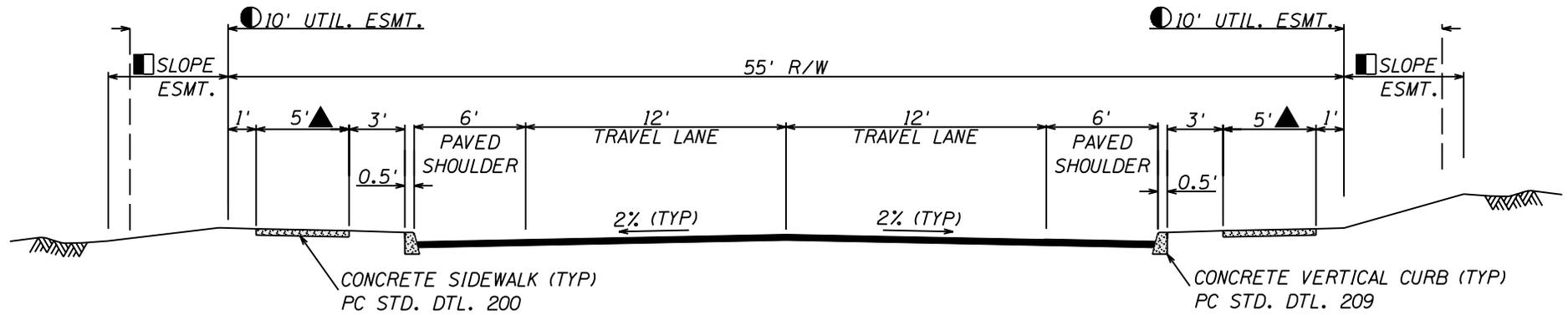
<sup>1</sup> Pima County Department of Transportation. Pavement Marking Design Manual, Tucson, 2002.

<sup>2</sup> Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.

<sup>3</sup> Pima County. Pima County Code, Tucson, 2003.

<sup>4</sup> American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets, Washington D.C., 2001.

- <sup>5</sup> American Association of State Highway and Transportation Officials. Roadside Design Guide, Washington D.C., 2002.
- <sup>6</sup> Pima County. Major Streets and Scenic Routes Plan, Tucson, 2002.
- <sup>7</sup> Pima County and City of Tucson. Standard Specifications for Public Improvements, Tucson, 2003.
- <sup>8</sup> Pima County. Ordinance 1999-FC1: Floodplain and Erosion Hazard Management Ordinance, Tucson.
- <sup>9</sup> Pima County. Drainage and Channel Design Standards for Local Drainage, Tucson, 1984.
- <sup>10</sup> Maricopa Association of Governments. Uniform Standard Details for Public Works Construction, 1998.
- <sup>11</sup> Pima County Department of Transportatio. Roadway Design Manual, Tucson, 2003.
- <sup>12</sup> Arizona Department of Transportation. Standard Drawings - Structures Section, Phoenix, 1992.



- OR AS DETERMINED BY UTILITY COMPANIES
- ▣ WHERE APPLICABLE
- ▲ IF SIDEWALK IS PLACED ADJACENT TO THE CURB, IT SHALL BE 6' WIDE

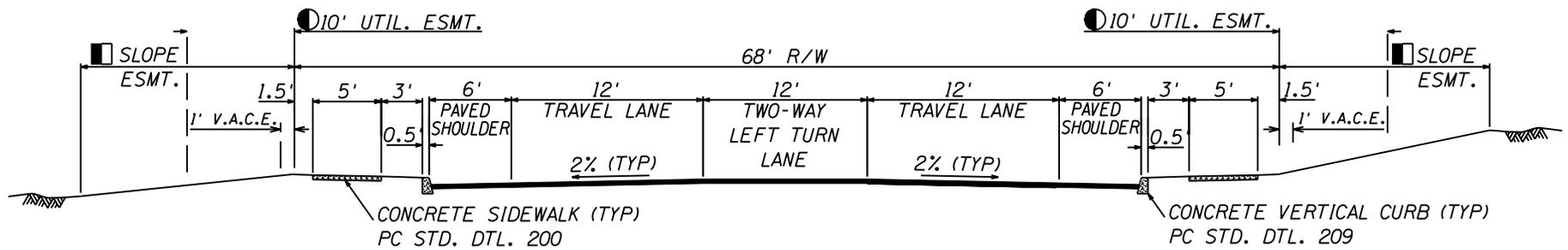
NOTE: NO PARKING ALLOWED

DETAIL 7.1

LOCAL STREET  
 COMMERCIAL OR  
 INDUSTRIAL SUBDIVISION  
 (See Table 3.1 for Street Classification)



PIMA COUNTY  
 DEPARTMENT OF  
 TRANSPORTATION



- OR AS DETERMINED BY UTILITY COMPANIES
- WHERE APPLICABLE

**NOTES:**

PLACEMENT OF SIDEWALK ADJACENT TO CURB SHALL NOT BE ACCEPTABLE

NO PARKING ALLOWED

DETAIL 7.2

COLLECTOR  
COMMERCIAL OR  
INDUSTRIAL SUBDIVISION  
(See Table 3.1 for Street Classification)



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

## 8. COMMERCIAL AND INDUSTRIAL DEVELOPMENTS

Before using this chapter verify that the development meets the requirements outlined in section 2.3 for commercial and industrial developments.

The design standards covered in this chapter are applicable to industrial or commercial parcels that submit individual development plans to Pima County.

### 8.1. DRIVEWAY DESIGN

The location of driveways and their geometric features have an effect on the safety and capacity of the adjacent street. This section introduces a group of design standards that are intended to minimize the negative safety and capacity impacts of driveways.

#### 8.1.1. Location

The factors that must be considered when determining the location of commercial or industrial driveways are driveway spacing, the number of driveways per lot, and clearance to intersections.

##### 8.1.1.1. Spacing

Driveway spacing must be sufficient to allow drivers on the adjacent street to react to vehicles joining the traffic stream or turning into the driveway. In consequence, the minimum spacing is a function of the speed on the adjacent roadway. Table 8.1 illustrates the minimum driveway spacing (measured from driveway centerline to driveway centerline) based on the distance needed to reduce collision potential due to overlapping right turns. The values in Table 8.1 shall be met in all cases, unless a proper request is filed and approved in accordance with Chapter 9, "Administration of the Standards."

Table 8.1. Minimum driveway spacing

Posted Speed on Adjacent Street (mph)	Minimum Driveway Spacing (ft) Centerline to Centerline
25	105
30	125
35	150
40	185
45	230
50	275

Pima County may request increased driveway spacing in rural areas, or when warranted by field conditions such as significant weaving or insufficient left turn queue storage (during the peak period).

In addition to the requirements identified above, the maximum number of driveways for any lot shall be limited to two per three hundred feet of frontage along any single street.

**8.1.1.2. Corner Clearance**

Adequate corner clearances preserve good traffic operations at intersections, as well as the safety and convenience of access to corner properties. Safe corner clearance is affected by the posted speed limit, whether the driveway is upstream (before) or downstream of (after) the intersection, and whether the intersection is signalized or not. Corner clearance shall be measured from the nearest pavement edge of any driveway to the curbline of the nearest intersecting street, as indicated in Figure 8.1.

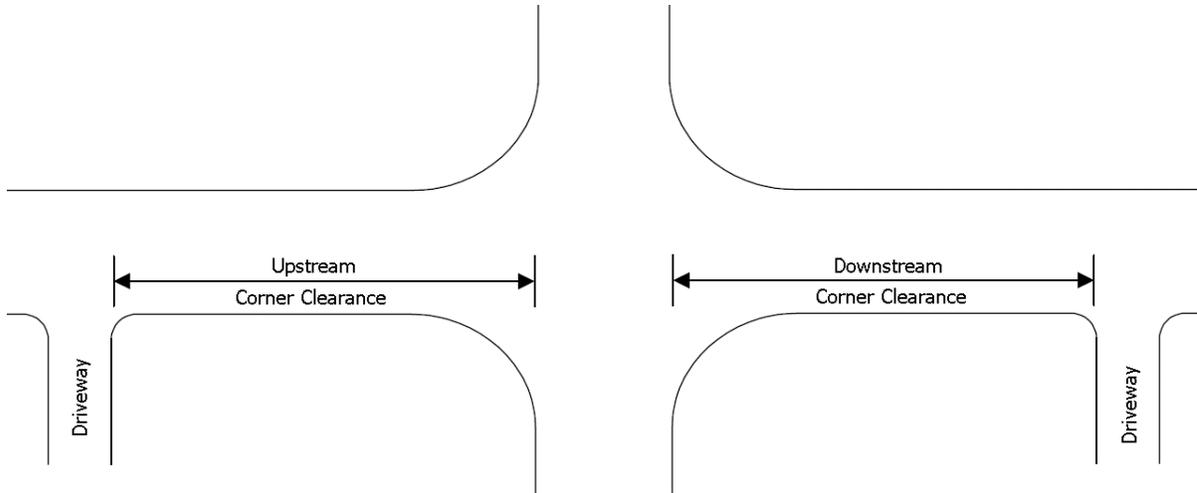


Figure 8.1. Corner Clearance

The minimum allowable corner clearance is presented in Table 8.2. If it is unfeasible to meet the minimum clearance requirements because of lack of lot frontage, Pima County may allow reduced corner clearance if a proper request is filed and approved in accordance with Chapter 9, “Administration of the Standards.” However, in those cases, the driveway shall be located at the farthest property line from the intersection. If return radii are used for the driveway, the returns shall be located within the extension of the property line, to ensure that they do not interfere with the adjacent property.

Table 8.2 Minimum corner clearance for commercial and industrial driveways

Posted Speed on Adjacent Street (mph)	Minimum Corner Clearance (ft)
≤35	150
40	185
45	230
50	275

**8.1.1.3. Need for Turning Lanes**

In addition to the corner clearance requirements, the construction of dedicated turning lanes in the adjacent street may be required at driveway locations subject to

heavy traffic. The need for dedicated turning lanes shall be determined by evaluating the warrants in Section 3.1.3.

#### **8.1.1.4. Shared Driveways**

The use of shared driveways reduces the number of potential conflict points in the roadway network, thus improving safety and operations. New developments should study the possibility of providing shared access to the lots.

In arterials or collector roadways where access density is already high, or at locations where access management policies are in effect, Pima County may request private access easements to minimize the number of access points. The location and dimensions of said easements shall be approved by Pima County according to the procedures outlined in Chapter 9, "Administration of the Standards."

#### **8.1.2. Driveway Aprons and Return Radius**

Driveways on rural, uncurbed streets shall have return radii fitted with 6-inch by 12-inch concrete headers placed adjacent to the pavement on all returns. On streets with vertical curbs, the utilization of driveway aprons with curb cuts is preferred to the utilization of return radii. The design of the driveway apron shall be done according to the Pima County/City of Tucson *Standard Details for Public Improvements*<sup>1</sup> (Detail 206).

Return radii may be allowed on curbed roadways instead of standard curb cuts when one or more of the following conditions occur:

- The projected Average Daily Traffic (ADT) of the driveway exceeds one hundred vehicles<sup>2</sup>. The projected ADT must be calculated using the trip generation rates published in the latest edition of *Trip Generation*<sup>3</sup> from the Institute of Transportation Engineers (ITE).
- The posted speed limit on the roadway is greater than 45 mph<sup>4</sup>.

- The driveway is served by a specific median opening with left turn storage<sup>4</sup>.
- The type of development, the amount of truck traffic, or the prevailing travel speeds, make curb cuts unsafe or undesirable<sup>2</sup>.

If return radii are used, the minimum radius of the return shall be 25 feet on local streets and 40 feet on collectors and arterial streets. In addition to these requirements, the radius of the return must be enough to accommodate all possible turning movements from the largest vehicle expected to use the driveway. The designer should also consider that excessive curb radii are detrimental to pedestrian traffic and complicate the adequate placement of signs. The minimum return radii by type of roadway are summarized in Table 8.3.

Table 8.3. Minimum return radius

Condition	Minimum Return Radius (ft) *
Local street	25
Collector or Arterial Street	40

\* Verify that the radius will be large enough to accommodate turns from the largest vehicle expected to use the driveway

For driveways designed with return radii, a pavement section with a Structural Number (SN) of at least 1.5 shall be provided between the adjacent roadway and the right-of-way line. A pavement section of 2.5 inches of asphaltic concrete (AC) on 4 inches of compacted aggregate base (AB) course can be used to meet the minimum SN required. The grades and dimensions for commercial driveways with return radii are shown in Detail 8.1.

### 8.1.3. Geometric Elements

Several geometric features are critical to the safe and efficient operation of driveways and the streets adjacent to them. This section addresses width, sight distance, grade, angle of connection, and throat length requirements.

**8.1.3.1. Width**

Narrow driveways limit the access speed to and from the driveway, obstructing the through traffic and increasing the likelihood and severity of rear end collisions. Driveways should also be wide enough to allow access of emergency vehicles. Based on those considerations, the minimum width for commercial or industrial driveways shall be 24 feet.

Driveways that are too wide often confuse drivers and are difficult for pedestrians to cross. The maximum width for two-lane driveways shall be 30 feet. Where more than two lanes are provided, a raised median island between 6 and 16 feet wide shall be installed<sup>5</sup>. Each side of a median-divided driveway shall be at least 16 feet wide to ensure accessibility of emergency vehicles. As an example, for a median-divided driveway with 1 inbound lane and 2 outbound lanes, the minimum inbound width would be 16 feet and the minimum outbound width would be 24 feet.

**8.1.3.2. Sight Distance**

Commercial and industrial driveways must meet the intersection sight distance requirements defined in Section 3.2.4.2.

**8.1.3.3. Grade**

The vertical profile of a driveway should allow a smooth transition to and from the roadway. Steep driveways force motorist to slow their speed when entering or exiting the driveway to avoid “bottoming out”. Significant speed reductions make through traffic slow down and increase the potential for accidents. Therefore, the maximum allowable grade for commercial and industrial driveways shall be 6%. On the other hand, the grade should be significant enough to ensure proper drainage.

**8.1.3.4. Angle of Connection**

Connection angles at the intersection of driveways with public roadways should be set at 90°. In any event, the connection angle shall be between 80° and 100°.

### 8.1.3.5. Throat Length

The throat length is the distance between the edge of the pavement of the adjacent street and the end of the driveway inside the development. Figure 8.2 illustrates this concept. Inadequate throat length can lead to situations in which traffic turning into a development backs up onto the arterial roadway while waiting for vehicles to clear the short driveway. Provision of sufficient throat length reduces driver confusion, accident frequency and severity, and improves traffic flow on the adjacent street.

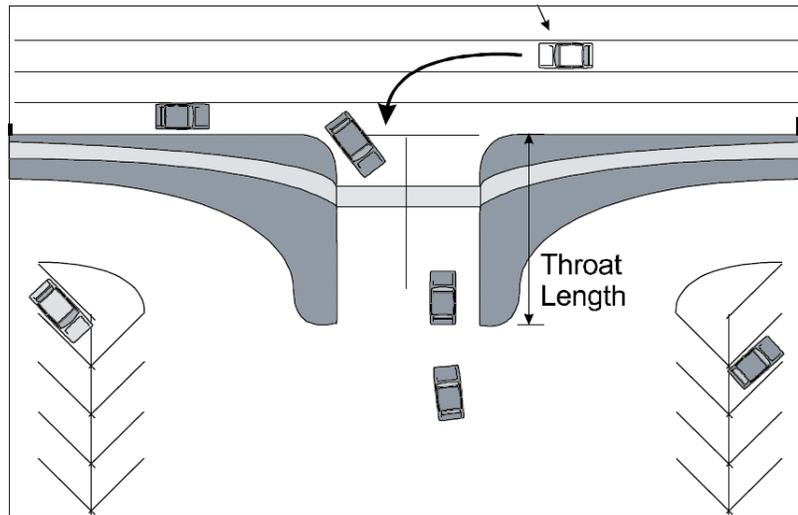


Figure 8.2. Driveway throat length (Source: Florida Department of Transportation<sup>4</sup>)

In the case of developments that require a Traffic Impact Study (TIS), a queuing analysis should be performed as part of the TIS to determine expected queue lengths. The throat length should be designed to accommodate the calculated queues. However, in no case shall the driveway throat length be less than 50 feet.

## 8.2. DESIGN OF PARKING AREAS

Parking lot layout is an integral part of proper site planning. It involves the arrangement of circulation aisles, parking stalls, median islands, pedestrian facilities and landscaping to provide safe and efficient access to the development. The requirements defined here are in addition to those established in the *Pima County Code*<sup>6</sup>, Section 18.75 and in the *Pima County Commercial Design Manual*<sup>7</sup>.

### **8.2.1. Layout**

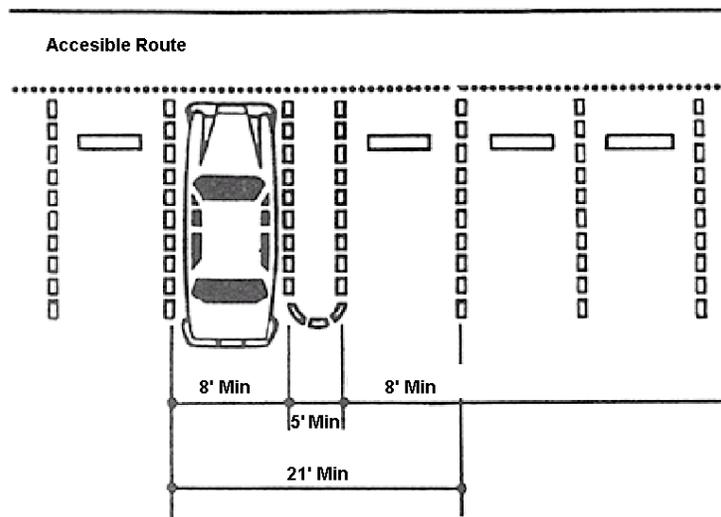
All parking areas shall conform to the following requirements, in addition to the requirements set forth in all subsections of Section 8.2.1:

- Passenger drop-off points, separated from street traffic and readily accessible without hazardous maneuvering, shall be provided in conjunction with the following uses: Hotels, motels, hospitals and clinics, educational facilities with fifty or more pupils, day care centers, religious facilities with one hundred or more seats, transit terminals, major recreational facilities, commercial airports, public buildings, and offices and financial services greater than five thousand square feet of gross floor area.
- All parking lots shall provide unrestricted access by emergency and service vehicles. The designer shall utilize geometric characteristics of the SU-30 design vehicle with forty-two-foot turning radius to accommodate these vehicles.
- Parking spaces in paved parking areas shall be permanently marked with striping in accordance with the Manual on Uniform Traffic Control Devices<sup>8</sup>. Space lines shall be a minimum of three inches wide, white paint or plastic, and extend for a minimum of ten feet for interior lines. End lines shall extend the full length of the space.
- Parking areas and spaces shall be provided with bumper barriers, wheel stops or wheel stop curbing, designed to prevent parked vehicles from extending beyond the property lines, damaging adjacent landscaping, walls or buildings, or overhanging sidewalk areas. Wheel stops or wheel stop curbing shall be located three feet from the front of the parking space.

### 8.2.1.1. Parking Area Dimensions

The minimum dimensions for standard parking spaces shall be 9 feet by 20 feet. Handicapped accessible spaces shall be a minimum of 13 feet by 20 feet. However, two accessible parking spaces may share a common access aisle as provided in the *ADA Standards for Accessible Design*<sup>9</sup> and illustrated in Figure 8.3. Under that alternative, each of the two spaces shall be at least 8 feet wide and the common aisle shall be 5 feet wide (8 feet if spaces are van accessible).

Figure 8.3. Handicapped parking with shared aisle (Source: *ADA Standards for Accessible Design*<sup>9</sup>)



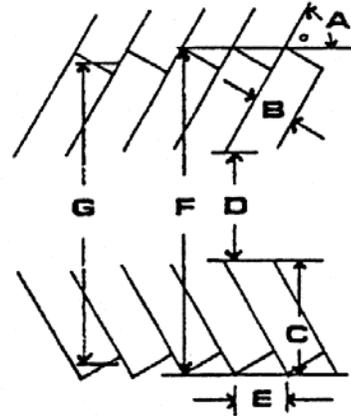
The orientation of Parking Area Access Lanes (PAALs) shall be perpendicular to the building faces to accommodate convenient pedestrian movements and provide greater visibility to pedestrians and drivers. However, PAALs parallel to the building can be used for small developments.

The minimum width of PAALs shall be 12 feet for 30° parking, 13 feet for 45° parking, 18 feet for 60° parking and 24 feet for 90° parking. The dimensions of PAALs and parking spaces (based on the parking angle) are provided in Table 8.4.

Table 8.4. Parking area dimensions and guidelines

**ELEMENTS**

- A Parking Angle
- B Space Width
- C Space Depth
- D Aisle Width
- E Curb Length
- F Curb to Curb Bay Width
- G Space Center to Center Width



A	B	C	D	E	F	G
0°	9.0	9.0	12.0	23.0	30.0	-
	9.5	9.5	12.0	23.0	31.0	-
	10.0	10.0	12.0	23.0	32.0	-
20°	9.0	15.3	12.0	26.4	42.6	34.1
	9.5	15.7	12.0	28.0	43.4	34.5
	10.0	16.3	12.0	29.6	44.6	35.2
30°	9.0	17.8	12.0	18.0	47.6	39.8
	9.5	18.2	12.0	19.0	48.4	40.2
	10.0	18.6	12.0	20.0	49.2	40.5
45°	9.0	20.4	13.0	12.7	53.8	48.0
	9.5	20.6	13.0	13.4	54.2	48.0
	10.0	21.2	13.0	14.1	55.4	48.3
60°	9.0	21.9	18.0	10.4	61.8	57.5
	9.5	22.1	18.0	11.0	62.2	57.7
	10.0	22.5	18.0	11.5	63.0	58.0
70°	9.0	22.0	19.0	9.5	63.0	60.3
	9.5	22.2	19.0	10.1	63.4	60.3
	10.0	22.3	19.0	10.5	63.6	60.3
80°	9.0	21.5	24.0	9.6	67.0	-
	9.5	21.5	24.0	10.1	67.0	-
	10.0	21.5	24.0	10.6	67.0	-
90°	9.0	20.0	24.0	9.0	64.0	-
	9.5	20.0	24.0	9.5	64.0	-
	10.0	20.0	24.0	10.0	64.0	-

Parking areas shall not be designed to require or encourage vehicles to back into a street, pedestrian access way, or alley in order to leave the lot or maneuver out of a parking space.

A back-up spur shall be provided at the end of a row of parking if no ingress or egress is provided at that end. The spur shall be at least 6 feet in depth, with a 3-foot radius, and shall have a wheel barrier to prevent encroachment onto any unsurfaced areas. A minimum distance of 3 feet shall be provided between the back of the spur and any wall, screen, or other obstruction over 6 inches in height (see Figure 8.4).

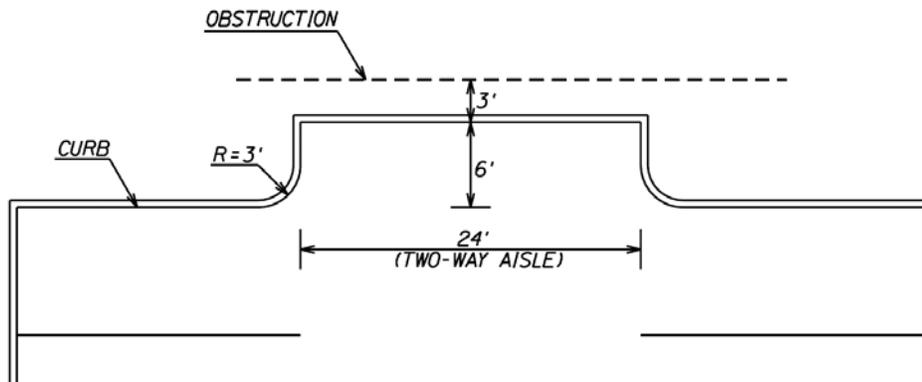


Figure 8.4. Dimensions of back-up spur

### 8.2.1.2. Pedestrian Circulation

Commercial developments generally have a significant amount of pedestrian traffic generated by people that walk to the development and by people that drive to the development and park their cars. Therefore, pedestrian accessibility is an important part of the overall circulation at the site. The following provisions are made in regards to pedestrian accessibility<sup>7</sup>:

- Sidewalks shall be provided on all sides of the lot that abut a curbed public street (see Chapter 7 for dimensions).
- A continuous internal pedestrian walkway, no less than 5 feet in width, shall be provided from the public sidewalk or right-of-way to the principal entrance of buildings at the site. At a minimum, walkways shall connect focal points of

pedestrian activity such as, but not limited to, transit stops, street crossings and building entry points.

- All pedestrian walkways internal to the site shall be distinguished from driving surfaces through the use of durable, low maintenance surface materials such as pavers, bricks, or concrete to enhance pedestrian safety and comfort, as well as to improve the aesthetics of the walkway.

### **8.2.1.3. Bicycles**

Bicycle parking spaces shall be provided as specified Section 18.75 of the *Pima County Code*<sup>6</sup>. The dimensions and location of those spaces, as well as the overall bicycle site circulation, shall be designed in accordance with the *Pima County and City of Tucson Bicycle Parking Development Standards*<sup>10</sup>.

### **8.2.2. Drainage**

The construction of a parking area in the floodplain of a regional watercourse shall not be permitted unless it can be shown, to the satisfaction of Pima County that it does not<sup>11</sup>:

- Create a danger or hazard to life or property (acting alone or in combination with any existing or future uses). Pima County may require certification by an Arizona Registered Professional Engineer that the proposed use will not result in an increase in the floodway elevation during the occurrence of the 100-year flood; and/or will not result in the proposed use diverting, retarding or obstructing the flow of flood waters.
- Increase the 100-year flood elevation by more than 0.1 feet.
- Adversely affect ground-water recharge.
- Increase erosion potential upstream and/or downstream.
- Adversely affect important riparian habitats.

Parking shall be permitted in the flood plains of regional watercourses, washes and detention/retention basins, provided that the maximum depth of flooding is 1 foot

during the 100-year event. Such parking lots shall have a prominent sign posted at the entrance to the parking area that contains the information that the parking lot is subject to periodic flooding of depths up to 1 foot, and that overnight parking is not advised. Whenever feasible, the areas which have the maximum depth of ponding should be located in the more remote areas of the parking lot.

Drainage of parking lots can be accomplished by means of curb openings, scuppers, catch basins and storm drain systems in general as discussed in Section 6.2. Inverted roadway crowns or concrete valley gutters are allowed in parking aisles. The minimum longitudinal slope permitted within parking lot storage facilities is 0.5%.

### **8.2.3. Pavement**

In order to control particulate matter, all parking areas shall be paved, regardless of their size. Parking areas with up to 10 spaces can use a double chip seal or brick pavers as dust control treatments, provided that there is no significant truck traffic.

For parking areas with ten or more spaces, a minimum Structural Number (SN) of at least 1.35 shall be required. Based on the structural coefficients presented in Section 3.3, that structural number can be obtained by using two inches of asphaltic concrete (AC) on four inches of compacted aggregate base (AB) course. Depending upon the expected traffic conditions, Pima County may request a pavement design report prepared by a Registered Professional Engineer, to determine if a pavement section with a greater SN is needed.

Other types of surfacing may be used with the concurrence of the Pima County Department of Transportation provided that the pavement structural requirements are met and a Registered Professional Engineer certifies the design.

Paving may not be required in certain vehicle-accessible areas such as contractors yards or storage areas. However, those areas shall still use surface treatments such as gravel or decomposed granite to ensure dust control.

#### 8.2.4. Drive-thru Queuing

The provision of sufficient storage for drive-thru lanes is an important component of the site circulation. Insufficient or poorly designed storage of queued vehicles can cause blockage of the through lanes or of parking areas, resulting in unsafe operating conditions.

The minimum storage requirements for the most common types of drive-thru facilities are presented in Table 8.5 (an average front bumper-to-front bumper distance of 20 feet has been assumed). The storage lengths shown in Table 8.5 shall be accomplished without interfering with the through streets or the parking area. For drive-thru facilities not included in Table 8.5, the storage length to be provided shall be determined by a TIS, if available, or with the concurrence of Pima County (if a TIS is not available).

Table 8.5. Minimum required drive-thru storage per lane

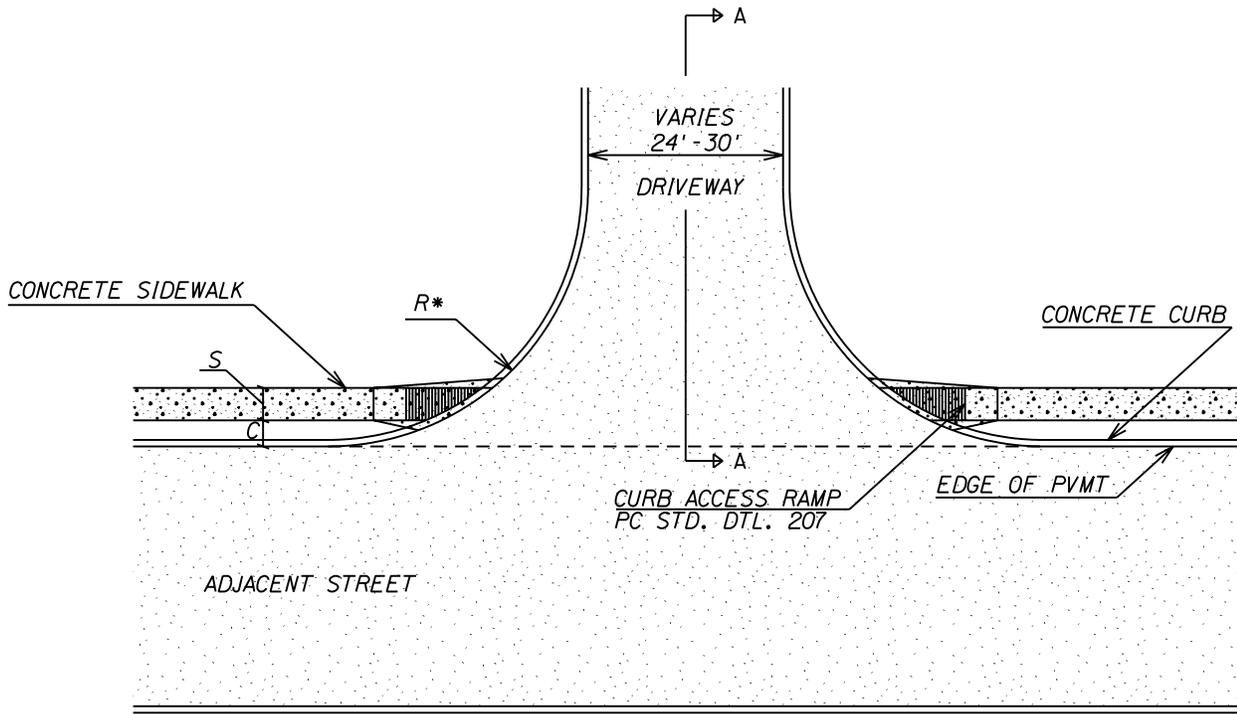
Drive-Thru Facility	Required Storage per Lane (veh)	Required Storage per Lane (ft)
Fast-Food	9	180
Bank	7	140
Car Wash (self-service)	2	40
Day Care	9	180
Dry Cleaner	2	40

Source: *Queuing Areas for Drive-Thru Facilities*, ITE Journal, May 1995<sup>12</sup>

## **REFERENCES**

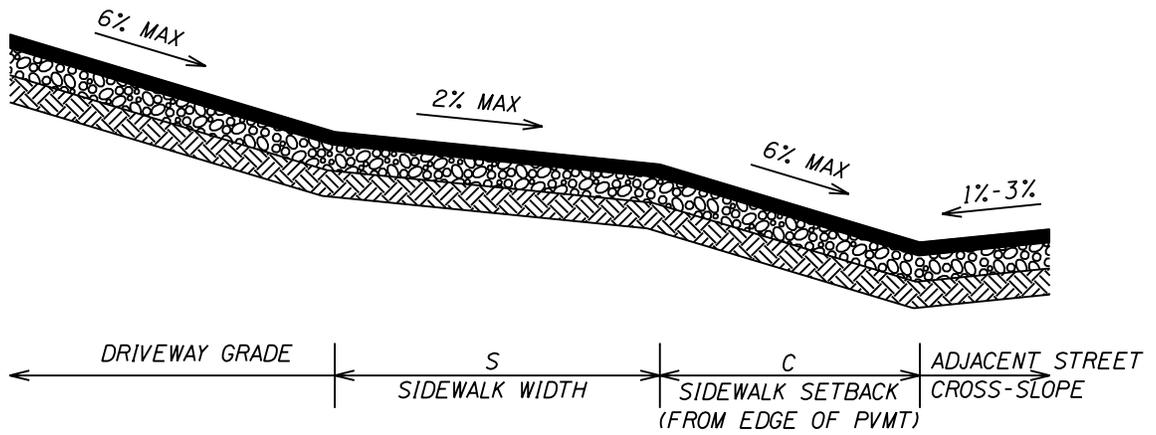
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- <sup>1</sup> Pima County and City of Tucson. Standard Details for Public Improvements, Tucson, 2003.
- <sup>2</sup> City of Tucson. Development Standards, Tucson, 2000.
- <sup>3</sup> Institute of Transportation Engineers. Trip Generation, 6th edition, Washington D.C., 1997.
- <sup>4</sup> Florida Department of Transportation. Site Impact Handbook, Tallahassee, Florida, 1997.
- <sup>5</sup> Koepke, Frank J. and Levinson, Herbert S. NCHRP Report 348, Access Management Policies and Guidelines for Activity Centers, Transportation Research Board, Washington D.C., 1989.
- <sup>6</sup> Pima County. Pima County Code, Tucson, 2003.
- <sup>7</sup> Pima County. Commercial Design Manual, Tucson, June 2003.
- <sup>8</sup> Federal Highway Administration. Manual on Uniform Traffic Control Devices, Washington D.C., 2000.
- <sup>9</sup> United States Department of Justice. ADA Standards for Accessible Design, Washington D.C., 1994.
- <sup>10</sup> Pima County and City of Tucson. Bicycle Parking Development Standards (draft), Tucson, September 2003.
- <sup>11</sup> City of Tucson. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.
- <sup>12</sup> ITE Technical Council Committee 5d-10. Queuing Areas for Drive-Thru Facilities, Institute of Transportation Engineers, Washington D.C., ITE Journal, May 1995.



PLAN VIEW

*	<u>STREET TYPE</u>	<u>R</u>
	ARTERIAL OR COLLECTOR	40'
	LOCAL STREET	25'



SECTION A-A

DETAIL 8.1

TWO-LANE COMMERCIAL  
DRIVEWAY WITH  
RETURN RADII



PIMA COUNTY  
DEPARTMENT OF  
TRANSPORTATION

## **9. ADMINISTRATION OF THE STANDARDS**

This section addresses the procedures that shall be followed to manage and implement the standards and requirements in this manual. It is the responsibility of the County Engineer to administer, coordinate and enforce the provisions and standards in this manual, and to appoint and coordinate the activities of a subdivision and development street standards committee, here-in-after referred to as the "Committee". The County Engineer may seek the recommendation of the Committee for interpretations and modifications of the standards in this manual. The appointed Committee shall have the following characteristics:

1. Number of members: The Committee shall be composed of five (5) persons.
2. Affiliation and qualifications of members: The affiliation of the members shall be as follows:
  - At least three (3) members shall be from the Pima County Department of Transportation.
  - At least three (3) members shall be registered Professional Engineers (P.E.) in the State of Arizona.
  - All members shall have knowledge and experience in subdivision design and have a good understanding of the development review process.
3. Appointing Authority: All Committee appointments shall be made by the County Engineer.
4. Term: Committee members serve at the pleasure of the County Engineer.
5. Transaction of Business
  - a. Procedures: The Committee may adopt policies and standard operating procedures, subject to the approval of the County Engineer, to assure the efficient, predictable, fair and balanced administration of the Committee's work.
  - b. Meeting frequency: The Committee shall meet as necessary to conduct the Committee's business.

- c. Quorum: The Committee shall be considered to be duly assembled at meetings where at least three members are present, and at least two of the three members present shall be from the Pima County Department of Transportation. If fewer than three members are present the meeting shall be re-scheduled.
- d. Voting: Each member of the Committee shall have one vote in all decisions requiring a vote. A request to the committee for an interpretation or a modification requires a vote.
- e. Minutes: A recording secretary shall prepare meeting minutes which shall include all agenda and discussion items and all votes and consensus actions by the committee. Minority opinions shall be included in the meeting minutes when requested by the member(s) casting the minority vote(s).

#### **9.1. MODIFICATIONS AND INTERPRETATIONS**

In some cases, strict compliance with these standards may not be feasible or an interpretation may be required. In those cases, Pima County may grant an interpretation or modification from these standards. Neither the committee, nor the County Engineer shall grant a modification or interpretation unless the following criteria are met:

1. For modifications, the strict application of the provision(s) in question would create an extraordinary and unnecessary hardship due to unusual topographic or other pre-existing physical conditions of the land. The hardship shall not arise from a condition created by an action of the owner of the property.
2. The modification or interpretation is in harmony with the general intent and purposes of the standards and the provision(s) from which the modification or interpretation is requested, and compatible with the general regulations, provisions, and purpose of the applicable zoning code chapter 18.69 or 18.75.
3. The modification does not violate State law or other provisions of Pima County ordinances or policies.

4. The modification will not cause injury to, or adversely affect the rights of surrounding property owners and residents.
5. The modification is the minimum necessary to afford relief.
6. The modification is not granted solely to increase economic return from the property.
7. The modification will not reduce traffic safety and visibility, functional utility of the street system, and emergency vehicle access on or off-site.

#### **9.1.1. Requests for Modifications and Interpretations**

All requests for modifications and interpretations shall be submitted to the Development Review and Technical Support Division of the Development Services Department. The following elements must accompany each request:

- A street standards modification or interpretation request application.
- Payment of an application fee.
- Documentation supporting the need for a modification(s) based on extraordinary hardships or unique site conditions and compliance with the requirements in Section 9.1. or documentation supporting the need for an interpretation.
- Other information and material submitted in conformance with requirements, standards, and procedures adopted by the Committee.

#### **9.1.2. Committee and County Engineer Actions on Modification and Interpretation Requests**

The County Engineer shall review the complete application including relevant documentation, information, and material required in Section 9.1.1. and may at his sole discretion grant, deny or refer the request for modification or interpretation to the Committee for the Committee's review and recommendation. The County Engineer may at his sole discretion refer minor interpretations to the Development

Review and Technical Support Division of the Development Services Department for the Division's review and action.

All requests submitted at least 14 calendar days prior to a scheduled Committee meeting and requests referred to the Committee by the County Engineer will be reviewed by the Committee during the said meeting. Requests submitted fewer than 14 calendar days prior to the Committee's scheduled meeting and requiring Committee action as determined by the County Engineer must wait for the next scheduled Committee meeting for consideration, in order to allow sufficient time for Pima County to study the request.

Pima County will notify the applicant of the date of the Committee meeting in which the request will be studied and Committee action taken. Applicants requesting modifications are encouraged to attend that meeting to present their rationale for requesting the modification and to answer the Committee's questions. In some cases, modification or interpretation requests may also require the consultation from technical experts from fields not represented on the Committee. In those cases, the Committee may invite such experts to the meeting to provide technical consultation and advice.

Conditions may be imposed on a modification that will secure the purpose of this manual and preserve compatibility with the purpose, intent, general regulations, and provisions of the applicable zoning code chapter 18.69 or 18.75 and that mitigate adverse impacts to the subject site and surrounding properties and residents.

If the majority of the Committee members present vote to approve a modification or interpretation, the request shall be considered approved except as provided in the following paragraph. A request shall be considered denied if the majority of the Committee members present vote against a modification or interpretation except as provided in the following paragraph. In the event of a tie vote, the request shall be recorded as a denial, except as provided in the following paragraph. A request may

be continued by the majority of the Committee members if more information is needed. The continuance shall not exceed 10 working days unless the applicant requests more time and the Committee agrees to the continuance. Technical experts invited to advise the Committee shall have no voting authority.

The County Engineer or his designee may accept or reject the Committee's recommendation within three (3) working days of the Committee's recommendation. Within three (3) working days of the County Engineer's decision to reject a Committee recommendation, the County Engineer shall set forth the rejection in writing to the applicant giving the reasons for rejecting the Committee's recommendation.

Pima County will notify the applicant in writing that the request has been either approved, denied, or continued.

## **9.2. AMENDMENTS**

The Committee shall continuously monitor the standards within this manual to ensure that they:

- Are consistent with the latest engineering accepted practices.
- Do not impose extraordinary burdens on typical subdivision or land development projects.
- Are not in conflict with other Pima County policies, provisions and requirements in the Pima County Code, Arizona State Law or the public interest.

The Board of Supervisors is the only institution that can amend these standards. However, if a member of the general public, Pima County staff, the County Engineer, or one or more Committee members believes that any of the standards and requirements in this manual are in conflict with the assurance statements made

above, or that the manual should be revised, they should bring the issue to the attention of the Committee.

The Committee shall then be in charge of evaluating proposed changes to the standards and decide by vote, whether or not to recommend an amendment to the manual. In the event the County Engineer agrees with the Committee's recommendation, the County Engineer shall present the recommendation of the Committee to the Board of Supervisors after the Committee's recommendation is first submitted to the Planning and Zoning Commission for the Commission's review and confirmation to the Board that the recommendation is compatible with the general regulations, provisions, and purpose of the parent zoning code chapters 18.69 and 18.75, and that the purpose and street design and development standards in the Subdivision and Development Street Standards Manual are not compromised or conflicted by the recommendation.