2016

Pima County Subdivision and Development Street Standards

Pima County

Final

Draft

PIMA COUNTY

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1 INTRODUCTION

1.1 PURPOSE

These standards have been adopted by Pima County to guide planners and engineers in the preparation of subdivision plats and commercial/industrial site plans that are consistent with the Pima County Comprehensive Plan, other Pima County standards, and the latest State of Arizona and national standards.

The requirements set forth herein are intended to provide for the design and quality construction of roadway systems that can handle vehicular, pedestrian and bicycle traffic in an effective and efficient manner, both within the development and at the interface with the existing roadway network. This manual incorporates complete streets sustainable and low impact development which supports accessible, livable and attractive communities. Providing context sensitive transportation infrastructure that is sustainable, accessible and durable is key to creating these communities.

1.2 APPLICATION

These standards apply to 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.

It is not the intent of Pima County to limit design to the requirements prescribed herein if the objectives contained in the above listed purpose statement can be achieved by other recognized engineering practices and performance based approaches. Submittal of alternative performance based designs aligned with the objectives outlined above is acceptable and will be reviewed on a case by case basis.

In order to assist developers with deferring block plat spine infrastructure first-costs to facilitate opening master-planned communities, certain requirements in this standard may be deferred until a determined volume threshold is met. Examples of requirements include all-weather crossings, intersection controls and drainage infrastructure. However, and in

order to approve deferments under this clause, the applicant shall demonstrate that the deferred elements do not compromise the overall design from a functional, operational, and maintenance perspective. Approved deferments shall be memorialized in a development agreement.

1.3 LIST OF REFERENCES

Many of the requirements presented in this manual are based on applicable references published by local, state and national agencies and organizations. A listing of those references is presented in the appendix. The designer should reference the latest edition of any reference manual.

2 DEVELOPMENT CLASSIFICATION

This chapter presents the criteria used to classify each development, in part or as a whole, as rural residential, urban residential, conservation residential, or commercial/industrial.

It is recommended that developers and design engineers meet with Pima County staff to discuss the proposed project prior to submittal of rezoning applications, development permits, or subdivision plats. This is imperative if the development meets any of the following criteria:

- The proposed project will have direct access to a street shown on the Major Streets Plan.
- The project will generate Average Daily Traffic of 1,000 vehicles or more. For residential subdivisions, this is equivalent to approximately 100 residential units.
- The project will impact regulatory floodplains, erosion hazard areas, or mapped riparian habitat; or flows from proposed improvements alter existing drainage patterns.
- The project will disturb existing vegetation, particularly native vegetation protected by state or federal law.

This type of meeting will provide an opportunity to coordinate the development with Capital Improvement Projects (CIP) in the vicinity of the project, and it will help design engineers better prepare their submittal to reduce project review time. These meetings may be scheduled through the Development Services Department.

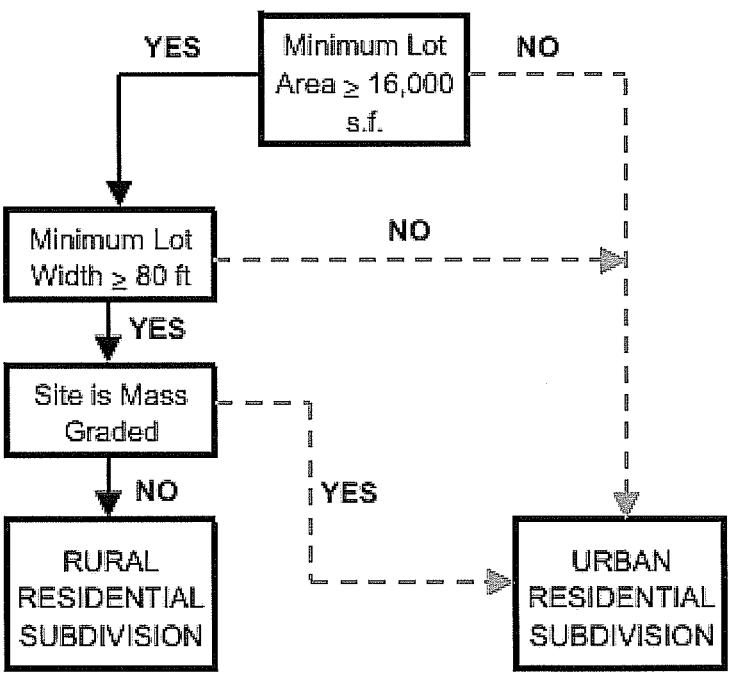
There may be cases in which a development cannot be clearly classified into the categories presented here. If that is the case, Pima County will determine the classification of the proposed development based on the prevailing conditions and applicable criteria. Note that certain developments may encompass 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.

2.1 RESIDENTIAL SUBDIVISIONS

As a general rule, residential subdivisions are those where property is used for dwellings, regardless of the zoning classification, and the lots individually access a local street. The exceptions to the rule are condominiums and other multi-family subdivisions that are similar to commercial and industrial developments in terms of access lanes and parking, among other elements. Therefore, condominiums, and other multi-family subdivisions may use 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".

Figure 2.1: Flowchart for Residential Subdivision Classification



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 typical minimum lot size is 16,000 square feet

AND

- The typical minimum lot width is 80 feet as defined in Chapter 18.03 of the *Pima County Code*[1]

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.

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 square feet

OR

- The minimum lot width is less than 80 feet as defined in Chapter 18.03 of the *Pima County Code*[1].

OR

- The subdivision is mass graded. Mass grading is the process of grading the subdivision streets and lots at the same time.

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. In order to achieve the goal of conservation, a special set of street standards has been developed for conservation subdivisions and is described in Chapter 4; however their use is restricted to subdivisions that comply with Chapter 18.09.100 of the *Pima County Code*[1].

Conservation subdivisions shall generally comply with the requirements for rural residential subdivisions; however, in situations where the minimum lot size, lot width or the type of grading fall within the criteria defined for urban residential subdivisions, the urban standards must be used.

2.2 COMMERCIAL AND INDUSTRIAL DEVELOPMENTS

The development of any land for commercial, industrial, or any other non-residential use shall follow the commercial development standards. Subdivisions for non-residential uses shall use the commercial/industrial street standards described in chapter 4. Apartments, condominiums and other multi-family residences of four or more units that use a system of parking and access lanes and common parking areas shall be treated as commercial developments. However, and contingent on average daily traffic (ADT), multi-family residences may use residential subdivision standards for off-site improvements when connecting to a local residential street.

3 TRAFFIC AND SAFETY

3.1 TRAFFIC STUDIES

Development-generated traffic and access needs for proposed subdivisions and developments must be evaluated to determine its impact on the adjacent roadway network. This impact, and requirements for off-site improvements to mitigate those impacts is determined by a Traffic Impact Study (TIS) or Traffic Memorandum (TM). A brief letter report for small projects may be submitted in lieu of a TM or TIS if approved by Pima County.

Traffic Impact Study

A Traffic Impact Study is required for projects that meet one or more the following conditions:

- The project generates 100 or more gross trips during the morning (AM) and/or afternoon (PM) peak hour.
- There is a previous TIS for the project that is more than 3 years old and:
  - Additional developments have been approved in the vicinity of the project that impact the site, or
  - Current traffic has increased by 15% or more over the traffic volumes shown in the TIS, or
  - A Capital Improvement Project (CIP) project is within ¼ mile of the proposed project and involves changes to lane configurations, traffic signals, roadway lighting, pedestrian/bicycle facilities, or drainage improvements.

Traffic Memorandum

A Traffic Memorandum is required for projects that generate less than 100 gross trips during the AM and/or PM peak hour **and** meet one or more of the following conditions:

- The development triggers the Left-Turn Lane Warrants or Right-Turn Lane Warrants as outlined in Section 4.6.

- The development has an access point connecting to a Pima County maintained roadway within 500 feet of an interstate interchange.

- The development has an access point connecting to a Pima County maintained roadway within 300 feet of a railroad crossing.

- The development generates more than 25 trips during the peak hour and has an access point connecting to a Pima County maintained roadway within 500 feet of an intersection that has a three year crash rate 10% greater than the three year system crash rate. The intersection crash rates/system crash rates can be obtained from the latest Unsignalized Intersections and Signalized Intersections reports on the Pima County Department of Transportation website.

- The development generates more than 25 trips during the peak hour and has an access point connecting to a Pima County maintained roadway segment that has a three or five year crash rate 10% greater than the three year system crash rate. The segment crash rates/system crash rates can be obtained from the latest Low Volume Road Segments (≤ 10,000 VPD) and High Volume Road Segments (>10,000 VPD) reports on the Pima County Department of Transportation website.

- There is a previous TM that is more than 3 years old and:

  - Additional developments have been approved in the vicinity of the project that impact the site, or
  - Current traffic has increased by 15% or more over the traffic volumes shown in the TM, or
  - A CIP project is within ¼ mile of the proposed project and involves changes to lane configurations, traffic signals, roadway lighting, pedestrian/bicycle facilities, or drainage improvements.

General Requirements for TIS and TM

- Criteria for formatting and scope of the TIS and TM are posted on the County website.

- The number of trips generated is to be calculated using the latest edition of the Institute of Transportation Engineers Trip Generation Manual, or from a trip generator curve that has been developed specifically for that development and approved by Pima County. Trip factors based on proposed land use and other useful information is posted on the Development Services website to aid in the trip generation calculation and the TM threshold determination. Please note the Chief Building Official may issue a Certificate of Occupancy limiting the number of authorized building occupants commensurate with the input information used for trip generation. It is therefore strongly suggested that trip generation/occupancy data not be underestimated in order to preserve the full occupant loading of buildings as determined by the building code.

- Hourly volume information for traffic counts can be obtained from the PAG website at http://gismaps.pagnet.org/trafficcounts.

- A project that is an addition to an existing use, or a previously approved project that resubmits for modifications or changed use, is subject to these requirements. The trip generation of the existing use shall be added to the trip generation of the addition to determine the gross trips.

- A project that has a prior approved TM may submit a revision to the TM unless the gross trip generation is 100 or more, in which case a TIS is required.

- Any change or update to an approved TIS/TM shall include the originally approved TIS/TM with the update submittal as reference material.

- The TIS or TM must be prepared under the supervision of and be sealed by a registered professional engineer in the State of Arizona who has demonstrated proficiency in traffic engineering and transportation planning.

Scope Requirements for a TIS

- TIS Categories: Based on the size and phasing of the proposed development, the TIS categories shown in Table 3.1 have been established as the basis to determine the study area and horizon.

Table 3.1: TIS Categories

TIS Category	Morning or Afternoon Peak Hour Trips[1]
1	100-499
2	500-999
3	≥ 1000 Single Phase Development
4	≥ 1000 Multi-Phase Development

1The peak hour with the greatest number of trips should be utilized to determine the TIS category

- Study Area and Study Horizon: The minimum study area and study horizon shall be determined by project type and size in accordance with Table 3.2. The study area for the proposed development shall include traffic controlled intersections, site access driveways and major unsignalized intersections. Unsignalized intersections where at least one of the intersecting streets is a collector or arterial are considered major unsignalized intersections.

Table 3.2 Design Attributes by Functional Class

TIS Category	Study Horizons[1]	Minimum Study Area[2]
1	1. Opening year	1. Site access driveways 2. All signalized intersections and/or major unsignalized intersections within 1/4 mile
2	1. Opening year 2. Five years after opening	1. Site access driveways 2. All signalized intersections and/or major unsignalized intersections within 1/2 mile
3	1. Opening year 2. Five years after opening 3. Twenty years after opening	1. Site access driveways 2. All signalized intersections and/or major unsignalized intersections within 1 mile
4	1. Opening year of each phase 2. Five years after build-out 3. Twenty years after build-out	1. Site access driveways 2. All signalized intersections and/or major unsignalized intersections within 1 mile

1. Assume full occupancy and build-out for single phase developments
2. An enlarged study area may be required as discussed in 3.2.2.3

- Crush volumes: Developments where the peak volume occurs in less than one hour (such as schools) should use a peak hour factor (PHF) of 0.55 or less and account for peak loads through internal site circulation design. The ITE publication *School Site Planning, Design, and Transportation* provides further information related to schools.

- Analysis time period: Both the morning and afternoon weekday peak hours need to be analyzed. If the peak traffic hour in the study area occurs during a time period other than normal peak travel periods, those peak hours must also be analyzed in addition to the normal peak travel periods.

- Data Collection Requirements: All data is to be collected in accordance with the latest edition of the ITE *Manual of Transportation Engineering Studies* or as directed by the Traffic Engineering Division Manager, if not specifically covered in the ITE manual.

- Turning movement counts shall be obtained for all existing cross-street intersections to be analyzed during morning and evening peak periods as identified in Table 3.2. Turning movement counts associated with developments that have crush volumes should be taken at five minute intervals. Available turning movements may be extrapolated a maximum of three years with concurrence of the Traffic Engineering Division Manager. The current and projected daily traffic volumes shall be presented in the report.

- Trip Generation: The latest edition of ITE's *Trip Generation Manual* shall be used for selecting trip generation rates. The guidelines contained in the Trip Generation Manual 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 Traffic Engineering Division Manager in cases where the Trip Generation Manual 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. If the development is a chain development, then the developer can calculate their own applicable trip generation curve based on other sites if ITE rates do not apply.

- Trip Projection: The trips must be projected for the study horizon years allocated by the TIS category.

- Trip Distribution and Assignment: Projected trips shall be distributed and added to the projected non-site traffic on the roadway network. The projected traffic volumes must be shown for all roadways internal to the development 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 by the study.

- 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.* While the use of the operational methodologies presented in the *Highway Capacity Manual* is always desirable, analyses such as the planning method included in the FLDOT Traffic Analysis Handbook are acceptable for analysis planning of new facilities.

- Traffic Signal Needs: Analysis of traffic signal needs shall be provided for all major collector/major collector and larger intersections per the *Manual on Uniform Traffic Control Devices.* If the warrants are not met for the opening year, they should be evaluated five years after opening for Category 2, 3 and 4 Traffic Impact Studies.

- Crash Analysis: An analysis of the five-year crash data within the study area shall be conducted to determine if the level of safety in terms of crash rates and severity index needs improvement due to the addition of site traffic.

- Queuing Analysis: An analysis shall be conducted for all turn lanes within the study area.

- 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 Level of Service (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.

- 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 also evaluate the need for turning lanes on all major unsignalized intersections. In addition, if the delay is increased by 10% more than the existing, mitigation measures must be taken to decrease the delay to the 10% threshold.

- Alternative Modes: Multi-modal conflict points with vehicles must be identified. Recommendations must be made to facilitate reasonable operation of alternative modes, especially at the interface with the roadway network.

- Additional information regarding scope criteria is posted on the Pima County web site.

3.2 SIGHT DISTANCE

In the design of streets, driveways, and intersections, including roundabouts, both stopping sight distance, and intersection sight distance, must be considered.

STOPPING SIGHT DISTANCE

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 3.3. Roundabout designs should be checked to insure that stopping sight distance is provided at every point within the roundabout and on each entering and exiting approach.

Refer to the latest edition of AASHTO *A Policy on Geometric Design of Highways and Streets*[2] for information about the effects of grade on stopping sight distance, and how to calculate stopping sight distance on grades other than those listed below.

Table 3.3 Stopping Sight Distance

Design Speed (mph)	SD (ft) Grades ≤2%	SD (ft) 2% < Grades ≤ 6%
20	115	120
25	155	165
30	200	215
35	250	275
40	305	335

Source: AASHTO A Policy on Geometric Design of Highways and Streets[2]

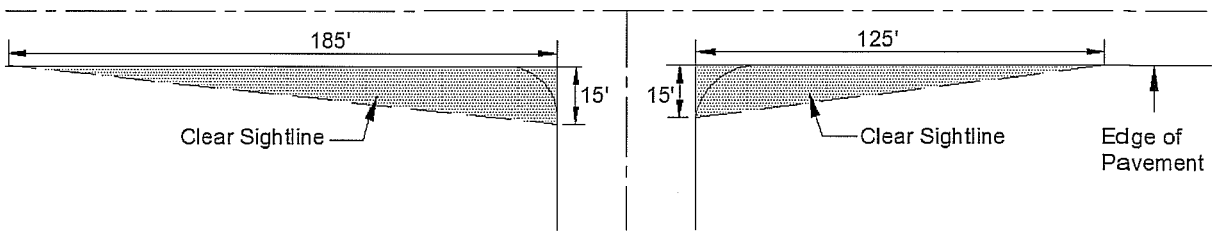
INTERSECTION SIGHT DISTANCE

At intersections, an unobstructed and continuous view of both the intersection and the intersecting roadway helps drivers avoid conflicts. The sight triangle at each intersection quadrant must be clear of any visual obstructions including structures, cut slopes, vegetation, and mounds of earth or rock over 30 inches in height. Sight triangles are required to be shown on tentative plats, site plans and construction plans with obstructions in both the horizontal plane and the vertical plane being reviewed. Three intersection cases are addressed in this manual.

Case 1

The required sight visibility triangle for local to local and local to residential collector intersections where both streets have a design speed of 25 mph is 185 feet to the left side and 125 feet to the right side. Figure 3.1 demonstrates how these measurements are translated into sight visibility triangles measured from the edge of pavement to edge of pavement.

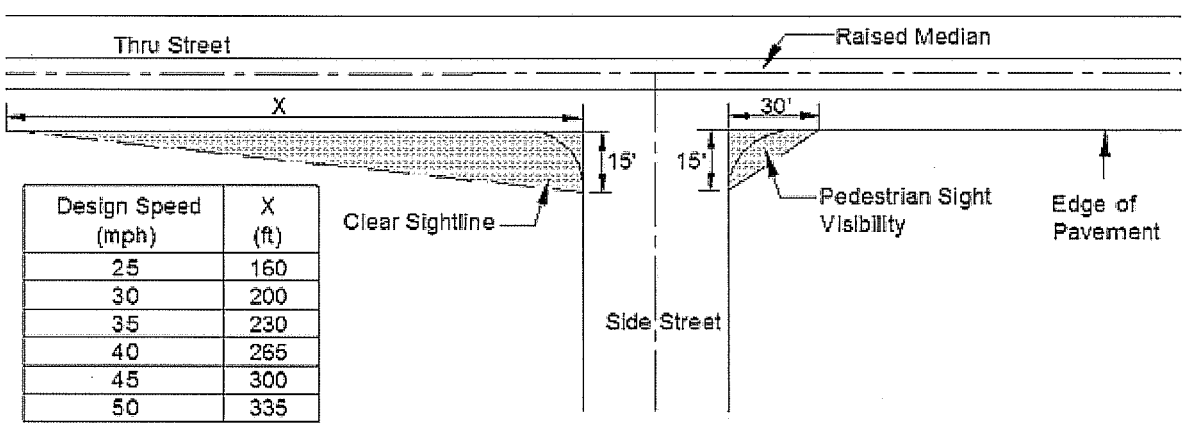
Figure 3.1 Local-Local and Local-Residential Collector
Sight Visibility Triangles



Case 2

At intersections where the thru street has two-way traffic separated by a median with no opening for the side street, only the left side sight visibility triangle, based on the design speed of the thru street, is required. However, a pedestrian visibility triangle shall be maintained in place of the right side triangle as indicated in Figure 3.2.

Figure 3.2 Pedestrian Sight Visibility Triangle



Design Speed (mph)	X (ft)
25	160
30	200
35	230
40	265
45	300
50	335

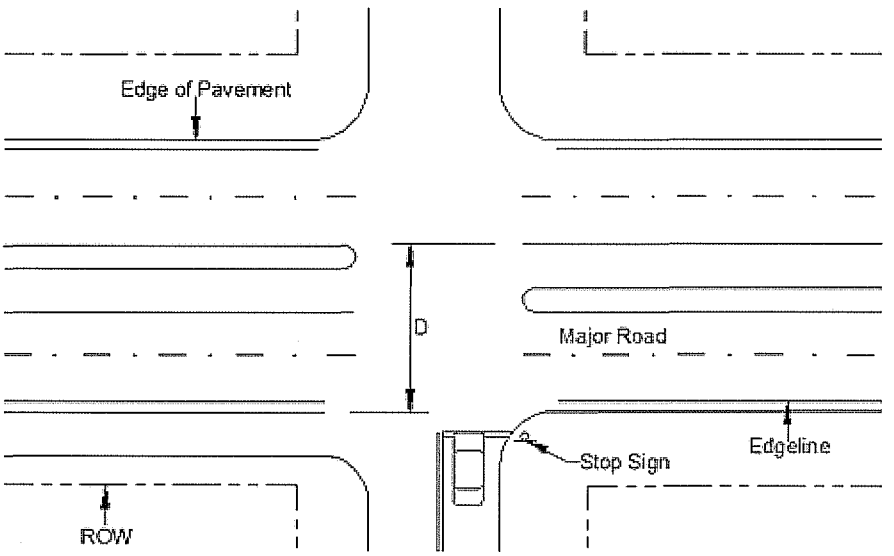
Case 3

The required intersection sight distance for vehicles turning onto a major collector, commercial/industrial collector or arterial shall be calculated in accordance with the following procedure. For this case, Pima County practice is to consider only the sight distance required for a left-turning vehicle.

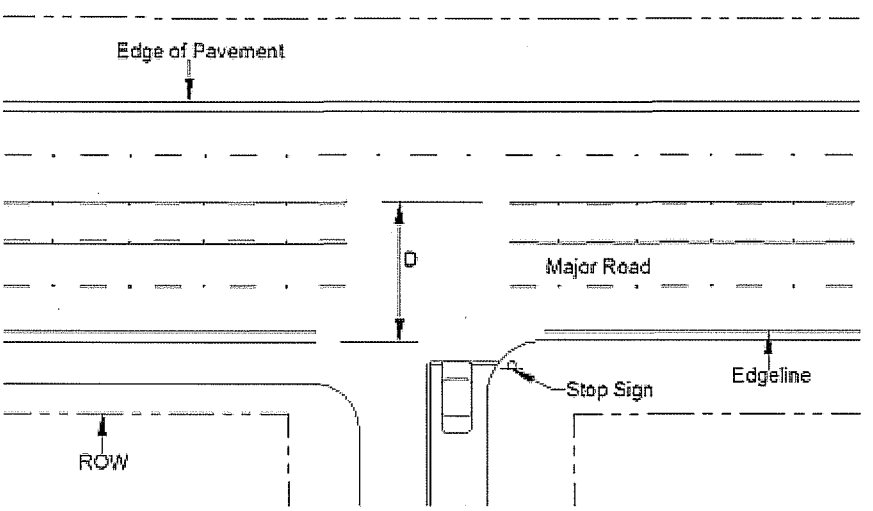
- Measure the distance on the major road from the edge of pavement to the first lane the vehicle can turn into for a left-turn. If there is a right-turn lane on the major road

to turn onto the minor road being studied, the width of the right-turn lane is not included in the distance measurement. This distance is indicated as "D," in figure 3.3.

Figure 3.3 Distance "D" Examples



Four-Lane Divided Roadway with Left-Turn Lanes, a Right-Turn Lane and Paved Shoulders



Five-Lane Roadway with Paved Shoulders

- Utilize the following equation to calculate the intersection sight distance, designated as "B" in Figure 3.4, required for each approach to the minor road.

$$B = 1.47 V_{major} t_g$$

where

B = intersection sight distance for a left-turn from stop (feet)

V_{major} = speed limit on the major road (mph)

t_g = time gap for the minor road vehicle to enter the major road and make a left turn (seconds)

- If D ≤ 11feet, then $t_g = 7.5$.
- If D > 11 feet, then $t_g = 7.5 + \left(\frac{D}{22} - 0.5 \right)$
- If steep grades are involved, or if the design vehicle is other than a passenger car the time gap value must be adjusted per AASHTO *A Policy on Geometric Design of Highways and Streets*[2].

Figure 3.4 Intersection Sight Distance Triangle Examples

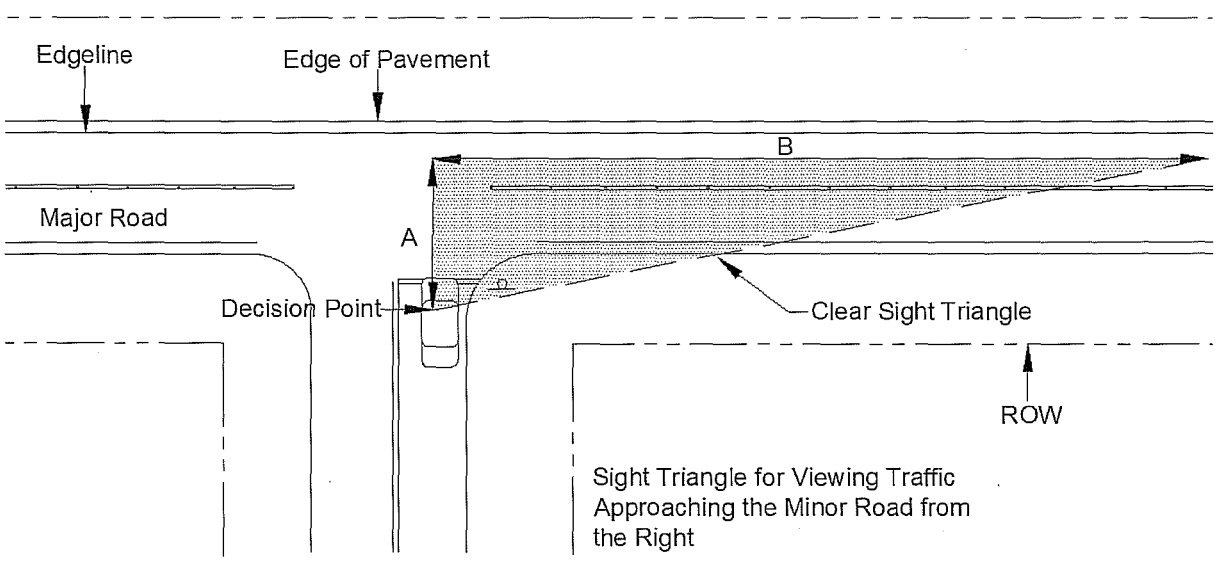
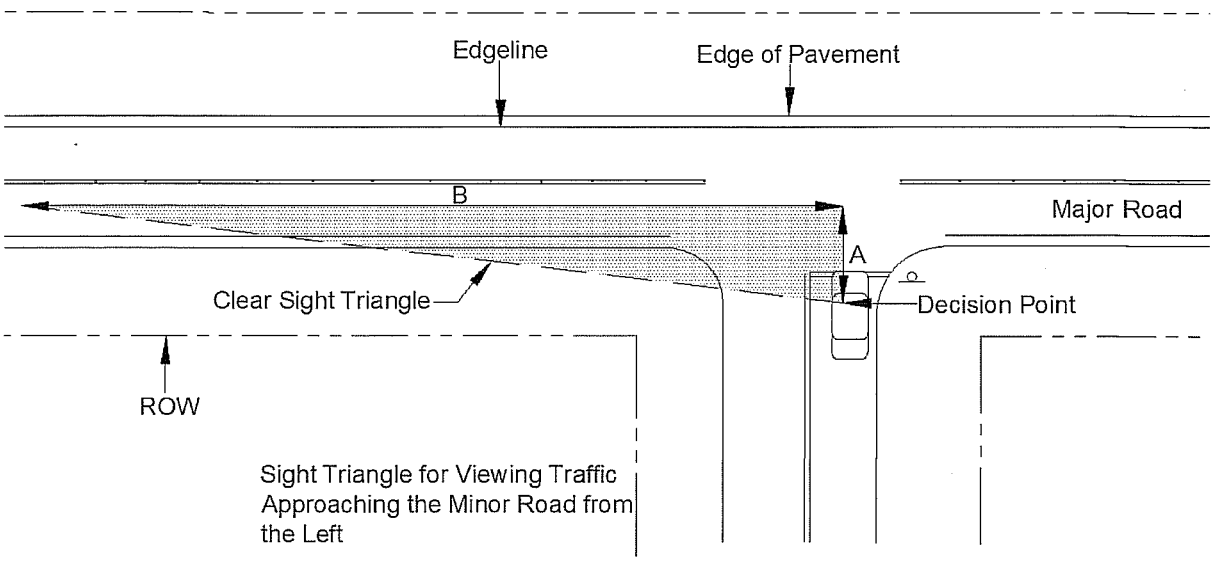


Figure 3.4 Continued



A = The distance from the Decision Point to the center of the closest approach lane to the minor road from the left or the right. The Decision Point is typically 15 feet from the edge of the major road traveled way, but may be increased to 18 feet depending on the design vehicle. Refer to AASHTO A Policy on Geometric Design of Highways and Streets for information on roundabout sight distance.

3.3 TRAFFIC CALMING

The goal of traffic calming is to improve roadway safety and overall quality of life in residential neighborhoods by promoting traffic speeds that are consistent with the design speed of the street and the character of the development. Traffic calming can be achieved through the utilization of operational measures, design features or physical barriers that provide contextual cues which allow drivers to self-enforce slower speeds. 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, street classification and traffic parameters. Planners, designers and engineers are encouraged, especially in residential developments, to incorporate additional traffic calming features such as:

- Intersection constrictions
- Raised intersections or crosswalks (See Detail 3)
- Speed tables or speed humps
- Chicanes (See Detail 3)

- Medians, especially on curves
- Traffic circles (See Details 2 & 3)

Chicanes, when designed properly, are ideal for stormwater harvesting basins to meet the first flush retention requirement and can be incorporated into the on-site drainage plan.

Source: Green Infrastructure for Southwestern Neighborhoods

The following manuals provide additional guidance for traffic calming:

- *Model Design Manual for Living Streets*[21]
- *Pedestrian Policies and Design Guidelines*[22]
- Traffic Calming Library[23]

3.4 STREET LIGHTING

Street lighting helps to increase and supplement vehicle headlight visibility at night. It also helps to delineate points and areas of potential conflict and allows improved traffic operations at times of darkness that may reduce crash frequency and severity.

Street lighting should be considered in the following circumstances:

- One of the intersecting streets is a major collector or arterial.
- The horizontal or vertical curvature of the roadway or other factors at or leading into the intersection constitute a confusing or unsatisfactory condition that may be improved with lighting

- The location has a marked crosswalk or trail crossing.
- The area has residential, commercial or school development on both sides of the road and these developments are active at night and may result in nighttime pedestrian crossings.

In determining the appropriateness of a street lighting application, consideration should be given to the availability of a power source, the nature of the surrounding area and existing development, and whether the lighting would create a nuisance or hazard based on grade elevation differences of surrounding areas.

Street lighting plans shall be prepared in conformance with the Pima County Street Lighting and ITS Conduit Design Manual, Illuminating Engineering Society guides and practices, and the AASHTO Lighting Guide. Street lighting must conform to the requirements of the Pima County Outdoor Lighting Code[58].

3.5 STREET SIGNING AND PAVEMENT MARKING

Signing and pavement marking plans shall be provided as needed. Signing and pavement marking submittals must conform to the latest editions of the Pima County Signing Manual, Pima County Pavement Marking Design Manual and Manual on Uniform Traffic Control Devices (MUTCD)[12].

Signing plans shall include the MUTCD or Pima County specialty sign code, sign size, sign schematic and sign location. Pavement marking plans shall include pavement marking code, dimensions and locations, including stations and offsets if available.

3.6 HORIZONTAL CLEARANCE TO OBSTRUCTIONS

URBAN ROADS

When the standard three foot curbway is provided, fixed objects such as utility poles or boxes, traffic barriers, mailboxes, or fire hydrants are to be placed behind the sidewalk unless the object has a recognized breakaway feature and does not block sight distance or is flush mounted and does not present a tripping hazard.

If the curbway width is increased, such objects may be allowed in the curbway provided they are offset from the back of curb at least 5 feet, and preferably 8 feet.

RURAL ROADS

Rural roads must provide obstruction free zones that meet or exceed the distances presented in Table 3.4. These distances are measured from the edgeline, or edge of pavement if no edgeline is provided.

Table 3.4 Rural Road Horizontal Clearance

Foreslope or 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'

Source: AASHTO Roadside Design Guide[28]

3.7 TRAFFIC BARRIERS

Roadside barriers are systems used to shield motorists from natural or man-made obstacles located along the traveled way and may be used to protect pedestrians and bicyclists from vehicles under certain conditions. Because of the low design speeds, barriers are generally not required for local streets; however, engineering judgment must always be exercised by the designer.

- Roadside obstacles and embankments that may warrant shielding by a roadside barrier require evaluation in accordance with the barrier warranting process identified in the latest edition of the AASHTO *Roadside Design Guide*[28].

- Barrier warrant analysis shall be included with any plan submitted for review and shall include the location and description of the obstacle, evaluation of the need for a barrier and the location and design of any proposed barrier.

- Barrier and/or guardrail treatment shall be placed at the face of the curb for curbed roadways and back of shoulder for uncurbed roadways.

- The length of barrier shall meet the recommendations presented in the latest edition of the AASHTO *Roadside Design Guide*[28].

- The selected barrier shall have been crash tested and approved by FHWA, for situations compatible with the intended use.

- Barriers must be installed in accordance with current ADOT standard Specifications and Drawings. Use of non-ADOT barriers will be reviewed on a case by case basis.

3.8 HANDRAILS

Handrails shall be installed for protection of pedestrians whenever slopes are steeper than 2:1 (H:V) within 3 feet of the walkway or sidewalk and the embankment height is 3 feet or greater. The design engineer may determine that differences in elevation between the walkway or sidewalk and nearby terrain under other circumstances may also warrant the installation of handrail. Handrail shall be built in accordance with PAG Standard Detail 105.

3.9 TRANSIT GUIDELINES

When a project is constructed adjacent to an existing bus stop location or along an existing bus route, coordination with Sun Tran is required to determine if a new bus stop or relocation or improvement of an existing bus stop is necessary.

- Project plans shall show existing and proposed bus stops, including loading pads, benches, signs, trash receptacles, bus shelters and bus pullouts.

- Sidewalks or multi-use pathways, with interconnecting access ramps, consistent with the transportation and public accommodation provisions of the ADA, should connect the bus stop to the nearest intersection, local commercial development or other passenger destinations, such as educational facilities, senior citizen housing, or medical facilities.

- When a bus stop is constructed on streets that do not include outside curb, the bus stop and associated pedestrian facilities should be placed as far as possible from the edge of pavement, in accordance with applicable AASHTO guidelines.

- Further guidance regarding transit facilities can be found in the Pima County Transit Guidelines for Roadway Design and Construction.

4. STREET DESIGN

4.1 STREET CLASSIFICATION

Three types of streets are addressed in this manual.

- Local streets are low volume undivided roadways with no lane designation that provide direct access to abutting properties. Service to through traffic movement is discouraged on local streets.

- Residential/commercial collectors provide a combination of mobility and land access within residential neighborhoods or commercial/industrial developments.

- Major collectors provide connectivity from large subdivisions to the arterial roadway system, and are normally situated at mid-section locations. Given the level of mobility that they provide in terms of volumes and speed, direct access to adjacent property from major collectors is limited.

Generally, only local and collector streets are required for the traffic generated by a single development. However, there may be developments that because of their size, location or other conditions require improvements to or the construction of an arterial roadway. In those cases, the design must follow the requirements in the *Pima County Roadway Design Manual*[3].

The design characteristics for local and collector streets are summarized in Table 4.1. In the table, segment length is the distance between consecutive breaks in roadway alignment. The following elements create breaks in the alignment.

- Knuckles. See Details 1A and 1B

- Sharp horizontal curves with an intersection angle greater than 60 degrees and a radius not exceeding 300 feet.

- Traffic circles. See Detail 2 and Detail 3

- Intersections.

Table 4.1 Summary of Design Characteristics by Street Classification

Parameter	Local Street	Residential/Commercial Collector	Major Collector
REQUIRED CRITERIA			
Volume (veh/day)	< 1,000	1,000 – 2,500	2,500 – 10,000
Segment Length (mi)	< ⅛*	¼ - 1	1 - 3
Design Speed (mph)	25	25-30	35-40
Direct Access to Property	Yes	No**	No
RECOMMENDED CRITERIA			
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

* Subdivisions greater than 1 acre lots can have a segment length of ¼ mile

**Direct access to property can be provided if the maximum segment length is limited to ¼ mile AND the design speed is 25 mph

4.2 GENERAL DEVELOPMENT REQUIREMENTS

- All residential, commercial or industrial developments shall provide, legal, paved, all-weather access to the public roadway system. The developer is responsible for the cost of connecting the development to the public roadway network.

- Individual direct access for residential lots adjacent to major collectors or arterials is not permitted. All residential lots shall be accessed by internal subdivision streets.

- All subdivision lots shall have a minimum street frontage of 30 feet to allow room for the driveway and 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 sidewalk and garage opening to ensure that cars parked in the driveway do not block the sidewalk.

- Common driveways 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 protection and trash pick-up.

- All roadway infrastructure such as travel lanes, medians, shoulders, curbs, sidewalks and drainage structures shall be located in public right-of-way or private common area and not in easements. Easements may be granted for certain cross section elements such as utilities and slopes.

- A 1 foot wide Access Control Easement (ACE) shall be granted to Pima County when it is determined that vehicular access to or from a development or subdivision should be prohibited at a particular location.

- Connectivity of pedestrian facilities is required in order to provide a Complete Street system. Additional guidelines regarding pedestrian facilities can be found in AASHTO *Guide for Planning, Design, and Operation of Pedestrian Facitilites*[25] and the FHWA PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System[26].

4.3 STREET LAYOUT AND CONNECTIVITY

Pima County promotes a Complete Streets design approach with an interconnected street system that accommodates all users and modes of travel. An interconnected street system is beneficial as it:

- Promotes public health, safety, and welfare

- Provides improved access for emergency and service vehicles

- Connects neighborhoods with one another, neighboring commercial developments and recreational areas.

- Promotes walking, biking, and equestrian activity.

- Reduces vehicle miles traveled resulting in better air quality and longevity of the roadway

CONNECTIVITY STANDARDS

- The design of a subdivision shall attempt to provide multiple direct connections in its local street system without requiring the use of arterial streets and to ensure that each lot has a secondary means of access. The minimum number of required external connections to the subdivision is specified in Table 4.2. When required to provide more than one external connection, the connections shall be spaced in such a manner as to maximize radial connectivity external to the subdivision without necessitating the use of arterial streets.

- The number of connections required in Table 4.2 may be reduced if the development boundary contains constraints to include, but not limited to: existing unconnected development, washes of 100 yr/500CFS or greater, crossings requiring Clean Water Act Section 404 permits, riparian areas, conservation lands, wildlife linkages, other natural features, planned lands of incompatible uses, unplanned public lands, and engineering constraints of similar conditions. In these cases, the proportion of the subdivision perimeter subject to the constraints would be calculated and the number of required connections shall be reduced proportionally (e.g., if 1/3 the perimeter of a subdivision is subject to constraints and Table 4.2 specifies 3 connections for the subdivision, then the required number of connections may be reduced to 2).

- Each subdivision shall incorporate and continue all collector and local streets stubbed to the boundary of the development by previously approved but unbuilt or existing developments, except in instances where the stub-out is not accepted as a public street and the owner or homeowner's association is prohibiting a connection thereto.

- Subdivisions requiring only one external connection or those containing multiple connections to collectors/arterials may be gated. However, both subdivisions with private or public streets are required to provide public access to adjacent dedicated/established public open spaces, public trails and other amenities, except when access is provided by other means.

- Stub streets designed to connect to future streets on abutting land shall be provided with a temporary turnaround at the end of the street conforming to Detail 4C.

- Street segments terminating in cul-de-sacs may serve up to 100 lots and shall contain a pedestrian connection from the end of the turnaround to another street when exceeding 660 feet in length, including the turnaround. The pedestrian connection shall be waived when subject to site constraints and surrounding land use.

- Walls bordering collector streets which pass through designated natural open space common areas shall be discouraged in order to accommodate movement of wildlife.

Table 4.2 Number of Required External Connections*

Lots	Connections
Up to 30	1
31-80	2
81-200	3
> 200	4

* For master planned communities, this table is applicable to each block

4.4 STREET CROSS SECTIONS

Using the appropriate development classification from Chapter 2 and the street classification from Section 4.1, the required street cross section should be selected from

Standard Details 8-15. All subdivision streets must be constructed in conformance with the applicable street cross section.

The minimum dimensions of roadway elements for urban residential streets, rural residential streets and commercial/industrial streets are summarized in Tables 4.3, 4.4 and 4.5, respectively.

Table 4.3 Standard Element Dimensions for Urban Residential Streets

	Local Street	**Residential Collector**	**Major Collector**
Pavement Width	24'[1]	24' or 28'[2]	46'
Travel Lane	Not Designated	Not Designated	11'
Paved Shoulders	Not required	Not required	6'
Two-Way Left-Turn Lane/Median	Not required	Not required	12'
Turning Lane	Not required	12'	12'
On-Street Parking	Yes	No	No
Cross Slope	2%	2%	2%

1. Local street pavement width shall not exceed 30 feet.
2. Reduced width value for collectors is applicable when traffic calming devices are installed at intervals not to exceed 660 feet

Table 4.4 Standard Element Dimensions for Rural Residential Streets

	Local Street	Residential Collector	Major Collector
Pavement Width	20' or 24'[1]	24' or 28'[2]	34'
Travel Lanes	Not designated	Not designated	11'
Paved Shoulder	Not required	Not required	6'
Unpaved Shoulder	6'	6'	4'
Turning Lanes	Not required	12'	12'
On-Street Parking	Yes	No	No
Cross Slope	2%	2%	2%

1. Reduced width value for local streets is applicable when header curb is installed for edge protection or for conservation subdivisions.
2. Reduced width value for collectors is applicable when traffic calming devices are installed at intervals not to exceed 6 60 feet

Table 4.5. Standard Element Dimensions for Commercial and Industrial Subdivisions

	Local Street	Collector Street
Pavement Width	34'	46'
Paved Shoulders	Not required	6'
Travel Lanes	Not designated	11'
Two-Way Left-Turn Lane/Median	Not required	12'
Turning Lane	Not required	12'
On-Street Parking	Yes	No
Cross Slope	2%	2%

4.5 SIDESLOPES

All cut and fill slopes shall be constructed in accordance with Chapter 18.81 of *the Pima County Code*[1] and AASHTO *A Policy on Geometric Design of Highways and Streets*[2].

- The Pima County standard for cut and fill sections is a 4:1 slope on urban roadways, and a 6:1 foreslope and 4:1 backslope on rural roadways.

- Cut and fill slopes over 2 feet in height shall be revegetated or stabilized as shown in Table 4.6. All revegetated areas, as well as the method of irrigation and maintenance responsibility until final stabilization must be clearly identified in the landscape plans per the Pima County Landscape manual.

Table 4.6 Treatment methods for cut-fill slopes over 2 feet in height

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

- Alternative methods of stabilization may be allowed if certified as stable by a registered geotechnical engineer, and approved by Pima County.

4.6 AUXILIARY LANES

All access points for a development must be evaluated to determine if an auxiliary right or left turn is warranted.

- Figures A1, A2 and A3 in Appendix A shall be used to determine if an auxiliary lane is required.

- Use of any alternative warrant criteria shall be supported by a traffic analysis and approved by Pima County.

- The *Pima County Roadway Design Manual*[3] and Pima County *Pavement Marking Manual*[17] provide design criteria for left-turn lanes and right-turn lanes. The minimum

design criteria referenced in these manuals, such as storage lengths, may need to be increased due to the amount of traffic utilizing the lane or due to a large presence of truck traffic.

4.7 DESIGN CONTROLS

The two main roadway design controls are design speed and the design vehicle. The minimum design speed for local streets, residential/commercial collectors and major collectors are summarized in Table 4.7.

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 4.7.

Table 4.7 Design Controls for Geometric Design

	Local Street	**Residential/ Commercial Collector**	**Major Collector**
Design Speed/ Posted Speed Limit (mph)	25	25	35
Design Vehicle	WB-40	WB-40	WB-62

The standard design vehicles for the various classes of streets are also presented in Table 4.7. Although the standard design vehicles are listed in the table, the design vehicle should be selected based upon the street classification and the existing and anticipated vehicle type and volume. For example, the school bus may be appropriate for the design of subdivision street intersections, and an interstate semitrailer may be appropriate for a commercial/industrial development attracting large volumes of truck traffic. The dimensions and turning templates for design vehicles may be found in the latest edition of AASHTO *A Policy on Geometric Design of Highways and Streets*[2].

4.8 STUB STREETS AND CUL-DE-SACS

A stub street is a street with a temporary dead end, typically at the boundary of a subdivision, but is intended to be extended with future development. Cul-de-sacs are streets with a permanent dead end that provides a single point of access. Stub streets and cul-de-sacs are subject to the following design standards:

- A turnaround is required at all dead ends.
- Bulbhead cul-de-sacs (Standard Details 4A and 4B) are preferred for turnarounds because of their overall efficiency and maintainability and should be used almost exclusively.
- The maximum slope in cul-de-sac areas shall be 8% in any direction and landscaping and first flush stormwater harvesting may be provided in the center.
- T-shaped and Y-shaped turnarounds (Standard Detail 5) may be used on private streets with a maximum ADT of 140.

4.9 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. Medians on two lane roads shall have openings a minimum of 660 feet and a maximum of 1,320 feet apart and shall be designed in accordance with the latest edition of the Pima County *Pavement Marking Design Manual*[17].

Median islands are short sections of medians used primarily at intersections or access drives for aesthetics, to protect pedestrians or to channelize intersection movements. The design of any median or median island shall meet the following criteria:

- The width of medians and 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 6 feet.

- The maximum median or median island width for all street classes at intersections shall be 24 feet.

- Landscape placed in the median or median island shall not interfere with the stopping sight distance lines, nor shall it cause sight obstructions within the sight visibility triangles of an intersection. For further information on landscape refer to the Pima County *Landscape manual.*

- Where practical, landscaped medians or median islands may be depressed to provide for stormwater harvesting. Refer to the *Design Standards for Stormwater Detention and Retention*[57] manual for further information

- For turning lanes, the turn bay opening and storage length shall be designed following the latest edition of the Pima County *Pavement Marking Design Manual*[17].

- 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 markings. Taper rates and length shall meet the requirements of the latest edition of the Pima County *Pavement Marking Design Manual*[17].

- At locations where pedestrian traffic is expected across a median or median island, a pedestrian refuge area at least 6 feet wide must be provided. Refer to PAG Standard Detail 207.

4.10 GATED ENTRIES

Gated entrances shall be allowed for commercial/industrial developments such as apartments where on-site parking areas are privately maintained and for residential subdivisions with private streets. An example of a gated entry is provided in Detail 6. Gated entries shall meet the following requirements:

- Stopping locations for keypads, card-readers, guard shacks, etc. shall be set back 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 development, it shall include a queuing analysis for the gated entry to ensure sufficient storage capacity.

- The gate may not encroach into the travel lane when open.
- Each side of a median-divided roadway/driveway shall be at least 16 feet wide to provide accessibility of emergency vehicles.
- Any equipment or obstructions such as keypads or card-readers shall be installed in a median island.
- The design of the entrance shall allow vehicles that do not go past the gate to turn around without interfering with other traffic.
- The turnaround area shall be located within the development boundary outside of the collector or arterial right-of-way.

4.11 SURVEY MONUMENTATION

Permanent brass cap survey monuments shall be installed on all street right-of-way centerlines at intersections, points of change in direction or curvature of streets, stub street termini, and at other points that Pima County determines are critical to locating the right-of-way centerlines. Permanent brass cap monuments shall be installed per PAG Standard Detail 103, Survey Monument

- Permanent brass cap survey monuments with frame and cover shall be placed within the development boundary at section corners, quarter corners and sixteenth corners and at locations where the development ties into the existing roadway network. Permanent brass cap survey monuments with frame and cover shall be installed per PAG Standard Detail 103, Survey Monument (Frame and Cover).
- The Bureau of Land Management standards shall apply to any existing aliquot corners replaced or re-set.

4.12 UTILITIES

The information below applies to all public and private utilities including but not limited to communication, electric power, gas, water, sewer, cable television, telephone, fiber optics, irrigation, and similar facilities that are located on, over, and under the roadway right-of-way.

- All overhead utility lines, utility poles, and other above ground utility structures shall be constructed outside the clear zone in accordance with the latest edition of the AASHTO Roadside Design Guide[28] and as specified by the Pima County Roadway Design Manual[3].
- Pole guys are not permitted within the functional limits of an intersection and discouraged within road right-of-way, especially when adjacent to sidewalks, equestrian paths, and along property frontage where existing and future access may be affected.
- Overhead lines are not permitted within the operational limits (i.e. fifteen feet vertically and horizontally) of overhead traffic signals, lighting, signing, and other similar type features.
- Surface features placed in the pavement shall be located outside vehicular wheel paths and bicycle lanes to the extent practicable.
- Service meters, backflow preventers, private service lines and all features identified by a utility as private, shall be placed outside of public right-of-way except for house connection sewer (HCS)/building connection sewer (BCS) connections.
- All above ground utility facilities (AGF) such as, but not limited to, transformers, splice cabinets, and pressure relief valves shall be placed away from roadways, driveways, alleys, drainage ways and sidewalks/pedestrian facilities.
- AGF shall not block safe cross corner sight distance, impede or hinder pedestrian access.
- Aesthetic as well as practical considerations shall be studied prior to locating AGF.

- Air pressure relief valves, natural gas regulators, water backflow prevention assemblies, and other similar facilities should be placed subsurface.

- Where it is necessary for underground utility lines to cross a roadway, the trench for such utility lines shall be constructed per specifications for utility trench construction. Special consideration should be given to the use of a joint or common trench when multiple utilities cross a roadway.

- Abandoned utilities are to be removed from public right-of-way per Pima County Code Chapter 10.50.150, Abandonment of Facilities.

- Refer to PAG Standard Detail 411 for irrigation sleeving

Further guidelines for the placement of sewer facilities within the road right-of-way include:

- HCS/BCS connections within streets may be private or public at the discretion of the serving utility

- Abandoned public sewer lines and manholes in the right-of-way are to be removed or grouted by the serving utility

- Maintenance access shall be provided for manholes located further than 5 feet from back of curb, including on roundabouts. When access requires traversing sidewalk or curb, mountable curb and 6-inch thick unreinforced concrete sidewalk shall be used

4.13 LANDSCAPE

Refer to the Pima County landscaping standards for landscaping requirements in the right-of-way.

4.14 HORIZONTAL ALIGNMENT

The horizontal alignment of a roadway is comprised of horizontal curves and tangent sections. Superelevation is introduced into the alignment to provide appropriate balance between centrifugal forces and side friction on the tires of the vehicle moving through the

curved section. The primary factors that provide the framework for the horizontal alignment are design speed and stopping sight distance.

GENERAL DESIGN CONSIDERATIONS

Values for design elements, including minimum curve radii, design speed, and superelevation, are found in the *AASHTO A Policy on Geometric Design of Highways and Streets*[2]. When designing the horizontal alignment of a roadway, the following considerations must be taken into account:

- The design of the horizontal alignment should be well coordinated with the vertical profile to avoid undesirable driver reactions. For more information on this topic, refer to the latest edition of the AASHTO *A Policy on Geometric Design of Highways and Streets*[2].
- Differences in design speed between successive horizontal curves should be avoided.
- Median openings along horizontal curves are generally discouraged.
- Minimum radius horizontal curves should be avoided at points where driver expectation is low, such as at the ends of long horizontal and/or vertical tangent sections.
- Sharp horizontal curvature near the low point of a sag vertical curve should be avoided.
- An angle point is acceptable for breaks in tangent alignment of less than 1°08'.
- When two tangents of a local street are connected by a curve of less than the minimum radius, a knuckle design as shown in Detail 1A or 1B must be used.
- 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.

- Curves with an intersection angle (Δ) greater than 60 degrees and a radius not exceeding 300 feet are considered sharp curves.

- Broken-back curves (i.e. two horizontal curves in the same direction separated by short tangent sections) should be avoided.

- Where superelevation is used, a minimum tangent separation between curves of at least 4/3 the longer of the two superelevation runoff lengths shall be used.

- The maximum superelevation rate 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 the latest edition of *AASHTO A Policy on Geometric Design of Highways and Streets2*.

HORIZONAL 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 4.8. The table 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). These values are based on the design for low-speed urban streets in AASHTO *A Policy on Geometric Design of Highways and Streets*[2]. If a different superelevation is used, the equation provided must be used to determine the minimum curve radius.

Table 4.8 Limiting Side Friction Values and Minimum Curve Radius

Design Speed (mph)	20	25	30	35	40
Maximum f	0.27	0.23	0.2	0.18	0.16
R_{min} (ft) with e= -0.02 (ft/ft)	107	198	333	510	762
R_{min} (ft) with e= 0.04 (ft/ft)	86	154	250	371	533

Source: AASHTO A Policy on Geometric Design of Highways and Streets[2]

HORIZONAL SIGHT LINE OFFSET

The sight distance available to drivers across the inside of horizontal curves is an important element in the design and review of horizontal alignment.

When sight obstructions such as walls, outside curbline barriers, guardrail, cut slopes, buildings, and continuous median barriers exist on the inside of curves, the distance to the obstruction from the center of the inside travel lane must be checked. This distance, HSO, is termed the horizontal sight line offset. Instructions for calculating the HSO are provided in the latest edition of the AASHTO A Policy on Geometric Design of Highways and Streets[2], and are based on stopping sight distance and the radius of the curve.

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

where:

HSO = Horizontal sight line offset, ft

S = Stopping sight distance, ft

R = Radius of curve, ft

4.15 VERTICAL ALIGNMENT

The vertical profile is the reference line by which the elevation of the pavement and other roadway features are established. The profile of a roadway is defined by a series of tangent grades and vertical curves.

GENERAL DESIGN CONSIDERATIONS

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

- The design of the vertical profile should be well coordinated with the horizontal alignment to avoid undesirable driver reactions. For more information on this topic, refer to the latest edition of the AASHTO *A Policy on Geometric Design of Highways and Streets.*
- A smooth grade line with longer tangent grades and fewer vertical curves should be a design objective.
- Grade breaks of 0.5% or less do not require a vertical curve.
- Two vertical curves in the same direction separated by short sections of tangent grade (broken-back grade lines) should be avoided.
- Crest vertical curves should not be coincident with or immediately precede sharp horizontal curves.
- When designing long upgrades, it is preferable to place the steepest grade at the bottom and reduce the grades at the top to increase the safety at the crest of the hill. Roller coaster and hidden dip profiles should be avoided.
- The drainage patterns at the top of crest and at the bottom of sag curves should be given careful consideration.

- The principal design control for both crest and sag vertical curves is the provision of adequate stopping sight distance along the entire length of the curve. All portions of the profile shall meet sight distance requirements for the design speed of the roadway.

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 4.9.

Table 4.9 Allowable Grades for Local and Collector Streets

Street Class	**Grade**
Residential Driveways (within public right-of-way)	14.0%
Commercial and Industrial Driveways (within public right-of-way)	6.0%
Local Street – Max. grade	10.0%
Local Street – Conservation Subdivision	15%*
Collectors (Residential and Major) – Max Grade	8.0%
All Streets – Min. Grade	0.5%

* 18% for short sections

VERTICAL CURVE LENGTH

The minimum length of vertical curve based on stopping sight distance can be calculated from the equations in Table 4.10. Designing the length of the vertical curve for comfort based on three times the project design speed should only be utilized if the length is greater than the length provided for stopping sight distance utilizing the equations in Table 4.10.

Table 4.10 Minimum Length of Vertical Curves based on Stopping Sight Distance

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

Source: AASHTO A Policy on Geometric Design of Highways and Streets[2]

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 4.11. Note that both methods 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 4.11 Minimum Rate of Vertical Curvature (K) for Crest and Sag Vertical Curves

Design Speed (mph)	**20**	**25**	**30**	**35**	**40**
K_{min} (Crest Curves)	7	12	19	29	44
K_{min} (Sag Curves)	17	26	37	49	64

Source: AASHTO A Policy on Geometric Design of Highways and Streets2

Also, in order to ensure proper drainage, the rate of vertical curvature (K) shall not exceed 167.

4.16 INTERSECTIONS

The goal of intersection design should be to provide layouts that allow for safe and efficient crossing, merging, and diverging of conflicting traffic. These conflicts can be significantly reduced through the provision of adequate sight distances and efficient traffic control devices. Providing safe sight distances and effective control will depend on human factors related to the drivers, bicyclists, and pedestrians; the traffic volumes to be accommodated; and the geometric and topographical characteristics of the intersection itself.

INTERSECTION ALIGNMENT

The alignment of an intersection must take into consideration the following points:

- The centerlines of intersecting 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 (70) 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. The radii must be adjusted at skewed intersections to provide sufficient curvature. In all cases, adequate sight distances shall be maintained.

- 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 unless the intersection is controlled by a roundabout.

- 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 7). The tangent section may be waived if the curve at the connection point is at least three times the minimum allowable radius.

INTERSECTION SPACING

Intersections on the same or opposite sides of the street, shall meet the minimum spacing requirements shown in Table 4.12 and Figure 4.1.

Figure 4.1 Intersection Spacing

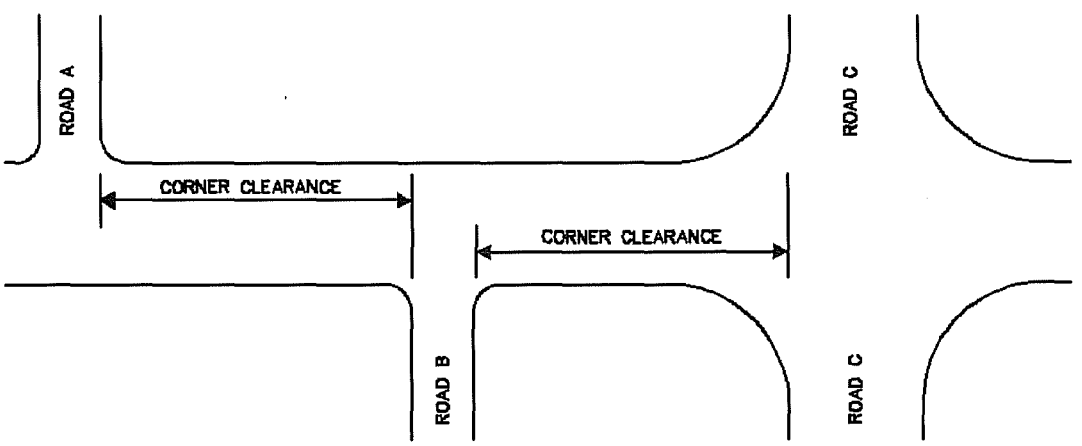


Table 4.12 Intersection (Roadway) Spacing

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

The minimum intersection spacing shall be measured from pavement edge to pavement edge. Pima County may request increased spacing in rural areas, or when warranted by field conditions such as significant weaving or insufficient left-turn peak period queue storage.

INTERSECTION RETURN RADII

See table 4.13 for intersection return radii.

Table 4.13 Intersection Return Radii

Street Classification	Local	Residential/Major Collector	Arterial
Local	25	25	25
Residential/Major Collector	25	30	30
Arterial	25	30	30

- The design radii can be modified as necessary for special conditions, such as large volumes of truck traffic and/or skewed intersection angles.
- Where auxiliary lanes are present at arterial/collector intersections, the return radius may be reduced to 25 feet, but in all cases must accommodate the design vehicle. Consideration must be given to the largest vehicle that may use the intersection.
- Three center curves should be considered to accommodate the need for a larger radius.
- Radii larger than 40 feet shall not be used for any street without approval from Pima County as this may lead to unsafe conditions for pedestrians and bicyclists.
- Uncurbed intersections shall utilize concrete header curb on the radius returns to prevent pavement raveling.
- Curb access ramps shall be provided at all curb returns with wedge or vertical curb and shall be designed according to the PAG Standard Detail 207.

ROUNDABOUTS

- Single-lane roundabouts should be considered for two lane and three lane two-way roadway intersections where all-way stop traffic control is warranted or expected.
- The type of roundabout that would be most appropriate for intersection control depends largely on the roadway types, user types, roadway volumes and surrounding land uses. Table 4.14 summarizes the characteristics of single-lane roundabouts and can provide guidance on which roundabout type to utilize.
- For detailed design guidance on roundabouts, refer to the NCHRP Report 672, Roundabouts: An Informational Guide, Second Edition, 2010[20].

Table 4.14 – Single Lane Roundabout Characteristics

Design Element	Mini- Roundabout	Urban Single-Lane	Rural Single-Lane
Maximum Entry Design Speed (mph)	15	20	25
Typical Inscribed Circle Diameter (ft)	45 - 80	100 - 130	115-130
Splitter Island Treatment	Raised if possible, crosswalk cut if raised	Raised with crosswalk cut	Raised and extended with crosswalk cut
Daily Service Volumes on 4-Leg Roundabout (veh/day)	10,000	20,000	20,000

4.17 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. The requirements and methodologies outlined in the Pavement Design section of the Pima County Roadway Design Manual (RDM) shall be used to design pavement structures within Pima County. In addition to the requirements and methodologies outlined in the RDM, roadways subject to the Subdivision and Development Street Standards will also be subject to the following requirements:

- The Pavement Design Report shall also include the following items:
  - Projected average daily traffic (ADT).
  - 18-kip Equivalent Single Axle Loads (ESAL) used.
  - Pavement thickness.
  - Subgrade acceptance chart.
- The latest addition of the Pima Association of Governments (PAG) Standard Specifications for Public Improvements shall be utilized for the required mix design

properties. All of these standard properties apply as stated with the exception of those listed below:

- Effective air voids shall be 3.5% +-0.2% for local streets and residential collectors
- Minimum voids in the mineral aggregate (VMA) shall be 16.0%
- Reclaimed asphalt pavement (RAP) is prohibited in local and residential collector street mix design
- Minimum compaction of asphaltic concrete (AC) shall be 96%

- Based on the 20 year projected ADT, the following ESAL's will be accepted for pavement design:

Table 4.15 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

*100,000 ESALs are required for cul-de-sacs

- When the projected 20 year ADT exceeds 2500, or when the engineer desires to calculate their 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

- The minimum weighted structural numbers (SN) and pavement sections by roadway classification are presented in the RDM and, for cul-de-sacs, in Table 4.16.

Table 4.16 Minimum Weighted Structural Numbers and Pavement Sections

Street Classification	Minimum SN	Minimum AC	Minimum AB
Cul-de-Sac-Local Streets	1.75	3.0"	4.0"

- Roller compacted concrete pavement may be used on local streets (minimum 5 inch thickness). No grinding or grooving is necessary if the placed finish meets the coefficient of friction requirements for 25 mph as noted in Table 4.8. If roller compacted concrete is utilized, a geotechnical report is required to provide the specifications and acceptance criteria that is not part of Pima County standard specifications.
- When existing streets are widened, the new pavement section shall either match the existing pavement section or meet the applicable minimum thickness as required in the RDM and Table 4.16 (for Cul-de-Sacs), whichever is greater.
- When a street is widened, the complete cross section will be subject to pavement replacement and/or surface treatment in accordance with the guidance offered in the Pavement Replacement Standard Details found in the Pima County Procedures for the Issuance of Right-of-Way Permits and Regulations of Work Under Permit
- When through streets are designed which may ultimately connect to future developments, pavement design and ESAL calculations shall accommodate future wheel loads to account for all future loading.

4.18 DRAINAGE

Roadways are frequently subjected to flooding either by runoff transported across the street, at drainage crossings or conveyed as shallow street flow. The following standards have been developed to reduce the hazards associated with storm runoff along or across a roadway. The goal of drainage design is to mitigate the effects of the impermeable surfaces so that flows at the project limits are maintained at pre-development rates. Field and topographic conditions should be considered in conjunction with these standards, and engineering judgment should be exercised in all cases to minimize adverse effects to adjoining property and to the right-of-way while maintaining traffic safety.

- A drainage report shall be prepared by a registered Professional Engineer and shall follow the provisions of this chapter and the requirements of the Pima County Regional Flood Control District website.

- All proposed drainage improvements must conform to the requirements of the Federal Emergency Management Agency (FEMA), Pima County Title 16, Pima County Drainage and Channel Design Standards for Local Drainage[9], and the Design Standards for Stormwater Detention and Retention[54] in Pima County.

STREET DRAINAGE

The provisions made in regards to drainage along streets are discussed below and summarized in Table 4.19 – Design Criteria for Longitudinal Street Drainage.

- Street flows shall not exceed 100 cfs or 1 foot in depth during the 100-year storm.

- The 100-year discharge outside of curbs must be contained within the right-of-way and cannot exceed 3 feet per second in velocity unless erosion mitigation is provided.

- On collector streets, except where at-grade crossings are approved in rural subdivisions, 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. Bypass gutter flows from intersecting streets shall be reduced as necessary to meet this requirement within intersections.

- On curbed streets, the runoff from a 10-year storm must be contained between the curbs of the street, except for roadside stormwater harvesting areas.

- Should the 10-year discharge water surface elevation exceed the top of the curb, storm drains or other treatments shall be provided to keep water from overtopping the curbs.

- The minimum pipe size for storm drains shall be 18 inches for laterals and 24 inches for mains. Storm drains are enclosed drain systems as opposed to culverts which have separate sizing and material requirements.

Table 4.19. 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 drainpipe diameter (in) lateral/main	18/24

- Drainage conveyed within the street shall only be discharged from the street right-of-way into common areas or privately maintained drainage easements (does not apply to non-regulatory flows on uncurbed streets).

- A drainage easement will be required whenever any natural watercourse has been altered to such a degree as to need a defined or constructed channel, or periodic maintenance.

- Public easements beyond the right-of-way limits shall be granted to Pima County where it is necessary to gain access to protect or maintain drainage features within the public right-of-way.

CURB OPENINGS

- Curb openings and curb depressions used for drainage shall have a maximum opening of 10 feet (excluding transitions) and shall be fitted with outlet aprons located within the right-of-way. The curb elevation must transition from the normal reveal to the level of the opening at a slope of 12:1 in instances where sidewalk is behind curb (see Detail 17 - Curb Opening Detail).

- If erosion protection extends outside of the right-of-way, a drainage easement shall be provided.

- Curb openings and curb depressions must be spaced a minimum of 150 feet (from centerline to centerline) unless scuppers are provided.

- Curb openings and drainage inlets shall be fitted with appropriate barricades to prevent vehicular access. Table 4.20 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 4.20 Design Standards for Curb Openings

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

CURB SCUPPERS

Scuppers are structures used to drain flow under a sidewalk, generally between a paved area and a drainageway. Scuppers must be designed to accommodate the 10-year storm without overtopping of the curbs. The PAG Standard Details 205 and 205.5 provide design alternatives for sidewalk scuppers.

CATCH BASINS

Catch basins are structures used to drain the pavement into storm drain systems. Catch basins must be designed to accommodate the 10-year storm without overtopping of the curbs. 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 pedestrians and bicyclists.

STORMWATER HARVESTING WITHIN THE RIGHT-OF-WAY

Stormwater harvesting is not required by these standards, however, the designer is encouraged to incorporate stormwater harvesting as part of a Complete Streets design approach to enhance the pedestrian experience by sustaining canopy trees and vegetation. Stormwater harvesting features, if designed correctly, will reduce runoff peaks and volumes and can be used to satisfy the first flush retention requirement. Stormwater harvesting may also offset additional grading required for stormwater detention basins. Guidance on stormwater harvesting features can be found in the Design Standards for Stormwater Detention and Retention[57] and the Low-Impact Development and Green Infrastructure Guidance Manual[56].

Stormwater harvesting features in the right-of-way are limited to basins in the median or roadside that do not retain more than nine inches of water (first flush retention). These basins must be designed such that the flows do not cause flooding onto the roadway.

In order to ensure adequate sight visibility, roadside stormwater harvesting basins should be located at least twenty feet from street intersections and at least five feet from driveway entrances. In addition, roadside stormwater harvesting basins should be setback at least one foot from sidewalks and six inches from the edge of curb where there is no on-street parking and two feet from the edge of curb where there is on street parking.

In areas where stormwater harvesting is designed to be in the curbway, the sidewalk may be narrowed to 4 feet to provide a greater curbway width, provided that ADA requirements are met. Pima County encourages wider right-of-way for stormwater harvesting and vegetation and under these circumstances; the curbway width is not limited.

When stormwater harvesting features are implemented in the right-of-way, vertical curb should be designed with curb core and curb cuts for stormwater features. Medians and traffic circles designed for stormwater harvesting may use header curb per PAG Standard Detail 213 to maximize the roadway runoff into basins.

When used for stormwater harvesting, curb cuts shall meet the following criteria:

- Curb cuts shall be separated from driveway aprons and other curb openings by a minimum distance of 10 feet
- Curb cuts shall be located a minimum of 20 feet from an end of a curb return (corner)
- Curb cuts shall be a maximum of 2 feet in width with 45-degree sloped sides

ROADSIDE CHANNELS AND DITCHES

- Channels or ditches parallel to the roadway shall be laid out to be either completely within or outside of the public right-of-way for the purpose of defining maintenance responsibilities and shall not straddle the right-of-way.
- 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 reasonable operation of the roadway, and
  - A ditch or channel that is parallel to the road is to be configured in a manner that is consistent with the cross-section configuration and operational and maintenance needs of that roadway. This includes the potential uses of the roadside by pedestrians, equestrians, bicycles, vehicles (on and off road types), utilities, traffic control devices or other applicable and relevant roadside features. The depth, foreslope, backslope, profile and hydraulic operation provided shall provide consideration of all these applicable uses in a manner that is reasonable and has been defined by practice and reasonable references (e.g. AASHTO Roadside Design Guide28).

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 Pima County Drainage and Channel Design Standards for Local Drainage.
- 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.

Drainage swales within the right-of-way that carry roadway runoff shall only be acceptable where 100-year velocities are less than 3 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.

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. Public easements beyond the right-of-way limits shall be granted to Pima County where it is necessary to gain access to protect or maintain drainage features within the public right-of-way.

CROSS DRAINAGE

Storm drainage across the roadway must be handled by culverts, at-grade crossings or by culvert and at-grade crossing combinations, depending on the design period and peak discharge. The specific design criteria for 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 Pima County Code, Chapter 16-36.

The Pima County *Code*[1] *Title 16* prohibits improvements which are not compatible with upstream and downstream drainage conditions and which have an adverse impact on surrounding properties. Flood limits, depths, and velocities shall be kept unchanged where flows impact adjacent property, unless an improved channel or other measures to prevent adverse impacts are provided. Common areas or privately maintained drainage easements shall be provided within the subdivision for cross-drainage. In addition, public easements beyond the right-of-way limits shall be granted to Pima County where it is necessary to gain access to protect or maintain drainage features within the public right-of-way.

When sheet flooding conditions impact a development and roadways are proposed perpendicular to flow, at-grade design is preferred to limit water surface elevation increases beyond the right-of-way, to minimize obstructions to flow, to avoid sedimentation issues associated with collector channels and to minimize off-site construction of training dikes.

CULVERTS

Culvert structures shall be required at all drainage crossings, except where at-grade crossings are provided in rural residential subdivisions, when flows are conveyed within natural channels and overbank areas or within constructed channels.

Public maintenance and access easements shall be granted for maintenance of collector channels or dikes outside of the public right-of-way.

In local streets, culverts shall be designed to convey at least the 10-year flow under the roadway, unless at-grade crossings are approved for sheet flooding conditions. 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 1 foot in the 100-year event. If the roadway is all-weather access, the flow depth shall not exceed the requirements defined in the Pima County Code[1] Title 16. Table 4.21 summarizes the minimum design flow requirements for culverts.

Table 4.21 Minimum design flow for culverts

Street Class	Design Standard
Local Street	Q_{10} under roadway, Q_{100} less than 1 foot* in depth with dip
Residential Collector	Q_{25} under roadway, Q_{100} less than 1 foot* in depth with dip
Major Collector	Q_{50} (Q_{100} if possible) under roadway, Q_{100} contained within dip*

*If roadway is an all-weather access, the maximum flow depth shall be in compliance with Pima County Code[1] Title 16

In addition to the specific requirements described above, culverts constructed for subdivisions must meet the following criteria:

- Pipe culverts shall have a minimum diameter of 24 inches. 18 inch pipes may be used if needed to meet clearances which would otherwise require significant site engineering to accommodate.

- Reinforced Concrete Pipes (RCP), Corrugated Metal Pipes (CMP), and Spiral Rib Pipe (SRP) are acceptable for pipe culverts. Pipes made of other materials will require approval from Pima County. HDPE pipe is approved for use in enclosed storm drain systems only.

- Headwalls or engineered slope protection 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, wingwalls and headwalls shall be required.

- Reinforced Concrete Box Culverts (RCBC) in right-of-way shall be at least 4 feet in height and shall be structurally designed according to Arizona Department of Transportation's (ADOT) *Structure Detail Drawings – Bridge Group*[40] or by a licensed Arizona registered engineer.

- Erosion protection must be provided at the culvert outlets according to the requirements of *Drainage and Channel Design Standards for Local Drainage* or *City of Tucson Standards Manual for Drainage Design and Floodplain Management.* 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 at least the distances outlined in Section 3.6 – Horizontal Clearance to Obstructions to protect errant vehicles and pedestrians. Where culverts cannot be extended for this distance, guardrails or other suitable traffic barriers must be used as discussed in Section 3.7 – Traffic Barriers.

AT-GRADE CROSSINGS FOR URBAN RESIDENTIAL, COMMERCIAL AND INDUSTRIAL SUBDIVISIONS

At-grade crossings shall only be used to supplement culverts during certain rainfall events (see Section 4.18 - Culverts), unless at-grade crossings have been approved for sheet flooding conditions crossing local streets.

- Post barricades shall be placed at at-grade crossings exceeding 50 cfs.

- 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 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 along the pavement edge.

- 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.

- At-grade crossings should be built at a minimum 4% cross slope to reduce deposition of sediment. A reduced cross slope may be approved if engineering justification is provided. This 4% grade shall be produced by supplying the vertical rise on the upstream side of the dip section with the downstream side meeting the existing grade.

- If controls for traffic safety, or accommodation of sheet flows, dictate a reduced cross slope, sediment reduction may be accomplished by installation of a sediment trap or other means approved by Pima County.

- The flow rate of the 100-year event for at-grade crossings shall not exceed 500 cfs.

AT-GRADE CROSSINGS FOR RURAL RESIDENTIAL SUBDIVISIONS

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

- If the 100-year peak discharge exceeds 500 cfs over the entire roadway length due to sheet flooding conditions, and the 100-year flow depth is less than one foot, at grade crossings are acceptable.

- 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.

- 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 depth of 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.
- The design thresholds for dip sections are illustrated in Table 4.22.

Table 4.22 Design thresholds for dip sections

Street Class	Design Standard
≤ 50 cfs	Concrete Headers
50-500 cfs	Cut-off walls
≥ 500 cfs	Culvert or Culvert + dip section

- At-grade crossings should be built at a minimum 4% cross slope to reduce deposition of sediment. This 4% grade shall be produced by supplying the vertical rise on the upstream side of the dip section with the downstream side meting the existing grade.
- If controls for traffic safety, or accommodation of sheet flooding conditions dictate a reduced cross slope, sediment reduction may be accomplished by installation of a sediment trap or other means approved by Pima County.

5 COMMERCIAL AND INDUSTRIAL SITE DESIGN

The design standards for commercial and industrial sites focus on driveway location and design and onsite circulation and parking. For commercial/industrial projects that are required to make improvements to adjacent streets, the off-site improvements shall adhere to the requirements of chapters 3 and 4 of this manual or the Roadway Design Manual, as appropriate.

5.1 DRIVEWAY LOCATION

Driveways should be located so that they have a minimum impact on the traffic flow and safety of the street. All driveways are subject to the following requirements.

- The distance between adjacent driveways shall meet the minimum spacing requirements in Table 5.1 and be measured from nearest driveway edge to nearest driveway edge as depicted in Figure 5.1. 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. On undivided roadways, the spacing requirements apply to driveways on both sides of the street.

- Corner clearance is the distance between a driveway and the adjacent street intersection. The minimum allowable corner clearance is presented in Table 5.1. The driveway to road spacing shall be measured from nearest driveway edge to nearest road edge as depicted in Figure 5.2.

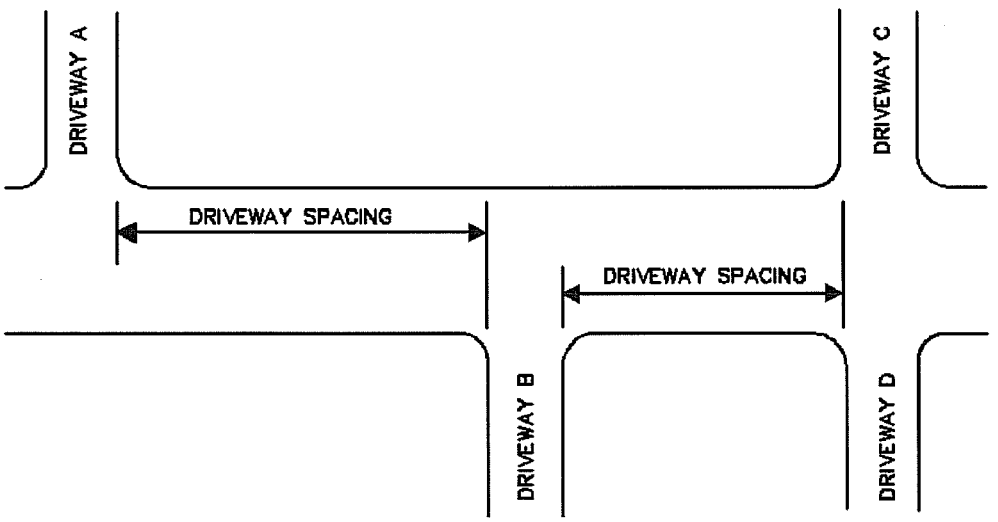
- Driveways shall not be located within the functional limits of the intersection unless approved by Pima County. The functional limits are defined as the area between the near curb line of the cross street and the beginning of tapers for right- and left-turn lanes.

- Pima County encourages shared access.

Table 5.1 Driveway Spacing

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

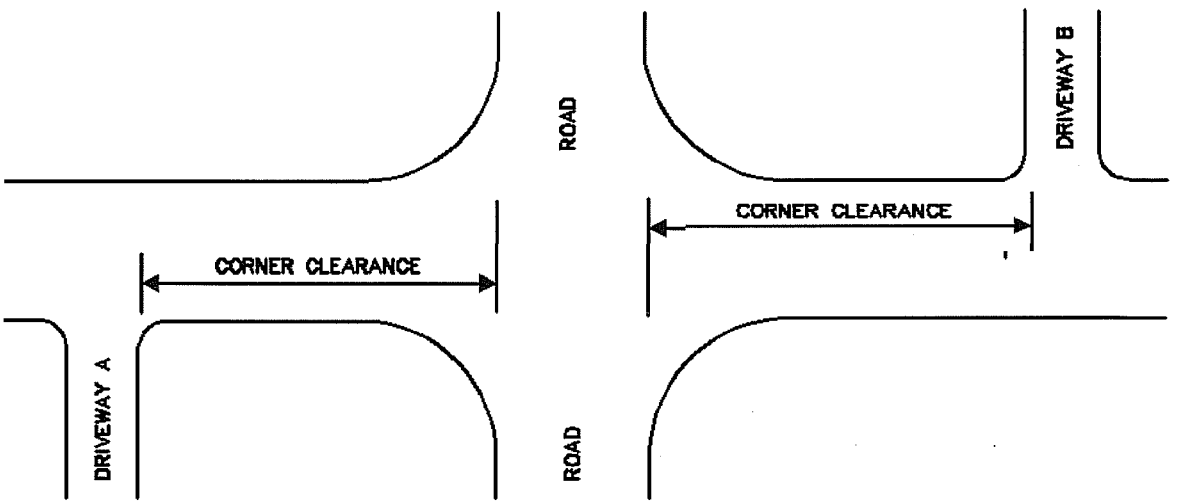
Figure 5.1 Driveway Spacing Measurement



- The maximum number of driveways for any lot shall be limited to two per three hundred feet of frontage along any single street.
- Driveways near median openings should be centered with the median opening or be a minimum of 100 feet from the center of the median opening.

- 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.

Figure 5.2 Driveway to Road Spacing Measurement



5.2 DRIVEWAY DESIGN

Driveway Aprons and Return Radius

- On streets with vertical curbs, the use of driveway aprons with curb cuts is preferred to the use of return radii. The design of the driveway apron shall be in accordance with PAG Standard Detail 206.

- Return radii may be allowed on curbed roadways (See Detail 16) 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. The projected ADT must be calculated using the trip generation rates published in the latest edition of *Trip Generation*[5] from the Institute of Transportation Engineers (ITE).
  - The posted speed limit on the roadway is greater than 45 mph.
  - The driveway is served by a specific median opening with left turn storage.

- The type of development, the amount of truck traffic, or the prevailing travel speeds, make curb cuts unsafe or undesirable.

- Driveways on rural, uncurbed streets shall have 6-inch by 12-inch concrete headers placed adjacent to the pavement on all returns per PAG Standard Detail 213.

- Driveway return radii larger than 40 feet shall not be used without approval from Pima County as this may lead to unsafe conditions for pedestrians and bicyclists.

- The minimum driveway return radii by type of roadway are summarized in Table 5.3.

Table 5.3 Minimum Return Radius

Functional Classification	**Minimum Return Radius***
Local Street	25
Collector or Arterial Street	30

*The radius must be large enough accommodate the design vehicle

Width

- For two-lane commercial driveways the minimum width shall be 24 feet and the maximum width shall be 30 feet.

- For a three lane driveway that is striped for one lane in and two lanes out without a median, the maximum width is 36 feet.

- For driveways greater than 36 feet in width, a median is required. Where a median island is provided to separate inbound and outbound traffic, it shall be not less than 6 feet or more than 16 feet wide.

- Each side of a median-divided driveway shall be at least 16 feet wide to ensure accessibility of emergency vehicles.

Grade

The vertical profile of a driveway should allow a smooth transition to and from the roadway. A minimum 20 foot long landing area of no greater than 3% slope shall be provided on roadway approaches. The maximum allowable grade for commercial and industrial driveways shall be 6%. (See Detail 16)

Angle of Connection

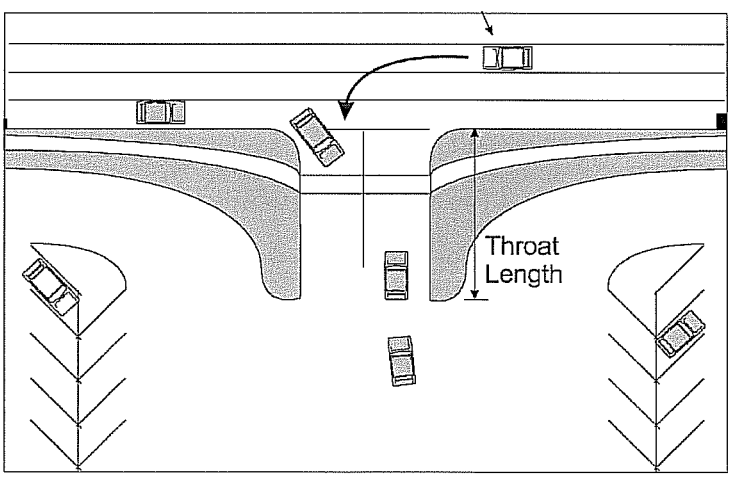
Connection angles at the intersection of driveways with public roadways should be as close to 90 degrees as practicable, but no less than 70 degrees.

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 as shown in figure 5.3.

- Where a driveway median is provided equal to the throat length, the throat length requirement only applies to inbound traffic.

Figure 5.3 Driveway Throat Length



Source: Florida Department of Transportation

- When a development requires 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.

- When there is no queuing analysis, the minimum driveway throat length is 50 feet.

- Single lot commercial developments can utilize a 30 foot throat length subject to the following:

  - Left turns are not allowed into the development.
  - A right-turn lane into the development is provided.
  - The parking configuration does not allow for backing vehicles to conflict with entering traffic.

5.3 DESIGN OF PARKING AREAS

Parking Lot Layout

- All parking spaces and parking aisles (access lanes) shall be designed in conformance with the parking area dimensions in Table 5.4.

- 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 Figure 5.4.

- The orientation of Parking Area Access Lanes (PAALs) shall be perpendicular to the building faces to accommodate convenient pedestrian movements.

- Passenger drop-off points, separated from street traffic and access lanes are to be provided in conjunction with the following uses: Hotels, motels, hospitals, clinics, schools with fifty or more pupils, day care centers, religious facilities with one hundred or more seats, and recreational facilities.

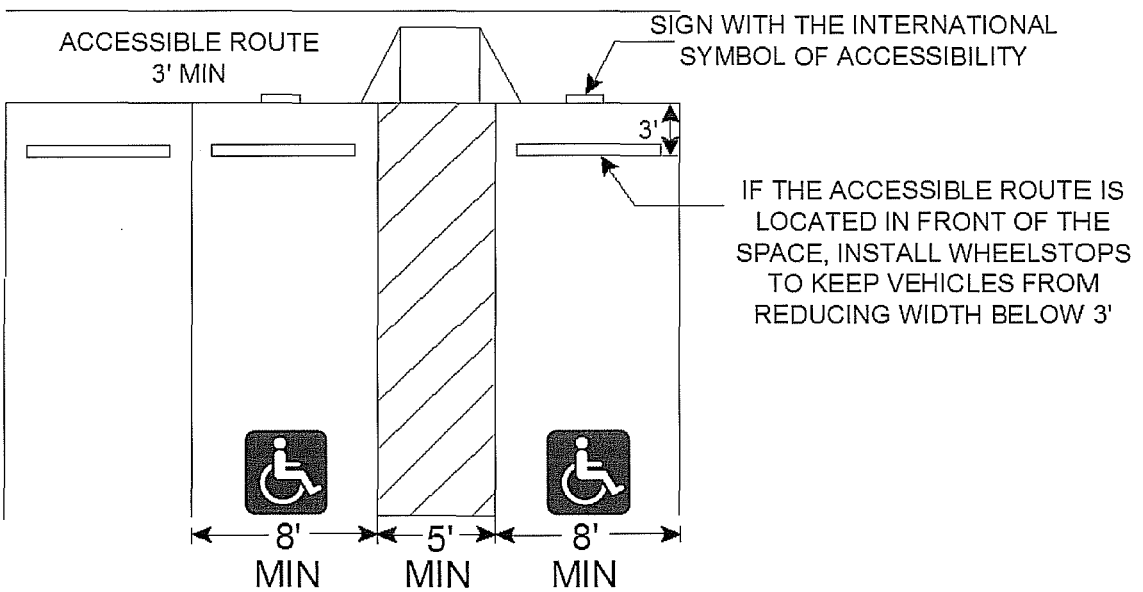
- All parking lots shall provide unrestricted access for emergency and service vehicles. The designer shall utilize geometric characteristics of the SU-30 design vehicle with forty-two-foot turning radius.

- Parking spaces in paved parking areas shall be permanently marked with striping in accordance with the Manual on Uniform Traffic Control Devices. Striping shall be, 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 pedestrian walkways.

Figure 5.4 Handicapped Parking with Shared Aisle

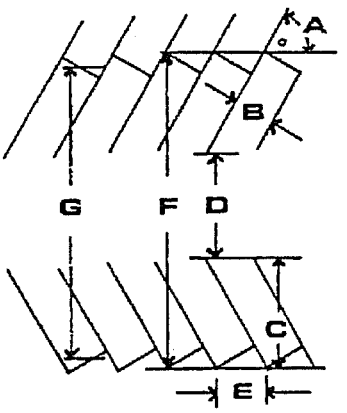


For Van Accessible parking spaces, the access aisle must be 8 feet wide and a "van accessible" sign must also be installed Refer to the latest ADA guidelines for further information and design guidelines

Table 5.4 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

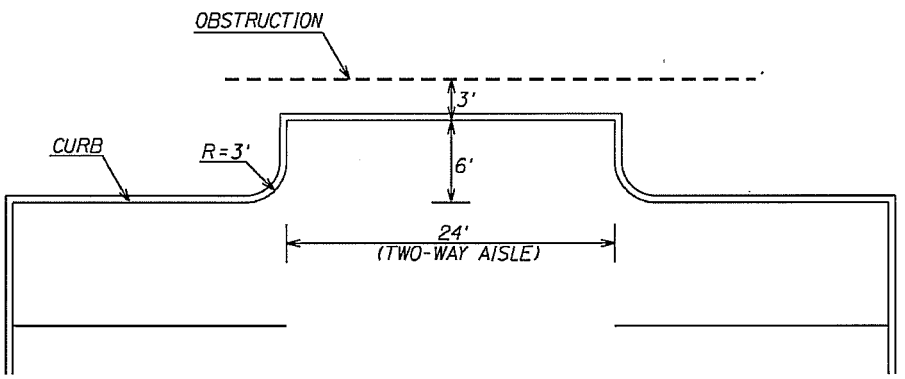


A	B	C	D	E	F	G
0°	9.0	9.0	12.0	23.0	30.0	-
	9.5	9.5	12.0	23.0	31.0	-
	10.0	10.0	12.0	23.0	32.0	-
20°	9.0	15.3	12.0	26.4	42.6	34.1
	9.5	15.7	12.0	28.0	43.4	34.5
	10.0	16.3	12.0	29.6	44.6	35.2
30°	9.0	17.8	12.0	18.0	47.6	39.8
	9.5	18.2	12.0	19.0	48.4	40.2
	10.0	18.6	12.0	20.0	49.2	40.5
45°	9.0	20.4	13.0	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. A minimum distance of 3 feet shall be provided between the wheel side of the barrier at the back of the spur and any wall, screen, or other obstruction over 6 inches in height (see Figure 5.5).

Figure 5.5 Dimensions of back-up spur



Pedestrian Facilities

- Sidewalks shall be provided on all sides of the lot that abut a curbed public street (see Section 3.5 for dimensions).

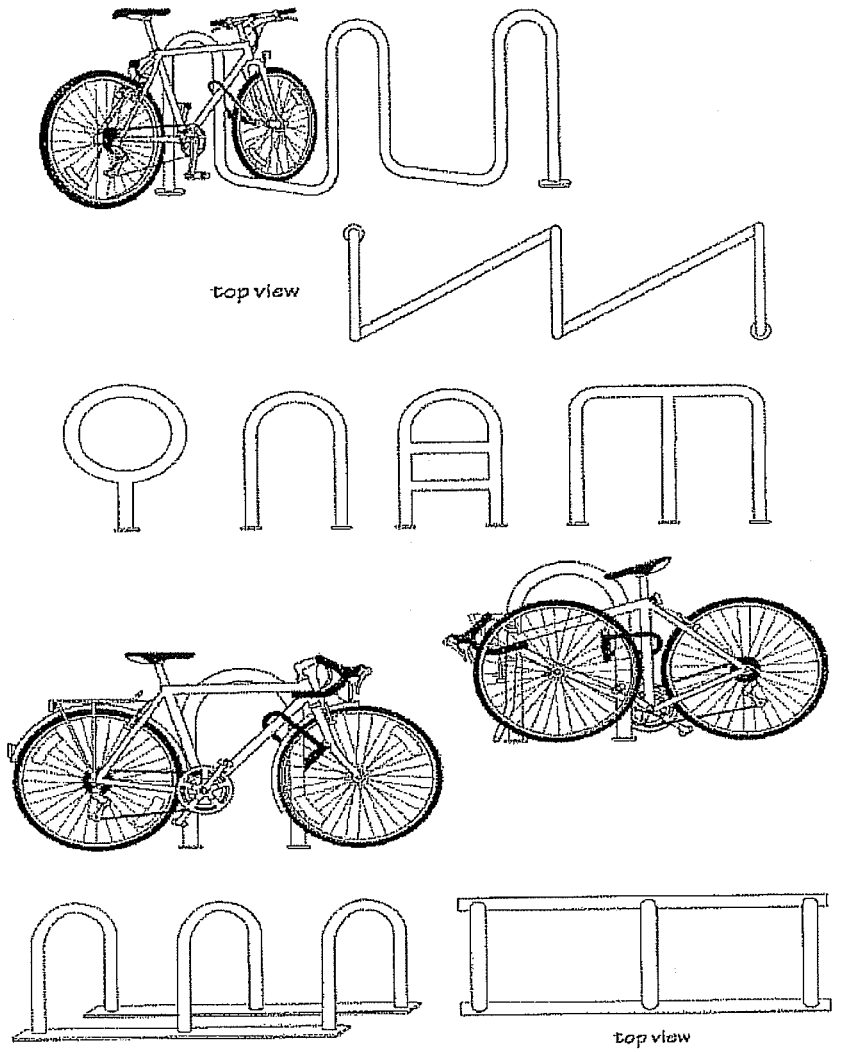
- A continuous internal pedestrian walkway, no less than 4 feet in width, shall be provided from the public sidewalk or right-of-way to the principal entrance of buildings at the site. At a minimum, walkways shall connect focal points of pedestrian activity such as transit stops, street crossings and 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. Surfacing may include porous materials, or cool toppings to reduce radiant heat from the pavement surface.

Bicycle Facilities

- Bicycle parking spaces shall be provided as specified in Chapter 18.75 of the Pima County Code[1].
- When bicycle racks are installed, they must adhere to the following guidelines.
- Bicycle racks must be securely anchored to the ground, floor, wall or ceiling.
- Bicycle racks must be designed so that the bicycle frame and one wheel can be locked to the rack with a high security, U-shaped lock if both wheels are left on the bicycle
- Bicycle racks must be designed such that a bicycle six feet long can be securely held with its frame supported so the bicycle cannot be pushed or fall in a manner that will damage the wheels or components
- A single bicycle rack must be designed and located to accommodate two bicycles
- Bicycle racks must not have sharp edges that can be hazardous to pedestrians, particularly individuals with visual disabilities.
- A bicycle rack must be a minimum of two and one half feet from a wall or other obstruction.
- An access aisle at least five feet wide must be provided between two rows of bicycle parking.
- Examples of acceptable bicycle rack designs are shown in Figure 5.6

Figure 5.6 Bicycle Rack Design Examples



Source: City of Tucson Land Use Code Section 3.3.9.5.A

PARKING LOT DRAINAGE

- Parking may be permitted in the flood plains of regulated watercourses, washes and detention/retention basins, provided that the maximum depth of flooding does not exceed 1 foot during the 100-year event, and the velocity is below 2 ft/s. 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.

- Drainage of parking lots can be accomplished by means of curb openings, curb cores, scuppers, catch basins and storm drain systems in general as discussed in Section 4.18. Inverted roadway crowns or concrete valley gutters are allowed in parking aisles or between stormwater harvesting basins. The minimum longitudinal slope permitted within parking areas is 0.5%.

PARKING LOT PAVEMENT

- In order to control particulate matter, all parking areas shall be paved. 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 1.35 shall be required. This structural number can be obtained by using two inches of asphaltic concrete (AC) on four inches of compacted aggregate base (AB). 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, including permeable pavements, may be used with the concurrence of the County 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 contractor's yards or storage areas that are access controlled. However, those areas shall still use surface treatments such as gravel or decomposed granite to ensure dust control.

DRIVE-THRU QUEUING

The minimum storage requirements for the most common types of drive-thru facilities are presented in Table 5.5. The storage lengths shown in Table 5.5 shall be accomplished without interfering with the through streets or the parking area access lanes. For drive-thru facilities not included in Table 5.5, or facilities known or expected to have higher than

typical trip generation, the storage length shall be determined by an engineered queuing analysis.

Table 5.5 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[38]

6 ADMINISTRATION OF THE STANDARDS

This section addresses the procedures that shall be followed to manage and implement the standards and requirements in this manual. Responsibility to administer, coordinate and enforce the provisions and standards in this manual shall be as follows:

- The County Engineer, or his/her designee shall have responsibility over all elements within the present or future street right-of-way, whether public or private, including areas having a direct safety, capacity or maintenance impact thereon
- The Chief Building Official, or his/her designee shall have responsibility over development areas outside street right-of-way

The due-process appeal route regarding interpretation or request for modifications to these standards shall be as follows:

- Elements within direct impact to present or future right-of-way: staff interpretation, SDSS Modification Committee, County Engineer
- Elements within development areas other than right-of-way: staff interpretation, SDSS Modification Committee, Chief Building Official, Board of Adjustment, Superior Court

6.1 STAFF INTERPRETATION AND MODIFICATIONS

County staff are empowered to interpret and approve minor modifications to these standards in alignment with the principles reflected herein or through referenced nationally recognized standards or methodologies.

6.2 SDSS MODIFICATION COMMITTEE

The County Engineer shall appoint and coordinate the activities of a subdivision and development street standards committee, here-in-after referred to as the "Committee". The appointed Committee shall have the following characteristics:

- Number of members: The Committee shall be composed of six persons.

Affiliation and qualifications of members: The affiliation of the members shall be as follows:

- Three members shall be from the Pima County Department of Transportation.
- Three members shall be employed in the private sector.
- Four of the members shall be registered Professional Engineers in the State of Arizona.
- All members shall have knowledge and experience in subdivision design and have a good understanding of the development process.

Appointing Authority: All Committee appointments shall be made by the County Engineer. The County Engineer may also approve an alternate for each member that may serve in the event of an absence.

Term: Committee members serve at the pleasure of the County Engineer.

Transaction of Business:

- 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.
- Meeting frequency: The Committee shall meet as necessary to conduct the Committee's business.
- Quorum: The Committee shall be considered to be duly assembled at meetings where at least three members or alternates are present If fewer than three members or alternates are present the meeting shall be re-scheduled.
- 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.
- 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).

Responsibility: The Committee shall not approve or deny any request for modification or interpretation, but shall only provide a recommendation for approval or denial to the County Engineer or Chief Building Official.

6.3 MODIFICATIONS AND INTERPRETATIONS

If the designer believes that a provision of these standards is vague or unclear, a formal interpretation may be requested from Pima County. In other cases, strict compliance with these standards may not be feasible due to unusual site conditions. Pima County may grant a modification of these standards if the following criteria are met:

- The strict application of the provision(s) in question would create an extraordinary and unnecessary hardship due to 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.

- The modification is consistent with the general intent and purpose of the standards and the provision(s) from which the modification is requested..

- The modification does not violate State law or other provisions of Pima County ordinances or policies.

- The modification will not cause injury to the rights of surrounding property owners and residents.

- The modification will not reduce traffic safety, capacity, functional utility of the street system or negatively impact maintenance.

- The modification makes a clear and definable contribution to Pima County's economic development priorities.

6.4 REQUESTS FOR MODIFICATIONS AND INTERPRETATIONS

Requests shall be submitted and processed per current procedures posted at the Development Services website.

6.5 COUNTY ENGINEER AND CHIEF BUILDING OFFICIAL ACTIONS ON MODIFICATIONS AND INTERPRETATIONS REQUESTS

The County Engineer or Chief Building Official may seek the recommendation of the Committee for interpretations and modifications of the standards in this manual.

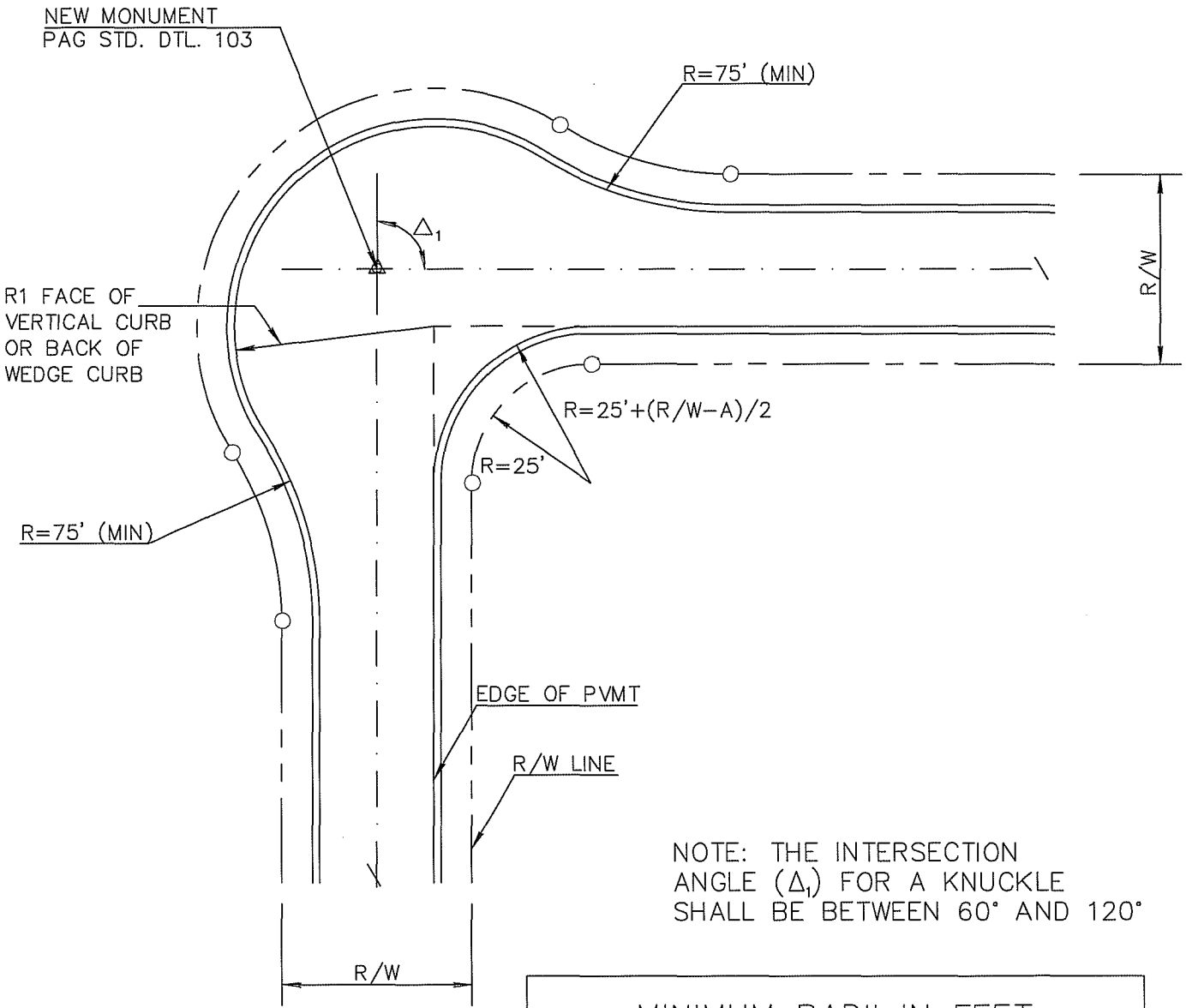
Contingent on the above listed scope of responsibility, the County Engineer, Chief Building Official or his/her designee may accept or reject the Committee's recommendation and provide the applicant a decision in writing three working days of the Committee meeting. The request shall include the reason why the Committee's decision is accepted or rejected.

Per statutory authority, the decision of the County Engineer over the street right-of-way is final and cannot be appealed. However, if the applicant is not satisfied with the decision of the Chief Building Official, the decision may be appealed to the County Board of Adjustment by notifying the project Site Review Manager of the request within thirty calendar days of the Committee decision. Appeals to the Board of Adjustment shall be scheduled within three working days of request for the next available Board of Adjustment meeting date, in accordance with County policy.

6.6 MODIFICATIONS TO THESE STANDARDS

Modifications to these standards which are identified as repeatedly approved through the County modification process shall be incorporated into an appendix chapter upon approval of the County Engineer or Chief Building Official, contingent on area of responsibility. Once incorporated herein, these modifications, in accordance with the limitations attached thereto, become part of the standards and may be used without invoking the modification process.

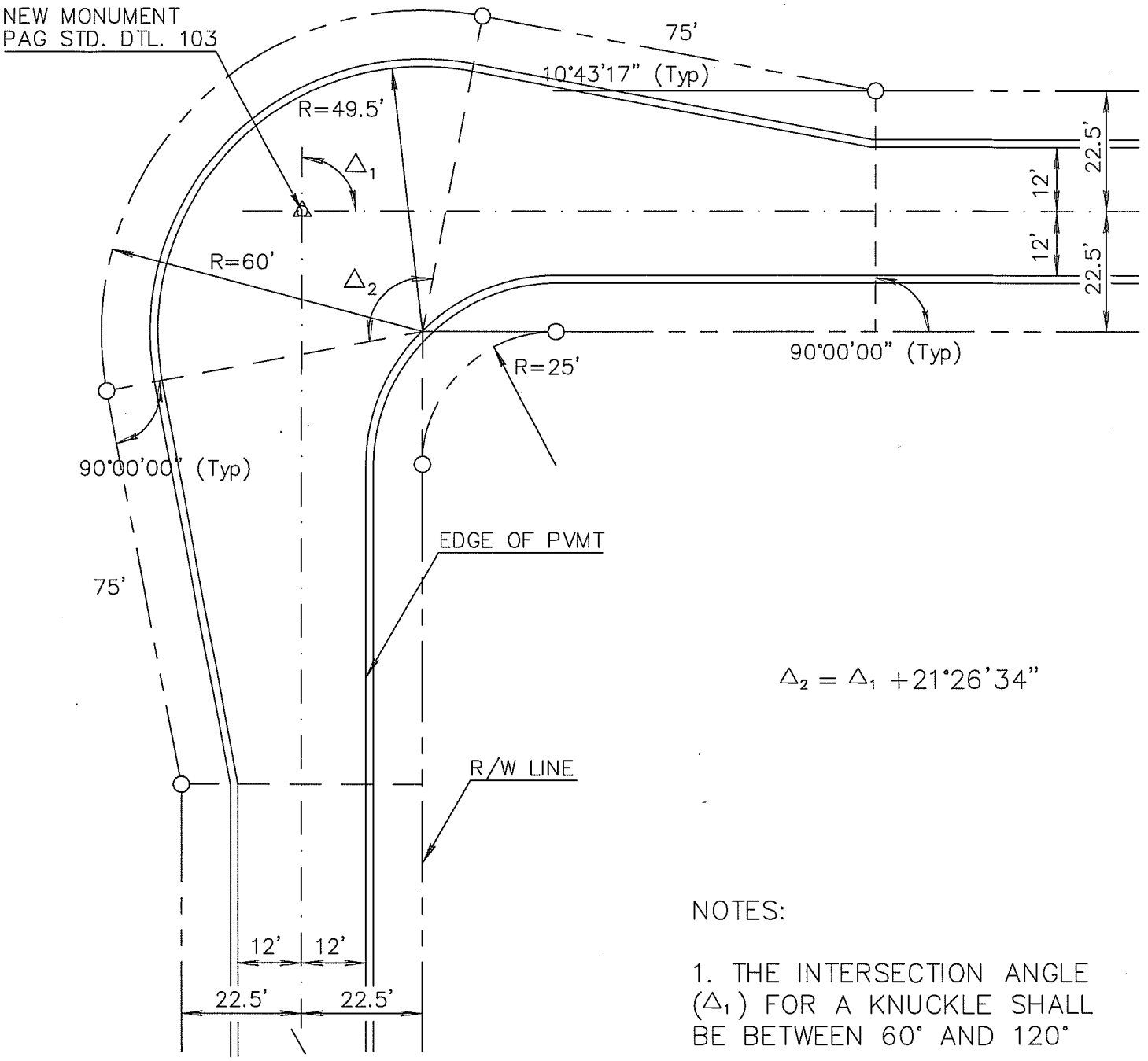
7 STANDARD DETAILS AND CROSS SECTIONS



NOTE: THE INTERSECTION ANGLE (Δ_1) FOR A KNUCKLE SHALL BE BETWEEN 60° AND 120°

MINIMUM RADII IN FEET		
	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
R1	42′	52′

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	KNUCKLE DESIGN ALTERNATIVE 1		1A
REVISED: 12/15				



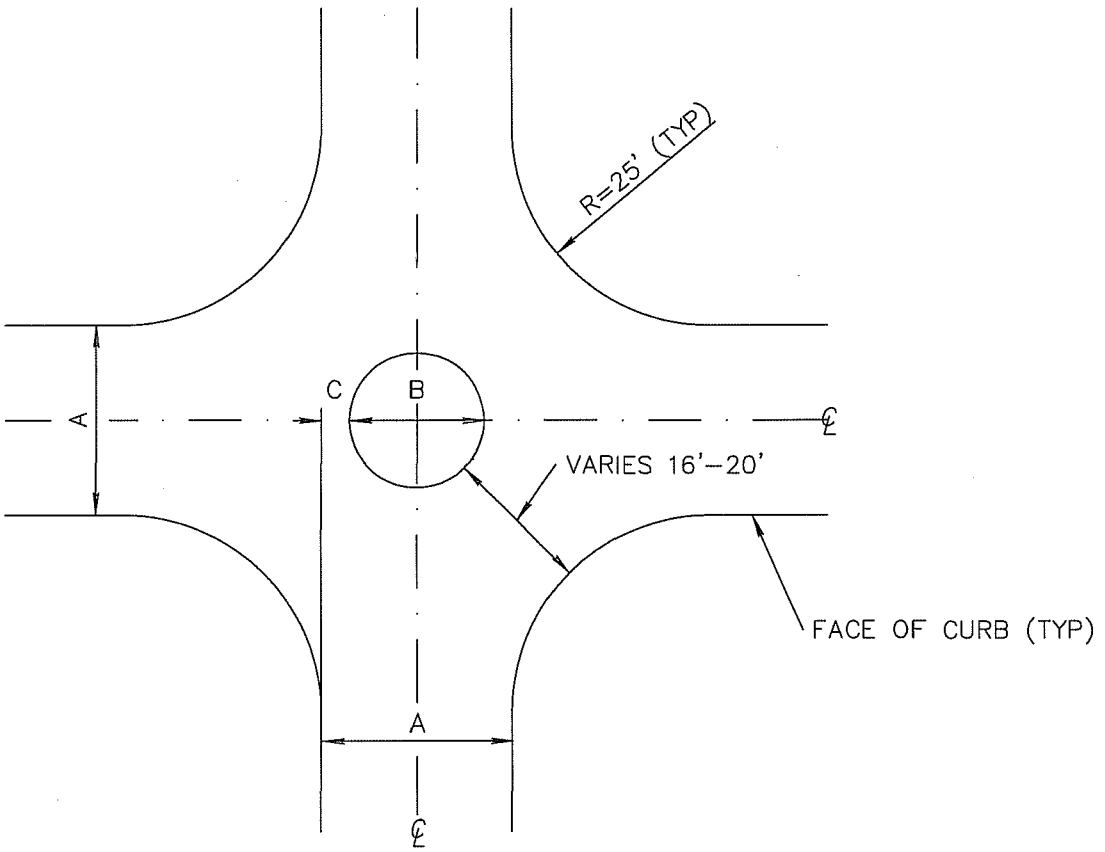
$\Delta_2 = \Delta_1 + 21°26'34"$

NOTES:

1. THE INTERSECTION ANGLE (Δ_1) FOR A KNUCKLE SHALL BE BETWEEN 60° AND 120°

2. THIS KNUCKLE IS TO BE USED ONLY WITH LOCAL STREETS.

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	KNUCKLE DESIGN ALTERNATIVE 2		1B
REVISED: 9/15				

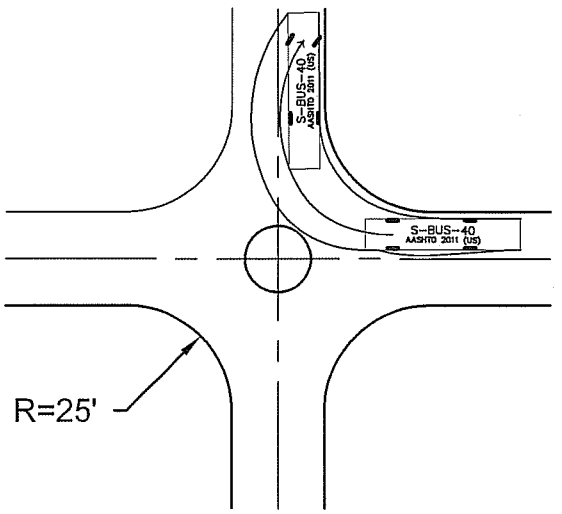


INTERSECTION DIAGRAM

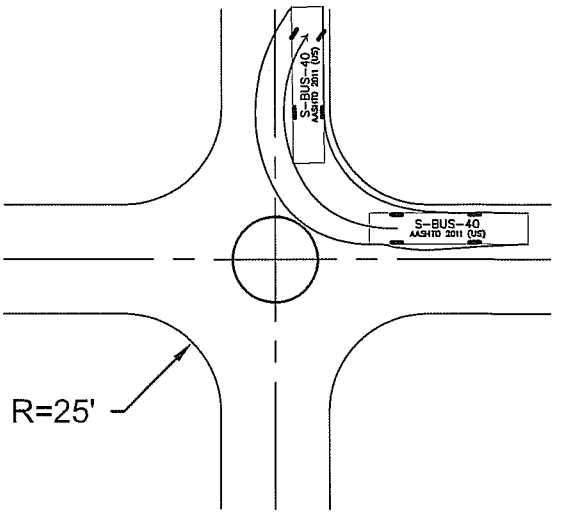
A STREET WIDTH	B CIRCLE DIAMETER	C
24'	17'	3.5'
26'	19'	3.5'
28'	22'	3.0'
30'	24'	3.0'
32'	27'	2.5'
34'	30'	2.0'
36'	33'	1.5'
38'	36'	1.0'
40'	38'	1.0'

NOTE: THE CIRCUMFERENCE OF THE TRAFFIC CIRCLE SHALL BE CURBED

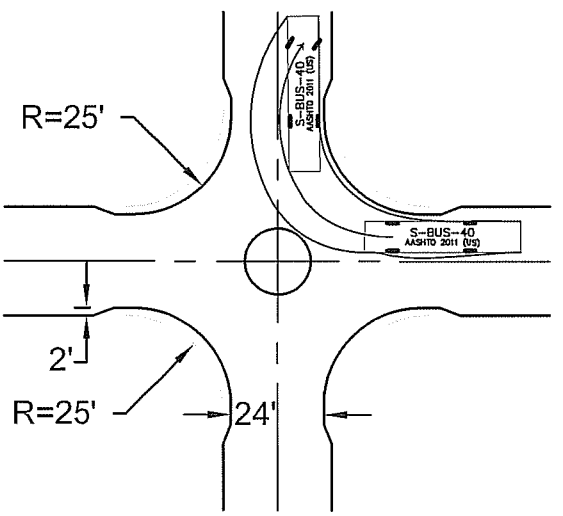
ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	TYPICAL TRAFFIC CIRCLE DESIGN		2
REVISED: 9/15				



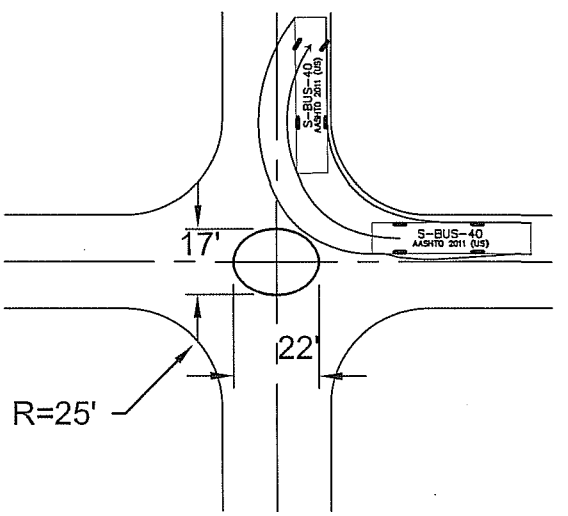
24' Roadway
17' Ø Traffic Circle



28' Roadway
22' Ø Traffic Circle

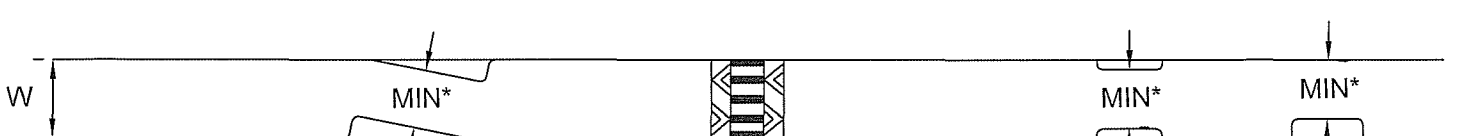


28' Roadway
17' Ø Traffic Circle



24' & 28' Roadway
17' x 22' Ellipse

LOCAL ROADWAY AND COLLECTOR INTERSECTION ALTERNATIVES



One Lane Chicane

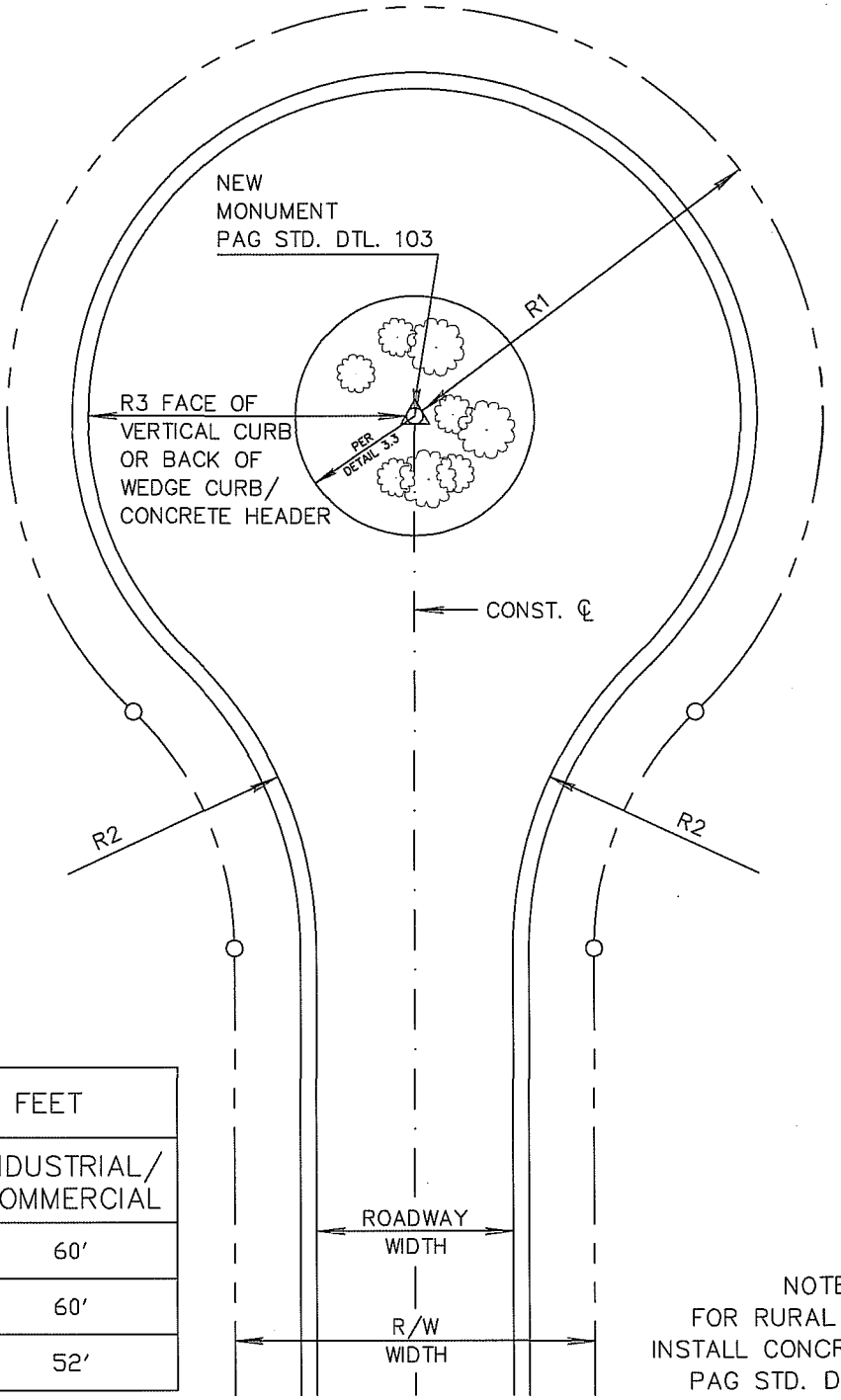
Raised Mid-block Crosswalk

Symmetrical or Asymmetrical Bump-Outs or Planters

PERIODIC MEASURES

*Minimum Width For Emergency Vehicle Accessibility

ISSUED:		STANDARD DETAIL		DETAIL NO.
12/15	PIMA COUNTY TRANSPORTATION	TRAFFIC CALMING AND SPEED MANAGEMENT OPTIONS		3
REVISED:				

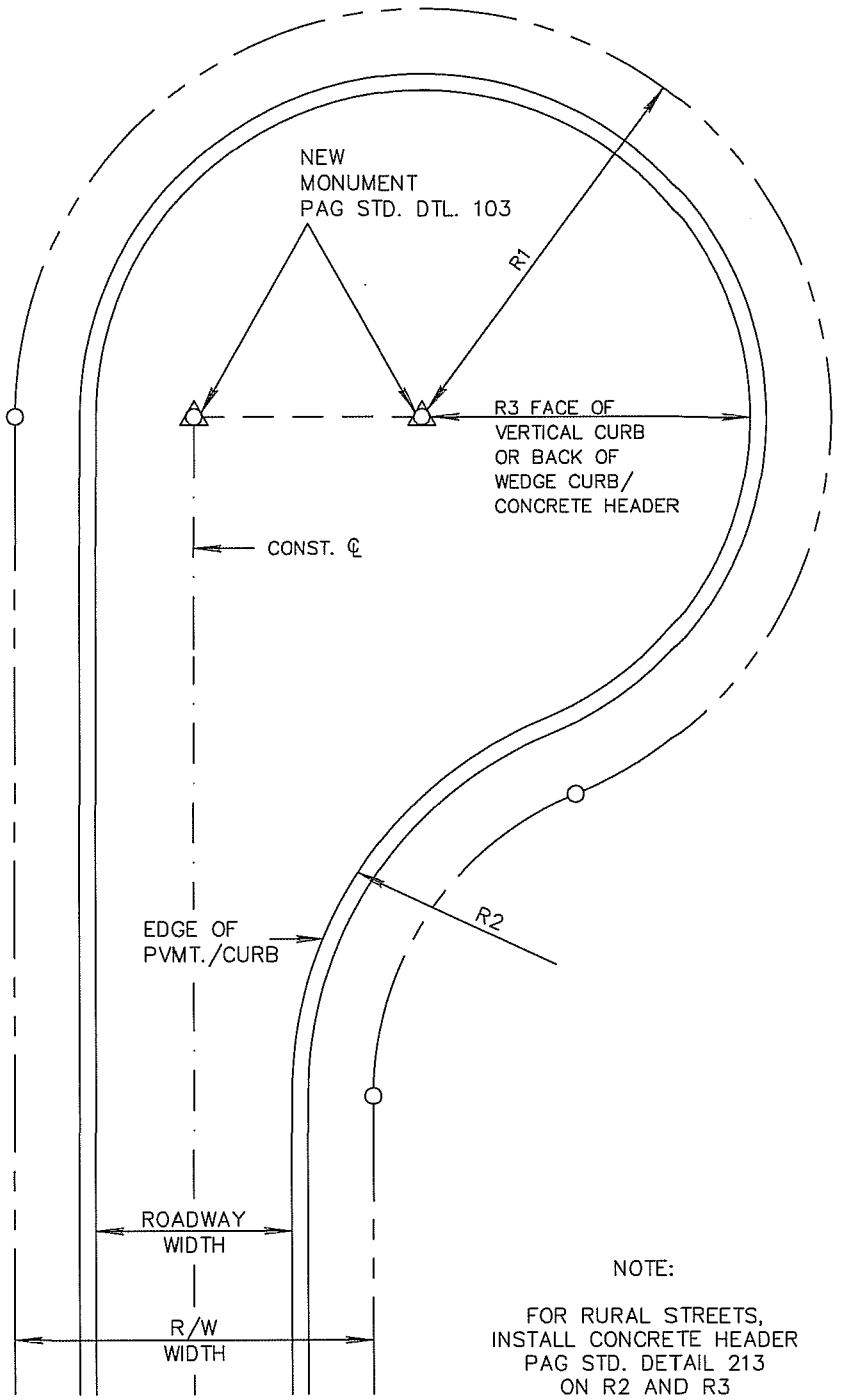


MINIMUM RADII IN FEET		
	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
R1	50′	60′
R2	50′	60′
R3	42′	52′

NOTES:
FOR RURAL STREETS,
INSTALL CONCRETE HEADER
PAG STD. DETAIL 213
ON R2 AND R3

CENTER LANDSCAPING/
STORMWATER HARVESTING
OPTION SHOWN

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	STANDARD CUL–DE–SAC		4A
REVISED: 12/15				

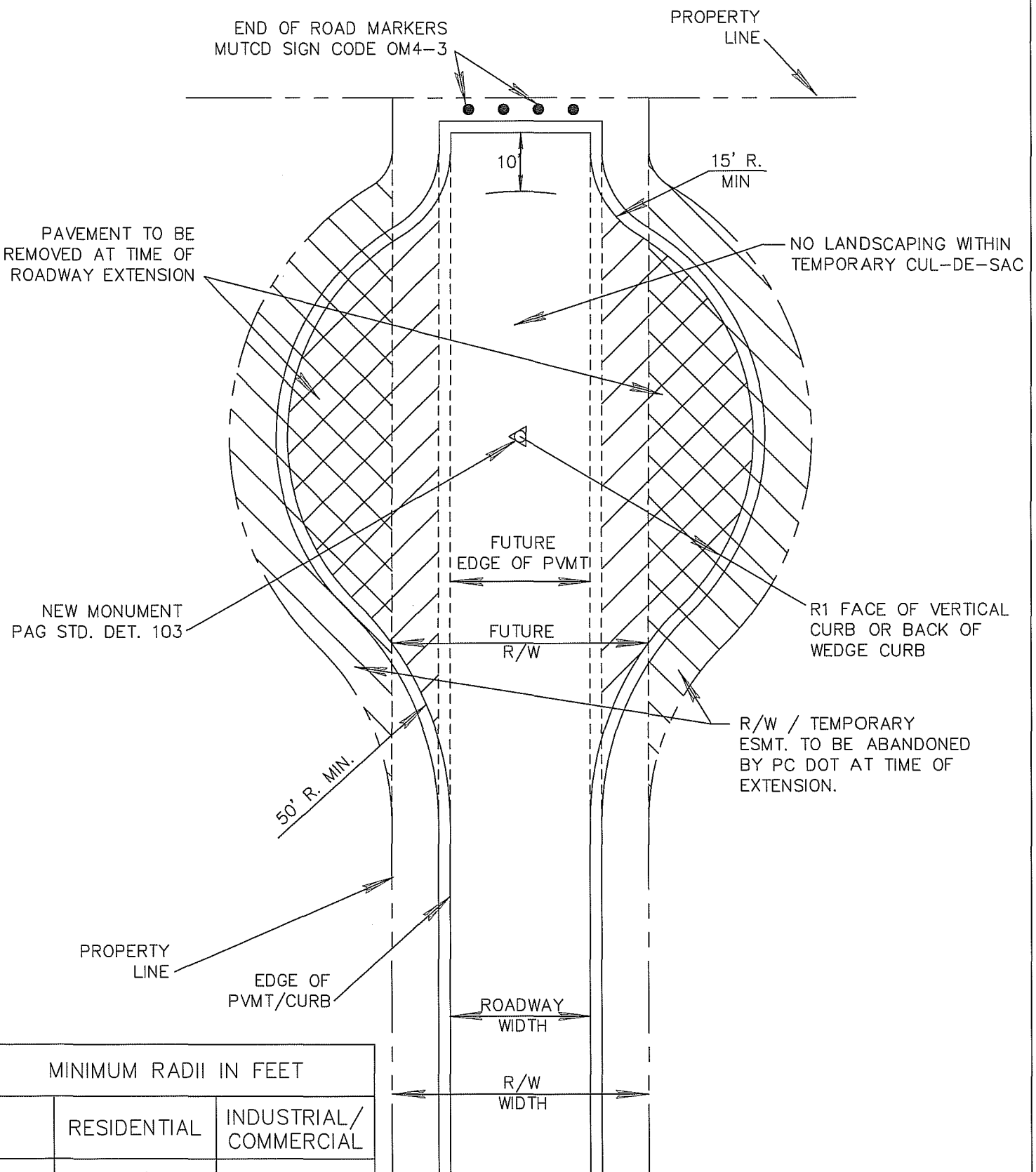


MINIMUM RADII IN FEET		
	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
R1	50′	60′
R2	50′	60′
R3	42′	52′

NOTE:

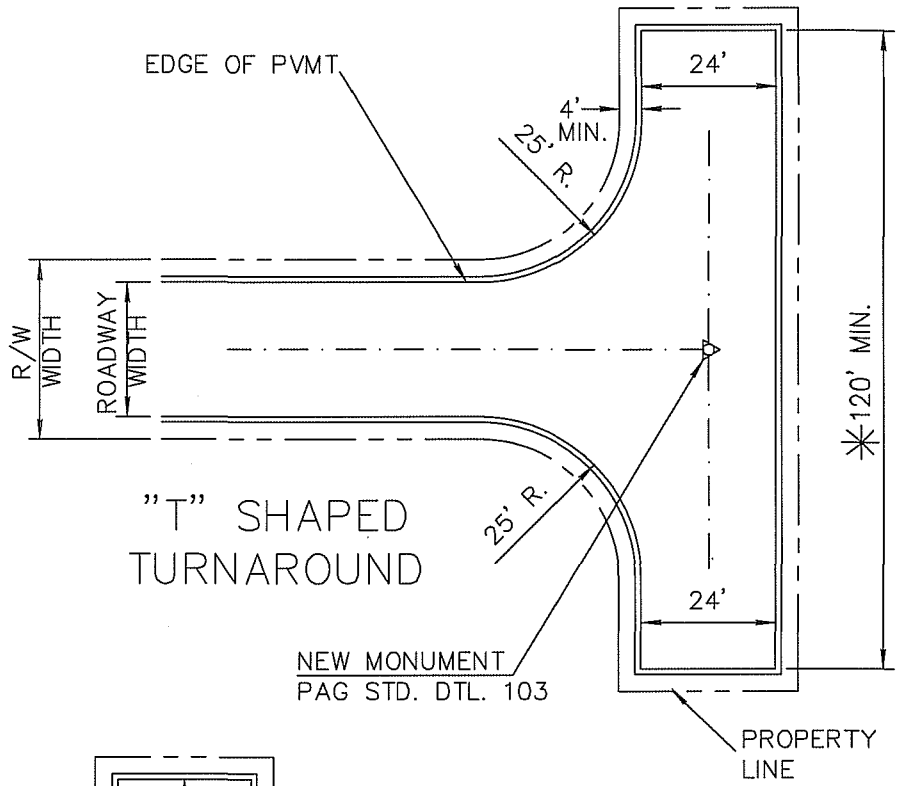
FOR RURAL STREETS,
INSTALL CONCRETE HEADER
PAG STD. DETAIL 213
ON R2 AND R3

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	OFFSET CUL-DE-SAC		4B
REVISED: 12/15				

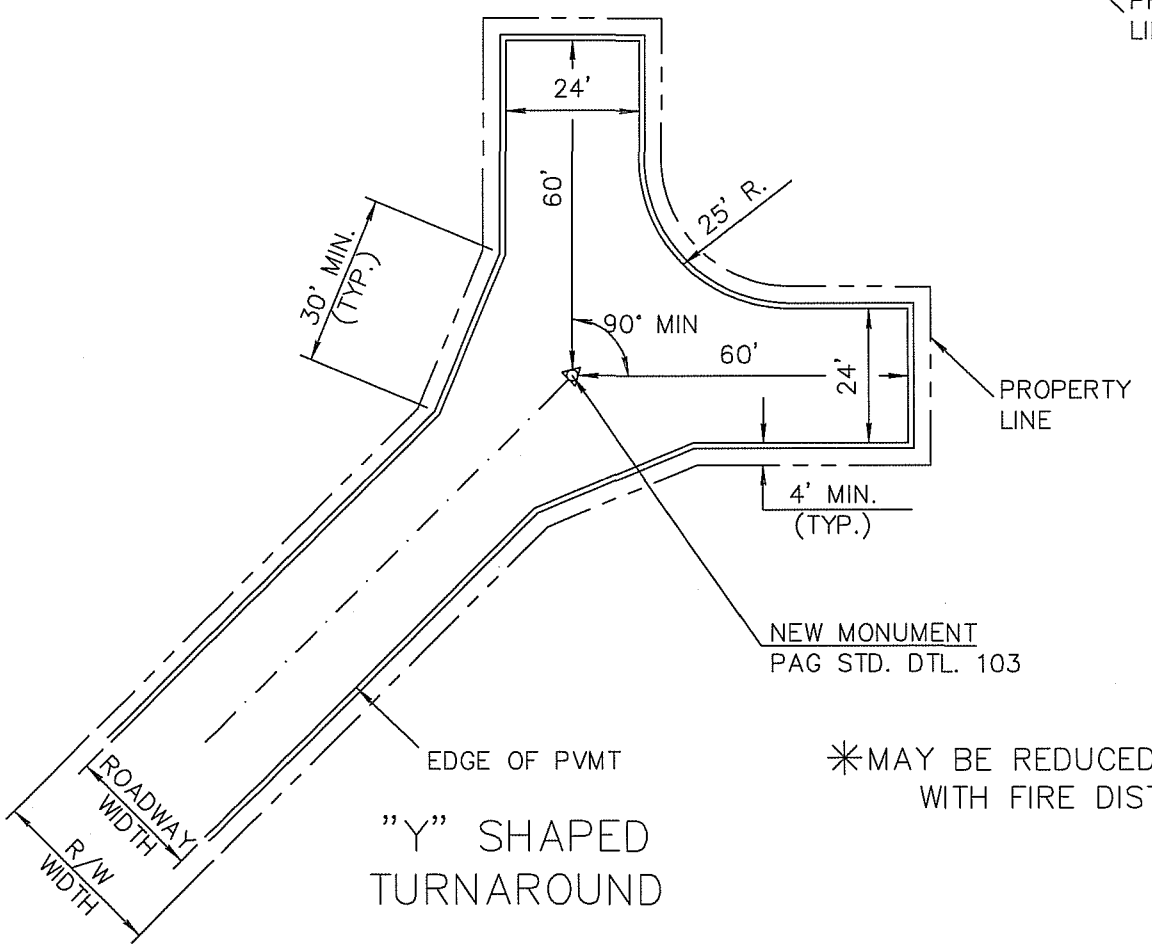


MINIMUM RADII IN FEET		
	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
R1	42'	52'

ISSUED:		STANDARD DETAIL		DETAIL NO.
12/15	PIMA COUNTY TRANSPORTATION	TRAFFIC CALMING AND SPEED MANAGEMENT OPTIONS		4C
REVISED:				



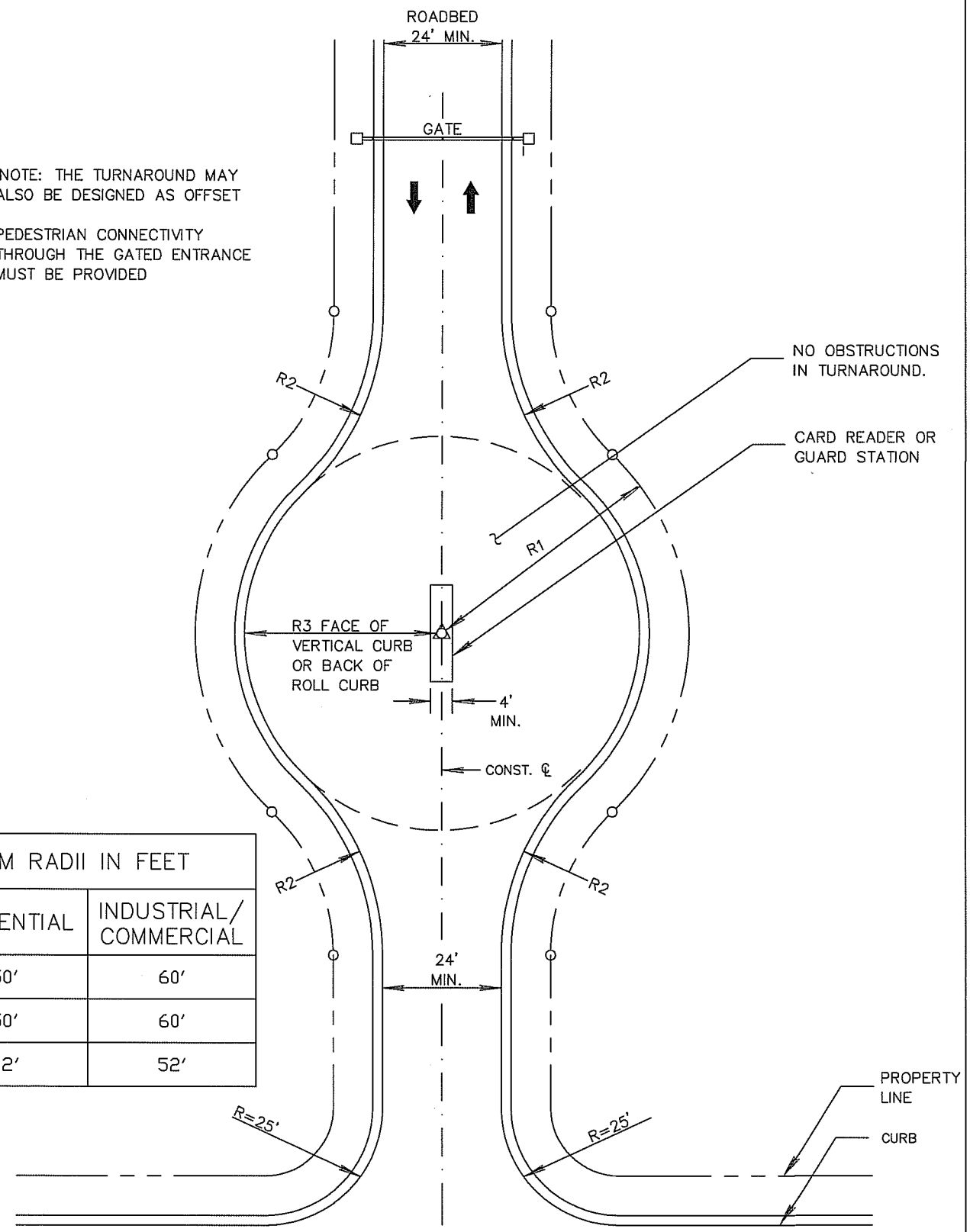
"T" SHAPED TURNAROUND



"Y" SHAPED TURNAROUND

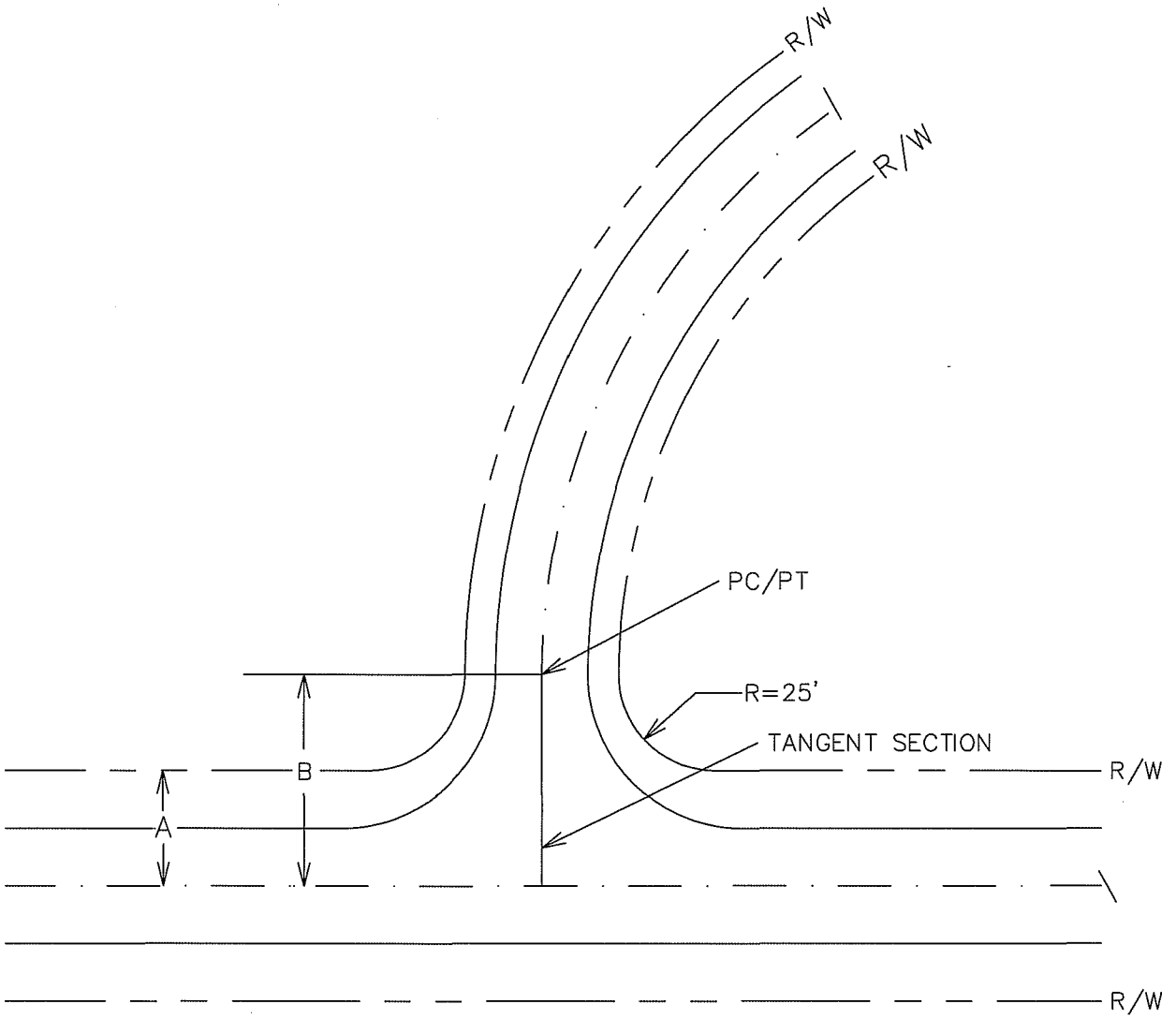
*MAY BE REDUCED IN ACCORDANCE WITH FIRE DISTRICT CRITERIA

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	TURNAROUNDS		5
REVISED: 9/15				



MINIMUM RADII IN FEET		
	RESIDENTIAL	INDUSTRIAL/ COMMERCIAL
R1	50'	60'
R2	50'	60'
R3	42'	52'

ISSUED:		STANDARD DETAIL		DETAIL NO.
1/15	PIMA COUNTY TRANSPORTATION	GATED ENTRANCE		6
REVISED: 12/15				

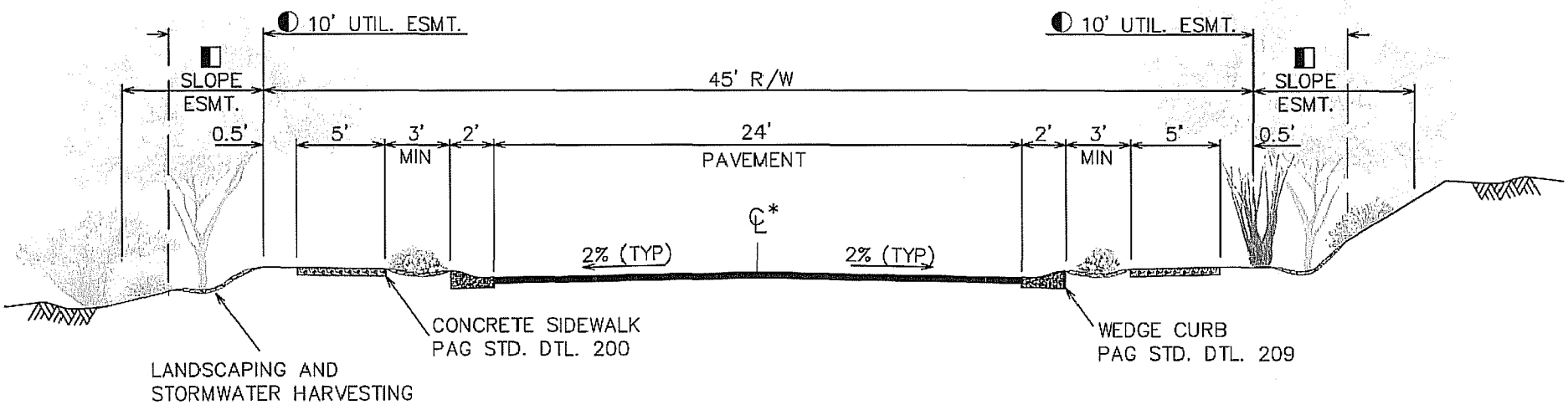


INTERSECTION DIAGRAM

INTERSECTION	TANGENT SECTION (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

ISSUED		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	MINIMUM TANGENT SECTION AT INTERSECTIONS		7
REVISED 9/15				

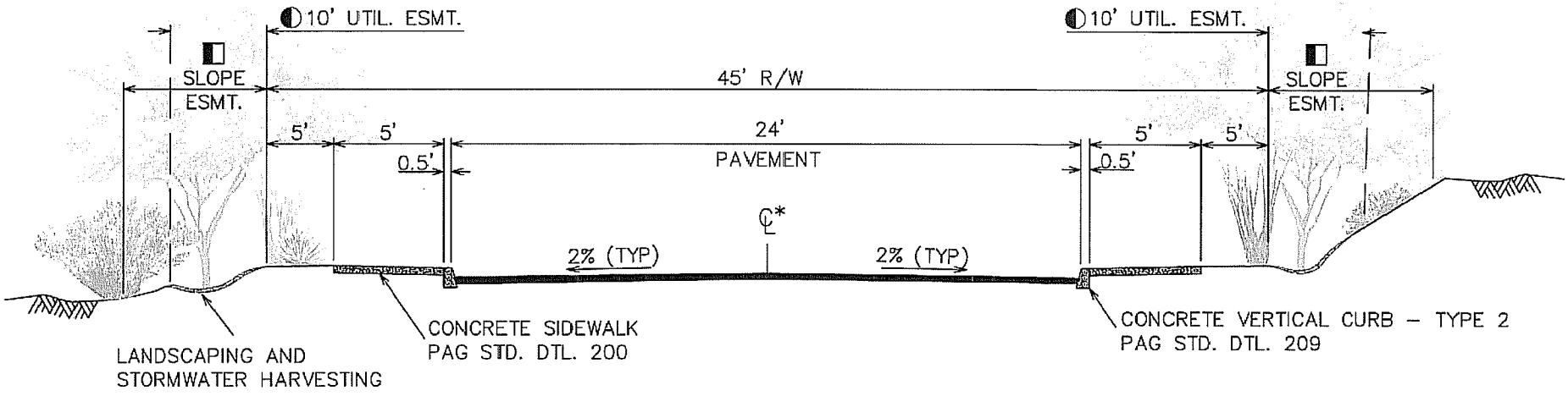


◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE
MUST EXTEND 5' BEYOND CATCH POINT

* THE CROWN SHALL BE AT ℄ OF PAVEMENT

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	LOCAL STREET URBAN RESIDENTIAL SUBDIVISION ALTERNATIVE 1		8A
REVISED: 12/15				

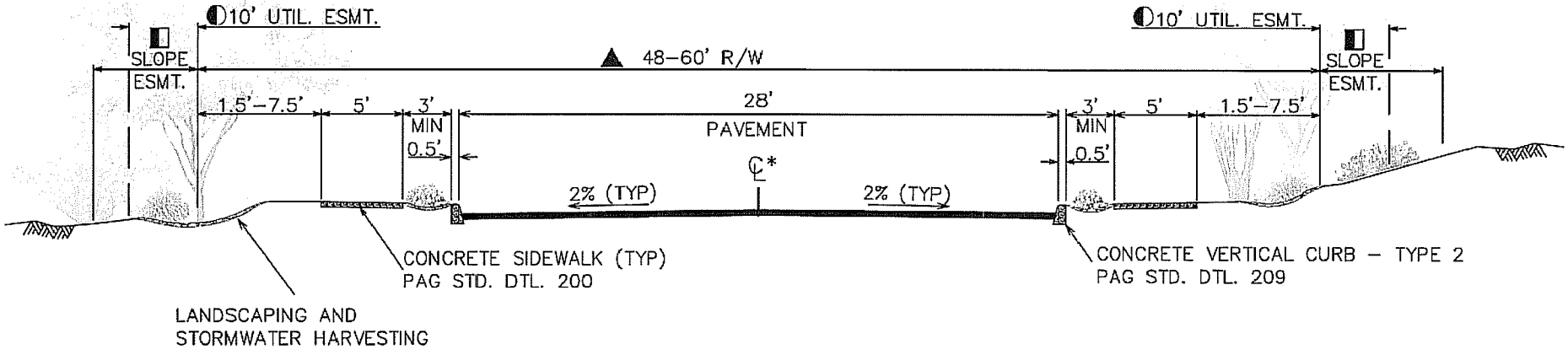


◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

* THE CROWN SHALL BE AT ℄ OF PAVEMENT

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	LOCAL STREET URBAN RESIDENTIAL SUBDIVISION ALTERNATIVE 2		8B
REVISED: 12/15				



◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

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

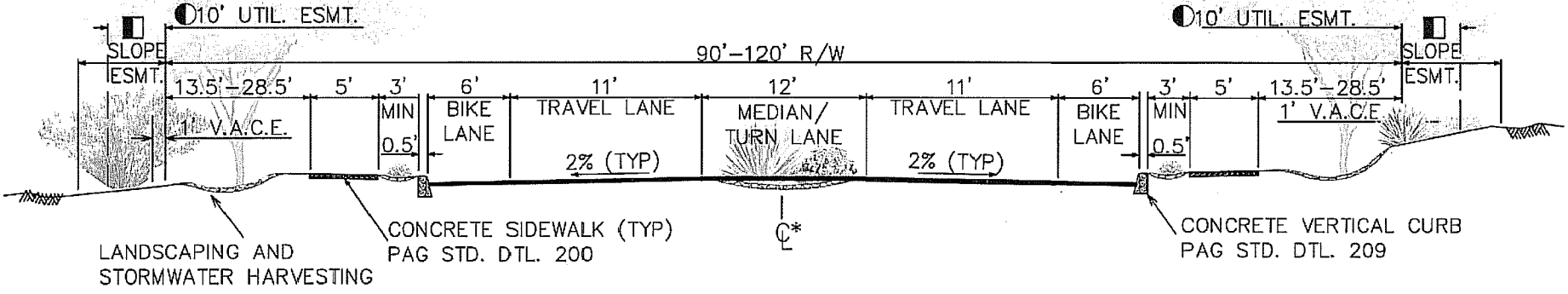
* THE CROWN SHALL BE AT ℄ OF PAVEMENT

NOTES:

PAVEMENT WIDTH MAY BE REDUCED TO 24' WITH THE INSTALLATION OF TRAFFIC CALMING ALTERNATIVES PER SECTION 3.4

NO PARKING ALLOWED

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	RESIDENTIAL COLLECTOR URBAN RESIDENTIAL SUBDIVISION		9
REVISED: 12/15				



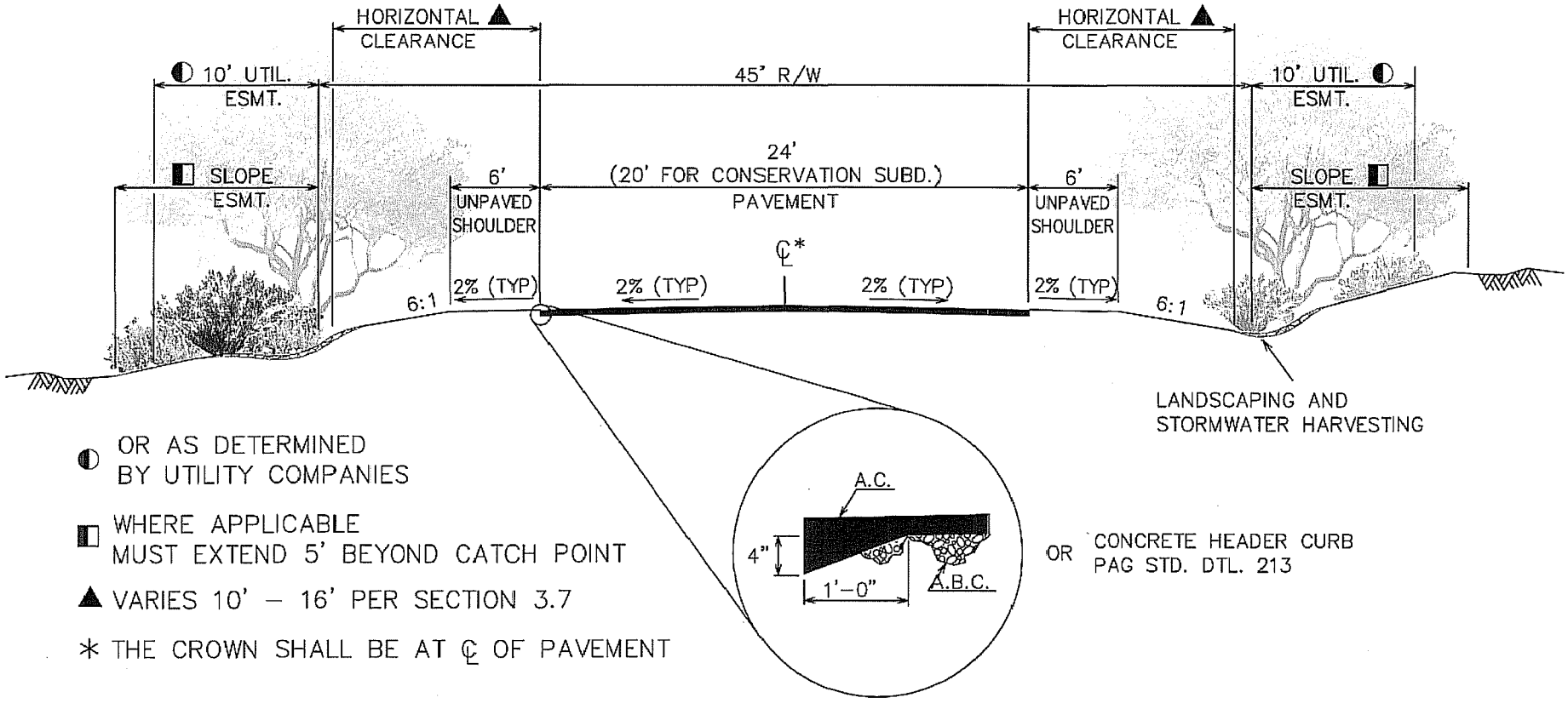
◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

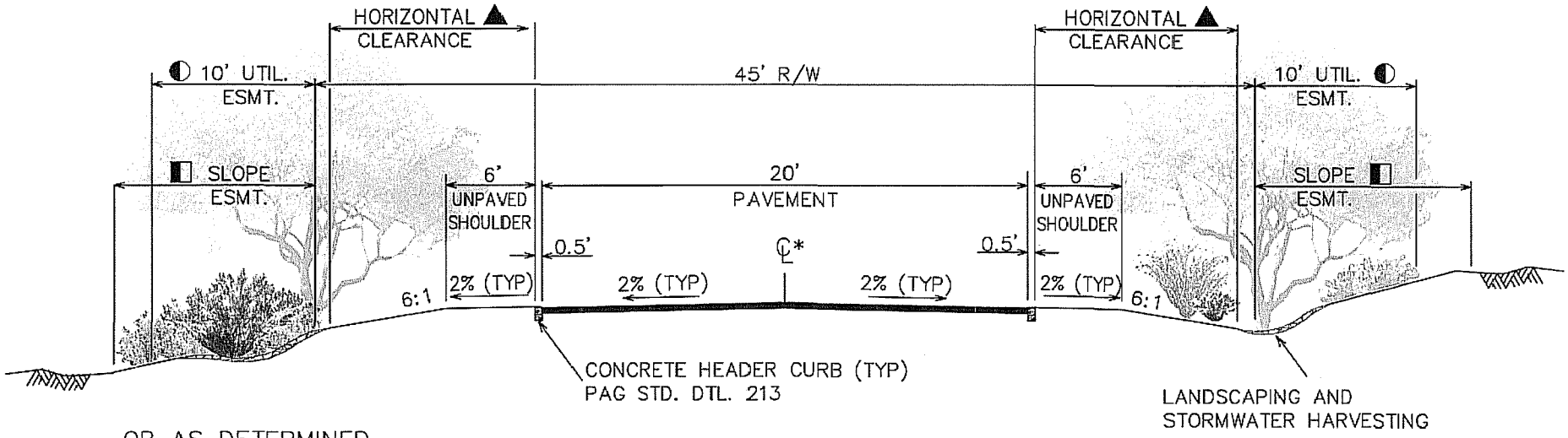
* THE CROWN SHALL BE AT ℄ OF PAVEMENT

NOTE: NO PARKING ALLOWED

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	MAJOR COLLECTOR STREET URBAN RESIDENTIAL SUBDIVISION		10
REVISED: 12/15				



ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	LOCAL STREET RURAL RESIDENTIAL SUBDIVISION ALTERNATIVE 1		11A
REVISED: 12/15				



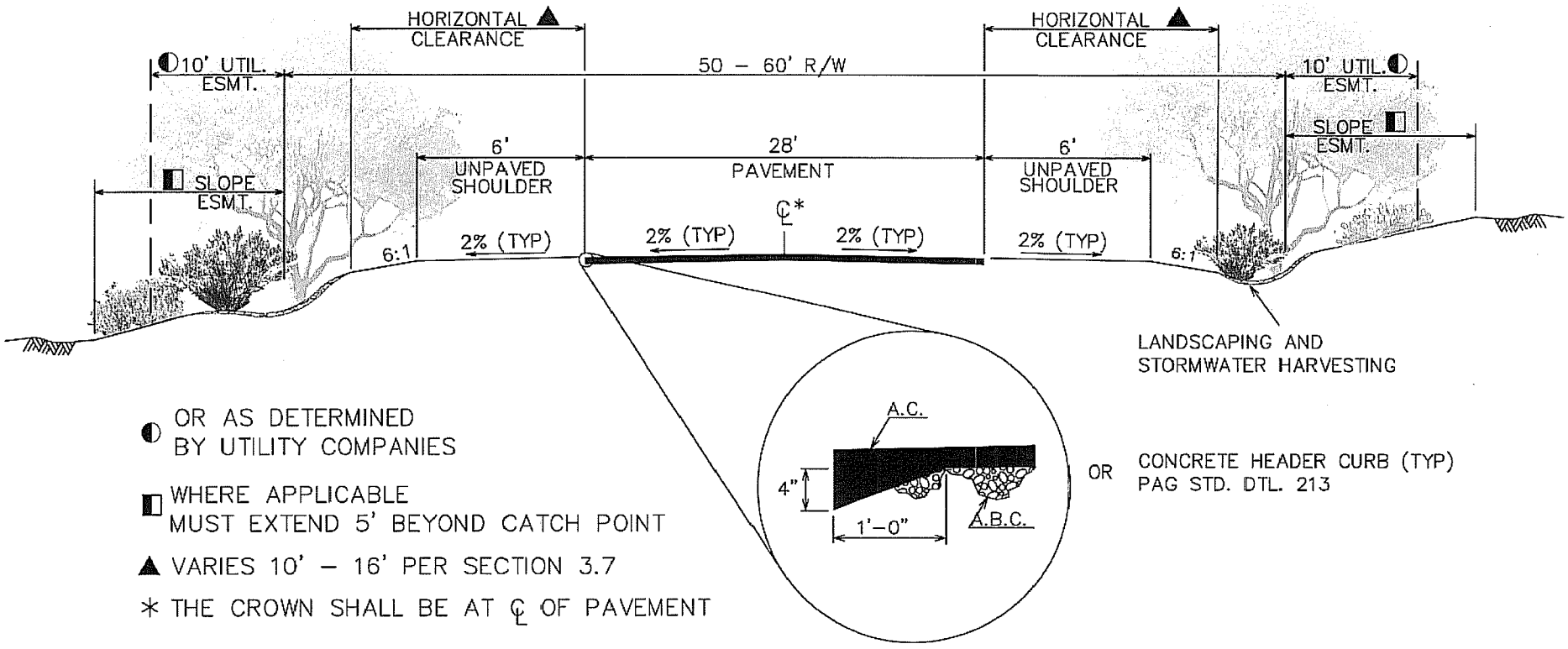
◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

▲ VARIES 10' – 16' PER SECTION 3.7

* THE CROWN SHALL BE AT ℄ OF PAVEMENT

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	LOCAL STREET RURAL RESIDENTIAL SUBDIVISION ALTERNATIVE 2		11B
REVISED: 12/15				



◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

▲ VARIES 10' – 16' PER SECTION 3.7

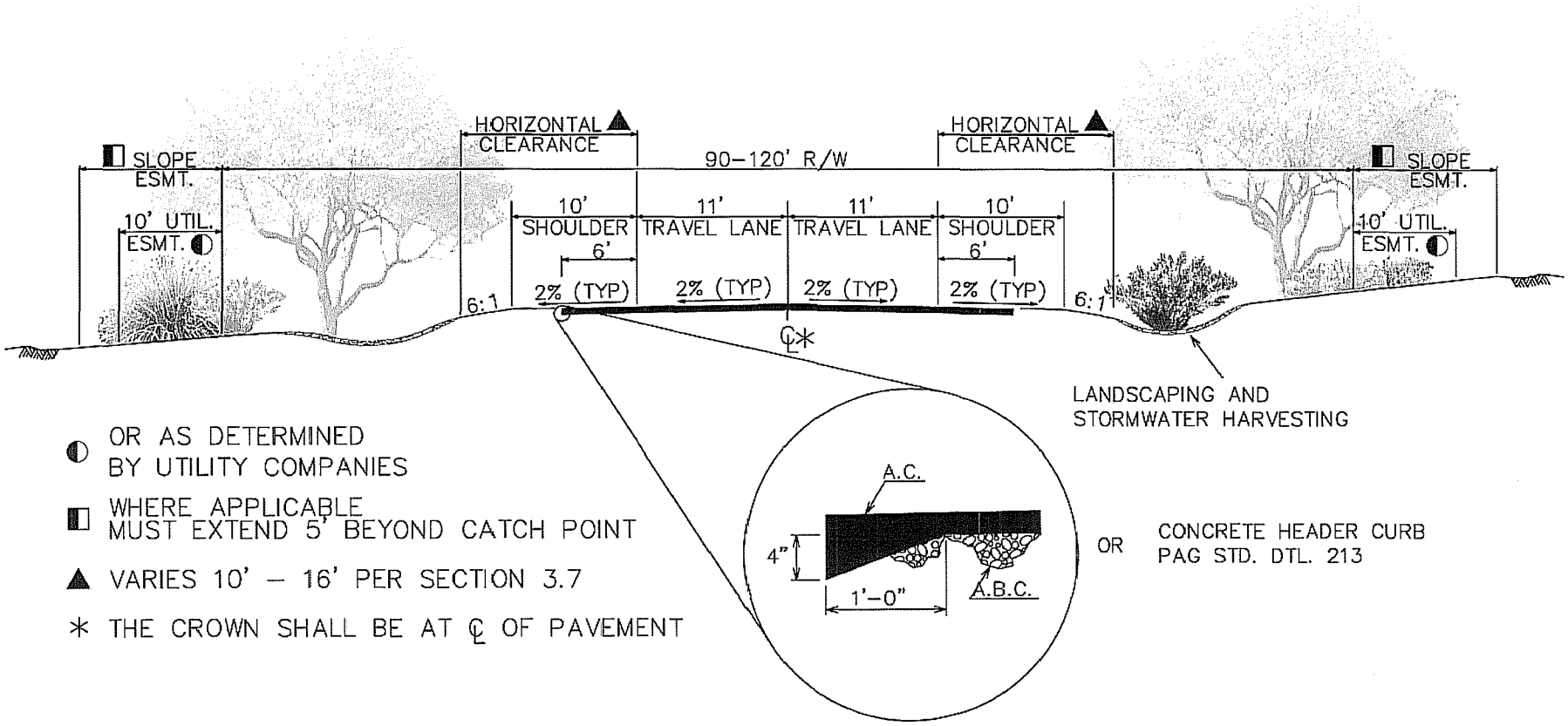
* THE CROWN SHALL BE AT ℄ OF PAVEMENT

NOTES:

PAVEMENT WIDTH MAY BE REDUCED TO 24' WITH THE INSTALLATION OF TRAFFIC CALMING ALTERNATIVES PER SECTION 3.4

NO PARKING ALLOWED

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	RESIDENTIAL COLLECTOR RURAL RESIDENTIAL SUBDIVISION		12
REVISED: 12/15				



◐ OR AS DETERMINED BY UTILITY COMPANIES

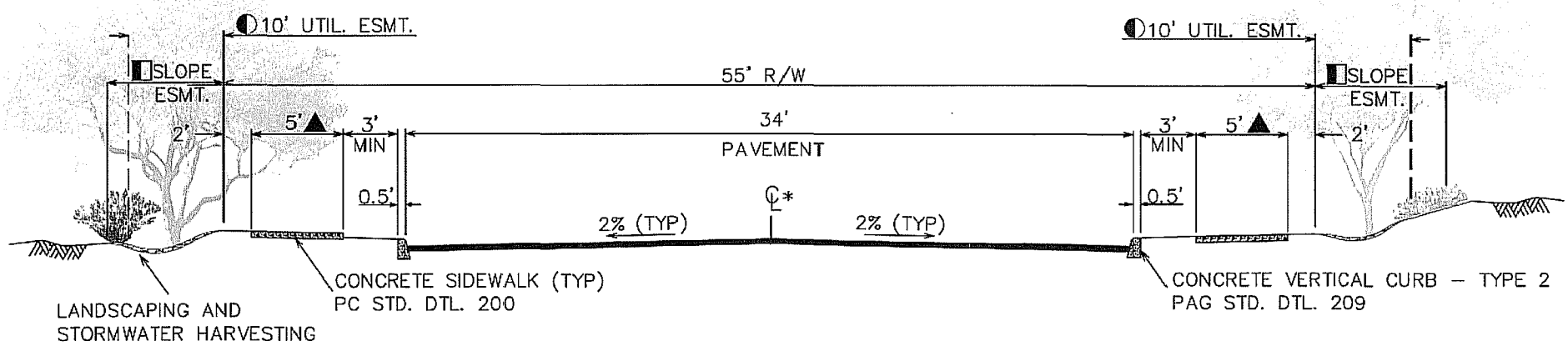
◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

▲ VARIES 10' – 16' PER SECTION 3.7

* THE CROWN SHALL BE AT ℄ OF PAVEMENT

NOTE: NO PARKING ALLOWED

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	MAJOR COLLECTOR RURAL RESIDENTIAL SUBDIVISION		13
REVISED: 12/15				



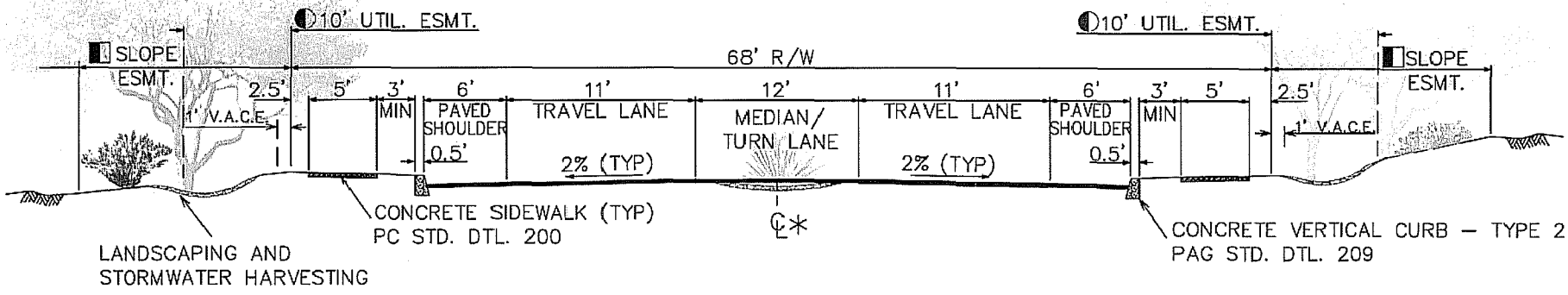
◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

▲ IF SIDEWALK IS PLACED ADJACENT TO THE CURB, IT SHALL BE 6' WIDE

* THE CROWN SHALL BE AT ℄ OF PAVEMENT

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	LOCAL STREET COMMERCIAL OR INDUSTRIAL SUBDIVISION		14
REVISED: 12/15				



◐ OR AS DETERMINED BY UTILITY COMPANIES

◧ WHERE APPLICABLE MUST EXTEND 5' BEYOND CATCH POINT

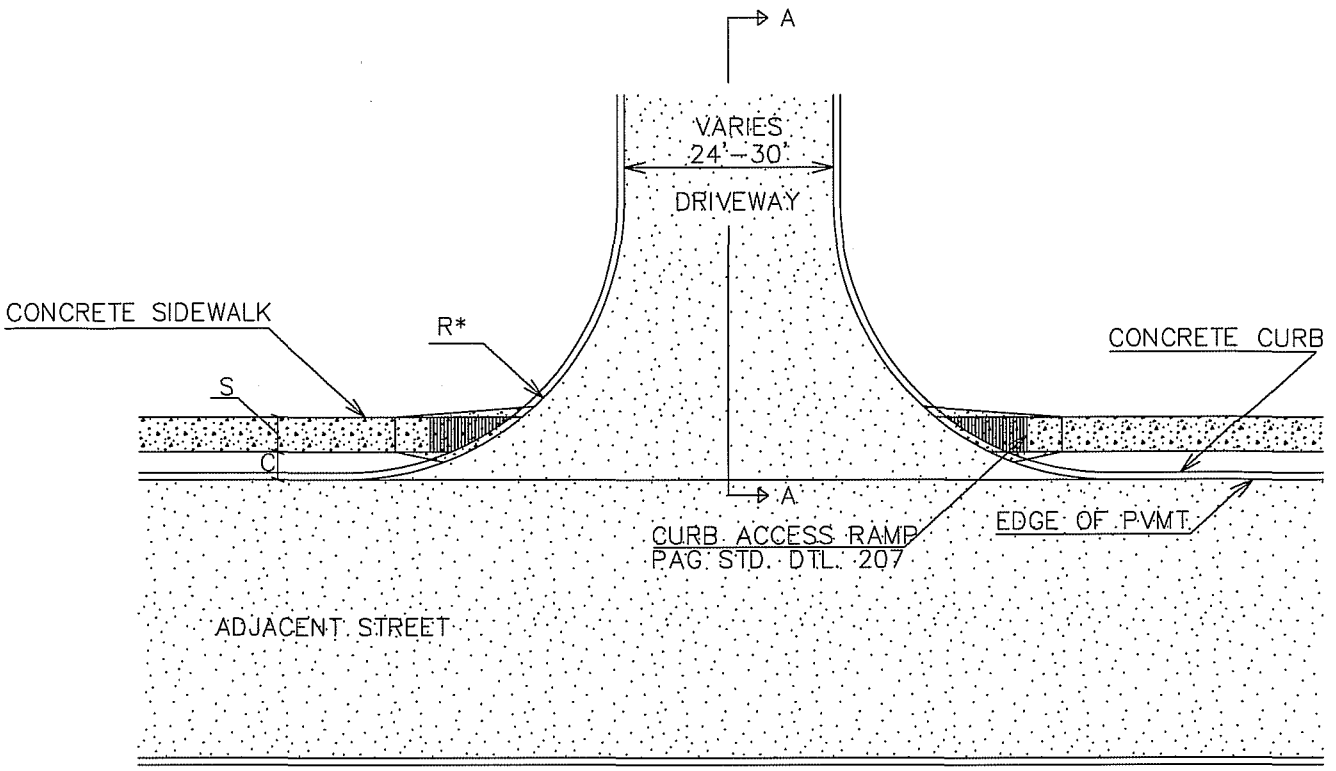
* THE CROWN SHALL BE AT ℄ OF PAVEMENT

NOTES:

PLACEMENT OF SIDEWALK ADJACENT TO CURB SHALL NOT BE ACCEPTABLE

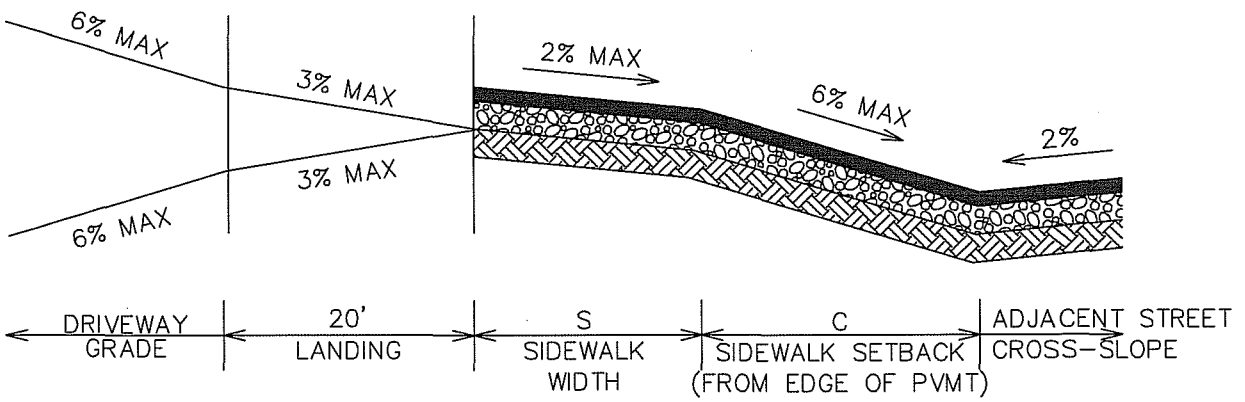
NO PARKING ALLOWED

ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	COLLECTOR COMMERCIAL OR INDUSTRIAL SUBDIVISION		15
REVISED: 12/15				



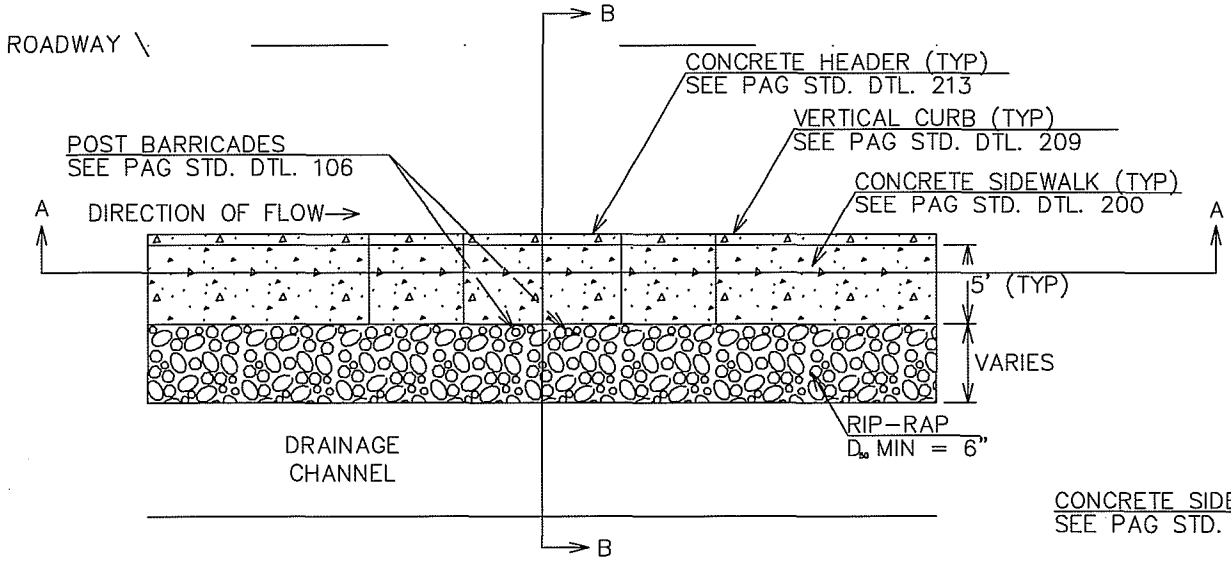
PLAN VIEW

* STREET TYPE	R
ARTERIAL OR COLLECTOR	30'
LOCAL STREET	25'

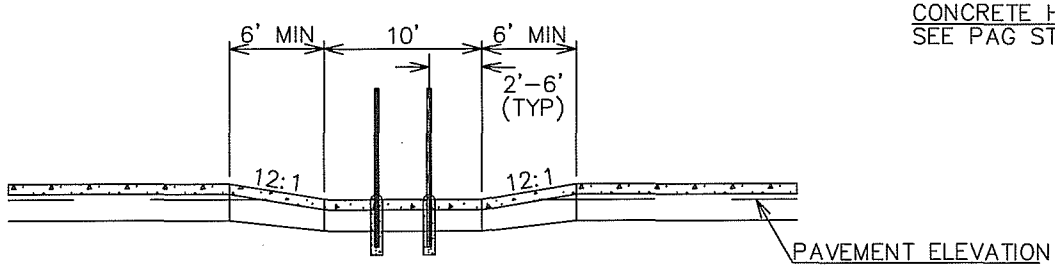


SECTION A-A

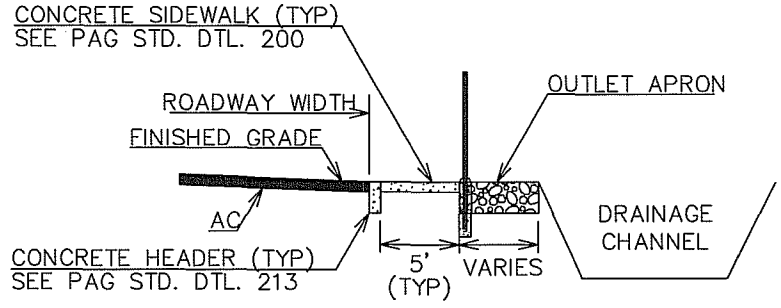
ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	TWO-LANE COMMERCIAL DRIVEWAY WITH RETURN RADII		16
REVISED: 12/15				



PLAN VIEW



SECTION A-A

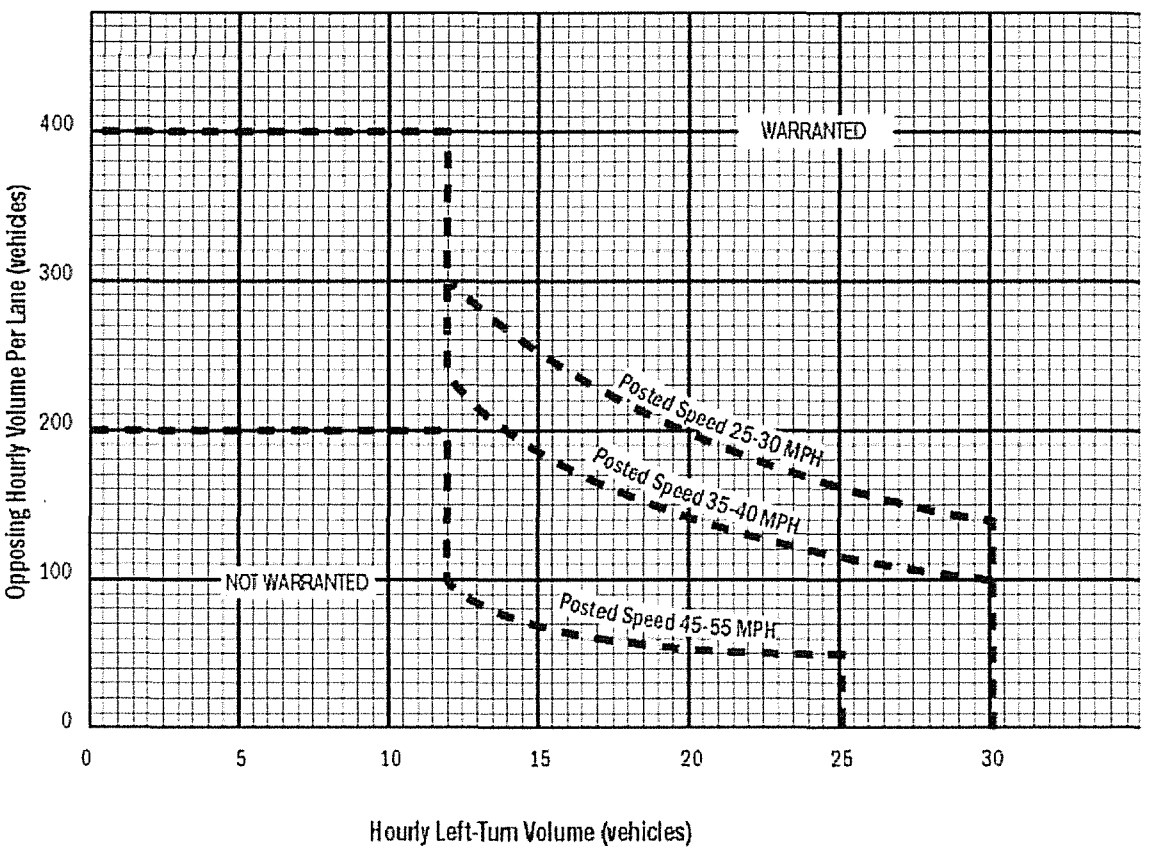


SECTION B-B

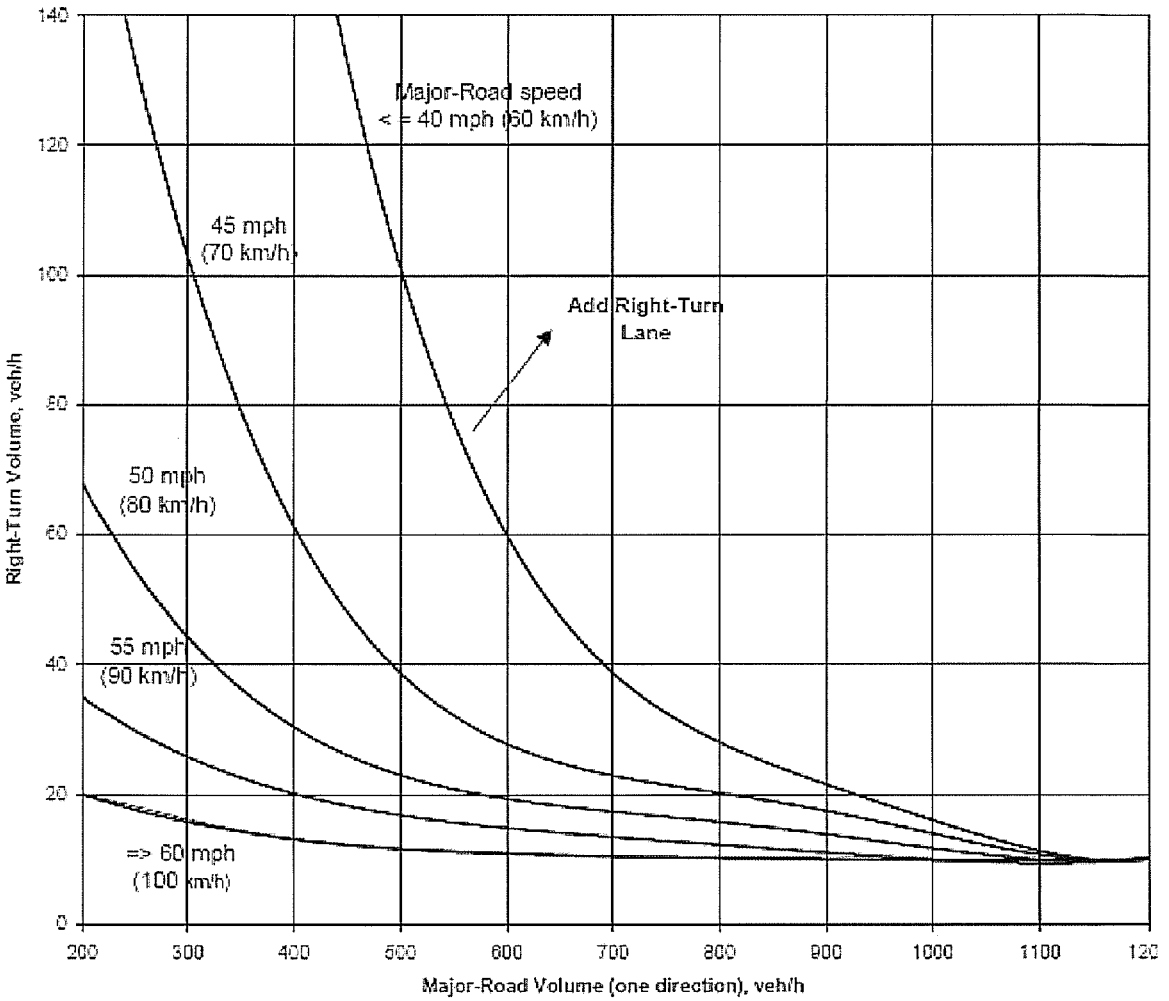
ISSUED:		STANDARD DETAIL		DETAIL NO.
4/05	PIMA COUNTY TRANSPORTATION	CURB OPENING DETAIL		17
REVISED: 1/15				

8. APPENDIX

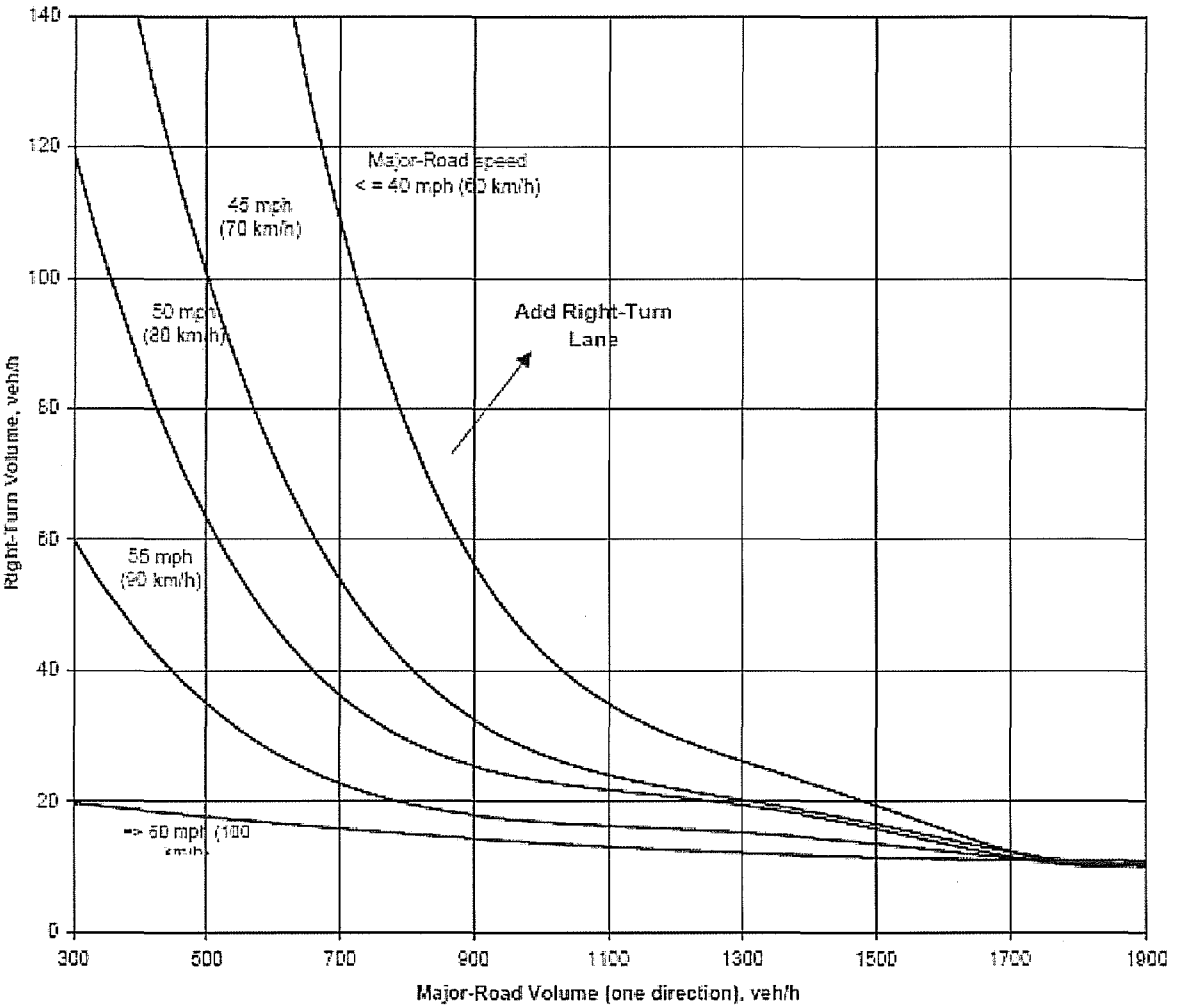
A-1 LEFT TURN LANE GUIDELINES[9]



A-2 RIGHT TURN LANE GUIDELINES FOR TWO-LANE ROADS[9]



A-3 RIGHT TURN LANE GUIDELINES FOR FOUR-LANE ROADS[9]



Note: Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

9. REFERENCES

1. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*, Washington D.C., 2011.

2. American Association of State Highway and Transportation Officials. *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, Washington D.C., 2004.

3. American Association of State Highway and Transportation Officials. *Highway Safety Manual*, Washington D.C., 2010.

4. American Association of State Highway and Transportation Officials. *Roadside Design Guide*, Washington D.C., 2011.

5. Arizona Department of Transportation. *Materials Preliminary Engineering and Design Manual*, Third Edition, Phoenix, 1989.

6. Arizona Department of Transportation. *Policies, Guidelines and Procedures: Section 240 Traffic Impact Analyses*, Phoenix, 2000.

7. Arizona Department of Transportation. *Standard Drawings - Structures Section*, Phoenix, 1992.

8. City of Tucson. Development Standards, Tucson, 2000.

9. City of Tucson. *Transportation Access Management Guidelines*, Tucson, 2011.

10. City of Tucson, *Land Use Code Section 3.3.9.2.*, Tucson, 1995.

11. City of Tucson/Pima County. *Outdoor Lighting Code*, Tucson, 2012.

12. Federal Highway Administration. *Pedestrian Safety Guide and Countermeasure Selection System*, http://www.pedbikesafe.org/PEDSAFE/.

13. Florida Department of Transportation. *Site Impact Handbook*, Tallahassee, 1997.

14. Florida Department of Transportation. *Traffic Analysis Handbook*, Tallahassee, 2014.

15. Institute of Transportation Engineers. *Manual of Transportation Engineering Studies*, Second Edition, Washington D.C, 2010.

16. Institute of Transportation Engineers. *School Site Planning, Design and Transportation*, Washington D.C, 2013.

17. Institute of Transportation Engineers. *Traffic Calming Library*, http://www.ite.org/traffic/.

18. Institute of Transportation Engineers. *Trip Generation Manual*, Ninth Edition, Washington D.C., 2012.

19. ITE Technical Council Committee 5d-10. *ITE Journal: Queuing Areas for Drive-Thru Facilities*, Washington D.C., May 1995.

20. Kindler, C.E. et al. *IHSDM Federal Highway Administration Report No. FHWA-RD-02-045:Intersection Diagnostic Review Model*, Washington D.C., 2003.

21. 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.

22. Los Angeles County. *Model Design Manual for Living Streets, Los Angeles,* 2011.

23. Maricopa Association of Governments. *Pedestrian Policies and Design Guidelines*, Maricopa County, 2005.

24. Maricopa Association of Governments. *Uniform Standard Details for Public Works Construction*, 1998.

25. Maricopa County Department of Transportation. MCDOT Traffic Impact Procedures, 2000.

26. National Cooperative Highway Research Program, *Report 659: Guide for the Geometric Design of Driveways*, Washington D.C., 2010.

27. National Cooperative Highway Research Program. Report 672: *Roundabouts: An Informational Guide*, Second Edition, 2010.

28. Pima Association of Governments. *Regional Pedestrian Plan*, Tucson, 2000.

29. Pima Association of Governments. *Regional Plan for Bicycling*, Tucson, 2000.

30. Pima Association of Governments, Standard Detail Drawings and Specifications, Tucson.

31. Pima County, *Design Standards for Stormwater Detention and Retention*, Tucson, 2014.

32. Pima County. *Eastern Pima County Trail System Master Plan*, Tucson, 1996

33. Pima County, *Low Impact Development and Green Infrastructure Guidance Manual*, Tucson, 2014.

34. Pima County. *Pima County Code*, Tucson

35. Pima County. *Major Streets Plan*, Tucson, 2015.
36. Pima County. *Ordinance 2010-FC5:Floodplain Management Ordinance*, Tucson, 2010.

37. Pima County. *Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines*, Tucson, 2001

38. Pima County Department of Transportation. *Environmentally Sensitive Roadway Design Guidelines*, Tucson, 2002.

39. Pima County Department of Transportation. *Pavement Marking Design Manual, Tucson*, 2002.

40. Pima County Department of Transportation. *Roadway Design Manual*, Tucson, 2013.

41. Pima County Department of Transportation. *Signing Manual*, Tucson, 2002.

42. Pima County Department of Transportation. *Transit Guidelines for Roadway Design and Construction*, Tucson, 2009.

43. Pima County Regional Flood Control District. *Drainage and Channel Design Standards for Local Drainage*, Tucson, 1984.

44. Smart Growth. Four Model Ordinances to Help Create Physically Active Communities, https://www.planning.org/research/smartgrowth/pdf/section48.pdf.

45. Smart Growth America. National Complete Streets Coalition, http://www.smartgrowthamerica.org/complete-streets.

46. Stakeholder Design Team. *Neighborhood Street Design Guidelines: An Oregon Guide for Reducing Widths*, Salem, 2000.

47. Transportation Research Board. *Highway Capacity Manual*. Fifth Edition, Washington D.C., 2010.

48. United States Department of Justice. *ADA Standards for Accessible Design*, Washington D.C.,1994.

49. United States Department of Transportation, Federal Highway Administration. *Highway Functional Classification: Concepts, Criteria and Procedures*, Washington D.C.,1989.

50. United States Department of Transportation Federal Highway Administration. *Manual on Uniform Traffic Control Devices*, Washington D.C., 2009.

51. Victoria Transport Policy Institute. *Roadway Connectivity*, http://www.vtpi.org/tdm/tdm116.htm

52. Watershed Management Group. *Green Infrastructure for Southwestern Neighborhoods*, Tucson, 2010.

53. Wisconsin Department of Transportation. *Model Street Connectivity Standards Ordinance*, http://transportation.ky.gov/Congestion-Toolbox/Documents/Connectivity Model Ordinance %28WSDOT%29.pdf.