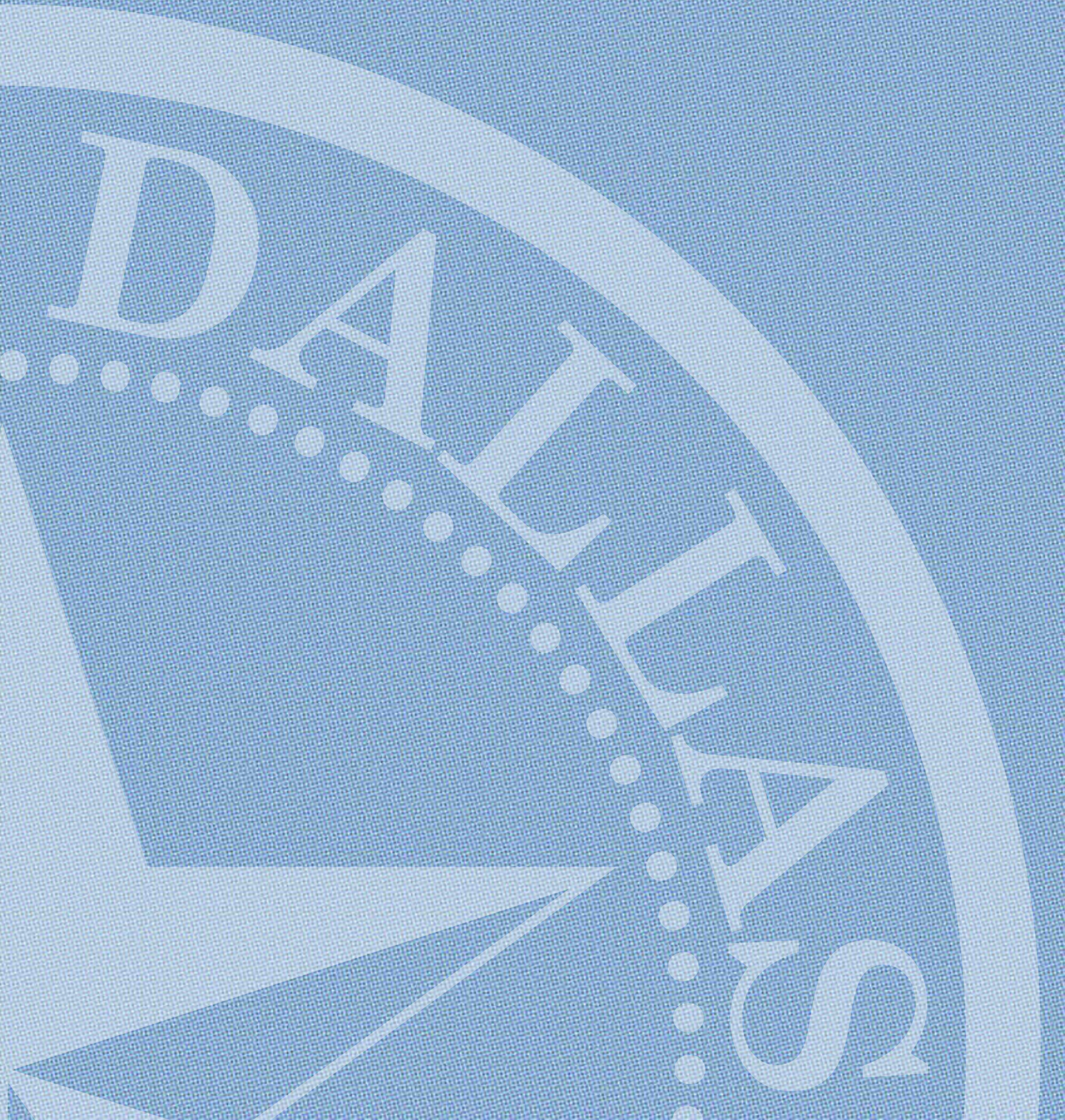


STREET DESIGN MANUAL

CITY OF DALLAS

SEPTEMBER 2019



City of Dallas
STREET DESIGN MANUAL

SEPTEMBER 2019

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SECTION 1

Introduction

This section is general discussion of the purpose, scope and organization of the manual and the related applicable standard documents to be used with the manual.

1.1 PURPOSE

The purpose of the Street Design Manual is to provide requirements and establish minimum standards for designing streets and thoroughfares, and to assist in preparing construction plans in the City of Dallas, such that streets are built to be safe, comfortable, and sustainable for everyone. This manual is intended to serve motorists, bicyclists, pedestrians (including impaired pedestrians), public safety, trucks and transit riders alike, so they can each use the streets simultaneously, safely, and efficiently. Also, the manual is intended to create streets that are great public spaces, support businesses, build communities, and make living in the city more enjoyable.

The standards set forth in this document are not a substitute for sound engineering judgment but are the minimum criteria permitted by the City of Dallas to be used in street design. Circumstances or conditions may arise that require variance from these standards. Any exceptions from the standards set forth in this manual must be accompanied by prior written approval of the Director.

1.2 SCOPE

The scope of the Street Design Manual includes various design elements, criteria, standards and instructions required to prepare construction plans for the City of Dallas Public Works Department. Included in the manual are the classification of the various streets and their zones according to the City Thoroughfare Plan and Dallas Complete Streets Design Manual. This manual replaces the document formerly known as the Paving Design Manual dated June 1998. This manual is also intended to work in conjunction with the latest versions of the Dallas Bike Plan and Neighborhood Plans and is guided by the policy, vision, and design concepts established in the City of Dallas Complete Streets Design Manual which was adopted by City Council in January 2016.

Streets are a central part of the city and play a role in many city initiatives. Plans such as Neighborhood Plus, the Arts District Plan, The 360 Plan and neighborhood plans should be consulted along with this manual.

Geometric Design standards to be used on the various street types and criteria for design of pavement structures are also presented. These standards should result in the construction of safe, economical, comfortable riding streets and thoroughfares carrying acceptable traffic volumes while providing for pedestrian, transit, and bicycle traffic. They enhance the public realm, provide for various modes of transportation, design unique streets within their specific context, incorporate flexibility for future changes, and address retrofitting of existing streets.

1.3 OVERVIEW

Section 1 Introduction is a general discussion of the purpose, scope and organization of the manual and the related applicable standard documents to be used with the manual.

Section 2 Street Types is a discussion of the functional classification and contextual street types. The different types of thoroughfares and streets in the City Thoroughfare Plan are defined, including minimum right-of-way, pavement, lane, median, and parkway dimensions. The purpose of each type of street is discussed. Contextual types as used in the City of Dallas Complete Streets Design Manual are defined. The zones that a street consists of: Frontage Zone, Sidewalk Clear Zone, Buffer / Furnishing / Curb Zone and Street Zone, are defined.

Section 3 Street Networks / Access Control discusses the connectivity of the street network, including the spacing of intersections, bicycle networks, pedestrian crossing locations, the configuration of alleys, and dead-end streets. This section also discusses the guidelines and minimum requirements to be used in the location of access streets and driveways to properties adjoining City thoroughfares and streets, including the location and spacing of median openings.

Section 4 Geometric Design provides the design criteria to be used in the alignment and geometric design of thoroughfares and streets. Also, this section discusses the guidelines and minimum requirements controlling the various design elements of the street zones, including the pedestrian (Sidewalk Clear) zone, street zone, and intersections.

Section 5 Pavement Structure provides the City's standard thoroughfare and street pavement structure designs. The manual discusses when alternate pavement structure designs are required and the guidelines controlling the alternate pavement structure designs.

Section 6 Street Lighting addresses the use of technology and code requirements in street lighting design for various modes of transportation.

Section 7 Construction Plan Preparation provides the minimum requirements and procedures to be used in the preparation of paving plans for constructing thoroughfare and street improvements for the City.

Appendices provide detailed recommended procedures referred to in Section 7. Detailed procedures for setting street grades and cross sectioning and the Standard Paving Plan checklist are included as guidelines. Together these items provide the minimum requirements controlling the preparation of construction plans for construction of streets in the City of Dallas.

The Street Design Manual is designed to be used in conjunction with two other City manuals:

- The Drainage Design Manual governs the design of all drainage and stormwater systems in the City of Dallas, including systems in street right-of-way and the drainage functions of the street.
- The Street Process Manual outlines the process for planning and designing streets in the City of Dallas. It applies to projects originated by the City of Dallas, by other government agencies, and by private landowners.

1.4 STANDARDS

The following City standards, as currently amended, shall be used with the Street Design Manual in the design of thoroughfare and street pavements and the preparation of construction plans:

City of Dallas Standards:

- City of Dallas Complete Streets Design Manual
- City of Dallas Standard Construction Details, File 251D
- Dallas City Code
 - Chapter 9 - Bicycles
 - Chapter 28 - Motor Vehicles and Traffic
 - Chapter 43 - Street and Sidewalks
 - Chapter 51A - Dallas Development Code
- City of Dallas Street Process Manual
- City of Dallas Addendum to the NCTCOG Public Works Construction Standards
- City of Dallas Thoroughfare Plan
- Dallas Central Business District Streets and Vehicular Circulation Plan
- City of Dallas 2011 Dallas Bike Plan
- City of Dallas Pavement Cut and Repair Standards Manual
- City of Dallas Traffic Barricade Manual
- Corridor Planning Documents and Standards (Forward Dallas! Comprehensive Plan)
- City of Dallas Drainage Design Manual
- City of Dallas Water and Wastewater Procedures and Design Manual
- City of Dallas Benchmarks (Vertical Control Manual)

Federal and State Regulations and Design Guides:

- Americans with Disabilities Act (ADA)
 - ADA Accessibility Guidelines (ADAAG)
 - ADA Standards for Accessible Design (ADA Standards)
 - Public Rights-of-Way Accessibility Guidelines (PROWAG)
- Texas Accessibility Standards (TAS)
- Texas Manual on Uniform Traffic Control Devices (TMUTCD)
- TxDOT Roadway Design Manual
- TxDOT Bridge Design Manual
- Texas Street and Highways Code and Texas Vehicle Code

Industry Standards and Design Guides:

- AASHTO Green Book
- NACTO Urban Street Design Guide
- NACTO Urban Bikeway Design Guide
- NACTO Transit Street Design Guide

Other Local Standards and Design Guides:

- Complete Streets Policy Statement, North Central Texas Council of Government (NCTCOG)
- NCTCOG Public Works Construction Standards
- NCTCOG iSWM Criteria Manual for Site Development and Construction
- DART Design Criteria Manual, Standard Drawings, and Standard Specifications
- Dallas County Fire Code

The *City of Dallas Complete Streets Design Manual* provides an improved method for the way streets are to be designed and built. The purpose of the *Complete Streets Design Manual* is to build streets that are safe and comfortable for all people using various modes of transportation. In addition, the manual incorporates more than just the travel lanes between the curbs into the design and considers the entire space that resides between buildings on either side of the streets.

The *City of Dallas Standard Construction Details (File 251D)* provides standard detailed paving, drainage, traffic control and related facility drawings showing construction items and features to be used with construction plans

provided to the City of Dallas. Construction plan designs prepared for the City shall be consistent with *Standard Construction Details*, as currently amended. Specific details have specific functions and uses, and this set of standard details must not be considered a catalog from which to choose. Special situations will require the designer to develop special details for the approval of the Director prior to incorporating into the construction plans. The *Standard Construction Details* is maintained and updated by the Department of Public Works.

The *Dallas Development Code, Article VIII of Chapter 51A* provides the regulations governing plat requirements and their review by the City Departments. Paving infrastructure requirements for developments in the City of Dallas are given in this code. The *Dallas Development Code* is maintained and updated by the Department of Planning and Development.

The *Dallas Development Code, Article X of Chapter 51A* defines the Landscape and Tree Preservation Regulations, which establish regulations on type of landscape, landscape placement, landscape maintenance, and other factors influencing the landscape in an urban setting.

The *City of Dallas Street Process Manual* is a guide for designers to understand the process of planning and designing a street in the City of Dallas. The *Street Process Manual* provides information regarding each phase of the public or private development project from community engagement and conceptual design to documentation and approval requirements.

The *City of Dallas Addendum to the NCTCOG Public Works Construction Standards*, set forth exceptions and requirements of the City of Dallas, and are consequently the most current standards to be followed. These specifications take precedence over existing requirements and conditions listed in previous standards.

The *City of Dallas Thoroughfare Plan and the Dallas Central Business District Streets and Vehicular Circulation Plan* provide detailed discussion of the history, purpose, approach and goals of the thoroughfare system within Dallas and details the current functional and dimensional classifications of the thoroughfares in the City. The *City of Dallas Thoroughfare Plan* provides descriptions of designated routes and provides minimum and standard pavement cross sections. The plan is maintained and updated by the Mobility Planning Division of the Transportation Department.

The *City of Dallas 2011 Dallas Bike Plan* identifies suggested routes for the bikeway system and provides design standards necessary to accommodate bicycles on the designated bike routes. The *City of Dallas 2011 Dallas Bike Plan* is maintained and updated by the Mobility Planning Division of the Transportation Department.

The City of Dallas Pavement Cut and Repair Standards Manual provides a reference for the repairs, excavations, installations, restorations and other operations to streets within the Dallas area. The standards detailed in the manual are set as the current methods to be utilized, with the provision that new methods and technologies may be employed as well.

The primary function of the *City of Dallas Traffic Barricade Manual* is to promote the safe and efficient movement of people and goods by providing traffic safety guidelines for persons working in or near the public right-of-way. This manual provides guidance for implementing temporary traffic control for urban streets. This manual is based on the *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*.

The *Corridor Planning Documents and Standards (Forward Dallas! Comprehensive Plan) Policy Plan* guides decisions made in regard to land use, housing, transportation, neighborhoods, environment, economic development, and urban design. The Transportation and Urban Design Elements set policy for achieving more walkable and pedestrian-friendly development throughout Dallas.

The *City of Dallas Drainage Design Manual* provides the guidelines for the design of storm drainage facilities in the City. The *Drainage Design Manual* is maintained and updated by the Department of Public Works.

City of Dallas Water and Wastewater Procedures and Design Manual provides for use in the design and construction of water, wastewater and reclaimed water mains owned and operated by Dallas Water Utilities (DWU).

The *City of Dallas Benchmarks, (Vertical Control Manual)* is the list of City of Dallas survey benchmarks that was compiled using modern Global Positioning equipment and techniques. It contains elevations in NAD27 for most benchmarks, as well as both State Plane Coordinates and Latitude and Longitude based on NAD83.

The Federal and State design manuals are for local governments that wish to use available federal and / or state funds that must be used on a street classification system based on arterials, collectors, and local streets. These funds are for streets and roads that are on the federal aid system.

The *Americans with Disabilities Act (ADA)* prohibits discrimination against individuals with disabilities in all areas of public life, including employment, educational facilities, transportation, and all places or services that are open to the general public. There are two manuals that mandate the ADA regulations and guidelines for public development: *ADA Accessibility Guidelines (ADAAG)* and *ADA Standards for Accessible Design (ADA Standards)*. The *ADAAG* are defined by U.S. Access Board and the *ADA Standards* are implemented by the U.S. Department of Justice. The [Public Rights-of-Way Accessibility Guidelines \(PROWAG\)](#) provide specific design guidance to address pedestrian accessible

features within public rights-of-way. PROWAG is spearheaded by the U.S. Access Board.

The *Texas Accessibility Standards (TAS)* is administered by the Texas Department of Licensing and Regulation and is based on ADA regulations.

The Texas Manual on Uniform Traffic Control Devices (TMUTCD) provides standards and guidance for the application of traffic control devices including roadway markings, traffic signs, and signals.

The *TxDOT Roadway Design Manual* applies to state highways and bikeways or federally funded roadway projects that are within local jurisdictions.

The *TxDOT Bridge Design Manual* applies to federal or state highway bridges in providing bridge design guidance based on AASHTO LRFD Bridge Design Specifications.

The Texas Streets and Highways Code and the Texas Vehicle Code include laws that must be followed in street design. These are embodied in the *TMUTCD*. Changes to the Texas Streets and Highways Code and the Texas Vehicle Code may cause the *TMUTCD* to change.

The *AASHTO Green Book* provides guidance for designing geometric alignment, street width, lane width, shoulder width, medians, and other street features. AASHTO originated as a design guide for highways, so it does not fully address city street issues and often has recommendations which favor high speed car traffic over other modes. The *NACTO Urban Street Design Guide*, *Urban Bikeway Design Guide*, and *Transit Street Design Guide* should be considered.

The North Central Texas Council of Governments (NCTCOG) is in the process of completing a regional Complete Streets Policy Statement, which when adopted, will provide guidance to implement a Complete Streets program in local governments that either do not have a complete streets policy or are in the process of modifying their existing policy. The NCTCOG's policy statement will apply to both new and retrofit projects as identified in the Transportation Improvement Program and the Metropolitan Transportation Plan. NCTCOG provides local governments assistance with the implementation of the NCTCOG Complete Streets Policy Statement. NCTCOG Public Works Construction Standards provides a framework for public works construction.

The *NCTCOG iSWM Criteria Manual for Site Development and Construction* provides guidance for effective and environmentally sustainable designs of storm water pollution prevention and management plans which may be required on City construction projects.

DART Design Criteria Manual, Standard Drawings, and Standard Specifications provide design standards and criteria for future development and expansion of the DART system.

Dallas County Fire Code provides regulations to protect buildings constructed in the unincorporated areas of the Dallas County from fire. The *Dallas County Fire Code* establishes minimum standards and requirements intended to promote and improve the health, safety, and welfare of the general public.

Guidance in Resolving Possible Conflicts in Referenced Standards:

Where other guidance documents and criteria conflicts with City criteria and requirements, the Engineer shall use engineering judgment and experience in determining and applying applicable laws and regulations, and in selection and application of the design criteria which is relevant and appropriate for each project. This must take into account site characteristics such as topography, environmental conditions, the built environment within and adjacent to the street, soils and geology, and future improvements or land forms which could reasonably be assumed to occur that should be accommodated. Where conflicts in design criteria may occur, the Engineer is responsible to resolve those items so that resultant design meets defined standards and does not impinge upon the safeguarding of life, health, and property and promotes the public welfare. The Engineer should have discussions with the City or other regulatory entities to obtain their opinion, guidance, or direction during preparation of that design, especially if public funds are involved.

1.5

DEFINITIONS

For the purposes of this manual, the following definitions shall apply:

City Project Manager – The person assigned by the City to represent the City and ensure that the scope, schedule and budget for the project are properly managed.

Director – Refers to the Director of Public Works.

Engineer or Designer – The person who is a licensed professional engineer, typically a consultant, who is the responsible engineer in charge of the project design and ensures that the plan set, the technical specifications, and the cost estimate are coordinated, are complete, and are adequate to meet the project scope, schedule, and budget. The Engineer may rely on the expertise of other licensed professionals including surveyors, architects, geologists, and other engineers for portions of the design product.





SECTION 2

Street Types

This section on Street Types is based in part on the City's adopted Thoroughfare Plan and the policy directives and streets vision from the City of Dallas Complete Streets Design Manual. Different types of thoroughfares and streets are defined, including minimum right-of-way, pavement width, number of lanes, traffic volumes, median and parkway dimensions. The purpose of each type of street is developed around its functional uses, the built environment or proposed environment through which the street traverses, and the character within and along the traveled ways.

2.1 STREET DESIGN GUIDANCE

The purpose of the *City of Dallas Thoroughfare Plan* is to “enable the urban street system to be progressively developed in a manner which will adequately serve existing and anticipated travel demands while creating a pleasing and efficient urban community.” The Thoroughfare Plan defines a hierarchy of streets based on traffic volumes, their locations and their alignments. As a long-range planning tool, it is intended to identify street needs for the next twenty years within the developed urban area, and to establish the thoroughfare system for undeveloped areas based on anticipated development patterns.

City of Dallas Complete Streets Design Manual is intended to provide high level goals of street design to be safe, holistic, vibrant, and sustainable. This manual looks closely at cultural changes and increasing demands of street use for non-motorists.

This *Street Design Manual* complements the *Thoroughfare Plan* and *City of Dallas Complete Streets Design Manual* by creating a matrix of street types, introducing specific design elements for zones within each street, and addressing how to implement these recommendations with each new and redeveloped street.

2.2 FUNCTIONAL CLASSIFICATION

2.2.1 General

The design of streets requires the balancing of functional classification and the consideration of the appropriate contextual street type. The Thoroughfare Plan provides guidance in setting locations, functional classifications and dimensional requirements of Dallas’ street system and their connectivity within the overall street network to achieve transportation objectives. Compliance with the Thoroughfare Plan is necessary in consideration of the functional classifications noted below.

Functional classification categorizes streets by their purpose, projected traffic volumes, speeds, and property access. In general, higher volumes and speeds have an inverse relationship with property access as shown in Figure 2.1. The functional classification system is used by most national and state roadway design guidelines to recommend lane widths, speeds, and geometry. Functional classifications do not account for different contexts, the adjacent land uses, and other non-motorist facilities.

This manual will also supplement the functional classification system with Contextual Street Types as defined in Section 2.4. The design considerations of any street will be determined by the product of the street’s functional classification and by one or more applicable contextual street typology.

There are three distinct elements of every trip on the street network: (1) main movement, (2) distribution / collection, and (3) access. Functional classifications used in this manual are the following:

1. Arterial streets provide the links between areas of the city delivering traffic from collector streets to freeways and facilitate movement from one part of the city to another. They are designed for relatively heavy traffic volumes and higher speeds.

2. Collector streets provide links between local and arterial streets. They provide access to the neighborhood by collecting or distributing traffic between the arterial and local streets. They accommodate medium traffic volumes and speeds.
3. Local streets provide access to adjacent property and are usually contained within a neighborhood. They carry low traffic volumes and lower speeds.

Each of the functional classes are further described in the following sections. In addition, Table 2.1 defines the classes according to several typical characteristics. Many roads will not fully match the definition of any one functional class; in these instances, a road should be categorized according to the class that it most closely matches. This manual will supplement the functional classification system with new street types defined in Section 2.3.

Figure 2.1 Functional Hierarchy of Roadways

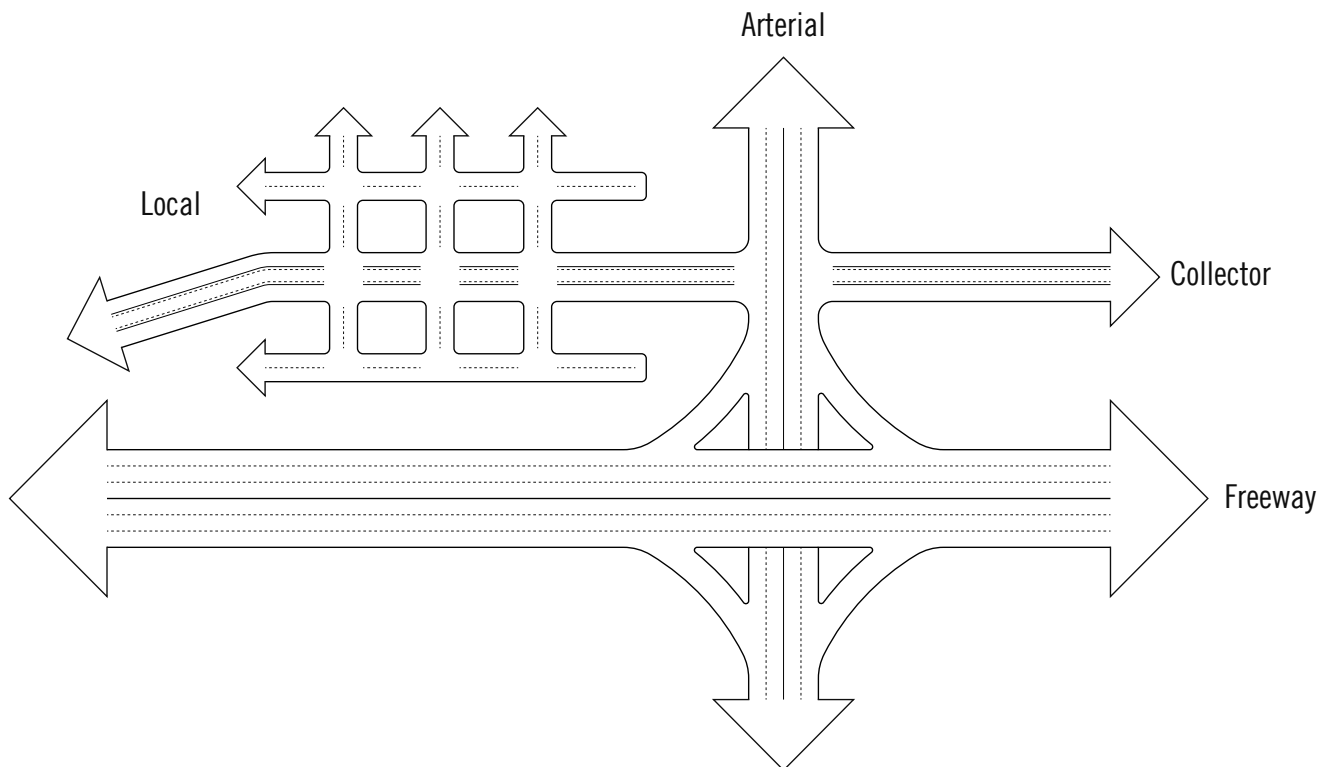


Table 2.1 Typical Characteristics of Functional Classifications

	Designated Thoroughfares			Undesignated Thoroughfares ¹	
	Principal Arterial	Minor Arterial	Community Collector	Residential Collector	Local
Function	Backbone of the street system; Mobility function is primary; Access function is minor; Serves long trip lengths	Provides route and spacing continuity with principal arterials; Mobility function is still primary; Access function is secondary; Serves moderate trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; Serves short trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; through traffic is undesirable; Serves short trip lengths	Remainder of surface streets; Access is primary; Through traffic is undesirable; Serves short trip lengths
System Continuity	Regional Continuity; Connects with freeway system; Crosses several community boundaries	Community continuity; Connects with freeway and arterial systems; Usually does not cross community boundaries	Neighborhood continuity; connects to arterial system; may extend across arterials	Neighborhood continuity; Connects to arterial system; Usually does not extend across arterials	Discontinuous
Roadway Length	>5 miles	2 to 5 miles	1/2 to 2 miles	1/2 to 2 miles	<1 mile
Traffic Volume	>3,500 vld 8 lanes: >28,000 vpd 6 lanes: >21,000 vpd 4 lanes: >14,000 vpd	2,500 to 5,000 vld 5 lanes: 15,000-30,000 vpd 4 lanes: 10,000-20,000 vpd 2 lanes: 5,000-10,000 vpd	1,250 to 3,500 vld 4 lanes: 5,000-14,000 vpd 2 lanes: 2,500-7,000 vpd	1,250 to 2,500 vld 4 lanes: 5,000-10,000 vpd 2 lane: 2,500-5,000 vpd	<1,250 vld 2 lanes: <2,500 vpd
Spacing	1 to 2 miles	1/2 to 2 miles	1/2 mile from other thoroughfares	1/2 mile from other thoroughfare	300' to 500' from other streets
Neighborhood Relationship	Traverses boundaries	Traverses boundaries	Traverses boundaries	Usually internal to one neighborhood	Internal to one neighborhood
Direct Land Access	Restricted; Some movements may be prohibited; Driveway spacing and number strictly controlled	Restricted; Some movements may be prohibited; Design controls are used to ensure safety	Design controls are used to ensure safety; limited regulation	Design controls are used to ensure safety	Design controls are used to ensure safety
Posted Speeds	30-45 mph	30-40 mph	30-35 mph	30 mph	30 mph
Target Speed	25-45 mph	25-40 mph	20-35 mph	20-30 mph	20-30 mph
Parking	Restricted	Restricted	Permitted	Permitted	Permitted
Through Truck Routes	Permitted	Permitted in Commercial Areas	No	No	No
Bus Routes	Yes	Yes	Yes	Yes	Not Encouraged
Bicycle Routes	Accommodated where required by Bike Plan or where feasible	Accommodated where required by Bike Plan or where feasible	Limited	Encouraged	Encouraged
Sidewalks	Yes	Yes	Yes	Yes	Yes

¹ Residential Collectors are only designated on the Thoroughfare Plan if they do not yet exist or have a substandard pavement width.

vpd - Vehicles per day

vld- Vehicles per lane per day

Function - A basic statement of the role that each classification plays in the street system; Identifies the relative balance of land access versus travel mobility provided; and specifies the average trip length served.

System Continuity - Identifies whether streets in a particular functional class are continuous through neighborhoods, communities, or large portions of the city / region; and how the functional classes interconnect.

Roadway Length - The length of a roadway that is generally recognized and used by the traveling public according to a given function.

Traffic Volume - The average daily traffic volume specified in vehicles per lane per day; represents a balance between volumes currently observed and desirable volumes for a given functional type.

Spacing - Spacing commonly found between thoroughfares in urban areas; spacing should decrease as the density of land use increases.

Neighborhood Relationship - Identifies whether a given functional type defines neighborhoods or traverses neighborhoods.

Direct Land Access - Level of access control that will be exercised in locating and designing driveways.

Posted Speed - The posted speed limit (usual values)

Target Speed - See Section 4.2.2..

Parking - Indicates whether on-street parking will be restricted; limitations are handled on a case-by-case basis.

Through Truck Routes - Identifies whether truck routes are permitted; truck routes are identified in the Dallas City Code, Motor Vehicles and Traffic, Article X, Section 28-69.

Bus Routes - Identifies where bus routes would be desirable.

Bicycle Routes - Routes are identified in the 2011 Dallas Bicycle Plan. These routes should be discouraged on arterial thoroughfares except when they are needed to maintain continuity.

Sidewalks - Sidewalks are required for all new streets, unless waived according to City policy; sidewalks are only installed in existing areas by citizen request. Sidewalks provide a purposeful, safe, off-street pedestrian route to and from neighborhood and community elements and facilities.

2.2.2 Freeways

The freeway system is a system of divided highways moving through traffic with controlled access. Entrances and exits to and from the freeway are located to provide minimum differences between the speed of the through traffic and the speed of the vehicle entering or leaving the freeway. Ramps usually maintain access between freeways and grade separated crossroads, thus forming the freeway “interchange”. Frontage roads are usually provided to serve access needs for properties adjoining the edges of the freeway corridor, to collect and distribute exit and entrance ramp traffic. Freeways are selected for principal arterial corridors which are to provide for the safe and efficient movement of high traffic volumes at relatively high speed.

Freeways and Tollways are planned, designed, constructed and maintained by the State Highway Agency of State / Local Turnpike Authority, usually through the Texas Department of Transportation and North Texas Tollway Authority. Additional information on planning and design of freeways is available from the Texas Department of Transportation Dallas District office.

2.2.3 Principal Arterial Streets

Principal arterial streets are the backbone of the City's street system. They serve the major centers of activity and

high volume traffic corridor, accommodate the longest trip desires, and carry a high proportion of overall travel on a small percentage of total system mileage. The network formed by the principal arterials is fully interconnected, and provides links to the freeway system and to areas outside the City. Geometric design and traffic control measures are used to enhance the movement of through traffic on principal arterials, while access to abutting property may be restricted, or managed, to protect the through traffic carrying capacity of the roadway. Access to abutting land is subordinate to the provision of travel service for major traffic movements.

Texas Department of Transportation non-controlled access roadways, such as Northwest Highway, Preston Road, and Garland Road, are to be considered principal arterial streets as they interconnect with the City's roadway network.

2.2.4 Minor Arterial Streets

Minor Arterial Streets are arterial streets that interconnect with and augment a principal arterial network. They serve traffic with a smaller geographic area of influence, accommodate trip lengths of moderate length, and offer greater opportunities for emphasis on land access than the principal arterial system. The minor arterials carry significant through traffic volumes and are needed to provide route and spacing continuity for the principal arterial system.

2.2.5 Community Collector

The collector street system is divided into two sub-classifications, “community” collector and “residential” collector. Community collectors provide both land access service and traffic circulation within residential neighborhoods and commercial / industrial areas. They differ from the arterial system in that collectors penetrate neighborhoods and distribute trips from the arterials through the area to their ultimate destinations. Conversely, the collector street also collects traffic from local streets in neighborhoods and channels it into the arterial system.

Collectors should accommodate short trip lengths, and do not typically extend across arterial thoroughfares or carry a high percentage of through trips. Although, in some circumstances collectors serve as a relief valve when the arterial system is congested. Traffic control devices may be installed to protect or facilitate traffic or pedestrians on a collector street.

Community collectors serve both residential and commercial neighborhoods. The mobility and access functions of this type of collector are generally balanced. The effective operation of community collectors is critical to the access of circulation needs of the area they serve.

2.2.6 Residential Collector

Residential collectors serve predominantly single family and multi-family neighborhoods. In some cases, a neighborhood served by a residential collector may also include a small amount of local serving retail. A roadway is only identified as a residential collector on the Thoroughfare Plan if it has a substandard pavement width and some improvement is desired by the community, or it is in an undeveloped / underdeveloped area and does not yet exist. Once a residential collector has been built to its planned width, its official thoroughfare designation will be removed and it will automatically be dropped from the Thoroughfare Plan maps.

2.2.7 Local Streets

Local streets comprise all roadways not identified as an arterial or collector thoroughfare; they are not specifically incorporated into the Thoroughfare Plan. Local streets offer the lowest level of mobility. Their primary function is to provide direct access to abutting land and access to collectors and arterials.

Through traffic should be discouraged on local residential streets. New residential subdivisions should be laid out with irregular street patterns and cul-de-sacs to minimize the opportunity for through traffic. Existing residential streets may be modified through the application of traffic control measures or traffic diverters.

2.2.8 Alleys

To supplement certain local streets in meeting access and parking needs for residential and commercial land uses, the City Development Code requires alleys to be provided in these cases. Alleys supplement smaller street pavement widths and higher zoning density cases. Alleys are required to supplement residential local streets with section designation L-2-U(B) (Local streets with a 26-foot wide pavement width) and section designation L-2-U(A) (Local streets with a 33-foot wide pavement width) if the local street serves property with zoning designations of R-5, MH, D, TH-1 or TH-2. Also, alleys should be prioritized for access over driveways, providing necessary circulation, and support service accommodations, such as utilities, drainage, and trash pick-up.

2.2.9 Street Volumes and Capacities

A correlation exists between the classification of a street and the volume and capacity of the street. Typically, a local or collector street carries less volume and capacity than that of an arterial street. Arterial streets due to their higher volume and capacities are designed with a wider, divided, multi-lane configuration. Table 2.2 shows typical volumes and capacities for streets of given designs within Dallas and demonstrates the relationship between functional classification, roadway configuration, volume, and capacity.

Table 2.2 Typical Volumes and Capacities for Streets of Given Design

Roadway Functional Classification	Roadway Configuration	Typical 24 Hour Volume	Typical 24 Hour Capacity
Arterial	6 Lane Divided	22,000 vpd	42,000 vpd
Arterial, Collector	4 Lane Divided	18,500 vpd	28,000 vpd
Collector	4 Lane Undivided	10,000 vpd	20,000 vpd
Local, Collector	2 Lane Undivided	4,000 vpd	10,000 vpd

Also refer to Section 4.2.3 which provides additional information with emphasis on the context of the street and surrounding development.

2.3 DIMENSIONAL CLASSIFICATION

2.3.1 General

Dimensional classification establishes the basic physical dimensions of a thoroughfare, including the number of lanes, right-of-way width, and pavement width. The dimensional classification that is applied to a road determines the design configuration for the road when it is funded for construction or reconstruction. The plan contains four dimensional classification categories: (1) standard, (2) minimum, (3) existing, and (4) special roadway sections:

- 1. Standard Roadway Sections** - Standard roadway sections should be used in all newly developed areas, and wherever possible, in existing areas. Elements incorporated into the standard cross sections are:
 - Lane width – 12 feet
 - Median width – 15 feet (where applicable)
 - Parkway width – 10 feet desirable / 8 feet minimum
- 2. Minimum Roadway Sections** - Minimum roadway sections should be used in all newly developed areas, and wherever possible, on existing areas. These cross sections represent minimum dimensions and would be applied where the application of the standard roadway section is undesirable because of economic, environmental, community, or other constraints. Elements incorporated into the minimum cross sections are:
 - Lane width – 10 to 11 feet
 - Median width – 14 to 15 feet (where applicable)
 - Parkway width – 5 to 10 feet

- 3. Existing Roadway Sections** - If no change is desirable due to community concerns or physical constraints, thoroughfares that do not meet the dimensional requirements of the standard or minimum roadway sections may be retained with their existing pavement and right-of-way width. When a roadway is dimensionally classified as “existing”, then its existing pavement width will not be widened.
- 4. Special Roadway Sections** - Special roadway sections are defined on a case-by-case basis when a unique design is needed that does not fit within either the standard or minimum categories. Circumstances warranting a special roadway section might include a five-lane roadway, one-way streets, or other types of unique design circumstances.

See Table 2.3 for street and thoroughfare typical standard dimensions based on functional classifications. This table also provides dimensional variations based on street section designation with minimum and standard dimensions for each one. Figure 2.2 provides a graphic depiction of minimum dimensions for right-of-way and pavement for various street types. Figure 2.3 provides a graphic depiction of standard dimensions for right-of-way and pavement for various street classifications.

2.3.2 Maps and Listings

A map of the *City of Dallas Thoroughfare Plan* and the specific street segment listings for the *Thoroughfare Plan* are found on the City of Dallas website (dallascityhall.com). Streets are listed in the *City of Dallas Thoroughfare Plan* table with the limits of the street segment, the proposed functional and dimensional classifications, the existing ordinance, and the amendment date.

Table 2.3 Street and Thoroughfare Geometric Standards

Functional Classification	Dimensional Classification Category	Section Designation	Pavement Width (ft) ¹	Median Width (ft)	Parkway Width (ft)	Normal Right-of-Way (ft)
Principal Arterial	Standard (divided)	S-8-D	2-48	15	9.5	130
		S-6-D	2-36	15	10	107
	Minimum (divided)	M-6-D (A)	2-33	15	9.5	100
		M-6-D (B) ²	2-30	15	7.5 ³	90
	Standard (couplet)	S-4-U	44	-	83	60
		S-3-U	36	-	10	56
	Minimum (couplet)	M-4-U ²	40	-	10	60
		M-3-U	33	-	8.5	50
Minor Arterial	Standard (divided)	S-4-D	2-24	15	8.5	80
	Minimum (divided)	M-4-D (A)	2-22	15	10.5	80
		M-4-D (B) ²	2-20	15	10	75
	Standard (undivided)	S-4-U	44	-	8 ³	60
	Minimum (undivided)	M-4-U ²	40	-	10	60
Collector (Community/ Residential)	Standard	M-4-U ⁴	40	-	10	60
		S-2-U	36	-	10	56
	Minimum	M-2-U	36	-	7 ³	50
Local Streets	Standard	S-2-U	36	-	10	56
		L-2-U (A) ⁵	33	-	10	53
		L-2-U (B) ⁶	26	-	12	50
	Minimum	M-2-U	36	-	7 ³	50
Alleys	Standard/Minimum	Alley	10	-	2.5	15

Notes

¹ Minimum and standard street sections are depicted in Figures 2.2 and 2.3.

² All pavement dimensions measured from face of curb. Additional pavement width is required for all thoroughfares on a bike route designated in the 2011 Dallas Bike Plan. For those thoroughfares, parking widths are adjusted as necessary to stay within the normal right-of-way width listed. See the 2011 Dallas Bike Plan for further details.

³ Section designations using ten-foot lanes should not be used for arterial streets carrying significant bus or truck traffic. Changes in thoroughfare sections require Thoroughfare Plan amendments. Use of section designations using ten foot lanes should be specifically approved by the Director.

⁴ Use of Section designations with parkways narrower than 8.5' may require special sight distance considerations in curved sections and may require larger than normal comer clips at street intersections.

⁵ Striped for 2 lanes

⁶ Alleys may be required, depending on zoning

⁷ Alleys required

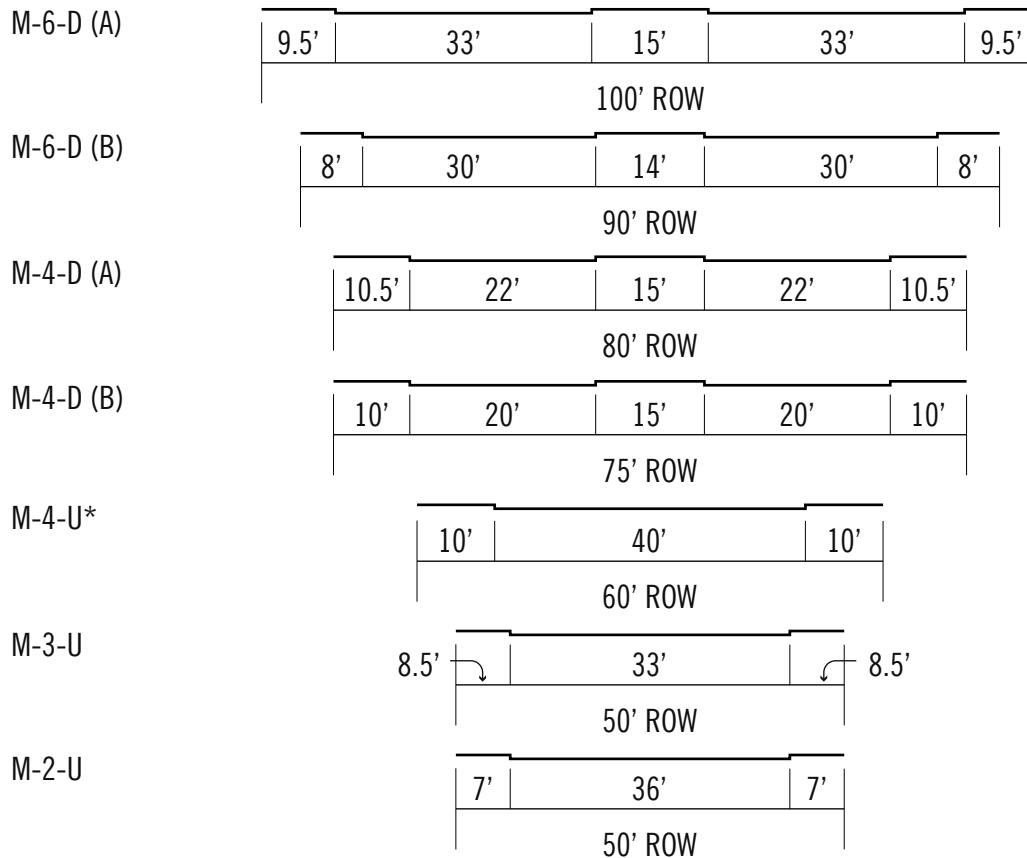
Table 2.4 Chapter 51A of Dallas Development Code: Requirements for Minor Streets

Zoning	Street Classification	Pavement Width	ROW Width	Min. Alley Required	Centerline Radius
R-1 thru R-7.5	L-2-U(B)	26'	50'	Yes	150'
	L-2-U(A)	33'	53'	No	200'
	S-2-U	36'	56'	No	230'
R-5, MH, D, TH-1, TH-2	L-2-U(A)	33'	53'	Yes	200'
	S-2-U	36'	56'	No	230'
TH-3, CH, Multifamily	S-2-U	36'	56'	No	230'
All non-residential districts except PDDs, and WR Districts in Article XIII	S-2-U	36'	56'	No	280'

(Adapted from Dallas Complete Streets Design Manual)

Figure 2.2 Minimum ROW Cross-Sections

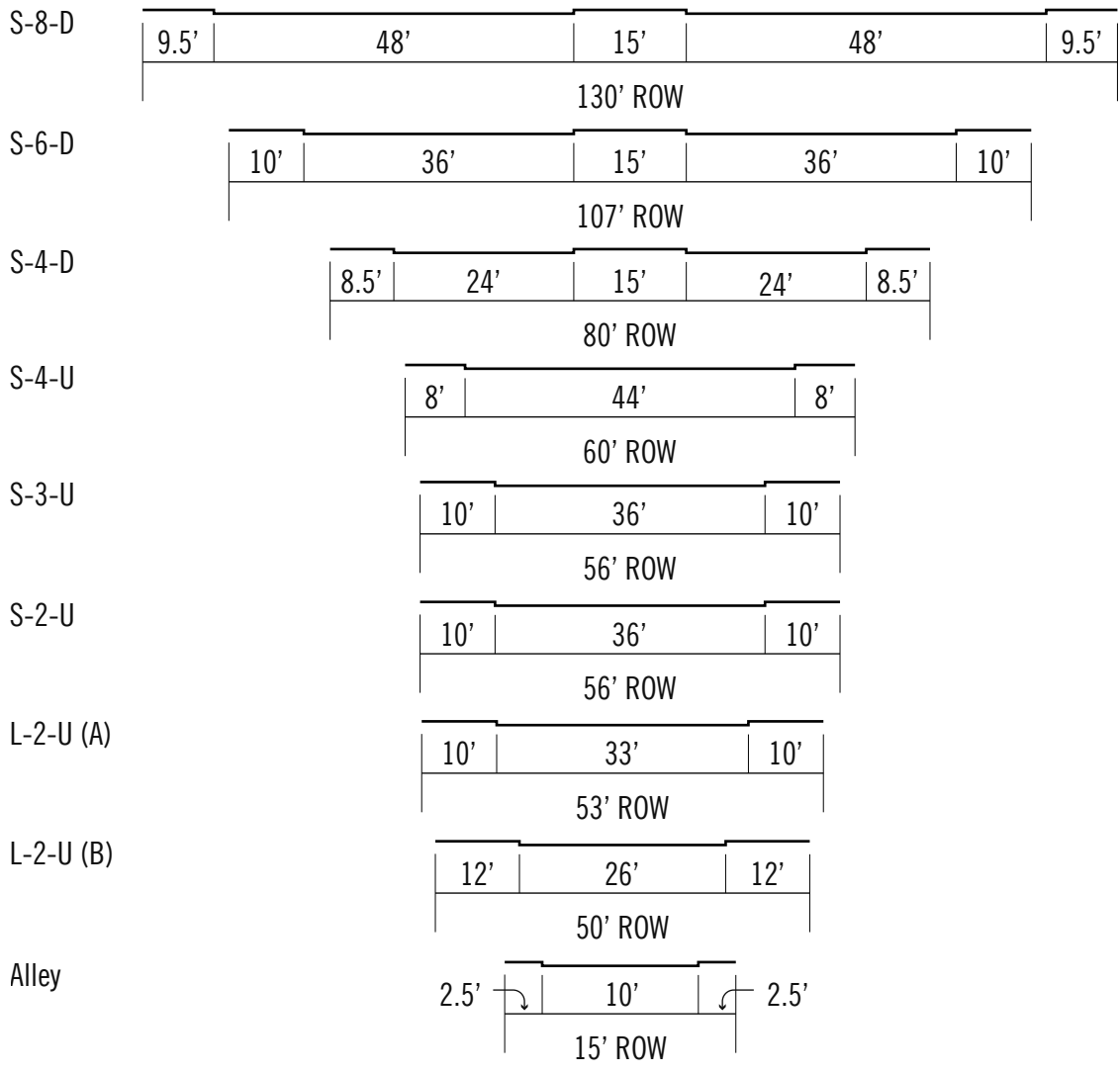
Minimum Roadway Sections



*M-4-U can be striped and operated as 2 or 4 lanes

Figure 2.3 Standard ROW Cross-Sections

Standard Roadway Sections



2.4 CONTEXTUAL STREET TYPES

2.4.1 General

Contextual street types are intended to serve as overlays on the City of Dallas Thoroughfare Plan functional and dimensional classification system. For example, a four-lane, divided arterial may be a Mixed-Use Street, and a Bike or Transit Network Street. Contextual streets are divided into six primary typologies: (1) mixed-use streets, (2) commercial streets, (3) residential streets, (4) industrial streets, (5) parkways, and (6) Woonerfs. Though not a street, alleys provide additional side or near yard access to private property with connectivity to the local street network. These designations provide the first step in determining how a particular street should be initially designed, as well as the enhancement elements potentially needed given the use, capacity, and context of the area. Contextual street types must correlate to adjacent land uses, whether existing and / or proposed, based on the development patterns and plans being implemented, and the City's policy and planning documents enumerated in Section 1.4 (*City of Dallas Complete Streets Design Manual, 2011 Bike Plan,*

CBD Streets and Circulation Plan), and infrastructure and development objectives of the City, land owners / developers, or both.

Figure 2.4 Relationship Between Functional Classifications and Contextual Street Types

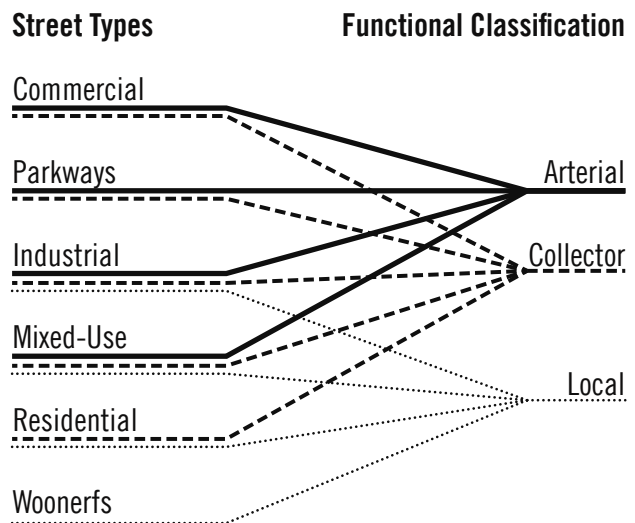


Table 2.5 Typical Street Types and Elements

	Frontage	Sidewalk Clear	Buffer/Furnishing/Curb	Parking	Travelway	Median
Mixed-Use	●	●	●	●	●	●
Commercial	●	●	●		●	●
Residential	●	●	●	●	●	
Industrial	●	●	●	●	●	
Parkways	●	●	●		●	●
Woonerf	●	●	●	●	●	
Alleys					●	



2.4.2 Mixed-Use Streets

The typical functional classifications for Mixed-Use Streets are: Collector and Local.

Downtown streets and other main streets are examples of mixed-use streets. These streets encompass a variety of street types and land use contexts, from downtown to small main street locations. Buildings are usually close to the street and offer a vibrant blend of opportunities to live, work, shop, and play. In their present form, these streets already have some pedestrian and bicycle activities. In some locations, they carry heavy traffic. On Mixed-Use Streets, the focus is on slower traffic speeds and a greater emphasis on pedestrian, bicycle and transit choices. This street type is the most flexible and the multipurpose use of street space—street parking is common along Mixed-Use Streets. Often there are large parking areas and other auto-oriented land uses located at the edges of commercial areas. The design of Mixed-Use Streets is targeted for pedestrians, bicyclists, and transit users with the goal of reducing motor vehicle speeds and creating a more desirable environment for people.

A range of street types are identified in the Downtown Dallas 360 Plan that further define streets and uses in the City Center, and additional information can be found in the CBD Comprehensive Transportation Plan.

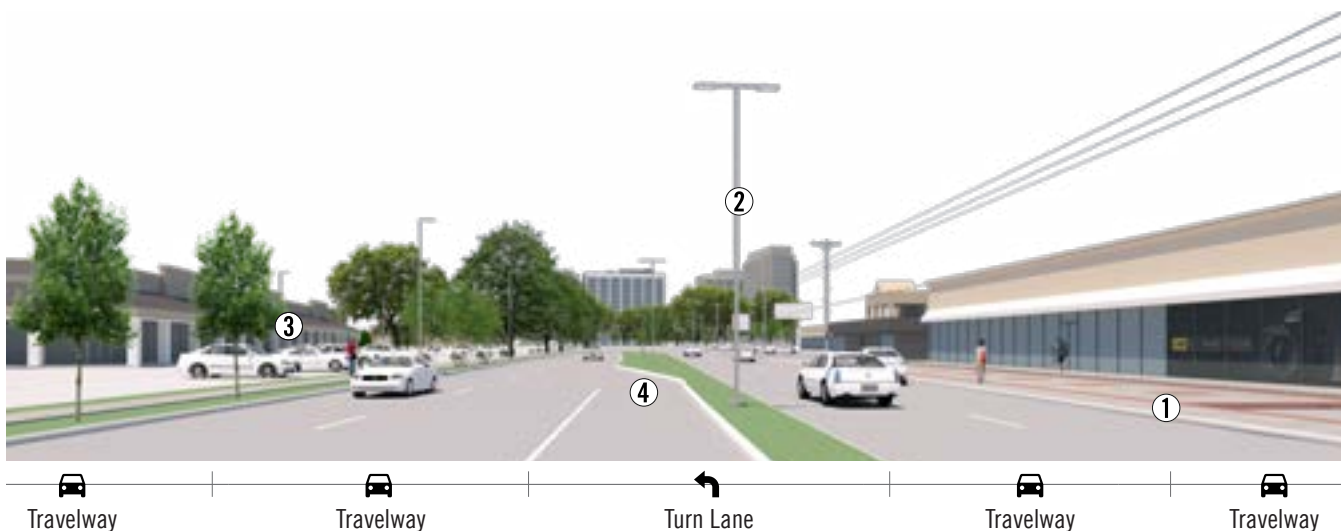
See Complete Streets Design Manual for more information.

Key Features:

- ① Wide pedestrian zones for high pedestrian traffic.
- ② Engaging frontages for pleasant pedestrian experience.
- ③ Alternative modes of transportation for flexibility of use.
- ④ On-street parking to provide convenience parking along the travelway.
- ⑤ Street and pedestrian lighting for safety and comfort.
- ⑥ Trees and landscaping for aesthetics and shade or buffer
- ⑦ Furniture and amenities for improved usability of the street.

Additional features may include:

- Wayfinding and signage for enhancing the user experience.
- Where feasible to accommodate specific transportation modes, provision of an off-street pathway for bicycles and micro-mobility devices should be considered.



2.4.3 Commercial Streets

The typical functional classifications for Commercial Streets are: Arterial, Collector, and Local.

These streets serve mostly commercial or institutional areas with low densities. Buildings are likely set back from the road, do not feature on-street parking, serve faster moving traffic, and provide regional connections. However, there are opportunities for improving walking, biking, and transit between destinations and this street type.

Adjacent land uses function as service and job destinations, with buildings located on separate parcels. Land uses include offices, restaurants, and a range of retail and commercial uses. Adjacent land uses may also include multifamily housing in low-, mid- and high-rise apartment buildings.

Commercial Streets should be designed to accommodate pedestrians while still maintaining vehicle traffic flow. This objective may be inherently unpleasant for pedestrian, bicycle, and transit users, however, the design of such facilities should take into account the safety of such users - particularly at intersections - as a paramount concern.

See Complete Streets Design Manual for more information.

Key Features:

- ① Continuous sidewalks with access to all businesses
- ② Uniform street lighting for safety and comfort.
- ③ Trees and landscaping for overall aesthetics.
- ④ Optional median for access control and as refuge area for pedestrian crossings.

Additional features may include:

- Transit Stops would also be included along streets designated as transit routes.
- Where feasible, provide generous parkways to provide a buffer between pedestrians and vehicular travel lanes.



2.4.4 Residential Streets

The typical functional classifications for Residential Streets are: Collector and Local.

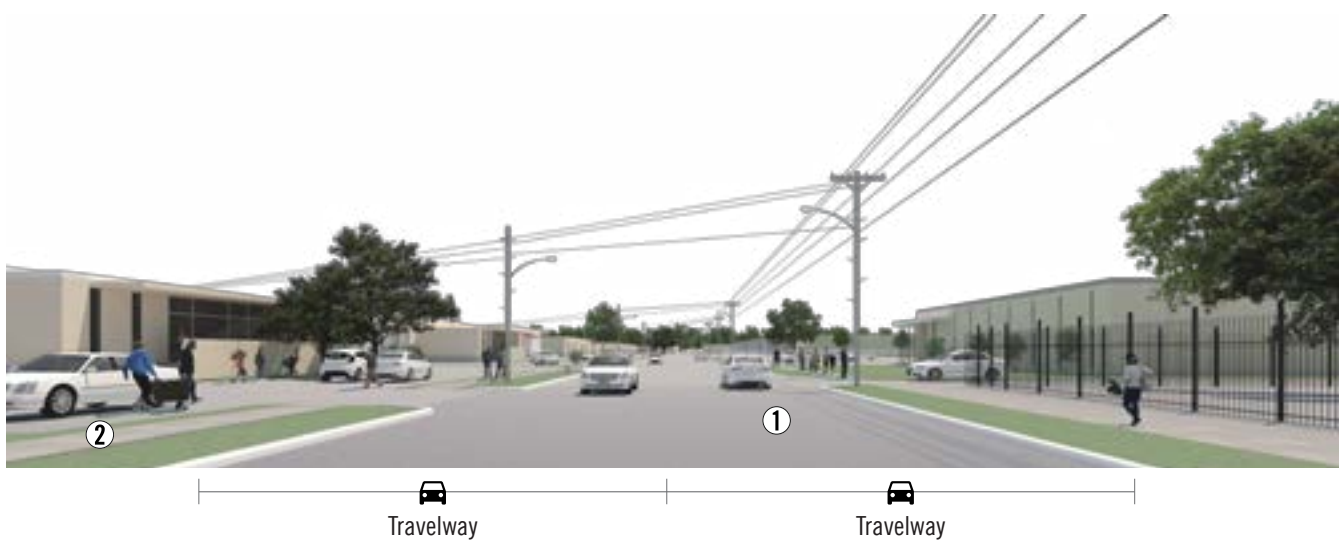
These streets serve residential land uses as well as schools, churches and businesses within residential neighborhoods. Residential streets can vary from serving high volumes and lower speeds, depending on the surrounding neighborhood context. However, the dominant land use is single family. This type of street will likely also have pedestrian bicycle, and transit activity to connect important neighborhood destinations.

Residential Streets are designed for lower vehicle speeds and place an emphasis on intersection safety for pedestrians, bicyclists, and transit users.

See Complete Streets Design Manual for more information.

Key Features:

- ① Continuous sidewalks connecting homes to schools and other neighborhood destinations.
- ② Transit stops throughout allowing alternative transportation.
- ③ Optional on-street parking to slow down traffic.
- ④ Street lighting for safety and comfort.
- ⑤ Trees and landscaping integrated harmoniously with properties.
- ⑥ Furniture and amenities for improved usability of the street.



2.4.5 Industrial Streets

The typical functional classifications for Industrial Streets are: Arterial, Collector, and Local.

Industrial Streets serve industrial corridors. They are built with wide lanes and intersections to accommodate trucks and other large vehicles. Industrial streets are located within large areas of land with a mix of low- and medium-density industrial buildings and industrial yards. They often have large surface parking lots for cars and trucks, and should have quality access. Due to the need for freight rail access, industrial streets are often linked to rail lines.

Transit, sidewalks, and pedestrian amenities are typically limited in these areas. However, industrial streets may serve as through-routes to adjacent land uses, and thus these amenities should not be overlooked on industrial streets if residential or transit facilities are in the vicinity.

See Complete Streets Design Manual for more information.

Key Features:

- ① Wide travel lanes for larger design vehicles.
- ② Continuous sidewalks accessing all properties.

Additional features may include:

- Optional median as refuge area for pedestrian crossing.



2.4.6 Parkways

The typical functional classifications for Parkways are: Arterial and Collector.

Parkways extend through natural areas (such as lakes, rivers, floodplains, streams, and parks) where there is a desire to maintain or create a park-like feel to the roadway. Parkways serve sensitive areas - such as White Rock Lake, the Escarpment, and the Great Trinity Forest - and may be elevated within these areas. Design elements may include wide landscaped medians, structures with natural materials, and shared use hike and bike paths alongside the roadway in lieu of sidewalks.

The primary objective of a parkway is to reduce motor vehicle speeds and provide safe intersections for pedestrians, bicycles and transit users.

See Complete Streets Design Manual for more information.

Key Features:

- ① Trees and landscaping, especially on optional medians, as an extension of the surrounding greenery.
- ② Continuous pedestrian zones or shared-use paths buffered from travelway for pedestrians and bicycles, integrated with landscaping.
- ③ Safe crossings for park access.



Shared

2.4.7 Woonerf Streets

The typical functional classification for Woonerf Streets are: Local.

The Woonerf street concept reclaims the street as public space for greater use by people in contrast to being a primary transportation oriented corridor for motorized vehicles.

Woonerf streets are shared streets used by streetcars, pedestrians, bikers, and automobile drivers. A shared street is based on an urban design concept, in which a street is designed to be shared among various modes of travel in order to minimize segregation between road users in a commercial or residential setting. They require traffic calming, very low speed limits, and audio and visual signage. Woonerfs blend the special borders, surfaces, or zones used by these several users. These also require careful intersections and crossings for pedestrian and bicyclists, as well as, controlled turn lanes for cars. Truck traffic is either prohibited or very restricted to only the smallest of delivery vehicles for local customers only.

Woonerf streets are considered as specialty streets which may have unusual design parameters and characteristics. The designer shall engage with City staff in defining the specific design criteria that will be used for the woonerf street, including any specialized construction details necessary for proposed materials and features to be incorporated.

Key Features:

- ① No curbs or vertical separation for free pedestrian movement.
- ② Optional pedestrian safety elements, such as bollards.
- ③ Urban design features, such as material changes, to slow traffic.
- ④ Street and pedestrian lighting for safety and comfort.
- ⑤ Trees and landscaping for aesthetics and shade.

Additional features may include:

- Wayfinding and signage for enhancing the user experience.



2.4.8 Alleys

The typical functional classification for Alleys are: Local.

In addition to the six contextual street types, alleys provide access for residential areas and commercial areas. They should be prioritized for access over driveways, providing necessary circulation, and support service accommodations, such as utilities, drainage, and trash pick-up. In general, alleys are not divided into pedestrian and vehicle zones, they are fluid and used as needed with enough clear space for cars and service vehicles to drive through.

Key Features:

- ① Optional artwork.
- ② No separation of pedestrians, bicycles, and cars.

2.5 ZONES

2.5.1 General

Regardless of its functional classification or contextual street type, a street is made of three different zones:

- The Pedestrian Zone
- The Street Zone
- The Intersection Zone

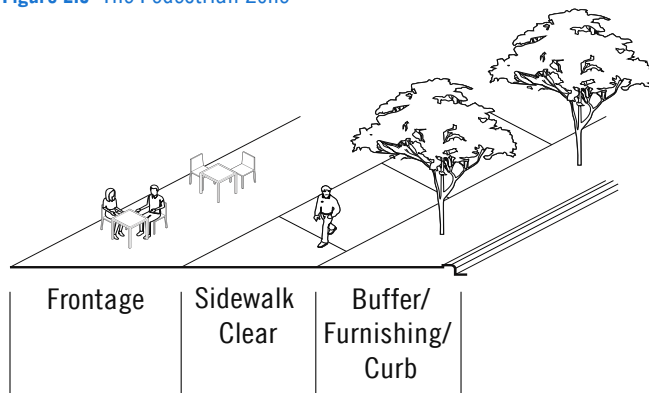
Each of these zones has specific functions and requires unique design considerations. However, they also interact in many ways and a good street design will consider them holistically.

2.5.2 Pedestrian Zone

The Pedestrian Zone involves the portion of the street that accommodates non-vehicular activity – walking as well as the business and social activities – of the street. These zones extend from the face of the building or edge of the property line to the face of the curb. Streets are the most extensively used civic spaces in the community. The Pedestrian Zone is comprised of three functional elements as shown in Figure 2.5:

- The Frontage Zone
- The Sidewalk Clear Zone
- The Buffer / Furnishing / Curb Zone

Figure 2.5 The Pedestrian Zone



See Complete Streets Design Manual for Pedestrian Zone Policy Guidance

2.5.2.1 Frontage Zone

The frontage zone is defined as the area between the face of the existing or future proposed structure or vertical element and the sidewalk clear zone. This zone is ideally located on private property in the building setback area where design standards are controlled by zoning. In existing dense urban situations such as Downtown and Old Main Street corridors, frontage zone design elements may need to extend into the public right-of-way. Given the variety of development patterns in Dallas, the frontage zone will vary from buildings with narrow or no setbacks to buildings with large setbacks. For buildings with narrow setbacks, the frontage zone provides a place for sidewalk cafes, outdoor retail displays, and landscaping, among other things. It is important that these elements do not infringe on the sidewalk clear zone.

2.5.2.2 Sidewalk Clear Zone

The sidewalk clear zone is the portion of the pedestrian zone that is specifically reserved for pedestrian travel. It should be well-lit and meet the ADAAG. This zone should be free of any physical obstructions to allow for continuous pedestrian movement. Materials used in the pedestrian zone should be consistent, and should not vary from block-to-block within the corridor. Surface design, dimensions, and slopes of this zone are critical for accessibility and safety. Note: Minimum Sidewalk Clear Zone is 6 feet wide within ½ mile of a transit facility (i.e. DART Station). Utility poles, signal boxes, street furniture, and vegetation should not encroach into the sidewalk clear zone.

Typically, bicycles and motorized scooters or other equipment are discouraged in the Sidewalk Clear Zone. In and around the downtown Dallas areas refer to the City's Dockless Vehicle Ordinance #30936 and related documents (map, operations requirements, etc.) for street designs in this area and accommodations for or precluding dockless vehicles.

2.5.2.3 Buffer / Furnishing / Curb Zone

The buffer / furnishing / curb zone is the area between the curb and the sidewalk clear zone that provides separation and protection from moving vehicle traffic. The buffer / furnishing / curb zone also provides space for the placement and organization of street elements such as landscaping, transit stops, street furniture, and above and below ground utilities. Where parking is allowed, the buffer / furnishing / curb zone creates space between the curb and vertical elements for proper clearance from moving vehicles or to allow car doors to open, and motor vehicle drivers to access the sidewalk. It also allows space for driveway aprons to ramp down from the grade of the sidewalk to the street in order to maintain a level sidewalk clear zone. In constrained areas, or where utilities are required, landscaping may be shifted to the frontage zone.

Figure 2.6 Zones

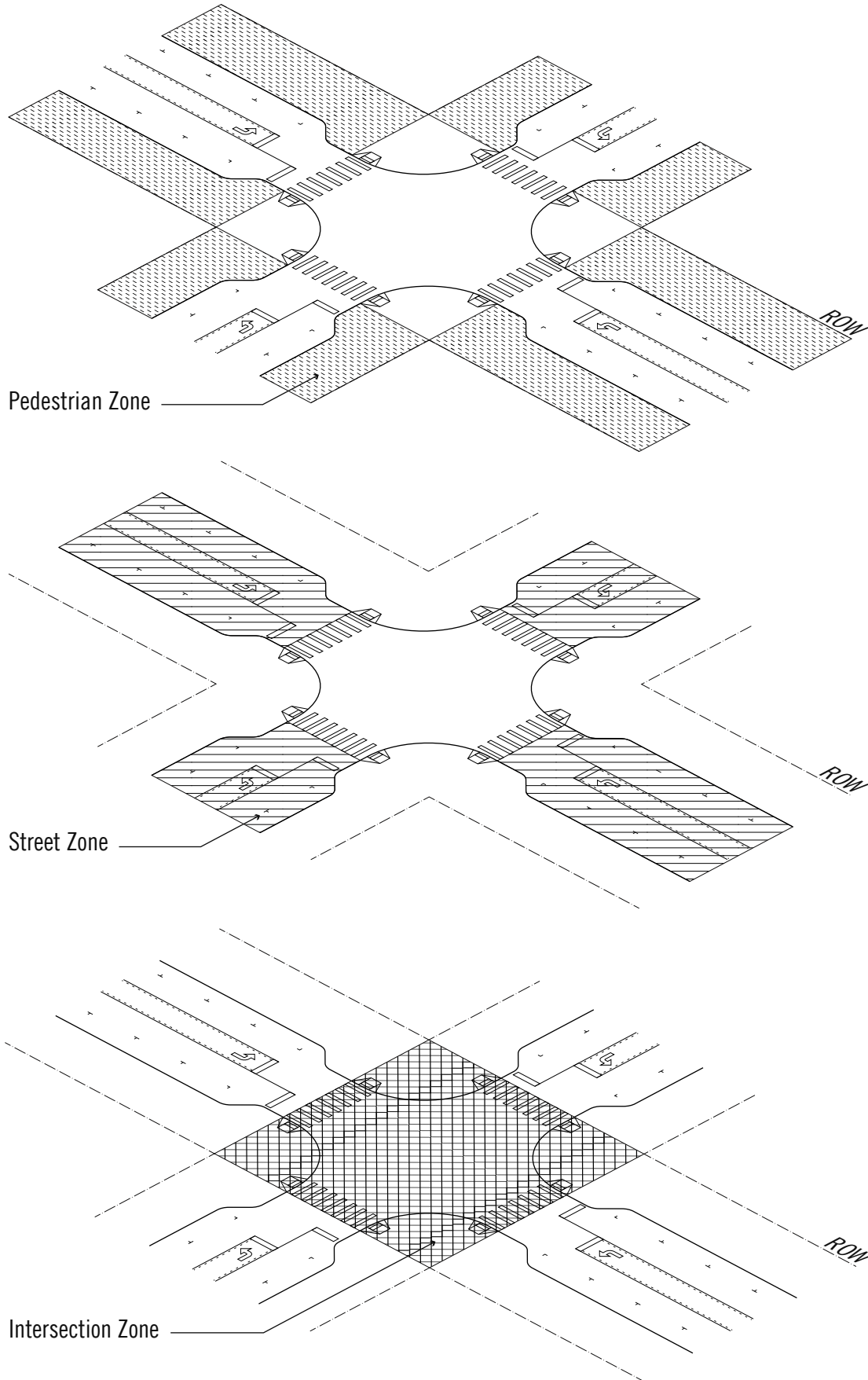
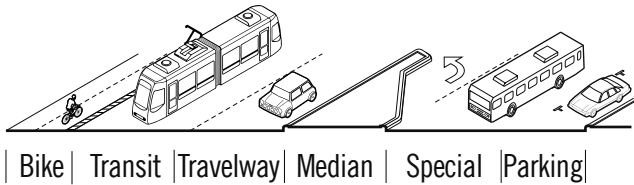


Figure 2.7 The Street Zone



2.5.3 Street Zone

The Street Zone supports adjacent land uses and should be designed to balance the efficiency of motor vehicle travel with considerations for pedestrians, bicyclists, and transit users. The Street Zones encompass the areas between the curbs and include the portion of the street that accommodates vehicular activity — transit, bicycle and motor vehicles. The Street Zones are comprised of three functional elements:

- The Parking Zone
- The Travelway Zone
- The Median Zone

Refer to City of Dallas Complete Streets Design Manual for Street Zone Policy Guidance.

2.5.3.1 Parking Zone

The Parking Zone is adjacent to the curb and may be parallel, perpendicular, angled, or back-in diagonal parking. The presence of on-street parking increases street activity, meets the parking needs of adjacent uses, protects pedestrians from moving traffic, and makes pedestrian crossing safer by slowing traffic. The parking zone may double as a travel lane at peak hours in high traffic areas or be dedicated for parking through the use of bulb outs. The parking zone is not an essential component of all streets as on-street parking may not be appropriate or necessary on some streets.

2.5.3.2 Travelway Zone

The travelway zone is the portion of the street that is reserved for vehicular travel of all varieties, including transit, bicycle and other two wheelers. Bikeways are encouraged to be buffered from travelways on streets with high speeds with a physical barrier or adjacent parking lanes. Speed and width are important in designing the travelway in walkability context. Because of the pedestrian-oriented nature of these areas, the target speed should be kept low (25-30 miles per hour). Lower speeds improve the users' perception of the street, creates a safer environment, accommodates parking maneuvers, and is consistent with restricted sight distances encountered in urban places. On-street parking can be used as a method of traffic calming and is encouraged on mixed-use streets.

The width of the travelway affects users' perceptions of the speed and volume of the street. Wide travelways will be preferred by motorists, whether in cars and light trucks, heavy trucks, or transit vehicles. But also, wide travelways may be perceived as a barrier for pedestrians where frequent crossings are desired.

2.5.3.3 Median Zone

Medians are the center portion of a street that separates opposing directions of travel. Medians vary in width and purpose and can be raised with curbs or painted and flush with the pavement. Medians on low-speed urban thoroughfares are used for access management, accommodation of turning traffic, safety, pedestrian refuge, and landscaping. Well-designed medians can serve as a focal point of the street or an identifiable gateway into a community, neighborhood, or district through the use of landscaping, lighting, and urban design features.

Wider medians provide pedestrian refuge at long intersection crossings and midblock crossings. Medians are not an essential element for all streets. They are specified in the Thoroughfare Plan if considered necessary for thoroughfares.

2.5.4 Intersection Zone

The intersection zone is where two streets meet. This is where all modes of transportation and movement in multiple directions must share space. The intersection zone includes the area where traffic lanes intersect the turn lanes, the crosswalks, and the sections of sidewalk immediately adjacent to the crosswalk. It is a combination of pedestrian zone and street zone. Well-designed intersections are critical to a connected transportation network and the safety and capacity of all traffic modes.





SECTION 3

Street Networks / Access Control

This section on Street Networks and Access Control discusses the connectivity of the street network, including spacing of intersections, bicycle networks, pedestrian crossing locations, configuration of alleys, and dead-end streets. This section also discusses the guidelines and minimum requirements to be used in the location of access streets and driveways to properties adjoining City thoroughfares and streets, including the location and spacing of median openings.

The following requirements and guidelines shall be used in the network of street types, location of street intersections, median openings, alleys and driveway approaches that affect access to streets from adjoining properties.

3.1

STREET NETWORK GUIDANCE

Objectives in design of Street Networks:

- Maximize paths of connectivity for all users for economic vitality and quality of life.
- Balance travel times for all expected users of the street network.
- Design with public safety as a primary criterion.

Every street is part of multiple networks. The trips made on a street – in a car, on a bike, on foot, on transit, or in a truck – all use other streets and even off-street pathways. The connectivity of a street within an overall street network is essential to its function. The most livable and economically thriving places in a city tend to be those that have the most connectivity for all travel modes.

Every connection added – to another street, to an alley, to a driveway – increases the number of possible paths, creating more direct routes to more destinations. But each connection added also adds friction, slowing the vehicular traffic down, increasing the length of trips, and possibly making the street less safe. Thus, the design of street networks involves tradeoffs. These tradeoffs become more difficult because different modes of transportation operate at different scales. Sending a driver moving 35 mph a quarter-mile out of their way adds 30 seconds to a trip; sending a pedestrian a quarter-mile out of their way adds 5 minutes.

Thus, regulation of access and networks is necessary to provide for adequate mobility and safe movement of traffic on streets and to ensure that adequate and appropriate access is provided in an equitable manner to the adjoining property owners. Street intersections, median cuts, and driveway approaches should be located to minimize conflicting traffic movements and to minimize unsafe intrusions into the arterial street system. Transit and bicycle lanes should work seamlessly with motor vehicle lanes. The result of following these guidelines will help ensure that City streets are designed with primary concern for the public safety.

3.2 STREETS

3.2.1 Spacing of Intersections

3.2.1.1 General

Intersections are where the greatest number of conflicts occur as streets converge and diverge, and various modes of transportation intersect. A conflict is an event in which two or more vehicles are at risk of a traffic collision or making an abnormal maneuver. These conflicting traffic movements can occur at intersections, driveways, crosswalks, lane drops, and other locations that may require a change in traffic movement. Streets must be designed for the safety, minimal delays, and ease of navigation for all modes of transportation.

An intersection shall normally not have more than four street approaches. Intersections shall intersect at 90° where possible but never less than 75°, except by approval of the Director. Proposed intersections along one side of an existing cross-street must, wherever practical, align with existing intersections on the opposite side of the cross street. Street centerline offsets less than 150 feet are not permitted.

Exceptions:

- The cross-street is divided by a raised median without openings at either intersection.
- Intersections with more than four street approaches require special design configurations, and separate approval by Director is required.

The intersection of two streets must not be located within 115 feet of a railroad right-of-way if one of the streets crosses the railroad right-of-way at grade. This 115 feet separation is measured from the nearest point of the intersection of the street right-of-way and the nearest point of the railroad right-of-way.

Spacing between street intersections shall be sufficient to ensure adequate space is provided for turning movements onto the intersecting streets and that access to adjoining properties can be made in a safe manner. The minimum spacing required depends on individual streets and thoroughfares.

The maximum intersection spacing shall be 1,600 feet. Both the driveway access requirements for the standard

AASHTO passenger car “P” vehicle for non-thoroughfare streets and the left turn storage and transition requirements provided in Section 4.4.4.1 Horizontal Alignment for thoroughfare streets shall be considered. The following minimum spacing requirements, as measured from centerline of intersection to centerline of intersection, shall be followed in locating street intersections:

3.2.1.2 Local and Residential Collector Streets

1. Spacing between local street to local street intersections shall be equal to or greater than 150 feet.
2. Spacing between residential collectors and local streets intersecting local and residential collector streets shall be equal to or greater than 170 feet.
3. Spacing between local and residential collector streets intersecting non-divided thoroughfare streets shall be equal to or greater than 190 feet.
4. Spacing between local or residential collector streets and collector thoroughfares intersecting undivided thoroughfare streets shall be equal to or greater than 190 feet (allows 140 feet for turning vehicle stacking without overlap).
5. Spacing between local or residential collector streets and minor arterial streets intersecting undivided thoroughfare streets shall be equal to or greater than 250 feet (allows 190 feet for turning vehicle stacking without overlap).
6. Spacing between local or residential collector streets and principal arterial streets intersecting undivided thoroughfare streets shall be equal to or greater than 290 feet (allows 240 feet for turning vehicle stacking without overlap).

For cases 5 and 6 above, add 160 feet to the minimum spacing for median transition and storage for intersections along divided arterial thoroughfare streets.

3.2.1.3 Collector Thoroughfares

1. Spacing between Community Collector and Minor Arterial thoroughfares intersecting undivided thoroughfare streets shall be equal to or greater than 305 feet.
2. Spacing between Community Collector and Principal Arterial thoroughfares intersecting undivided minor arterial streets shall be equal to or greater than 325 feet.
3. Spacing between Community Collector and Principal Arterial thoroughfares intersecting undivided principal arterial streets shall be equal to or greater than 375 feet.

For cases 1, 2 and 3 above, add 110 feet to the minimum spacing for median transition for intersections along divided arterial thoroughfares.

3.2.1.4 Minor Arterial Thoroughfares

1. Spacing between Minor Arterial and Principal Arterial streets intersecting collector thoroughfare streets shall be equal to or greater than 280 feet.
2. Spacing between Minor Arterial and Principal Arterial streets intersecting undivided minor arterial streets shall be equal to or greater than 380 feet.
3. Spacing between Minor Arterial and Principal Arterial streets intersecting undivided principal arterial streets shall be equal to or greater than 430 feet.

For cases 2 and 3 above, add 135 feet to the minimum spacing for median transitioning for intersections with divided arterial thoroughfares.

3.2.1.5 Principal Arterial Thoroughfares

1. Spacing between Principal Arterial Thoroughfares intersecting collector thoroughfare streets shall be equal to or greater than 300 feet.
2. Spacing between Principal Arterial Thoroughfares intersecting undivided minor arterial streets shall be equal to or greater than 400 feet.
3. Spacing between Principal Arterial Thoroughfares intersecting undivided principal arterial streets shall be equal to or greater than 500 feet.

For cases 2 and 3 above, add 135 feet to the minimum spacing for median transitioning for intersections with divided arterial thoroughfares.

3.2.1.6 Pedestrian Crossings

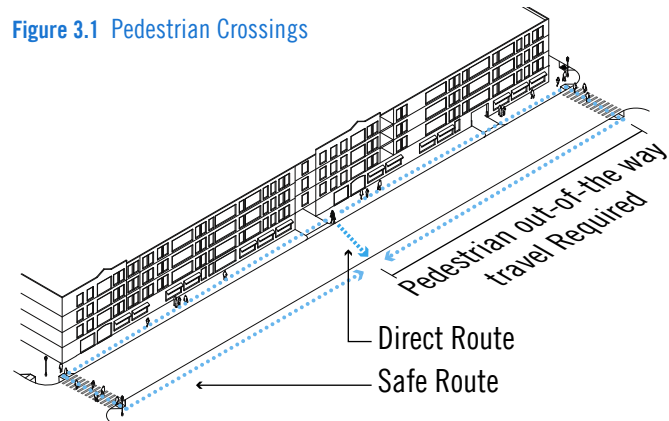
All streets should have regularly spaced, safe, pedestrian crossings. Every intersection that is on a pedestrian route should have pedestrian crossings with barrier-free ramps on the pedestrian route. All intersections shall accommodate pedestrian crossings whether the crossing is marked or not. Refer to the TMUTCD Section 3B.18 Crosswalk Markings for more information on the appropriate use of crosswalk markings.

Additional midblock pedestrian crossings may be justified where blocks are long or at locations of high pedestrian traffic. Mid-block pedestrian crossings are not preferred, but can be provided by approval of the Director. Reference Figure 3.1 Pedestrian Crossings.

NACTO states: *In general, if it takes a person more than 3 minutes to walk to a crosswalk, wait to cross the street, and then resume his or her journey, he or she may decide to cross along a more direct, but unsafe or unprotected, route. While this behavior depends heavily*

on the speed and volume of motorists, it is imperative to understand crossing behaviors from a pedestrian's perspective. (NACTO Urban Street Design Guide) The designer shall assess the path a pedestrian would take at a crossing and calculate time of travel using 3.5 feet per second as the pedestrian's travel speed. If a crossing is not within the 3-minute period, meet with City staff to discuss this situation and options which may be available to accommodate pedestrians.

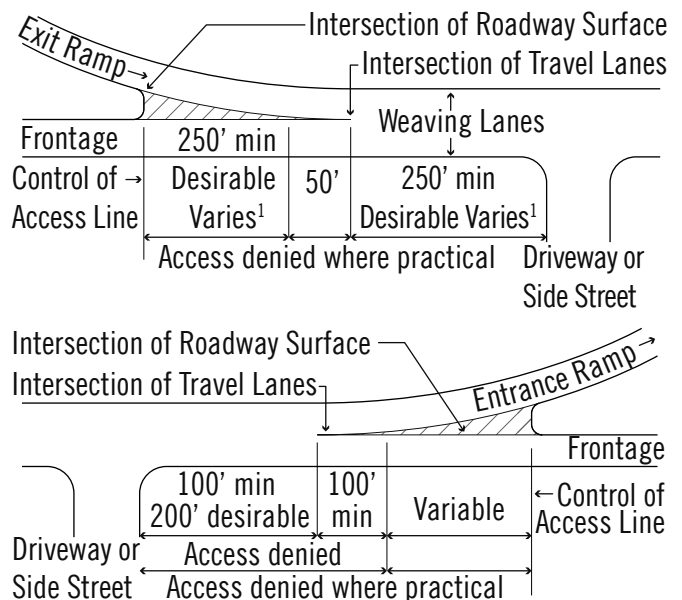
Figure 3.1 Pedestrian Crossings



3.2.1.7 Freeways

Street access along freeway frontage roads must be reviewed and approved by the responsible governmental agency. Refer to TxDOT Roadway Design Manual Chapter 3, Section 6 – Freeways, Frontage Road Access for exhibits and guidance on street access along freeway frontage roads, and Figure 3.2.

Figure 3.2 Street Access Along Freeway Frontage Roads



It may be desirable to place jiggle bars in cross-hatched area to discourage crossing

¹ See TxDOT Roadway Design Manual Table 3.16

3.2.2 Transition Zones

Street transition zones are those locations where new street improvements need to tie into existing street sections. The designer shall follow the following parameters in the design of transition zones.

1. Provide a clear and obvious path for vehicular traffic flow on the street. Curb or pavement edge transitions shall be gradual and not abrupt. The length of transition must consider the target speed on the street and the various vehicle types which would commonly use that street.
2. Where curb height differences occur or to transition from a normal 6-inch high curb to zero height, the length of transition shall be equal to or greater than 10 feet.
3. The pavement surface shall provide a smooth ride for vehicles at the target speed where the surface transitions from the old pavement surface to the new pavement surface. The maximum vertical point deflection at the interface shall not exceed 1.5%. Grade differences greater than 1% will require construction of a vertical curve in the proposed pavement appropriate for the target speed.
4. All street transitions must provide positive drainage along the curb line, or in adjacent bar ditch, if no curb line exists. Provide proper inlet capacity at or before the curb return to prevent street drainage from entering intersections.
5. Consider location of existing and proposed utilities – power poles, light poles, fire hydrants, etc. – in the design of transitions. Where necessary, relocate or adjust utility infrastructure in the transition zone to meet current criteria and regulations of the City and / or utility provider.
6. Provide adequate and appropriate pedestrian facilities through the transition zone. These may include sidewalks, curb ramps, cross walks, bus stops, etc. Comply with the requirements of ADA and TAS.
7. Incorporate required TMUTCD signs, traffic signals, pedestrian signal, railroad crossing signs and markings in the transition zone(s).

3.2.3 Median Openings

3.2.3.1 General

The following standards for median openings on divided arterial thoroughfares are established to facilitate traffic movement and promote public safety.

Median openings on non-controlled highways (Northwest Highway, Preston, and Garland) must be reviewed and approved by TxDOT.

3.2.3.2 Warrants

Median openings shall be provided at all intersections with public or private streets and at certain driveway approaches that generate a minimum traffic count of 250 vehicles in a 12-hour period as determined by the Director. Exceptions, including the proximity to other warranted median openings or hazardous situations, must be approved by the Director.

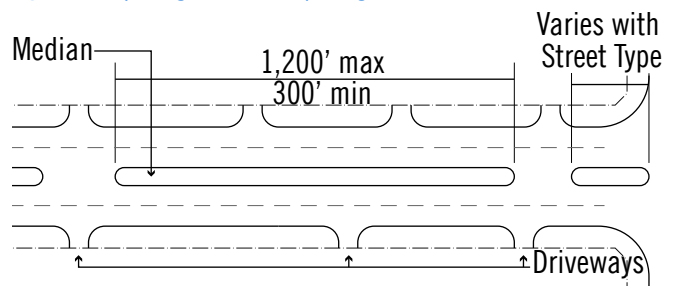
Median curb transitions, and left turn storage lanes where applicable, shall be provided to serve all median openings. Geometrics shall comply with applicable standards established in this manual.

Mid-block median openings are warranted on six-lane divided streets when the spacing between existing and / or proposed median openings near the location exceeds 1,200 feet and there is sufficient median width for a left turn. The requirements of Section 3.2.3.3 Spacing of Median Openings shall be followed.

3.2.3.3 Spacing of Median Openings

The following spacing requirements are measured between the noses of the medians: (Reference Figure 3.3 Spacing of Median Openings)

Figure 3.3 Spacing of Median Openings



A Spacing Between Median Openings

1. The spacing between median openings should be equal to or less than 1,200 feet.
2. Median openings serving non-arterial streets and driveway approaches along a divided thoroughfare shall be equal to or greater than 300 feet.
3. Median openings serving railroad crossings along a divided thoroughfare shall be equal to or greater than 210 feet from another non-arterial opening.
4. Mid-block median openings shall be equal to or greater than 300 feet from any other median opening.

B Location of Median Openings

1. Median openings are not allowed in left turn storage lanes or left turn transition curb areas.
2. Median openings shall be located, wherever feasible, to serve both sides of the street.

C Spacing of Median Openings

The following minimum spacing limitations from arterial thoroughfare intersections should be observed for the following types of median openings on divided principal arterials as measured between the noses of the medians:

1. Railroad Crossing Type Openings should be located equal to or greater than 260 feet from minor arterial intersections and equal to or greater than 335 feet from principal arterial intersections.
2. Driveway Approach Type or Mid-block Openings should be located equal to or greater than 350 feet from minor arterial intersections and equal to or greater than 425 feet from principal arterial intersections.
3. Non-arterial Street Type Openings should be located equal to or greater than 350 feet from minor arterial intersections and equal to or greater than 425 feet from principal arterial intersections.
4. Minor Arterial Street Type Openings should be located equal to or greater than 410 feet from minor arterial intersections and equal to or greater than 485 feet from principal arterial intersections.
5. Principal Arterial Street Type Openings should be located equal to or greater than 535 feet from principal arterial intersections.

3.2.3.4 Relocation of Openings

Existing median openings may be relocated if:

1. The existing opening does not provide service to a public or private street.
2. The proposed median opening meets the spacing requirements in Section 3.2.3.3 Spacing of Median Openings.
3. The existing median opening is no longer in use and the owners of the properties being served by the existing median opening sign a document requesting or approving the median opening relocation and the signed document is approved by the Director.

3.2.3.5 Freeways and Expressways

Refer to TxDOT Roadway Design Manual for requirements for medians on freeways and expressways.

3.2.4 Rail Crossings

3.2.4.1 General

Rail lines carrying freight and commuters crisscross the City of Dallas and frequently intersect the roadway system. The nature of these rail crossings vary dramatically. Some rail crossings have trains every few minutes, a few rail crossings only have a train or two a day. Some rail crossings –street light rail and streetcar crossings – allow for two-way coordination, where trains can be stopped to wait for vehicular and pedestrian traffic or vehicular and pedestrian traffic can be stopped to wait for trains. At other rail crossings, trains pre-empt all other movements.

Unlike street intersections, rail crossings can rarely be adjusted as part of a street improvement or reconstruction. The alignment and elevation of the tracks shall be assumed to be fixed unless the rail owner / operator determines otherwise. Therefore, the remainder of the roadway network must be designed around the existing rail crossing. The following guidelines and requirements shall apply.

3.2.4.2 Guidance

Where possible, rail crossings (except, obviously, for street-running rail lines) should be located away from intersections. Rail crossings immediately next to an intersection can confuse motorists. Ideally, a railroad crossing will be located far enough away from an intersection that the space between the crossing and the intersection can contain any traffic backup that may occur at the intersection.

If a rail crossing is located near a signaled intersection, it is required to link traffic signals to the railroad crossing signals so the traffic signals will not permit vehicular and pedestrian movements that conflict with the railroad crossing signals.

Visibility at and around a rail crossing is important.

Freight and commuter rails are required to sound horns at all crossings unless the crossing has gone through a federal approval process to become a designated “quiet zone.” “Quiet zone” requires specific design and signing measures which can impact other elements of the street, like medians and sidewalks. It should be established early in the design process whether a “quiet zone” is desired so the street components can be designed and constructed to meet the “quiet zone” requirements.

New streets should be designed to be grade separated from railroad tracks where an at grade crossing would result in a Level of Service (LOS) of D or less during either peak AM or peak PM periods as based on a traffic study analyzing existing and proposed conditions for current year and future build-out. It is also required to have a grade separation for all tracks crossing six lane arterials.

Where existing streets cross rail tracks and a rebuild or other major modification of the street is planned, the designer shall assess with involvement from the City; the feasibility of changing to a grade separation; or making other changes to the grade crossing that improve safety and convenience of the public and community. Such changes may include improved street geometrics, improved roadway section, improvement to the rail infrastructure at the street crossing, lighting enhancements, inclusion or upgrading visual and audible warning devices.

3.2.4.3 Requirements

The designer shall coordinate with the City and the railroad owner / operator for street modifications which cross rail tracks, or are in railroad right-of-way, whether for new construction or modifications of the existing street crossing. It is assumed that rail crossing safety devices (vehicular and / or pedestrian gates, beacons, gongs, etc.) will be provided, installed, and operated by the rail owner / operator. Also, track crossing panels needed for the roadway, walks, and trails will also be provided, installed, and operated by the rail owner / operator. The railroad owner / operator shall determine where new street work will match up to their facilities. However, exceptions to the railroad owner / operator paying for said safety devices may have occurred; therefore the entity which is paying for rail crossing safety devices needs to be confirmed by the designer.

Street Intersections shall be located at the minimum distance of 115 feet between a street intersection and a rail crossing. This 115 feet separation is measured from the nearest point of the intersection of the street right-of-way and the nearest point of the railroad right-of-way. This separation is to provide clarity to motorists and to provide space between the rail crossing the intersection for traffic queues from either the intersection or the rail crossing gates or signals. See Figure 3.4.

Provide street geometrics that provide clear lines of sight for motorists in both directions from the far side of the intersection to the far side of the rail crossing when intersections are within 200 feet of a rail crossing. If this is not possible due to topographical constraints, determine what can be provided and for what target speed for further discussion and assessment with the Department of Public Works and other City departments.

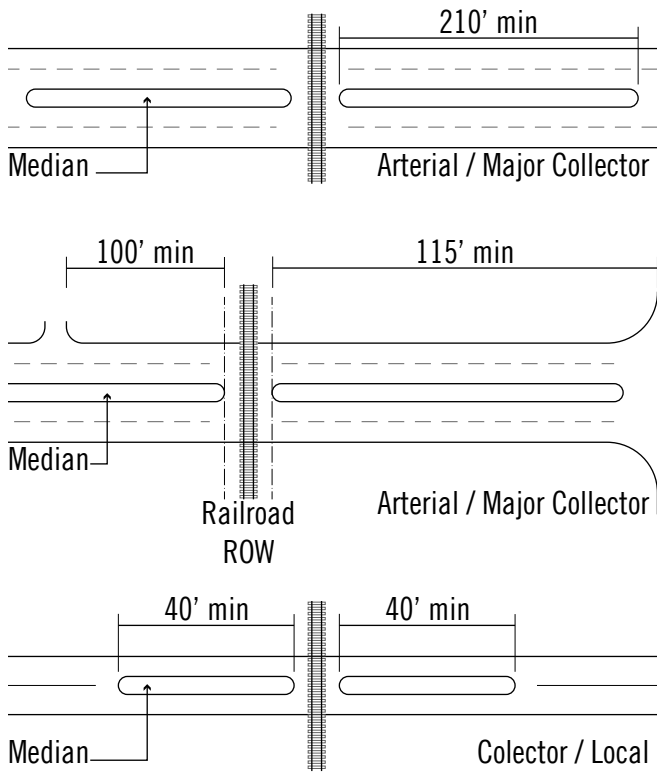
For two-way streets, provide barriers on either side of rail crossings that prevent motorists from running around the end of a down gate arm “to beat the train”. An effective barrier is a raised median which extends away from the gate arm separating two-way traffic. Minimum barrier length is 40 feet, but can be longer in high volume roadways (arterials and collectors) depending on the number of traffic lanes, expected traffic queue lengths, and other project site conditions.

A traffic analysis shall be performed to determine expected peak hour traffic volumes and queue lengths in each direction of the street which crosses the rail crossing. If the analysis results in a Level of Service C or lower at a traffic signal-controlled intersection or at the rail crossing, the traffic signal controller shall be integrated to the railroad crossing signals, if permitted by the railroad owner / operator and agreeable to the City. This interconnection of controllers is intended to provide traffic progression both across the tracks and through the intersection when trains are not present, and to provide cross street traffic progression when a train is crossing the street and the railroad gates are down.

New driveways shall not be permitted within 100 feet of the nearest railroad right-of-way. See Figure 3.4. Exception: Existing commercial and residential driveways that are limited to “right-in and right-out” only movements, and properties which have no other street frontage for access, are allowed within 100 feet but no closer than 20 feet of the existing railroad right-of-way. See related requirements in Section 4.4.4.5.

Include appropriate provisions for adjacent sidewalk and bike trail facilities to provide safe infrastructure that also allows progression of pedestrian and bike movements. Additionally, provisions should be provided to prevent pedestrian and bikes from going around the end of the down gate or fence. These provisions shall include items which may not be provided by the railroad owner / operator and may include lighting, striping, signage, fencing, and other elements.

Figure 3.4 Rail Crossings



3.2.5 Pedestrian Networks

City of Dallas policy in Ordinance #29478 and the Dallas Development Code Section 51A-8.606 requires that sidewalks be constructed with the construction of all public and private streets unless waived by City Council upon recommendation of the Director. A waiver of the sidewalk requirement, using the City’s “Sidewalk Waiver Application and Agreement Checklist” which is available in Building Inspection, may be appropriate in the following instances:

- The potential pedestrian traffic in the area is so minimal that sidewalks are not warranted.
- For projects in a single family or duplex zoning district, at least 50% of the lots located on the same side of the block as the proposed plat or project have been developed with completed, approved structures without sidewalks.
- Permanent line and grade cannot be set within the public street right-of-way.
- It is desirable to preserve natural topography or vegetation pre-existing the proposed project, and pedestrian traffic can be accommodated internally on the adjoining property through public easements or right-of-way.

All sidewalks must be designed and constructed to be barrier-free to the disabled, and in accordance with the requirements of Americans with Disabilities Act, Texas

Accessibility Standards, Texas Department of Licensing and Regulations, and the Standard Construction Details, File 251D-1. All sidewalks must be constructed in accordance with the requirements of Sections 4.4.5.4 Crosswalks and Crossings and 5.2.4 Sidewalks of this manual.

The pedestrian zone is composed of three zones: the frontage zone, sidewalk clear zone, and buffer / furnishing / curb zone. Refer to Section 2.5 Zones for guidance regarding these zones.

The frontage zone creates a buffer between where people walk and swinging building entrance doors. This space can also be used for retail displays or outdoor café seating. Use of public right-of-way for outdoor café seating and similar uses requires a license agreement or permit from the City for such encroachment and use. Frontage zone uses of public right-of-way shall not impinge upon required sidewalk widths.

The sidewalk clear zone is the clear space dedicated exclusively for pedestrians to travel. All above-ground elements shall be placed in the frontage or buffer / furnishing / curb zones. Surface design, dimensions, and slopes of this zone are critical for accessibility and safety. Refer to Section 4.5.3 Pedestrian Zone Widths for dimension guidelines. Refer to Section 5 Pavement Structure for paving material guidelines.

Within the buffer / furnishing / curb zone, locate trees, special landscaping, street furniture, light poles, signs and other structures to provide at least 2 feet of clearance from outermost edge of structure or vertical element to back of street curb and to the sidewalk clear zone. Paving material design requirements of the sidewalk zone apply to this zone. Minimum clear width of the buffer / furnishing / curb zone shall be equal to or greater than 2 feet for low speed traffic of 25 MPH or less. Higher speed roadways warrant a greater clear zone. Add a minimum 1 foot of clear width for each additional 10 MPH of posted speed up to 45 MPH (4 feet). Guard rails and other traffic-rated barriers can be in or along the buffer / furnishing / curb zone, but located and installed in accordance with other design criteria.

3.2.6 Bicycle Provisions

The City of Dallas promotes bicycling as a viable mode of transportation. The City has installed new bicycle facilities and has adopted context-sensitive infrastructure design approaches to integrate safe, comfortable bikeways onto more streets in the City. The 2011 Dallas Bike Plan is a policy guide for making Dallas more bike-friendly through policies and the implementation of a city-wide bikeway network. The adopted network plan maps out bikeways across the entire city. The bikeways are classified into two categories:

- **On-Street Bikeway:** Bike facilities within a street. These include facilities where bicyclists share the travel way

with vehicles, which are most appropriate for low-volume, low-speed streets as well as dedicated facilities such as a bike lane, which may have a barrier or buffer between bicyclists and vehicle traffic and in some situations, a side path behind the curb may be determined as the most appropriate bikeway for a corridor.

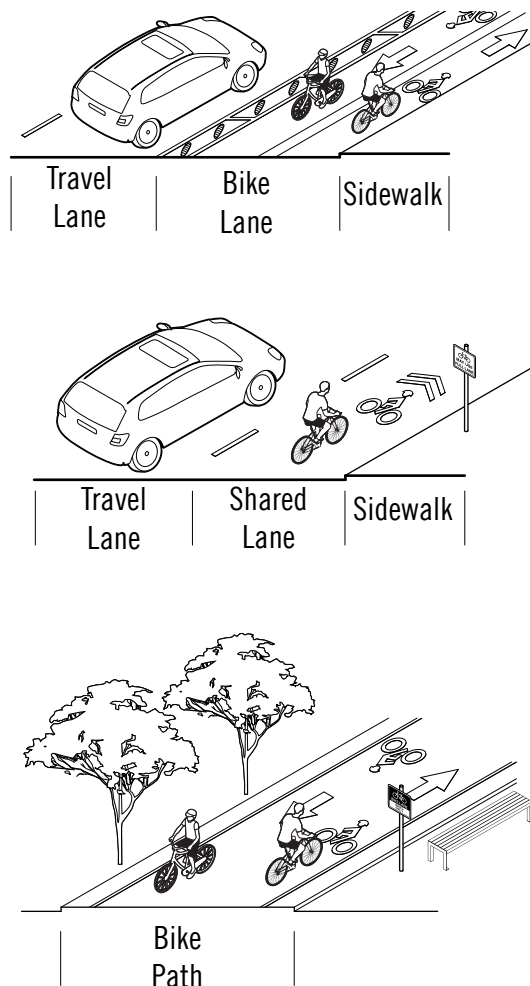
- **Off-Street Bikeway:** Dedicated path or trail, often shared with people walking or jogging, which is completely separated from vehicular traffic.

The connectivity of the bike network is critical. Leaving out a segment of the adopted plan will make bicycle trips less safe and will likely discourage people from riding their bikes between destinations.

Where a street is shown on the bikeway plan as having a bicycle facility, that facility shall become part of the design of the street as shown in Figure 3.5. In some cases, it will be appropriate to find an alternate route along a parallel street or right-of-way, but that is only desirable if the alternate route does not take bicyclists out of their way or disrupt the connectivity of the network. Coordinate with the City’s Bicycle Coordinator during the consideration of an alternate bike route or variation of the bicycle facility. Designer must obtain the Bicycle Coordinator’s concurrence prior to proceeding with an alternate design.

Streets not shown on the bikeway plan still need to consider bikes as a transportation mode. In some cases, the street could be a useful additional link to the bike network, or a way to implement a bike facility more quickly than a nearby corridor designated in the Bike Plan. Every street that connects to an off-street bikeway should be considered for bike path connectivity. More fundamentally, every home, business or institution on a street is a possible destination and there should be a way for a person on a bike to reach it.

Figure 3.5 Bicycle Provisions



3.2.7 Dead-End Street

3.2.7.1 General

Dallas Development Code Section 51A-8.506 provides specific requirements for dead-end streets, whether of a temporary nature or permanent. These are summarized below. The designer must comply with the following requirements and Chapter 51A of the Dallas Development Code. The Fire Department has specific requirements for turnaround of their vehicles, and those requirements must be met in configuration and roadway structure to support the weight of the Fire Department apparatus whether traveling or staged for an event.

With City staff, the designer shall assess the need for pedestrian connections at the end of dead end streets to connect with other trails, walks, or public spaces.

3.2.7.2 Temporary Dead-End Street

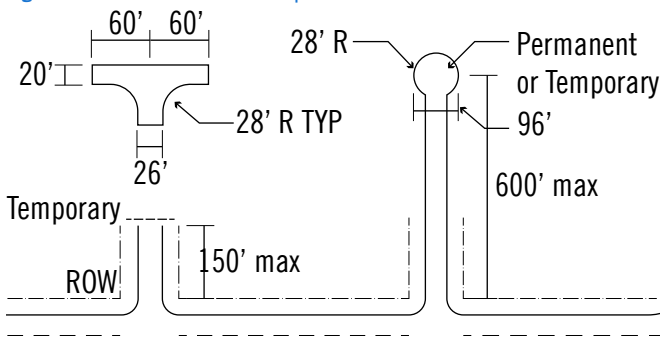
If adjacent property is undeveloped and a street must terminate temporarily, the permanent street right-of-way must extend to the boundary of the plat. When a temporary dead-end street is shown on a plat, a temporary circular or “T” shaped turnaround must be provided and shown as an easement on the subdivision plat, and the temporary pavement must be indicated on the plat by dotted lines. No turnaround is required if the dead end street is 150 feet or less in length, measured from the intersection of the cross street right-of-way line with the subdivision boundary. Reference Figure 3.6 Dead-End Street Requirements. All temporary turnarounds are subject to approval by the Director.

3.2.7.3 Permanent Dead-End Street

If a proposed plat would create a permanent dead-end street, the end would terminate in a circular turnaround with right-of-way equal to or greater than a radius of 50 feet. Street pavement shall be equal to or greater than 43.5 feet in radius. Final design requires approval from the Director which must include written concurrence from the City’s Chief Planning Officer. The length of a permanent dead-end street must not exceed 600 feet, measured along the centerline from the Cross Street right-of-way to the center of the cul-de-sac, as shown on Figure 3.6. Exception: the permanent dead end street may be extended due to topography or property shape requirements; must comply with the fire code along with obtaining City Chief Planning Officer and Director written approval.

A written waiver to the requirement of a circular turnaround is possible if the City’s Chief Planning Officer and Director determines that the turnaround is not needed to serve traffic on the dead-end street, the dead-end street complies with the Dallas Fire Code, and the dead-end street includes an approved turnaround or alternatives as denoted and graphically depicted in Appendix D of the Dallas Fire Code. The Dallas Fire Code states that the Dallas Fire Department has approved hammerhead alternatives “T” and “Y” for use. Refer to the Dallas Fire Code for more information on the details and requirements for hammerheads.

Figure 3.6 Dead-End Street Requirements



3.3 ALLEYS

3.3.1 General

Alleys are required in residential and commercial zoning districts when certain zoning conditions exist, and may be provided in other instances where they improve access or circulation. (See Section 2.2.8 Alleys).

The following requirements apply to new alleys:

- An alley must provide vehicular access from a dedicated public right-of-way or easement to another dedicated public right-of-way along pavement which is all within dedicated public right-of way.
- Alleys must either intersect with a dedicated public or private undivided street or another alley.
- Alleys shall not be directly accessed from divided streets. Should site topography or property shape unduly limit access to an undivided street or another alley, written approval to connect to a divided street must be gained from the Director.
- The distance between access points from streets or other alleys should not exceed 1,200 feet, as measured from the back of curb at alley tie-in location along the centerline of alley. The alley length may be increased to 2,000 feet upon approval of the Director if extraordinary topography or shape of the property unduly limits the development potential or if it is in the best interest of the City to extend the length of the alley.
- Permanent dead-end alleys are prohibited. Any exceptions will require written approval of the Director which may require providing an approved permanent turnaround or a dead-end length of less than 50 feet. Accommodations shall be required along the main run of the alley so that trash and recycled materials containers can be staged such that pickup can be accomplished without the truck driver having to back-up or perform non-typical truck movements to lift and empty trash and recycle containers.
- Alleys must function without reliance on fire lanes or access easements.

- Alleys adjoining and parallel to a street must be separated from the street. (See Section 4.4.5.9 Traffic Barriers)
- At an alley’s intersection with a street, the minimum spacing or separation between a driveway which also intersects that street and the alley shall be equal to or greater than 10 feet between the projected pavement edges of the alley and the driveway.

Existing alleys may be upgraded or reconstructed without meeting these requirements as long as current connectivity and access are maintained. No sections of any alley shall be abandoned if doing so causes the remaining alley sections to violate any of these requirements.

Alleys shall be prioritized for vehicular access over driveways, and street curb cuts for alleys shall allow continuous pedestrian circulation at their intersections where sidewalks must cross the alleys. Alleys must provide continuous vehicular access regardless of zoning.

Geometric requirements for alleys are given in Section 4.3.8 Alleys.

Structural requirements for alleys are given in Section 5.2.5 Alleys.

3.3.2 Intersections

An alley approach must not be located within 50 feet of a railroad right-of-way, as measured from the closest point of the railroad right-of-way and the closest point of the alley throat (excluding the alley approach flares). Access spacing requirements for alleys from street intersections are the same as for driveway approaches. See Figure 3.8, Minimum Distance from Intersections for Driveways.

3.4 DRIVEWAY APPROACHES AND CURB OPENINGS

3.4.1 General

3.4.1.1 Definition

A driveway approach is defined in the Dallas City Code, Section 43-32 as “An area, construction, or facility between the roadway of a public or private street and private property intended to provide access for vehicles from the roadway of a public or private street to private property.”

3.4.1.2 Use and Application

On redevelopment sites, new driveways shall be designed and constructed conforming to the requirements noted in this manual. Driveway location shall consider the condition and configuration of the street system, traffic patterns and traffic volumes, the presence of other driveways and alleys, visual obstructions, and the need for safety of the motoring public, pedestrians, bicyclists and others.

New driveways shall be designed and built to comply with current accessibility regulations and standards at sidewalk crossings.

Where feasible to do so, the use of common shared driveways can be considered, but such shared use will require easements or recorded agreements which run with the property.

Existing driveways shall be assessed whether they comply with current accessibility regulations and standards, and if deemed to be significantly deficient, in the sole opinion of the City, shall be reconstructed. Reuse of existing driveways may be allowed if the driveway is in good condition, has structural soundness for vehicular support and longevity with an appropriate surface for users, and it meets the intent of the above requirements

without maintaining or creating diminished safety or usability for its intended users or the public's use of street right-of-way.

Review the requirements in Sections 3.5 Off-Street Parking and Driveways and 4.5.8 Driveways and Curb Cuts regarding driveway types, the consistency of driveway types in established neighborhoods, and other related requirements.

3.4.1.3 Restrictions

Driveways should not be located and designed to encourage high traffic volume or truck use of local residential and residential collector streets. Where single family, townhouse, duplex, or other low to medium density zoned lots abut a divided principal thoroughfare, driveway access to the thoroughfare is prohibited unless there exists an extraordinary topography or shape of the property which unduly limits alternate access to the property. All such exceptions must be approved in writing by the Director. Traffic barriers shall be provided as given in Section 4.4.5.9 Traffic Barriers unless otherwise approved by the Director.

Additional guidelines concerning the geometric design of driveway approaches and curb openings is given in Section 4.5.8 Driveways and Curb Cuts.

Structural requirements for driveways are given in The Department of Public Works Standard Construction Details, File 251D-1.

3.4.2 Width and Number

Driveway approaches for all new or redevelopment projects shall meet the following requirements. Construction standards in addition to these are defined in the City's 251D-1 Construction Standards. Also, the Dallas Development Code has additional requirements noted therein. Exceptions to the following criteria may be granted by the Director.

Single-Family Zoned (R-xx), Duplex (D), and Agricultural (A) Lots:

- Minimum driveway approach width shall not be less than 10 feet, nor greater than 16 feet.
- Maximum number of driveways onto public streets shall not be greater than two.
- Circular driveways on residential lots are not permitted when street frontage is less than 65 feet.
- Single-family zoned lots may gain their driveway access from alleys as allowed by the Dallas Development Code.
- Driveway radii or flares shall not protrude onto the frontage of adjacent lots, unless agreed by the adjacent property owner.

Townhouse (TH-x), Cluster (CH), Multi-Family (MF-x), and Mobile Home (MH) Lots:

- Two-way driveway approach width from a public street shall not be less than 20 feet if not a designated fire lane, and 24 feet if designated as a fire lane.
- One-way driveways shall not be less than 16 feet wide, nor more than 20 feet. One-way driveways are not intended to serve as a fire lane.
- Maximum number of driveways onto public streets shall not be greater than two, unless supported by a traffic study approved by the City.
- Townhouse, Cluster, and Multi-Family lots may gain driveway access from alleys as allowed by the Dallas Development Code.
- Driveway radii or flares shall not protrude onto the frontage of adjacent lots, unless agreed to by the adjacent property owner.
- If required by the City, the designer shall provide traffic studies supporting the driveway widths, configurations and locations. The traffic studies shall address other relevant site conditions such as proximity of other driveways and intersections, their sizes and configurations, and impacts to nearby street intersections and capacity of the local street system.

Commercial Lots having zoning designations of NO, LO-x, MO-x, GO, NS, CR, RR, CS, LI, IR, IM, MU-x, MC-x, PD, and P, except Central Area (CA):

- Driveways for commercial lots shall be designed for two-way traffic. Minimum width shall be 24 feet which assumes two 12-foot wide lanes for inbound and outbound traffic.
- Maximum width for undivided driveways shall not exceed 30 feet unless supported by a traffic study approved by the City. This traffic study would define requirements for multiple inbound or outbound lanes to accommodate projected traffic demand and turning movements.
- Driveways divided by a median shall be supported by a traffic study approved by the City. Minimum width for entry and exit drives shall be 12 feet each way to accommodate single lanes of traffic.
- If required by the City, the designer shall provide traffic studies supporting the driveway widths, configurations and locations. The traffic studies shall address other relevant site conditions such as proximity of other driveways and intersections, their sizes and configurations, and impacts to nearby street intersections and capacity of the local street system.

Central Area (CA) Lots:

- Driveways serving Central Area lots may gain access from public streets or alleys.
- Where street and alley speeds are less than 20 MPH and pedestrian traffic on walks is significant, narrower curb cuts (12-foot for single lanes, 24-foot for two-way traffic) are preferred.
- All other requirements for Commercial Lots apply.

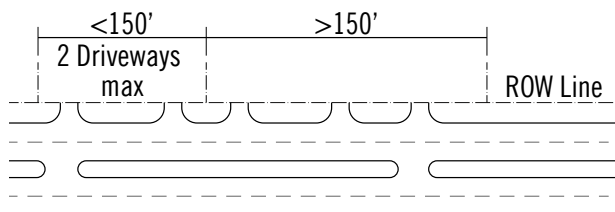
3.4.3 Spacing

Standard geometric details for driveway approaches are provided in Section 4.5.8 Driveways and Curb Cuts. The number of driveway approaches serving an adjoining property along a street, especially on arterial thoroughfares should be minimized. No more than two driveway approaches should be designed on any parcel of property with a frontage of 150 feet or less (Dallas City Code, Section 43-84). Driveways generating at least 250 vehicles in a 12 hour period should be located and designed to align with an existing or proposed median opening to facilitate efficient, safe traffic access. Excessive use of driveway approaches usually results from poor traffic circulation design on the adjoining property. Accident rates increase as the number of driveway approaches serving the property increase.

Many existing driveways do not meet these spacing requirements. The existing driveways can be retained as long as they remain in use. Any property which is replatted or redeveloped shall have their driveways closed / improved / relocated to meet current requirements where possible. Refer to Figure 3.7 for restrictions on driveways.

Any driveway which is no longer used for vehicular access to the property must be abandoned (Dallas City Code, Section 43-93). At the time any street is rebuilt, a determination should be made if any existing driveways along that street are no longer in use so the driveway(s) can be eliminated.

Figure 3.7 Restrictions on Driveways



3.4.4 Intersections

Driveway approaches shall not be located too close to street intersections. Locating driveways too close to an intersection results in blockage of driveway access due to vehicles stopped at the intersection. Two driveways near an intersection may encourage vehicular traffic to illegally bypass the intersection by driving through adjoining properties. As property redevelops, existing driveways near intersections are to be removed and replaced with new driveways meeting the requirements of this manual.

The minimum distances for driveway approaches and curb openings at intersections are given in Figure 3.8.

Driveway approaches at arterial thoroughfare intersections with other thoroughfares should be located equal to or greater than 55 feet as measured from the edge of the driveway throat to the projected face of curb line of the thoroughfare at the intersection. Angle or one way driveway approaches require a distance equal to or greater than 45 feet. At residential collector and thoroughfare intersections with local and residential collector streets, driveway approaches should be located equal to or greater than 40 feet. A minimum spacing of 30 feet shall be used from local street to local street intersections.

Driveway locations at free right turn designs have different minimum spacing requirements as shown in Figure 3.8. Values for “D” on Figure 3.8 are given in Table 3.1.

Driveway approaches must not be located within 50 feet of a railroad right-of-way as measured from the closest point of the railroad right-of-way and the closest point of the driveway throat (excluding the driveway approach).

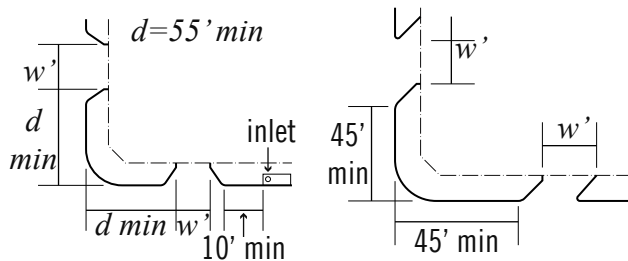
Table 3.1 D-Value Chart

Arterial Target Speed (mph)	Percent of Right Turns		
	<10%	10%-20%	>20%
35	30	40	50
40	35	50	60
45	40	55	65
50	45	60	70
55	75	80	85

Figure 3.8 Minimum Distance from Intersections for Driveways

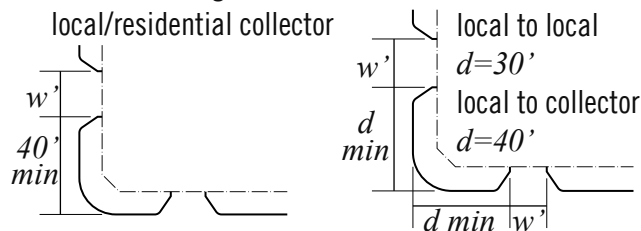
1. Intersection- Arterial thoroughfares with arterial & collector thoroughfares or pedestrian or school crossing

(A) 90° driveway approaches (B) Angle or oneway approaches



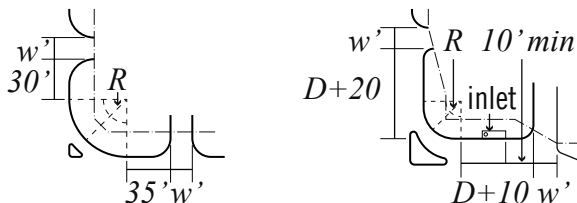
2. Intersection- All other cases (without free right turn lane)

(A) Arterial thoroughfare with local/residential collector (B) All other cases

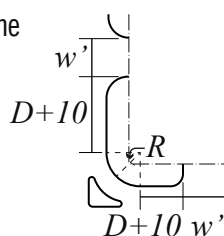


3. Intersection- Free right turns

(A) Free right turn lane no acceleration or deceleration lanes (B) Free right turn lane acceleration or deceleration lanes may exist



(C) Free right turn lane continuous flow



For arterial thoroughfares (standards apply to both 90° and angle approaches) location of driveway is dependent upon speed and free right turn traffic volume return percent.

R = Curb Radius
 W = Min Driveway Width
 D = D-Value (see Table 3.1)

3.4.5 Freeways and Expressways

All driveway approaches and curb opening cuts near freeway and expressway service roads must be approved by the responsible governmental agency. Any driveway approach design near a freeway and expressway must comply with the standards of TxDOT and / or NTTA as applicable to that owner or operator.

3.4.6 Legacy Conditions

Within the City there are legacy conditions which interfere with street performance, conflict with providing appropriate walks and trails within public right-of-way or easements, or limit the ability to provide driveways at desired locations where feasible. Undesirable legacy conditions shall be eliminated or modified to reduce street conflicts and improve safety and operation. Such conditions include:

- Diagonal Parking Spaces - Existing diagonal parking where a portion, or all, of those parking spaces may be on private property, and backing up into street travel lanes is required to exit those parking spaces. Also, diagonal parking may not provide an adequate pedestrian zone to accommodate sidewalks, lighting, and other street elements within the public right-of-way. As properties redevelop, including maintaining their current zoning designations, diagonal parking shall be displaced with other design solutions that fit within the complete streets policy directives and criteria stated within this manual.
- Drive Approach Widths and Number – Some existing drive approaches are now substandard in width, or exceeding the maximum number and / or widths as defined by current criteria. As properties redevelop, including maintaining their current zoning designations, driveway approach widths, number and their locations shall be reassessed and brought into compliance with the criteria and requirements stated within this manual.
- Consideration shall be given to pedestrian needs, especially in areas trending or planned as walkable and / or bikeable.
- Accessibility for Walk and Trail Crossings – Older style driveways that do not meet current pedestrian accessibility requirements shall be modified to meet requirements at usual designated crossing locations with public sidewalks, trails, or other designated pedestrian travel routes.

- Driveway Approach Type – In keeping with established neighborhood development patterns, whether with radius curb returns or dishpan flares, driveway approaches which do not match the predominant style already in existence shall be rebuilt in a style and configuration matching the neighborhood when properties are redeveloped or when new driveway approaches are built or reconstructed. See the 251D-1 Standards for applicable details.

The Complete Streets Design Manual directs the reduction or elimination of free right-turn movements where possible. The Designer shall look at the feasibility and practicality to eliminate or not create new free right-turns at intersections where significant pedestrian movements are expected, unless the free right turn is enhanced for those pedestrian movements and waiting areas. This may require additional warning signs for motorists, active Walk / Don't Walk signs for pedestrians, protected wait zones (such as curbed islands) for pedestrians, highly visible cross walks, and other design elements which are permitted by the TMUTCD.

3.5

OFF-STREET PARKING AND DRIVEWAYS

The City of Dallas “Off-Street Parking and Driveways Handbook” provides detailed guidelines and requirements for off-street surface, or garage parking, and driveway and access to that off-street parking.

Dallas Development Code, Sections 51A-4.201 - 51A-4.217 provide regulations for determining required number of parking spaces for development based on zoning districts and existing and / or proposed use(s) for the property. Section 51A-4.301 contains Off-Street Parking Regulations for many zoning districts in the City, construction and maintenance provisions, allowable and required parking space sizes, alternative configurations, lighting, screening, and certain restrictions of access to residential alleys. As an adjacent land use, off-street parking will need to work well with the street design, especially where driveways cross the pedestrian zone, and driver visibility triangles at street-street and driveway-street intersections. See Figure 3.9 for visibility triangles / dimensional requirements.

Special parking regulations outlined by the Handbook include shared parking, remote parking, and packed parking. Shared parking refers to the use of off-street parking for multiple uses. Remote parking refers to off-street parking placed at a distance of no more than 300 feet from the main facility. Packed parking is off-street parking that allows maximization of parking on a lot with an attendant present to park vehicles.

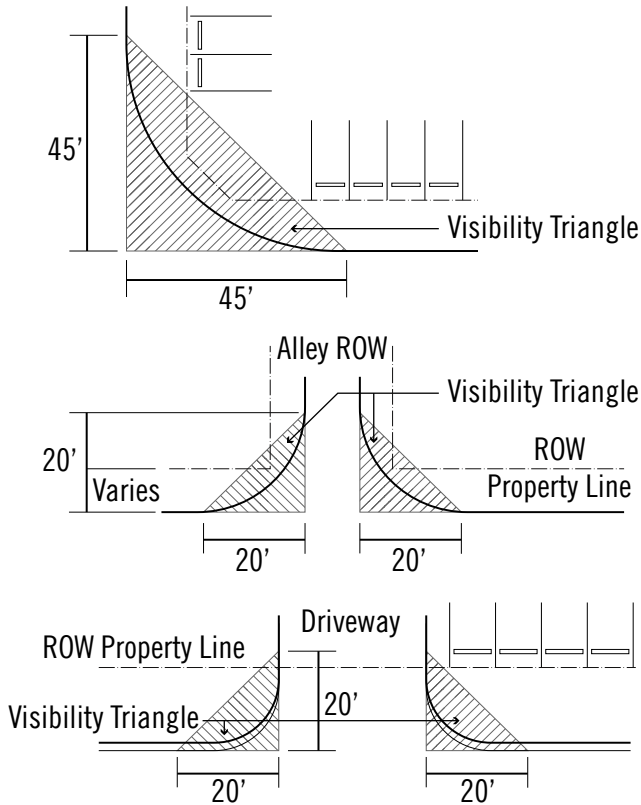
Ratio and design requirements for handicap parking spaces is based on compliance with Texas Accessibility Standards (TAS). A table for required handicap parking spaces is provided in the Handbook and in TAS.

In designing driveway locations for off-street parking, preference should be given to local streets where possible, and avoid designing and constructing driveways on arterial streets where possible.

See requirements in Section 4.5.8 Driveways and Curb Cuts.

See the Drainage Design Manual on how to address means, methods, and requirements for capturing and conveying of stormwater runoff from driveways, parking areas, stormwater flow considerations in streets at driveways and street intersections.

Figure 3.9 Visibility Triangle Guidelines



45 feet x 45 feet Visibility Triangle in all Zoning except:

- Central Business District
- PD 269 (Deep Ellum / Near Eastside District)
- PD 225 (State-Thomas Special Purpose District)
- PD 193 (Oak Lawn Special Purpose District: Only for Streets listed in the Thoroughfare Plan where the visibility is 30 feet x 30 feet)

The following Development Code sections have requirements that can affect driveway and off-street parking configurations and its construction.

- Section 51A-4.303 Off-Street Loading Regulations for providing off-street loading zones for specific uses in certain districts.
- Section 51A- 4.304 for Off-Street Stacking Space Regulations which promote public safety by reducing on-site and on-street traffic congestion.
- Section 51A-4.306 for Off-Street Parking In The Central Business District.





SECTION 4

Geometric Design

This section provides the design criteria to be used in the alignment and geometric design of thoroughfares, streets, and alleys. Additionally, the section discusses the guidelines and minimum requirements controlling the various design elements of the street zones, including the pedestrian (sidewalk clear) zone, street zone, and intersections.

4.1

GENERAL

Geometrics of city streets and thoroughfares may be defined as the geometry of the curbs and / or pavement areas that governs the movement of traffic within the confines of the rights-of-way. Included in the geometrics are the pavement width, degree of curvature, width of traffic lanes, parking lanes, or turning lanes, median width separating opposing traffic lanes, median nose radii, curb radii at street intersections, crown height, cross fall, geometric shapes of islands separating traffic movements and other features. Since city streets and thoroughfares are differentiated by their functions and location, there is also a variance in the geometry that describes the path vehicular traffic should follow.

The intent of the following design criteria is to provide safe streets that accommodate motor vehicles, pedestrians, wheelchairs, bicyclists, and transit users based on the contexts and land uses adjacent to the streets.

Streets shall be designed such that they support policies adopted by the City to reduce and filter stormwater runoff and be designed for sustainability and durability.

Geometric design of streets requires coordination with other City documents including the Complete Streets Design Manual, the Dallas Development Code (Chapters 51 and 51A), Off Street Parking and Driveway Handbook and related regulations, the Dallas Bike Plan, and many other documents. Where these requirements do not cover a specific roadway design condition, the design engineer shall defer to the latest version of the AASHTO Green Book (formally titled “A Policy on Geometric Design of Highways and Streets”), and supplemented by other industry design standards and guidance documents where appropriate for the context of the subject street.

See also the standards identified in Section 1.4 of this manual.

4.2

DESIGN CRITERIA

Design criteria are the primary factors used to guide the design of roadways. When designing urban thoroughfares that are also walkable, bikeable and wheel chair accessible, it is necessary to carefully consider a broad range of design criteria. Some design criteria are fixed—such as terrain, climate and certain driver performance characteristics – but most criteria can be influenced in some way through design and are determined by the roadway designer.

To achieve the complete streets vision, proper focus must be given to identifying the multi-modal user types, local access requirements, neighborhood or area development environment, topography, and safety of all road users including pedestrians, bicyclists, motorcyclists, and transit.

4.2.1 Design Vehicles

Design vehicle is the vehicle a road is designed to accommodate regularly without encroachment into opposing traffic lanes. The American Association of State Highway and Transportation Officials (AASHTO) has defined these vehicles and their minimum turning curb radii and lane widths. In accordance with AASHTO’s design vehicles, this manual defines which design vehicles are appropriate for which streets and contexts. The design vehicle should be one that regularly uses the road. For example, roads with daily bus routes would use a bus as a design vehicle.

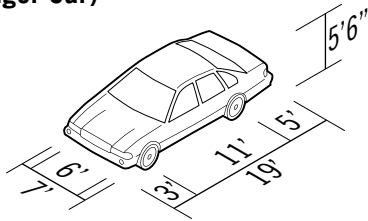
Control vehicle is an infrequently used large vehicle that must be accommodated. The National Association of City Transportation Officials (NACTO) has adopted use of control vehicles in providing capability of urban street systems to handle vehicles that are larger than the usual traffic mix, but are necessary on an infrequent basis. However, instead of using the largest vehicle that uses the road infrequently as the design vehicle, it is acceptable to allow the control vehicle to encroach into opposing traffic lanes, use multiple-point turns, or encroach into opposing lanes of the street side. An example of a control vehicle may be a larger than normal heavy truck, say a long haul tractor-trailer which may occasionally be on a local residential or commercial street. By allowing for encroachment into adjacent travel lanes, the enlarged turning radius must accommodate the movements of control vehicles such as fire apparatus (trucks), emergency

vehicles, and usual delivery and trash collection trucks within designated travel lanes.

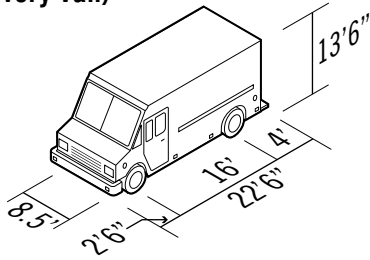
Vehicles classified as P, SU-30, and WB-50 shall be considered as usual design vehicles for most streets. However, arterial and major collector streets must accommodate WB-67 vehicles. Streets which are designated bus routes require BU-40 vehicle characteristics. The designer shall meet with the City to confirm the application of design vehicle. Consideration shall be given to possible changes to bus routes which would require application of BU-40 vehicle parameters on that street. Dimensional information for design vehicles is shown in Figure 4.1.

Figure 4.1 Design and Control Vehicle Dimensions

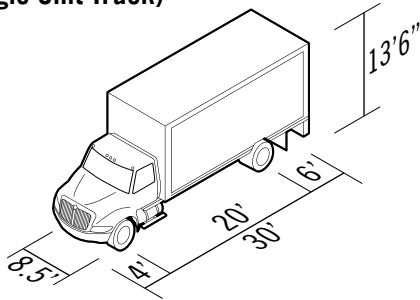
P (Passenger Car)



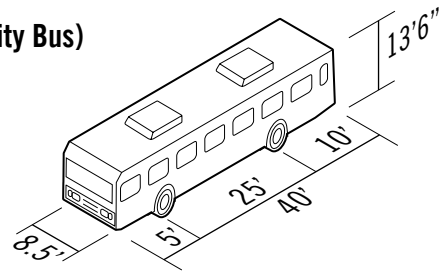
DL-23 (Delivery Van)



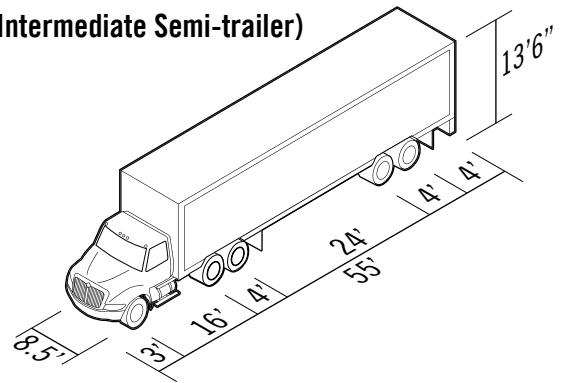
SU-30 (Single Unit Truck)



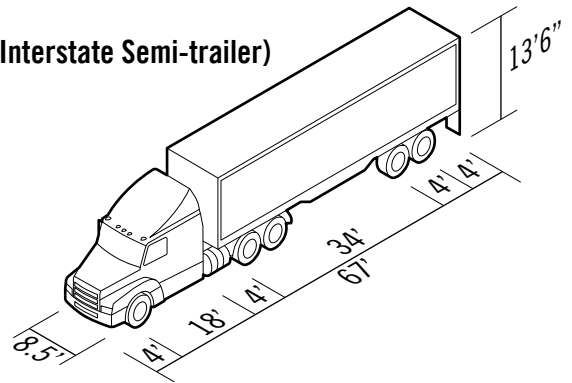
BU-40 (City Bus)



WB-50 (Intermediate Semi-trailer)



WB-67 (Interstate Semi-trailer)



American Association of State Highway and Transportation Officials

The turning templates for these six vehicles are shown in Figure 4.2 as a representative of the tools for design engineers. However, there are many more vehicle types and turning templates readily available for them. Control vehicles are more unique in their maneuvering capabilities on a street which can require more specific analysis by computer modeling with existing and / or proposed street and driveway configurations to affirm viability of a street layout.

Table 4.1 provides the minimum design vehicle which shall be used in design of intersections for various street types. The designer shall meet with the City to determine what control vehicles need to be assessed in design of a particular intersection.

To determine the correct design vehicle, the designer shall obtain classification counts to determine the mix of traffic and vehicle types, and estimate how this will change over time as the context changes. Also, the designer shall consider and estimate how the street and surrounding area will change over the life of the street. After determining a probable mix of vehicles expected for this street, the designer shall consult with City staff to establish the right selection of design and control vehicles which shall be analyzed during street design. The Fire Department must be involved in providing data for its fire apparatus.

Table 4.1 Design and Control Vehicle Criteria

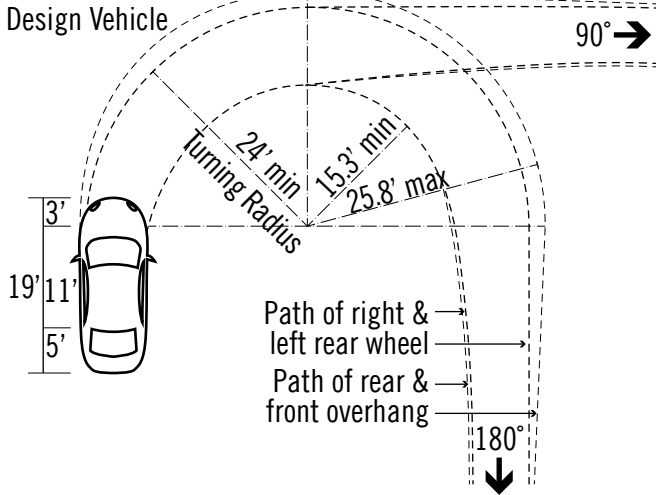
Intersecting Streets	Design Vehicle	Control Vehicle
Local to Local		
Commercial	SU-30	WB-50
Parkways, Mixed Use, Residential, & Woonerf	DL-23	SU-30
Industrial	WB-50	WB-67
Local to Collector		
Commercial	SU-30	WB-50
Parkways, Mixed Use, Residential, & Woonerf	DL-23	SU-30
Industrial	WB-50	WB-67
Local to Minor Arterial		
Commercial	SU-30	WB-50
Parkways, Mixed Use, Residential, & Woonerf	DL-23	SU-30
Industrial	WB-50	WB-67
Local to Principal Arterial		
Commercial	SU-30	WB-50
Parkways, Mixed Use, Residential, & Woonerf	DL-23	SU-30
Industrial	WB-50	WB-67
Collector to Collector		
Commercial	SU-30	WB-50
Parkways, Mixed Use, & Residential	DL-23	SU-30
Industrial	WB-50	WB-67
Collector to Minor Arterial		
Commercial & Parkways	SU-30	WB-50
Industrial	WB-50	WB-67
Mixed Use & Residential	DL-23	SU-30
Collector to Principal Arterial		
Commercial, Parkways, & Mixed Use	SU-30	WB-50
Industrial	WB-50	WB-67
Residential	DL-23	SU-30
Minor Arterial to Minor Arterial		
Commercial, Parkways, & Mixed Use	SU-30	WB-50
Industrial	WB-50	WB-67
Residential	DL-23	SU-30
Minor Arterial to Principal Arterial		
Commercial, Parkways, Mixed Use, & Residential	SU-30	WB-50
Industrial	WB-50	WB-67
Principal Arterial to Principal Arterial		
Commercial, Parkways, Mixed Use, & Residential	SU-30	WB-50
Industrial	WB-50	WB-67

Also use BU-40 as design vehicle on all arterial and collector streets, and as control vehicle on designated bus routes

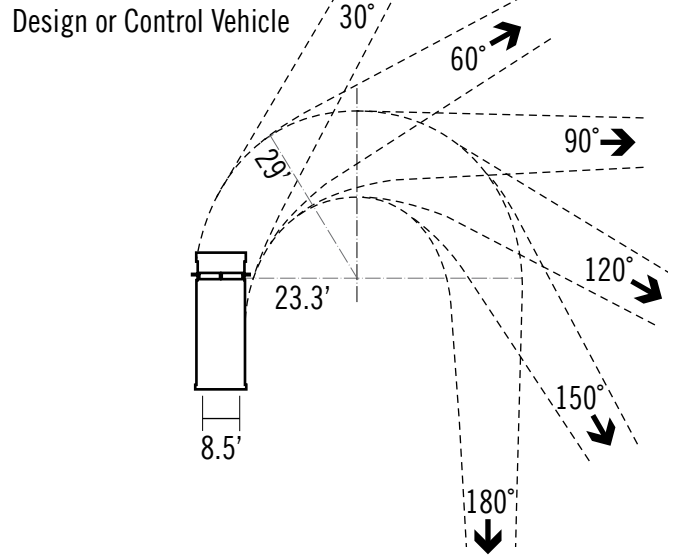
Also use WB-50 as design vehicle and WB-67 as control vehicle on any designated truck routes, regardless of street classification or contextual type.

Figure 4.2 Vehicles Turning Radii

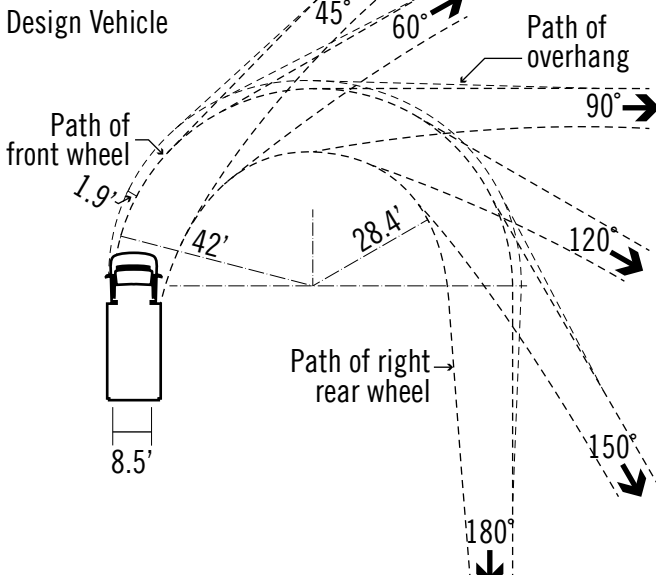
P (Passenger Car)



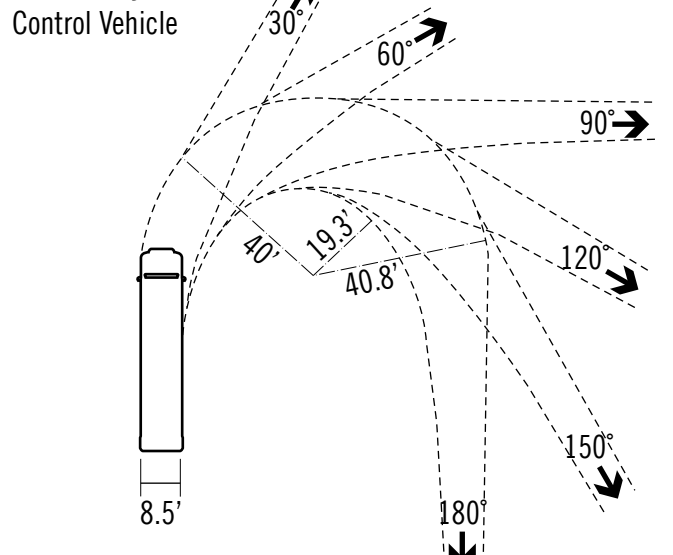
DL-23 (Delivery Van)



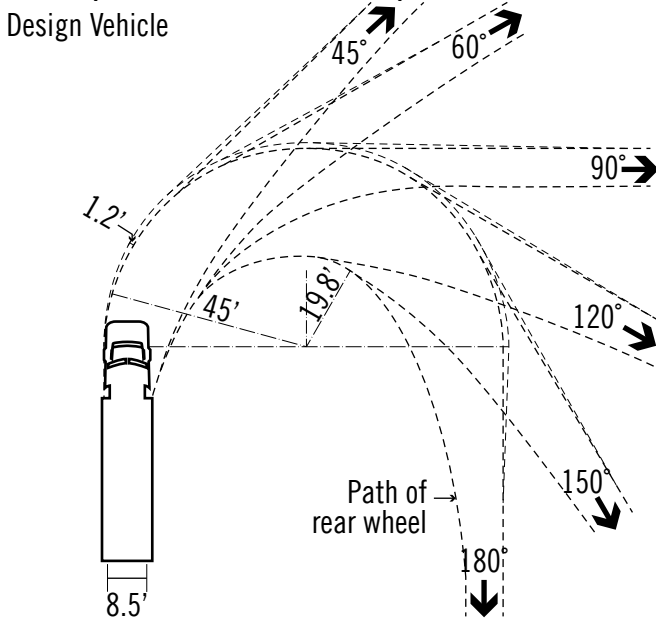
SU-30 (Single Unit Truck)



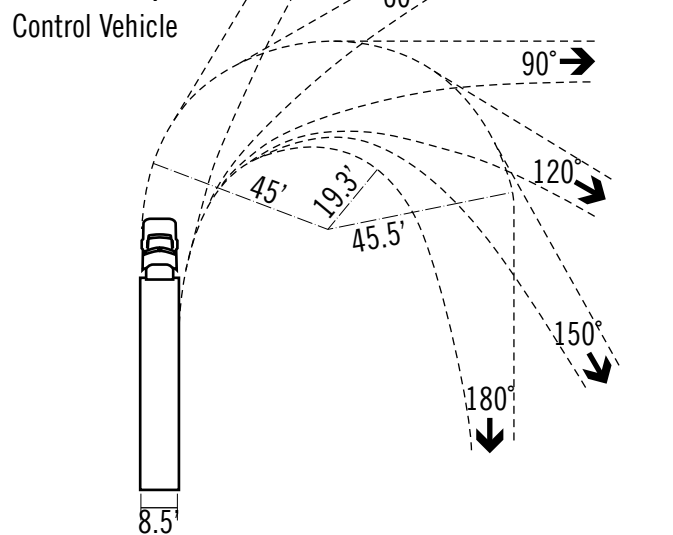
BU-40 (City Bus)



WB-50 (Intermediate Semi-trailer)



WB-67 (Interstate Semi-trailer)



A design vehicle is a vehicle which frequently uses an intersection. A control vehicle is a vehicle which must only be accommodated infrequently. Both are used in design.

The design vehicle must be accommodated within traffic lanes. A passenger car — the design vehicle for many streets — can turn easily from the curb lane with a 15-foot curb radius. See Figure 4.3.

At the same intersection, a truck can make the turn but must occupy a portion of the opposing lane in doing so. If truck traffic is infrequent — which means the truck is the control vehicle — this is acceptable. Expanding the curb radius to accommodate the truck turn within the lane would allow cars to make the turn at higher speeds, increasing the risk of collisions, especially with bicyclists and pedestrians. A larger curb radius would also increase the length of crosswalks, again increasing the risk of collision with pedestrians, and increase the real estate required.

Where the roadway in which a vehicle is turning into has more than one lane, the control vehicle can turn into the second lane. The design vehicle must be able to turn into the closest lane.

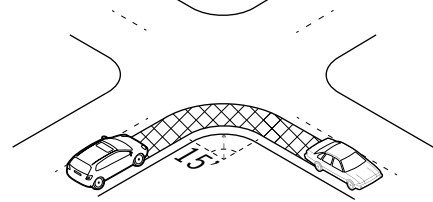
4.2.2 Target Speed

As adopted in the Complete Streets Design Manual by City Council, design speed is replaced by target speed which is based on the thoroughfare functional classification, thoroughfare type and context, and whether the ground floor land uses fronting streets are predominantly residential or commercial. Target speed then becomes the primary control for determining the geometrics of streets.

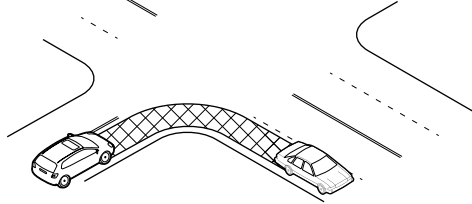
The operational speed of the roadway is defined as the 85th percentile speed which is based on an engineering study, and subsequently may become the posted regulatory speed. Traditionally, the posted speed limit was 5-10 miles per hour below the design speed or equal to or below the operational speed. Using the target speed approach, a desired traffic speed is determined before the design of a project starts, and the roadway is designed to encourage drivers to move at that speed. If the design is done well, the 85th percentile speed will align with the target speed and speed limits can be set to match the original intent of the design. Posted speed limits should not be the primary tool for setting roadway speeds.

Figure 4.3 Vehicle Turning Movement

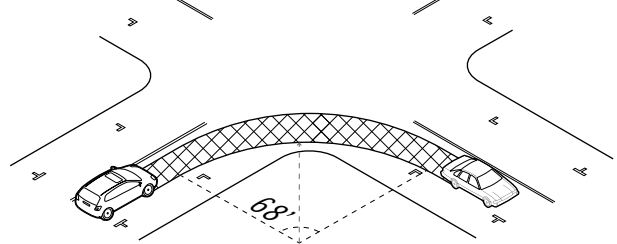
Passenger Car (P)
Design Vehicle Turning Movement



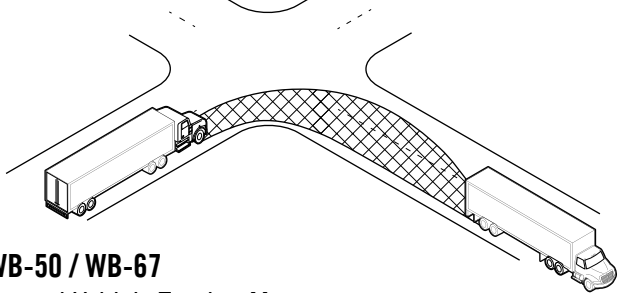
Passenger Car (P)
Design Vehicle Turning Movement
Multiple Lanes



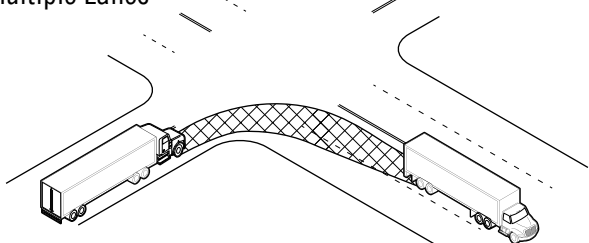
Passenger Car (P)
Design Vehicle Turning Movement
On Street Parking



WB-50 / WB-67
Control Vehicle Turning Movement



WB-50 / WB-67
Control Vehicle Turning Movement
Multiple Lanes



Target speed is based on the overall character and context of the street location and is intended to correlate closely to the posted speed and is the maximum speed that vehicles should operate on the completed street in its final developed condition. Target speeds are based on a specific context, and shall be consistent with the expected level of multimodal activity generated by adjacent land uses, provide both mobility for motor vehicles and a safe environment for pedestrians, bicyclists, and public transit users. The target speed shall be the primary factor in setting the horizontal and vertical alignment of city streets and thoroughfares. The design engineer shall hold a meeting with City staff early in the design process to set the target speed(s) to be used in design for a street project.

The appropriate target speed for a road segment is based upon context of that road segment and would include consideration of the following factors:

- Context, including consideration of current and future land uses along the street type and need for vehicle and pedestrian access to those uses, building setbacks and building access points, and any other salient characteristics.
- Functional classification.
- Street type.
- Mix and volume of anticipated vehicles and pedestrians that will use the street; the street may need to be subdivided into segments when the character changes from one intersection to another.
- Additional factors in urban areas include transition from higher- to lower-speed roadways, intersection spacing, frequency of access to adjacent land by driveways and drop-off areas, type of roadway median, presence of on-street parking, and level of pedestrian activity.

Where existing design features will influence the design of the roadway, target speed is influenced by:

- Horizontal and vertical curvature at roadway centerline, irregularly divided streets along outside curb line in each direction, and other terrain based considerations
- Street typical sections identifying lanes, crown and cross slope
- Pavement width and configuration of lanes, including designations for vehicle types such as usual travel lanes for all vehicles, designated transit lanes, or bike lanes
- Sight distance

- Clearances within the pavement between lanes, and to adjacent street elements and zones along the street
- Intersection radii for turning movement and intersection sight distance
- Super-elevation, if non-typical

If directed by the City, the design engineer shall prepare and submit an engineering study to establish and document the selected target speed(s), including identification and discussion of the above design factors in setting the project target speed(s).

The design engineer shall apply sound judgment in the selection of an appropriate target speed based on the above factors and reasonable driver expectations.

Target speed shall be applied to those geometric design elements where speed is critical to safety, specifically horizontal and vertical curvature, and sight distance along the roadway and at intersections. The target speed shall not be set arbitrarily, but rather is achieved through a combination of measures that will include the following items:

- Setting signal timing for moderate progressive speeds from intersection to intersection
- Using narrower travel lanes that cause motorists to naturally slow their speeds
- Using physical measures such as curb extensions and medians to narrow the traveled way
- Using design elements such as on-street parking to create a sense of “tightness” along the street
- Providing no horizontal offset between the inside travel lane and median curbs
- Eliminating superelevation
- Eliminating shoulders in urban applications, unless such shoulders are part of a dedicated bike lane
- Smaller curb-return radii at intersections and elimination or reconfiguration of high-speed channelized right turns
- Proper use of speed limit, warning, advisory signs, and other appropriate devices to gradually transition speeds when approaching and traveling through a walkable area, as may comply with TMUTCD.

Figure 4.4 and Figure 4.5 show elements and features which can be incorporated into the design of the streets to help achieve the target speed.

Figure 4.4 Tools for Influencing Traffic Speed (Mixed-Use Areas)

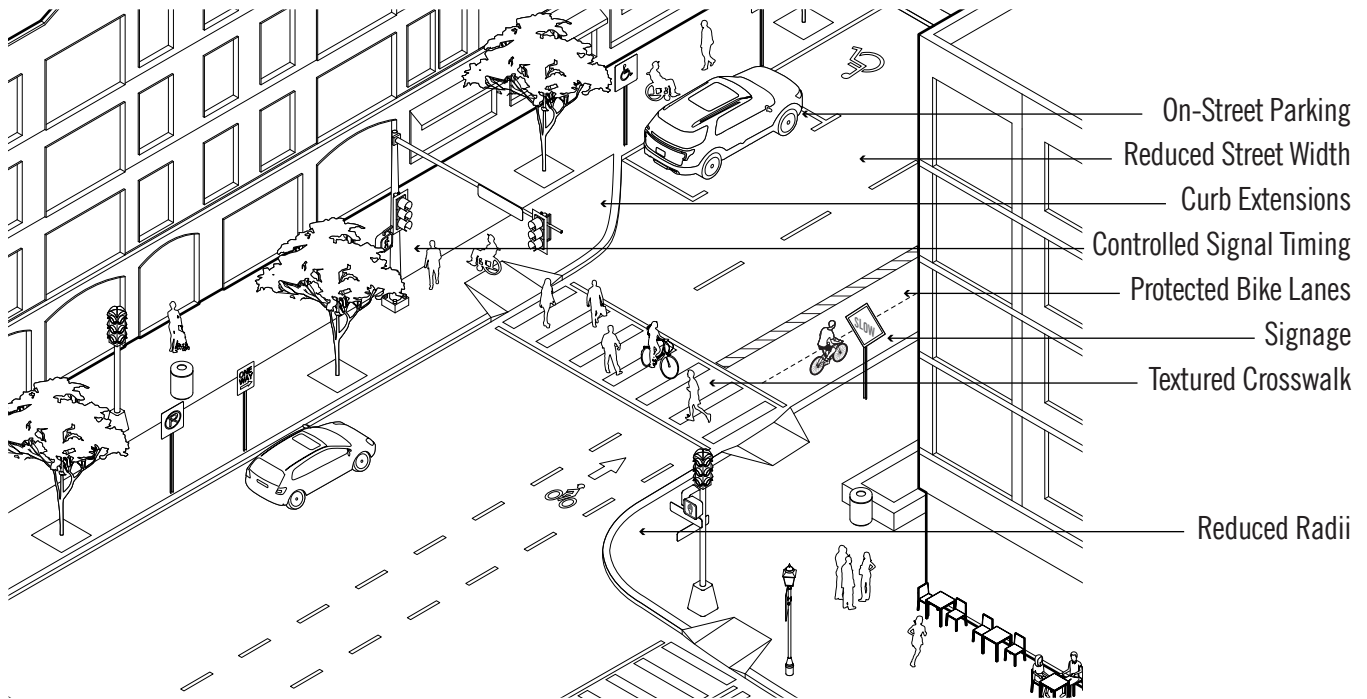
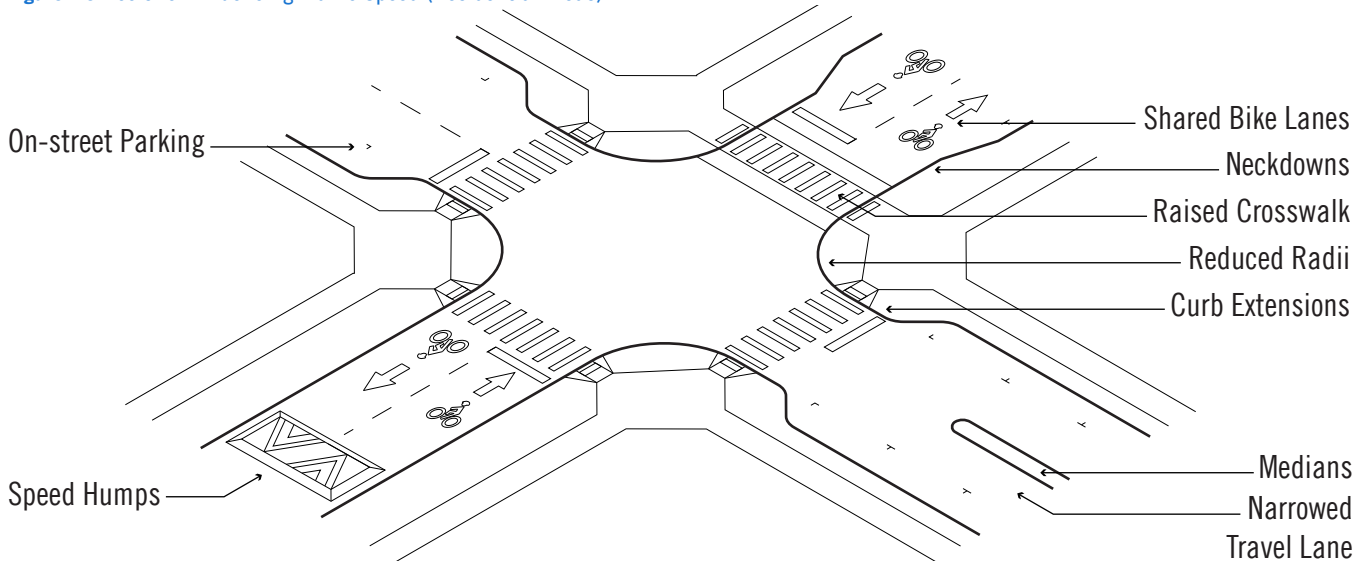


Figure 4.5 Tools for Influencing Traffic Speed (Residential Areas)



In urban areas, the designer should not relate speed to roadway capacity, avoiding the perception that a high-capacity street requires a higher target speed. In interrupted flow conditions, delay at regulated intersections by traffic signals or stop signs have a significantly greater influence on capacity than speed. The design engineer shall discuss and coordinate with City traffic engineers to determine the service levels that should be established or maintained in urban areas.

The City may require the design engineer to prepare and submit a detailed traffic engineering study to address capacity issues in areas of highly connected networks and sound traffic

operations management. This traffic engineering study shall address items such as coordinated signal timing, improved access management, removal of unwarranted signals, and the accommodations needed for turning traffic at intersections.

Table 4.2, which was taken from the Dallas Complete Streets Design Manual, designates target speeds by street type and functional classification. This table provides policy level guidance in setting an allowable range of target speeds for consideration by the design engineer.

Table 4.2 Target Speed by Street Typology and Functional Classification

Contextual Street Types and Functional Classification	Thoroughfare Plan			Complete Streets Policy
	ROW (ft)	Number of Lanes	Volumes (v/l/d)	Target Speeds (mph)
Mixed-Use Streets				
Principal Arterial	60 - 130	4 - 8	> 3,500	25 - 35
Minor Arterial	50 - 107	2 - 6	2,500 - 5,000	25 - 30
Collector	50 - 80	2 - 4	1,250 - 3,500	25 - 30
Minor/Local	50 - 56	2 - 4	< 1,250	20 - 30
Commercial Streets				
Principal Arterial	60 - 130	4 - 8	> 3,500	25 - 40
Minor Arterial	50 - 107	2 - 6	2,500 - 5,000	25 - 40
Collector	50 - 80	2 - 4	1,250 - 3,500	25 - 30
Minor/Local	50 - 56	2 - 4	< 1,250	25 - 30
Residential Streets				
Principal Arterial	60 - 130	4 - 8	> 3,500	25 - 35
Minor Arterial	50 - 107	2 - 6	2,500 - 5,000	25 - 30
Collector	50 - 80	2 - 4	1,250 - 3,500	20 - 25
Minor/Local	50 - 56	2 - 4	< 1,250	20 - 25
Industrial Streets				
Principal Arterial	60 - 130	4 - 8	> 3,500	25 - 45
Minor Arterial	50 - 107	2 - 6	2,500 - 5,000	25 - 40
Collector	50 - 80	2 - 4	1,250 - 3,500	25 - 35
Minor/Local	50 - 56	2 - 4	< 1,250	25 - 30
Parkways				
Principal Arterial	60 - 130	4 - 8	> 3,500	25 - 45
Minor Arterial	50 - 107	2 - 6	2,500 - 5,000	25 - 30
Collector	50 - 80	2 - 4	1,250 - 3,500	25 - 30
Minor/Local	50 - 56	2 - 4	< 1,250	25 - 30

For an informative discussion regarding speed management, measures to control or effect speed, and differing design approaches to roadway design, the design engineer shall review the Dallas Complete Streets Design Manual. This discussion provides specific active and passive measures and elements which may be considered for incorporation into the proposed street design. The design engineer shall not arbitrarily insert elements that do not fit into the proposed street type or its contextual environment. For example, an elevated speed table for a pedestrian crossing is usually not an appropriate element in an arterial street.

The design engineer shall discuss and coordinate with City staff in the application of active and passive speed management measures as design progresses. This coordination shall specifically include the Fire Department, Public Works, Transportation, Sanitation

Services, and Dallas Water Utilities after speed management measures are identified and located on the project. It may also be necessary that these discussions and coordination include other stakeholders such as sister agencies who have an interest in the project or adjacent landowners and developers.

4.2.3 Design Traffic Volumes

The general unit of traffic volume measurement on a thoroughfare or street is the average daily traffic volume (ADT). AASHTO, in its manual titled A Policy on Geometric Design of Highways and Streets, defines the average daily traffic on a street as the total number of vehicles which pass a point on the street during a given time period (expressed in whole days), greater than one day and less than one year, divided by the number of days in the given time period. Average daily traffic (ADT) is expressed in number of vehicles per day. The ADT is easily determined when continuous traffic counts are available for the street at the particular location. Where only periodic counts are taken, ADT volume can be established by adjusting the periodic counts according to controlling factors such as day of the week, month or season.

The average daily traffic, including the percentage of trucks and buses is a primary factor in the design of the thoroughfare function, number of lanes, and the thickness of the pavement structure. Other factors which affect the pavement design thickness are the required service and pavement life of the thoroughfare or street. Table 4.3 shows typical volumes and capacities for streets of given designs within Dallas.

Table 4.3 Design Traffic Volumes for Streets

Functional Classification	Number of Lanes	Traffic Loading	Weekday ADT (vpd)	Weekend ADT (vpd)	% Trucks & Buses
Principal Arterial	6	Normal	25,000	12,500	2%
		Heavy	40,000	20,000	10%
Minor Arterial	4	Normal	18,000	9,000	2%
		Heavy	25,000	12,500	10%
Community Collector	2	Normal	7,000	3,500	5%
		Heavy	7,000	3,500	20%
Residential Collector	2	Normal	5,000	2,500	3%
Local	1-2	Bus Route	2,500	1,250	<1.5%
		No Bus Route	2,500	1,250	<0.2%

For standard design purposes, Table 4.3 provides average daily traffic and percent trucks and buses used in the City standard designs for various roadway pavement classifications.

As may be required for the project or directed by the Director, the design engineer may be required to perform traffic counts at requested locations to determine the volumes of traffic including

the percentage of trucks and buses to provide a sound basis for geometric designs to accommodate complete street sections and to determine the required roadway pavement sections necessary for a minimum 30-year pavement life.

If required by the project or by the Director, designers and engineers shall conduct traffic studies for projects, the adjacent street systems, including its intersections, and project driveway intersections with streets. Designers and engineers shall use the latest version of the City's Traffic Study Guidelines document. Refer to Appendix A.6 for these Traffic Study Guidelines, but contact City staff to confirm whether any updates have been made to this document since the time of this publication. If so, the latest version of the document shall be used. Methods and models used for traffic studies shall be those identified herein and authorized by the City.

Traffic studies may include a site or project specific Traffic Study, a Traffic Impact Analysis (TIA), or a School Traffic Management Plan to determine the effects of specific new developments or redevelopment activity on existing or planned streets where traffic volumes are expected to increase or traffic vehicle types significantly change. Traffic volumes are typically measured on a Tuesday, Wednesday, or Thursday while school is in session. In some cases, such as near a large recreational or seasonal use area or facility, it may be necessary to measure traffic during other high use times or peak periods.

Where directed by the City, some wide Dallas streets can be redesigned to accommodate the complete streets vision using road diets within existing right-of-way. Road diets reduce the number of travel lanes or travel lane widths on a roadway and uses the added space for building complete streets elements such as expanded sidewalks, bike lanes and plantings. More detailed application and consideration can be found in the Dallas Complete Streets Design Manual.

4.2.4 Unusual Traffic Concentrations

Atypical traffic conditions, such as schools, hospitals, fire stations, large industrial facilities, and destination venues like museums and sports stadiums require special consideration. These conditions generate higher than usual vehicular traffic, high traffic loads at specific times, and differing types of vehicles. For increased heavy vehicle traffic by trucks and / or buses, modified pavement sections and configurations may be warranted.

Some common land uses, like office buildings and restaurants, can generate unusual needs. Short term loading and unloading, including pickup and drop-off, transportation-for-hire trips, express deliveries, and delivery trucks, can clog up a street if no provision is made for those uses.

The designer shall consider these types of conditions and provide provisions which address these site specific conditions.

4.2.5 Signalized Intersection Design

Intersections controlled by traffic signals must be designed to consider, and where directed by the City, to accommodate projected traffic which will traverse through that / those intersections. This accommodation shall be both in volume and by vehicle type. The designer shall consult with the City to present their assessment of vehicle types and volumes, and their recommendations for the proposed lane configurations for each leg of the intersection. For projects involving or gaining access to collector and arterial streets that are part of an integrated traffic signal network, the City may require the designer to use mathematic modeling software approved by the City.

Intersection layouts must also consider and provide for all other travel modes that are proposed or planned, such as bicycles, pedestrians, and streetcar. Intersection layouts must consider all other aspects of the complete street philosophy which are covered in this design manual. The City will review the designer's recommendations and provide direction to the designer on intersection layout to be used for final design.

Final design of signalized intersections shall conform to all other requirements of the City of Dallas, the TMUTCD, and industry standard practice in effect at the time of design.

4.3

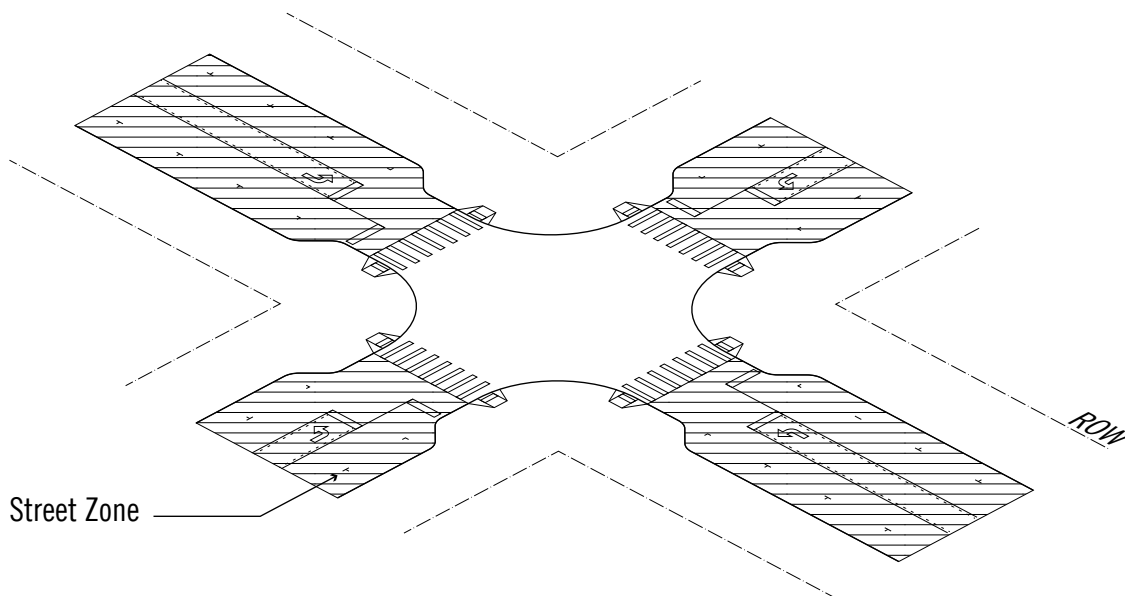
STREET ZONE

4.3.1 Design Intent

The street zone is defined as the zone between the curbs. See Figure 4.6.

At first glance, this area has one function: moving cars. But it does far more. Transit riders and bicyclists also use the street zone to get to their destinations. The street zone also vital for access to adjacent properties. On street parking, drop off zones, and loading zones are essential to supporting surrounding businesses, institutions, and residences. Below the street, utilities support the surrounding neighborhood, and the pavement itself plays a significant role in storm drainage.

Figure 4.6 Street Zone



4.3.2 Typical Cross Section

Each paving project shall be defined by one or more typical paving sections. Figure 4.7 provides typical configuration widths for various types of streets. The typical section(s) shall be placed on the quantity summary / general note sheet or on a separate detail sheet. Information which shall be shown on the typical section(s) includes:

- ADT.
- Target speed.
- Design vehicle.
- Control vehicle.
- Paving stations for which the typical section(s) applies.
- Right-of-way (ROW) width.
- Proposed material type, depth and width dimension of pavement. Steel reinforcement, if required.
- Subgrade stabilization including width and depth of treatment and amount of lime or cement to be added to the existing soil. Percent compaction should also be shown.
- Type, width, depth and treatment of base (if required).
- Dimension curb and gutter section or integral curb.
- Location and width of driveways and driveway grades.

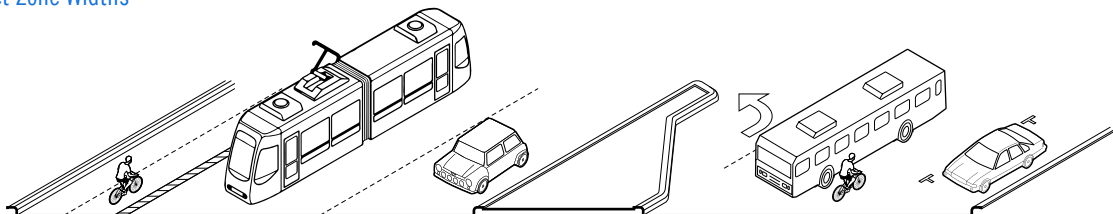
- Location and width of sidewalks including minimum and maximum slope which will be allowed. If the sidewalk abuts the curb, a sidewalk lug with all necessary details shall be included.
- Median width and location.
- Proposed slope grades (min. and max.)
- Pavement crown or cross slope (min. and max.).
- Parkway dimensions and requirements.
- Ties to existing grade.
- Existing typical ground line and features.
- Retaining walls (if required).
- Removal limits and pay limits with associated item numbers.

Designers should use "Preferred" dimensions whenever possible. Based on site specific analysis that considers the site conditions, right-of-way constraints and availability, and context of the street, the Designer shall propose street sections for review and acceptance by the City. As more information is available through analysis or other means during the design process, proposed street sections may need to be adjusted. Such adjustments shall be discussed with the City for their review and concurrence.

The following cross sections are typical for different street types and contexts. These are examples only. Specific conditions vary from street to street and even from block to block, and street designs should be adjusted accordingly. It is also important to realize that a section never captures all aspects of a street design; streets are experienced in three dimensions, not two.

See Section 4.5 Pedestrian Zone for street requirements bordering the Street Zones as shown in figures 4.8 - 4.12 on the following pages.

Figure 4.7 Street Zone Widths



	Bike		Transit		Travelway		Median*		Special Use		Parking	
	Min	Pref	Min	Pref	Min	Pref	Min	Pref	Min	Pref	Min	Pref
Mixed-Use	4'	6'	11'	12'	10'	11'	6'	15'	11'	12'	7'	8'
Commercial	4'	6'	11'	12'	10'	11'	6'	15'	11'	12'	-	-
Residential	4'	6'	11'	12'	10'	10'	6'	15'	11'	12'	7'	8'
Industrial	4'	6'	11'	12'	11'	12'	6'	15'	11'	12'	7'	8'
Parkways	4'	6'	11'	12'	10'	11'	6'	20'	11'	12'	-	-
Woonerf	5' Shared		11'	12'	10' Shared		-	-	12' Shared		7' Shared	
Alleys	-	-	-	-	9'	10'	-	-	-	-	-	-

*If included as a zone within the street.

4.3.2.1 50-Foot ROW

A 50-foot right-of-way (ROW) cross-section is typically found on local streets.

Accommodating street trees and a minimum sidewalk in commercial, residential, or industrial areas requires a pedestrian zone of 11.5 feet. This leaves 27 feet for the street zone. In a residential area with low traffic volumes and low speeds, this can cause intermittent permit parking on both sides of the street; where a car is parked on one side of the street two cars can still squeeze past, and where cars are parked on both sides cars can pass one at a time. In a commercial, mixed use area, or industrial area, this section will fit two traffic lanes with parking prohibited.

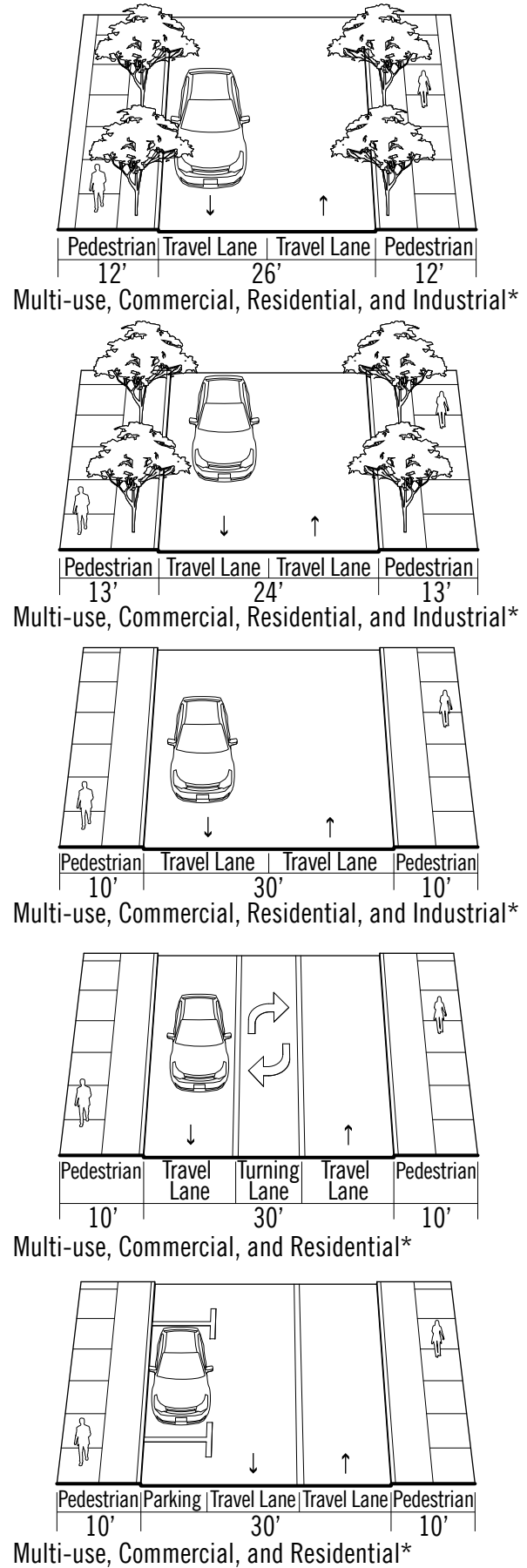
In a mixed use area, a 12.5 feet pedestrian zone is required. This leaves a 25-foot street zone, still enough for two traffic lanes with parking prohibited. However, this may not be desirable since mixed use areas have high parking and pick-up / drop-off demand; Therefore, if a wider right-of-way is possible, that is desirable.

If there are no street trees — which may be appropriate where adjacent properties have landscaping — a 10.5-foot Pedestrian Zone is sufficient. The remaining 29 feet of street zone can be allocated to two wide traffic lanes, two 10-foot traffic lanes (sufficient in a residential, commercial, or mixed used context) and a turn lane, or two 10-foot traffic lanes and on-street parking.

For minimum and preferred dimensions refer to Figure 4.8.

*On-street shared lanes may be used in street configurations with only one lane in each direction or two lanes in one direction with a speed of less than 30 mph and average daily traffic of less than 1,500 vehicles.

Figure 4.8 50-Foot ROW



4.3.2.2 60-Foot ROW

A 60-foot ROW cross-section can be found on local streets, collectors, and minor arterials.

On local streets, the cross-sections that work for a 50-foot ROW will also work here, with a more generous pedestrian zone. Refer to Figure 4.9 for minimum and preferred pedestrian zone widths.

The 11.5 feet minimum pedestrian realm with street trees in commercial or residential areas leaves 37 feet of pavement. Outside of industrial areas, it accommodates two traffic lanes with bike lanes, two traffic lanes with parking, or a combination of the two. It can also accommodate two wide traffic lanes with a turn lane in commercial, residential, or industrial areas.

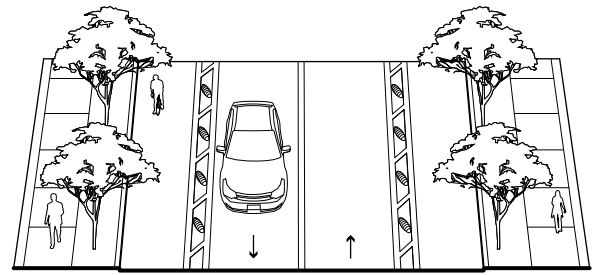
In a mixed use area, the minimum pedestrian zone with street trees is 12.5 feet. Since this does not leave enough space for more than two traffic lanes and parking, it is preferred to use a 30-foot street zone (which accommodates that easily) and widen the pedestrian zones further to 15 feet. This section, or a variant with slightly wider lanes, is also a useful section for industrial areas. The same section with 15-foot pedestrian zones can also accommodate two traffic lanes with non-buffered bike lanes in each direction or two traffic lanes with a two-way buffered bike lane. On a local street in a residential area, an unstriped 30-foot pavement will allow two-way traffic with parking on both sides.

A wider pedestrian realm is appropriate in areas with high pedestrian activity. Typically, 17 feet will leave space for two lanes, two lanes with a one-way striped bike lane, or an unstriped street in a residential area.

For preferred dimensions refer to Figure 4.9.

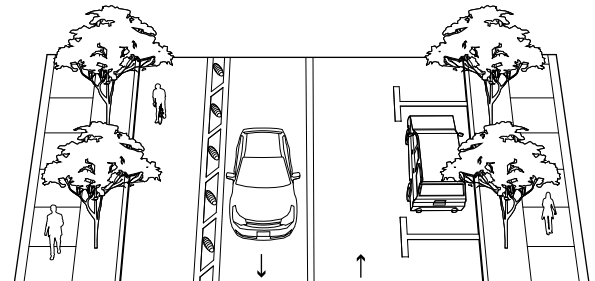
*On-street shared lanes may be used in street configurations with only one lane in each direction or two lanes in one direction with a speed of less than 30 mph and average daily traffic of less than 1,500 vehicles.

Figure 4.9 60-Foot ROW



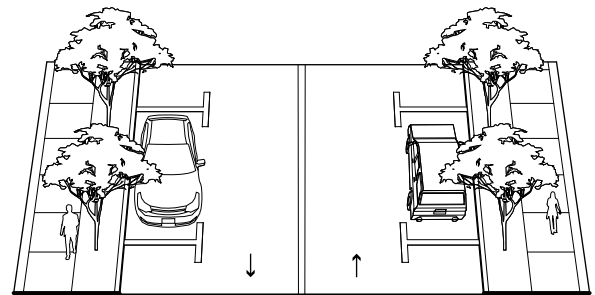
Pedestrian	Bike Lane	Travel Lane	Travel Lane	Bike Lane	Pedestrian
11' 6"		37'			11' 6"

Commercial and Residential



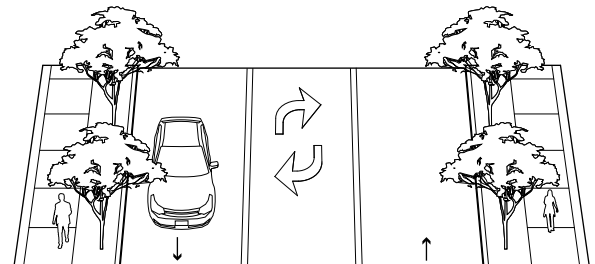
Pedestrian	Bike Lane	Travel Lane	Travel Lane	Parking	Pedestrian
11' 6"		37'			11' 6"

Commercial and Residential



Pedestrian	Parking	Travel Lane	Travel Lane	Parking	Pedestrian
11' 6"		37'			11' 6"

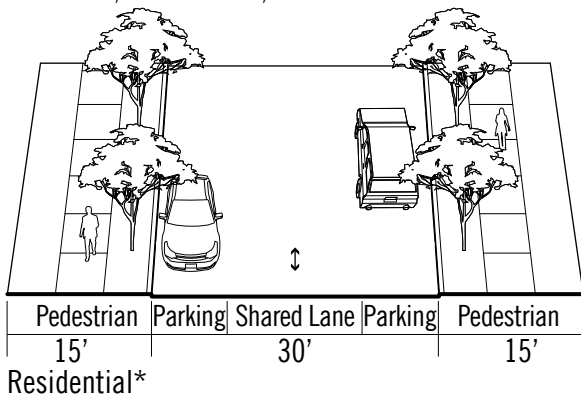
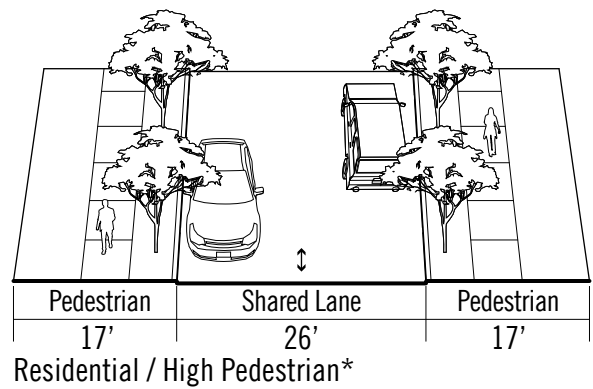
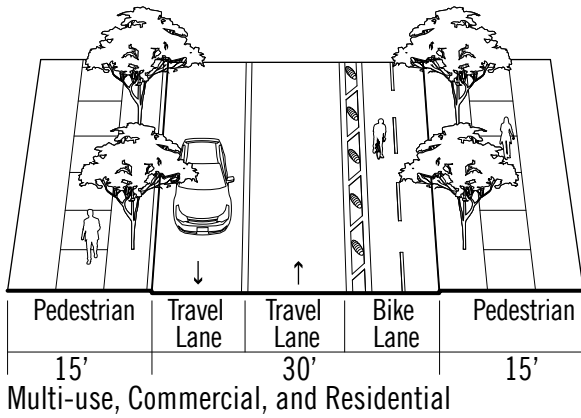
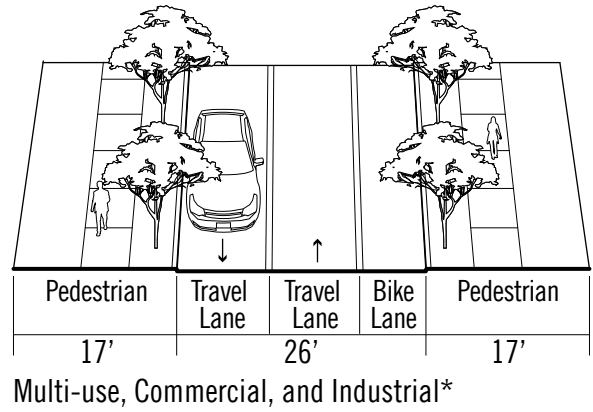
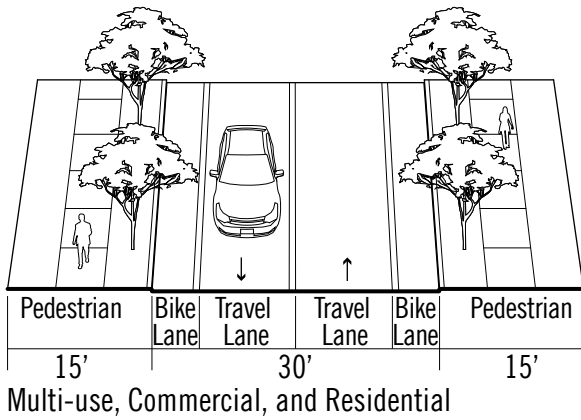
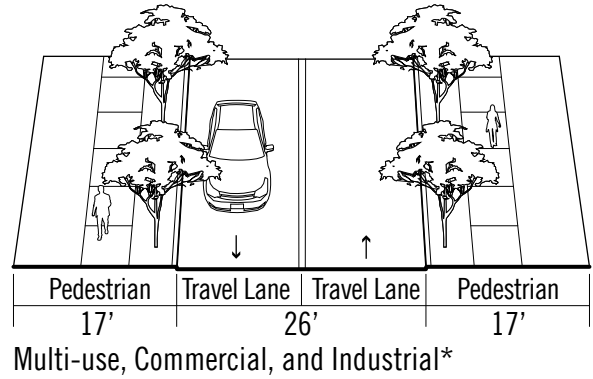
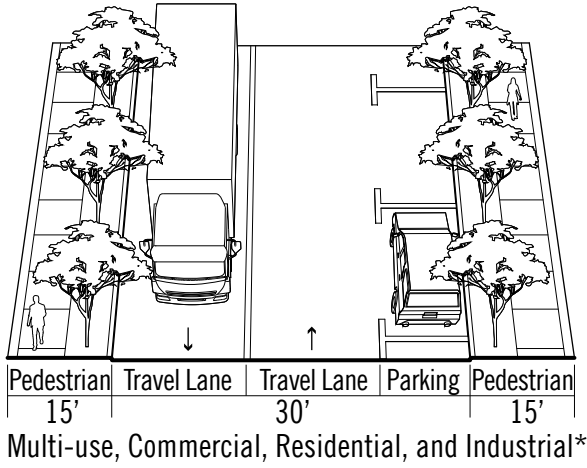
Commercial and Residential*



Pedestrian	Travel Lane	Turning Lane	Travel Lane	Pedestrian
11' 6"		37'		11' 6"

Commercial, Residential, and Industrial*

Figure 4.9 60-Foot ROW (continued)



4.3.2.3 80-Foot ROW

An 80-foot ROW cross-section can be found on collectors and arterials.

The 11.5-foot minimum pedestrian realm with street trees in commercial or residential areas leaves 57 feet of street zone. That can be divided into four travel lanes and a 13-foot median, which is enough for a left turn lane, but not for a left-turn lane with a pedestrian refuge. Adding two feet to the median allows for the pedestrian refuge, leaving space for a traffic lane with parking. Alternately, ten-foot lanes — which are adequate in commercial and residential areas — also allow for a median with turn lanes and pedestrian refuge.

In a mixed-use area, wider pedestrian zones are required. The minimum pedestrian zone — 12.5 feet — will accommodate two minimum lanes in each direction and a 15' median which can provide for a turn lane and pedestrian refuge.

Without a median, a wider pedestrian zone works easily with a variety of street zones, including four travel lanes, three traffic lanes with parking, and four ten-foot traffic lanes with buffered bike lanes.

For preferred dimensions refer to Figure 4.10.

*On-street shared lanes may be used in street configurations with only one lane in each direction or two lanes in one direction with a speed of less than 30 mph and average daily traffic of less than 1,500 vehicles.

Figure 4.10 80-Foot ROW

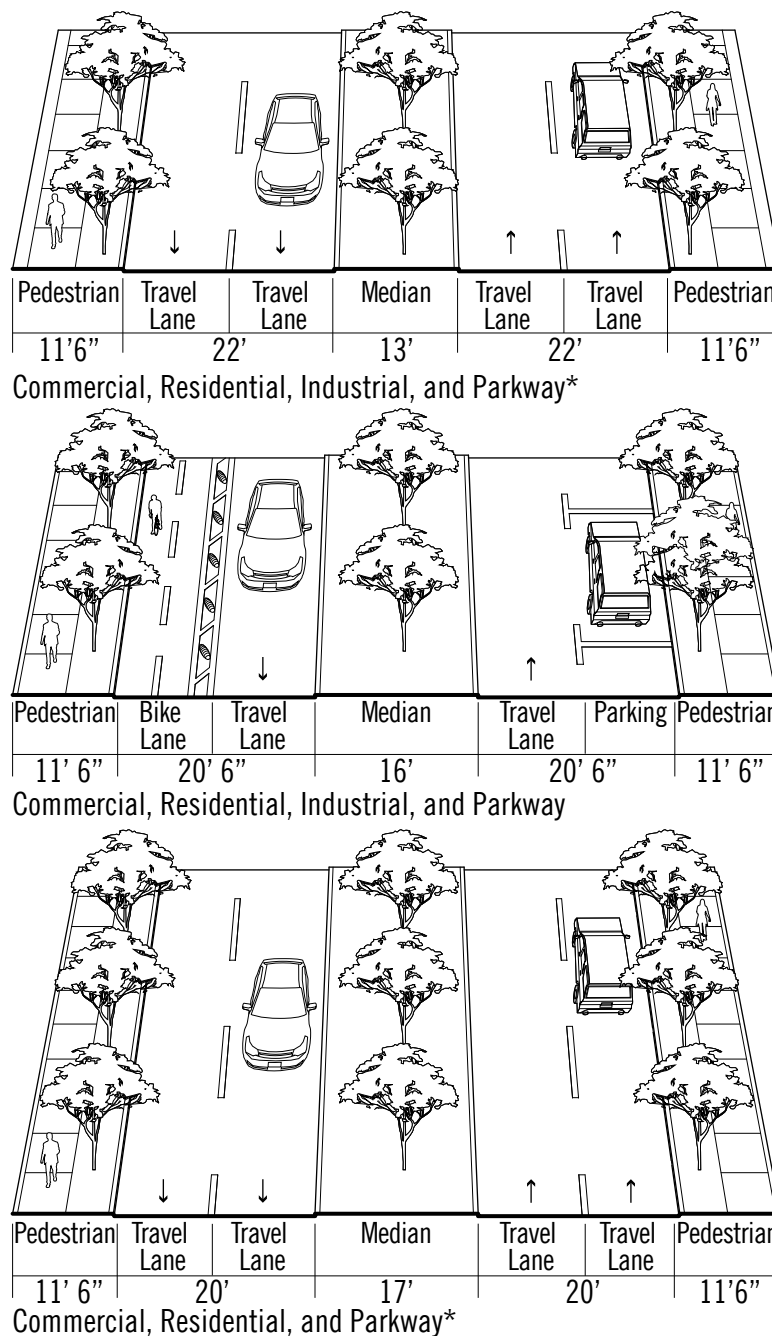
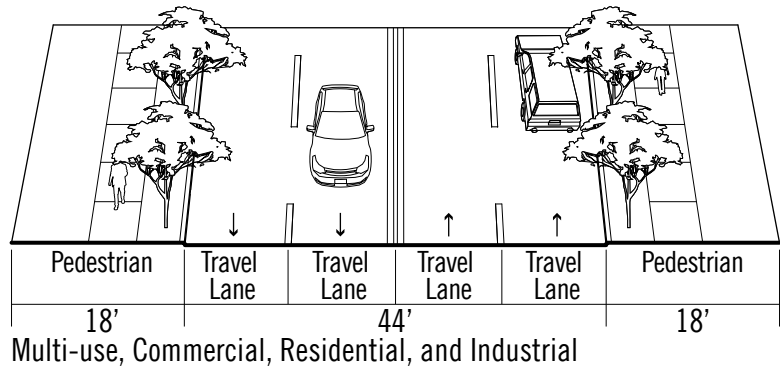
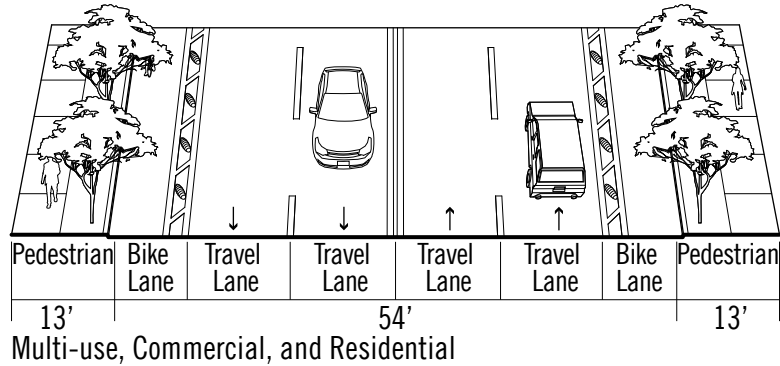
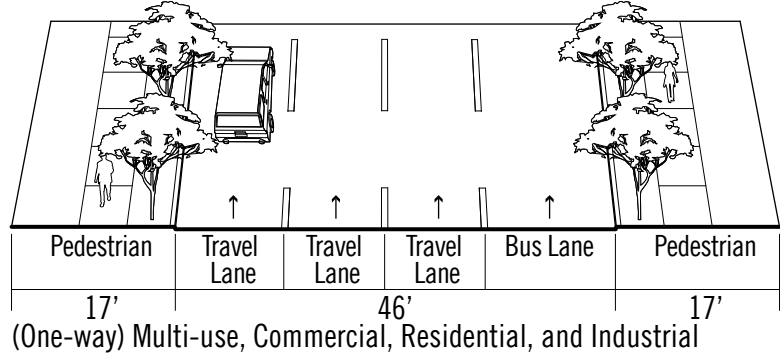
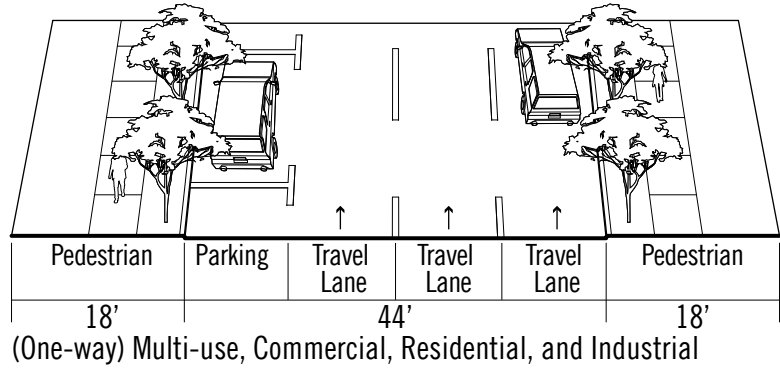
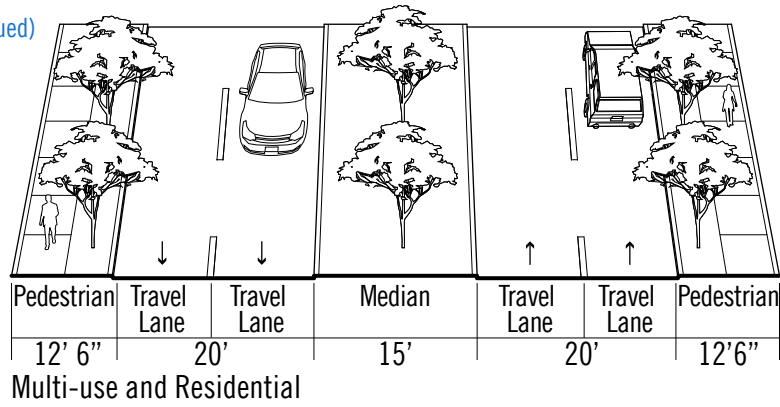


Figure 4.10 80-Foot ROW (continued)



4.3.2.4 100-Foot ROW

A 100-foot ROW cross-section can be found in some arterials.

A four-lane street fits comfortably in a 100-foot ROW, with or without a median, regardless of context. Without a median, bike lanes can also be accommodated efficiently.

With a minimum pedestrian zone, four lanes, parking or bike lanes, and a median with turn-lane and pedestrian refuge

will fit. A smaller median — without turn lane — will allow for a larger pedestrian zone. Without a median, four lanes and parking (or six lanes) still allows a generous pedestrian zone.

For preferred dimensions refer to Figure 4.11.

*On-street shared lanes may be used in street configurations with only one lane in each direction or two lanes in one direction with a speed of less than 30 mph and average daily traffic of less than 1,500 vehicles.

Figure 4.11 100-Foot ROW

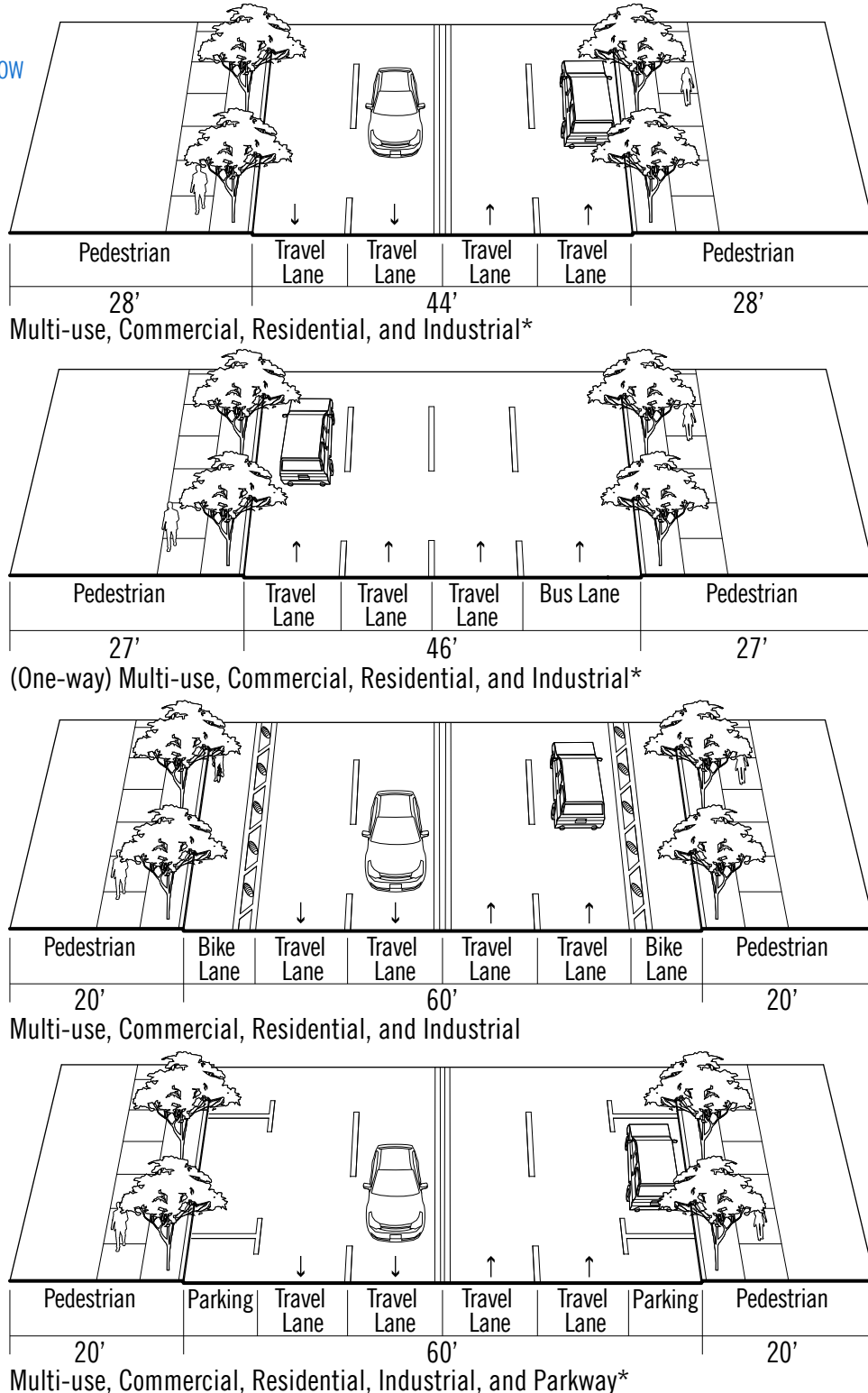
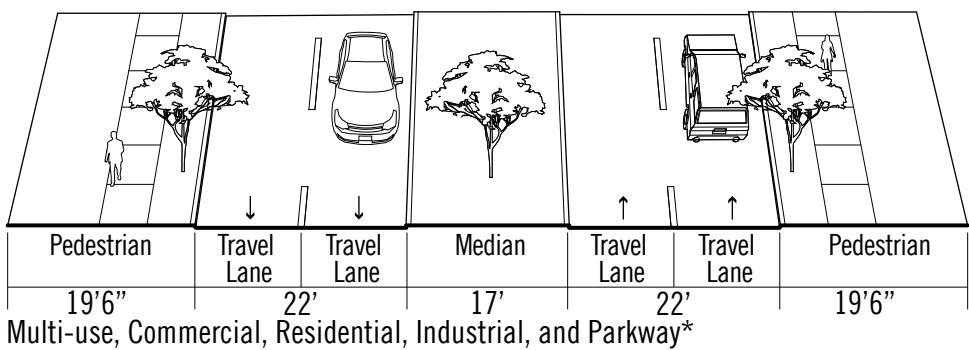
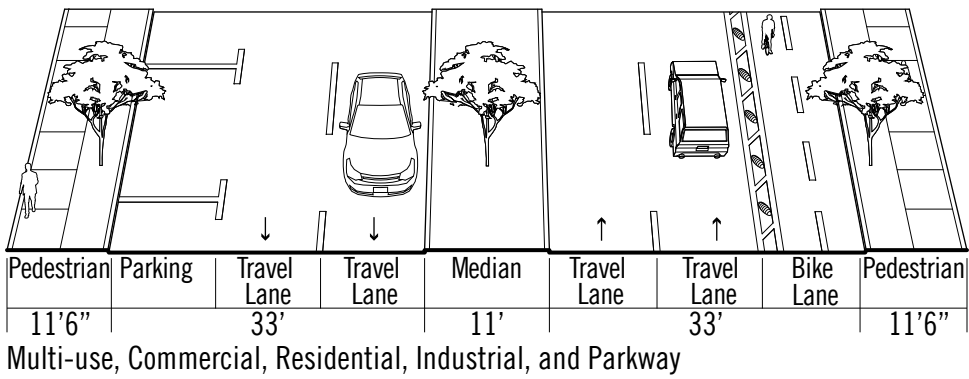
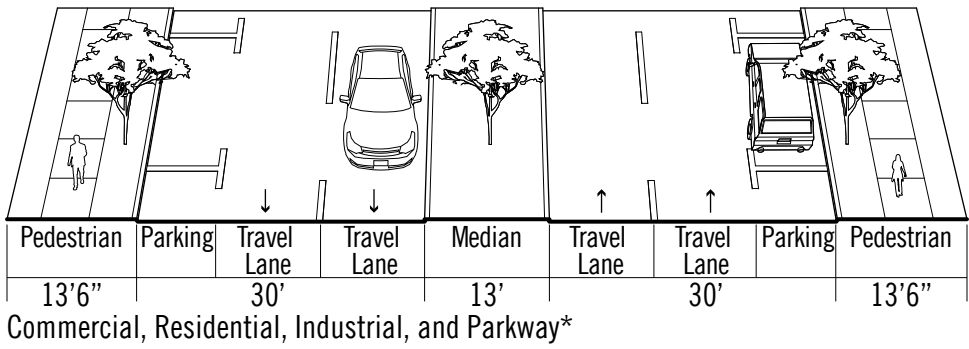
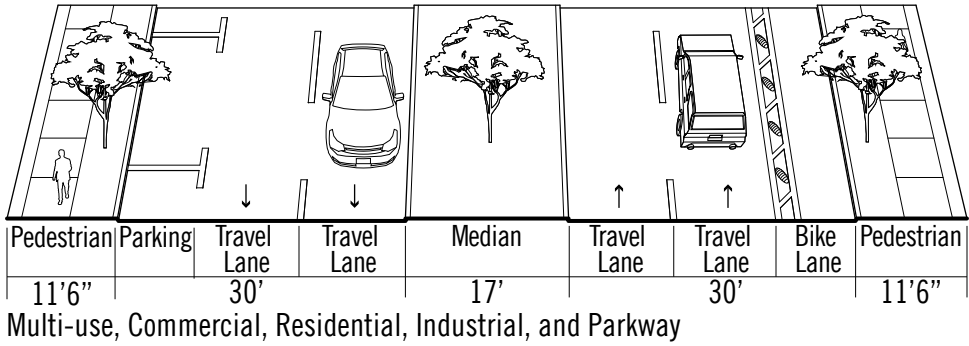
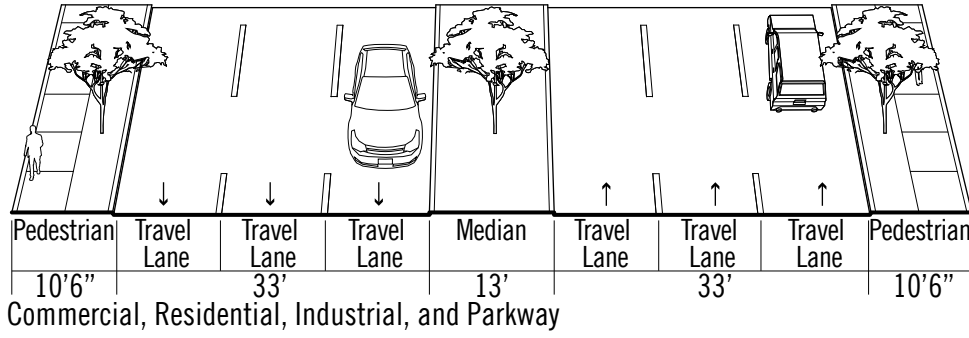


Figure 4.11 100-Foot ROW (continued)



4.3.2.5 130-Foot ROW

A 130-foot ROW cross-section can be found on some major arterials.

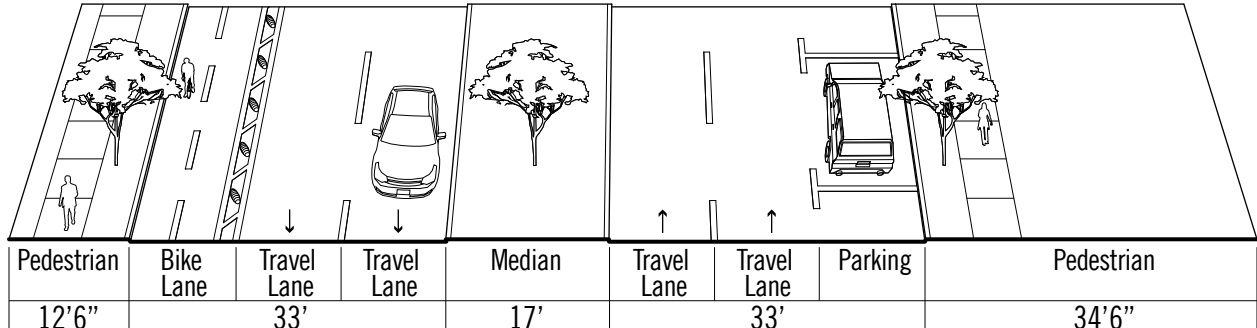
Any four-lane or six-lane cross-section can fit comfortably in this space. It also offers the flexibility to add generous public space, either on the side or in the middle of the ROW. Where there is much more activity on one side of

the street than the other — or differing building form — an asymmetric cross section may be useful.

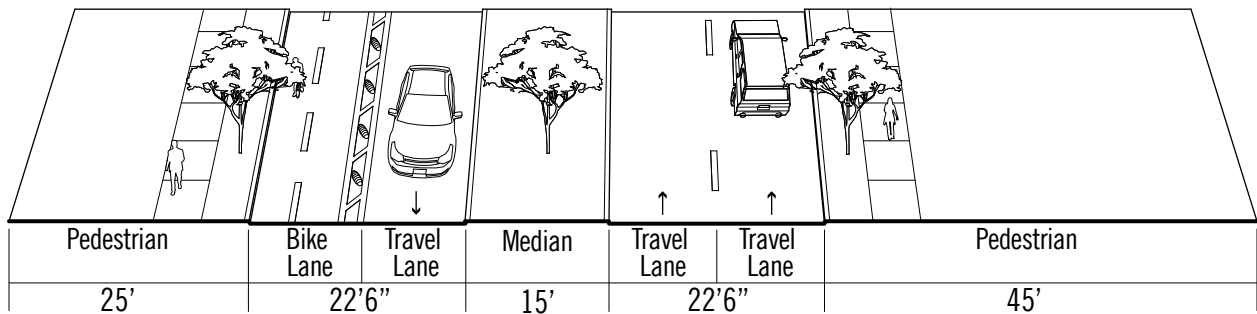
For preferred dimensions refer to Figure 4.12.

*On-street shared lanes may be used in street configurations with only one lane in each direction or two lanes in one direction with a speed of less than 30 mph and average daily traffic of less than 1,500 vehicles.

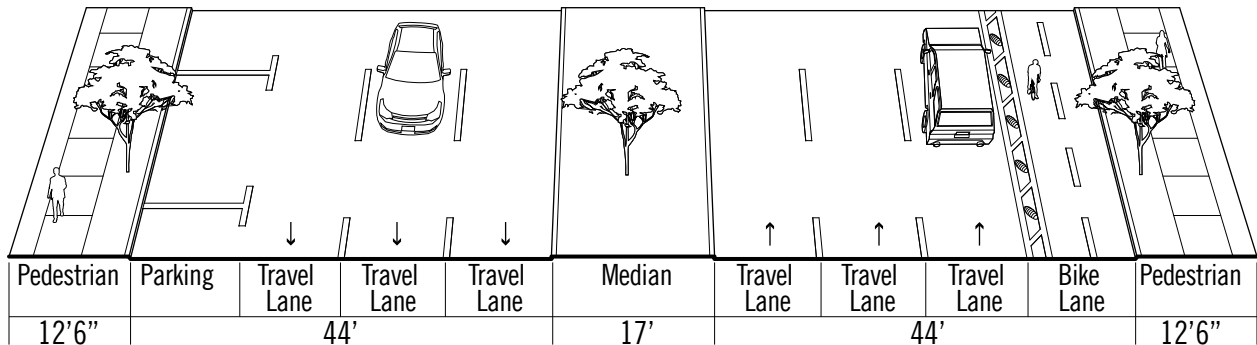
Figure 4.12 130-Foot ROW



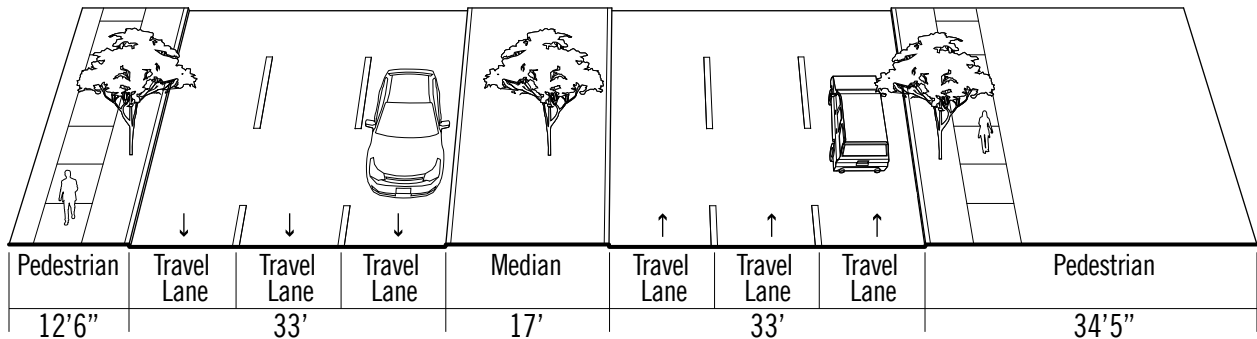
Multi-use, Commercial, Residential, Industrial, and Parkway



Multi-use, Commercial, Residential, Industrial, and Parkway

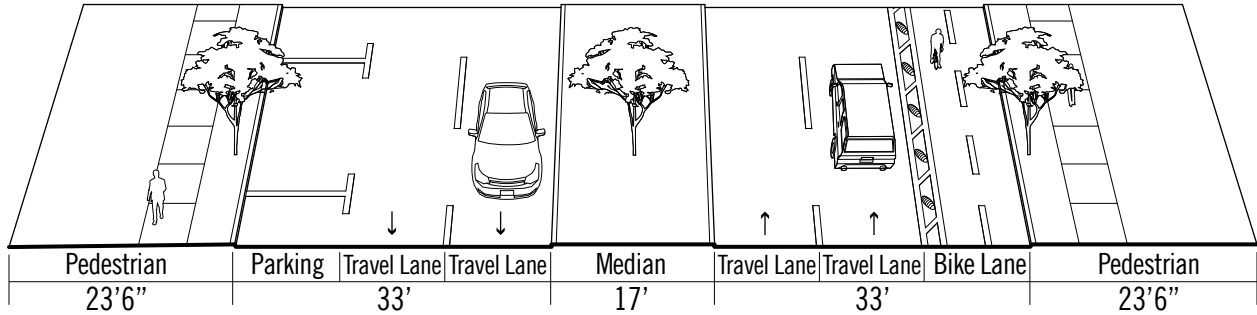


Multi-use, Commercial, Residential, Industrial, and Parkway

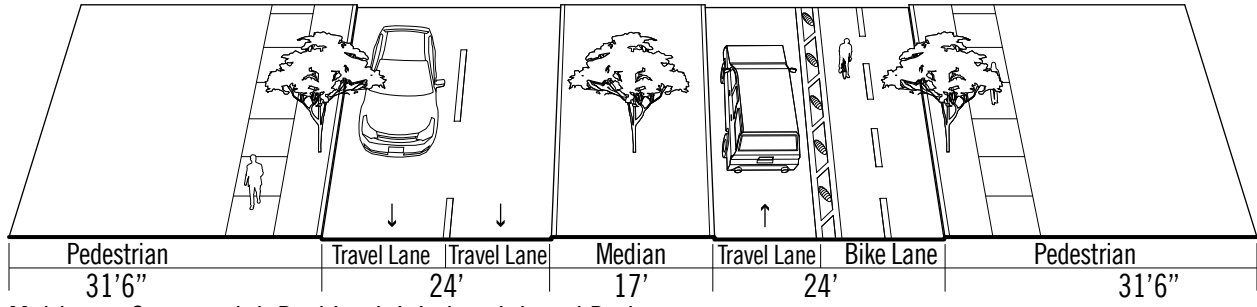


Multi-use, Commercial, Residential, Industrial, and Parkway*

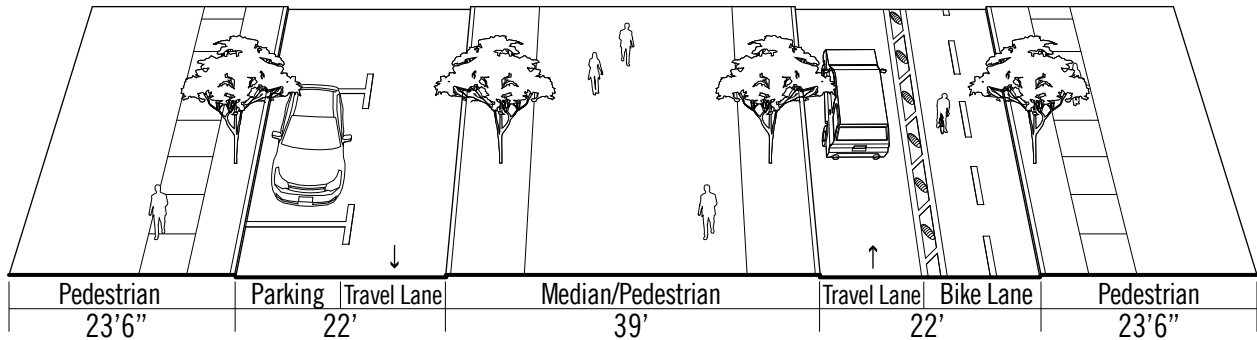
Figure 4.12 130-Foot ROW (continued)



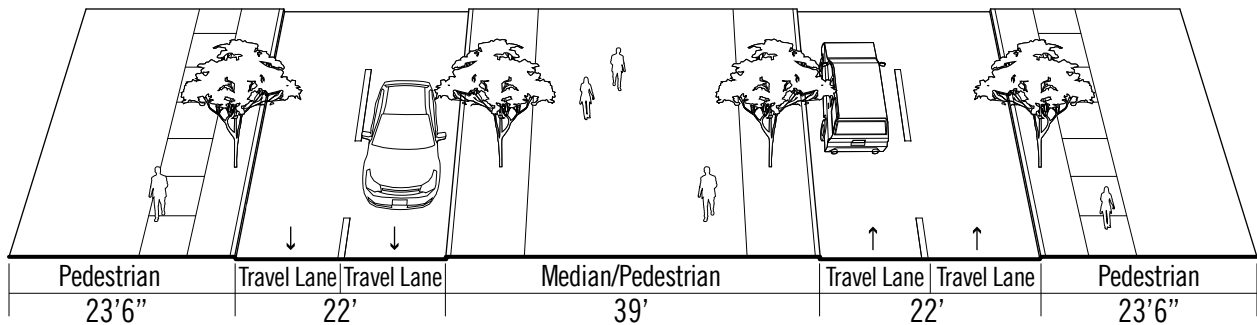
Multi-use, Commercial, Residential, Industrial, and Parkway



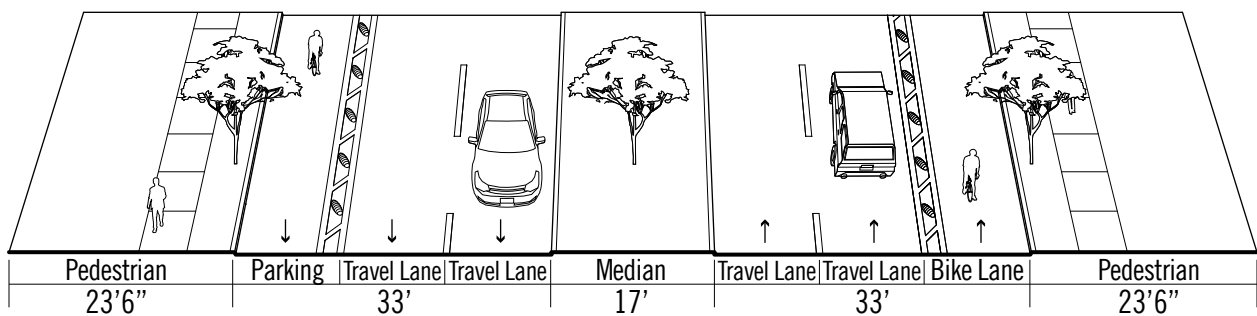
Multi-use, Commercial, Residential, Industrial, and Parkway



Multi-use, Commercial, Residential, Industrial, and Parkway



Multi-use, Commercial, Residential, Industrial, and Parkway*



Multi-use, Commercial, Residential, Industrial, and Parkway

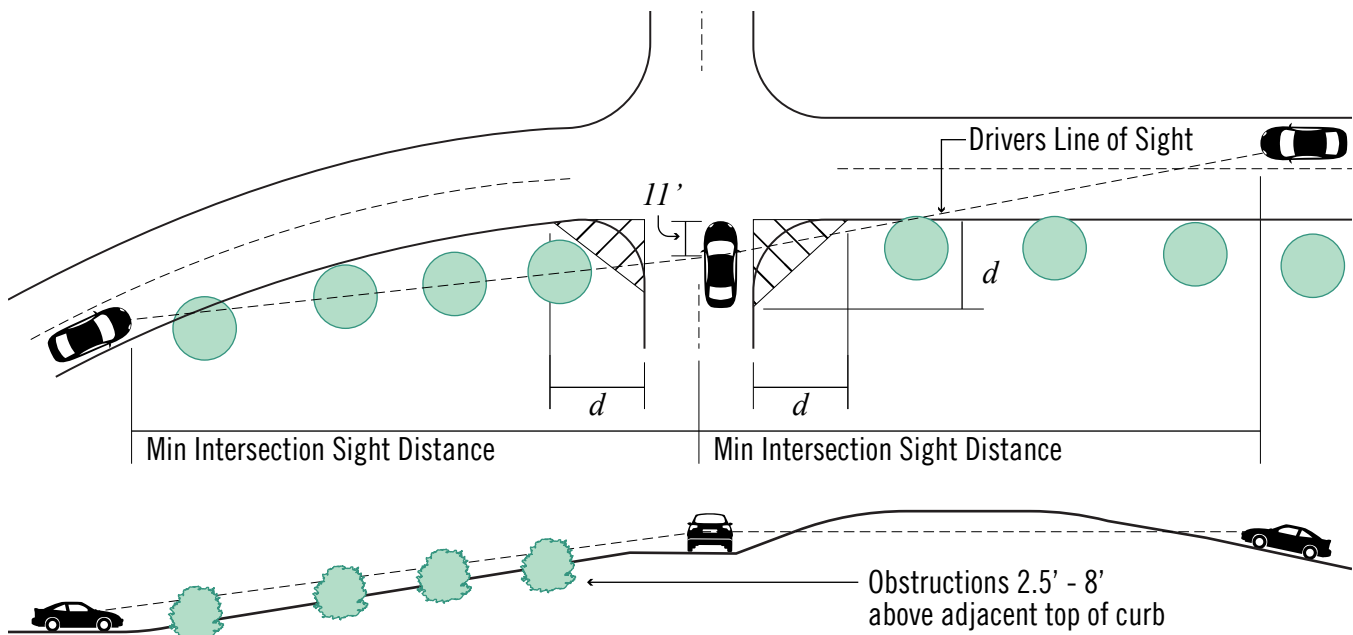
4.3.3 Visibility and Sight Distances

4.3.3.1 General Requirements

The Dallas Development Code (Section 51A, 4.602) identifies sight lines as “visibility triangles” measuring 45 feet at all street intersections and 20 feet at drive and alley intersections with streets, except where modified in certain Planned Development Districts. Figure 3.9 in Section 3.5, Off-Street Parking and Driveways, shows typical visibility triangles, defined as projections along curb lines or pavement edges. Parking is not permitted in visibility triangles. Landscaping in medians, pedestrian zones, and at intersections shall not obstruct the visibility of pedestrians and approaching motorists.

Also, site topography and street geometrics must be considered in design of streets, alleys and driveways. Also, the design of City streets and thoroughfares must account for a vehicle attempting to enter or cross the street or thoroughfare from a side street, alley or drive. The operator of the vehicle attempting to enter or cross should have an unobstructed view of the whole intersection and a sufficient length of the street to be crossed to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception and reaction time and during braking. This sight distance, which is termed intersection sight distance, can be calculated for different street or thoroughfare widths and for various grades both upwards and downwards. Figure 4.13 shows the method for measuring the intersection sight distance. The eye of the driver is assumed to be 3.5 feet above the road surface and the oncoming vehicle is assumed to be at least 4.25 feet above the pavement surface.

Figure 4.13 Sight Distance at Intersections



Recommended intersection sight distances are shown in Table 4.6 and were developed using formulation from the AASHTO Green Book.

To insure safety at intersections, the intersection sight distance must not be less than the minimum intersection sight distances shown in Table 4.6. The minimum intersection sight distances were determined from AASHTO minimum stopping distance requirements adjusting for the degree of driver recognition complexity present to provide an absolute minimum intersection sight distance.

The desirable intersection sight distances, given in Table 4.6, were determined using the standard AASHTO passenger car for all cases, and shall be used in design. These desirable sight distances will provide the minimum required for urban areas for the design vehicle crossing or entering the specified cross street. Desirable sight distances assume the oncoming cross traffic is traveling the target speed. A tailgate distance equivalent to a 2 second following distance between vehicles is also assumed.

Undeveloped or rural areas usually require larger intersection sight distances than urban areas due to higher vehicular speeds. In these areas, the desirable sight distance requirements shall be increased by using a speed of 100% of the target speed.

Depending on the grade of the thoroughfare, appropriate intersection sight distance shall be provided. Vehicles approaching an intersection on an upgrade need less distance to stop, and vehicles approaching an intersection on a downgrade need more distance to stop. See Table 4.6 for intersection sight distances requirements due to horizontal curve sizes and target speeds on cross streets.

Also, refer to and apply the applicable requirements for intersection sight distance and stopping requirements based on intersection condition that are enumerated in Section 9.5 of the AASHTO Green Book.

It is very important the designer check for intersection sight distance at all locations, but especially where a conflict may occur. Examples of areas where potential for sight distance conflicts may exist include:

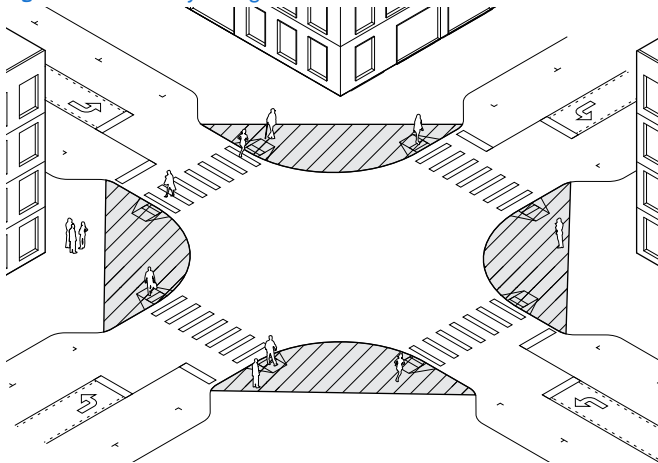
- Street and alley intersections where trees, bushes, utility poles, fences, guard rails, etc. may be present
- Street and alley intersections which may be in close proximity to a retaining wall
- Driveways subject to the conflict conditions above

4.3.3.2 Visual Obstruction Regulations

A General

The Dallas Development Code, Section 51A-4.602.d Visual Obstruction Regulations requires that no one shall erect, place or maintain a structure, berm, plant life, or any other item on a lot if the item is in the “visibility triangle” between 2.5 feet and 8 feet in height measured from the top of the adjacent street curb or, if there is no curb, from the grade of the portion of the street adjacent to the visibility triangle. Poles with diameters not exceeding 12 inches are exempt from this requirement. Removal of existing objects such as trees, historical structures, or terrain features should be a last resort. Other methods of safety improvement should be considered, such as, reduction of target speeds, increase of visibility using curb extensions or other design, and additional warning signs at the intersection. Figure 4.14 illustrates the visibility triangle. The “visibility triangle” is defined as follows:

Figure 4.14 Visibility Triangle



B Street to Street Intersection

In the central area districts, the Deep Ellum / Near Eastside District (Planned Development District (P.D.D.) No. 269) and the State-Thomas Special Purpose District (P.D.D. No. 225), the portion of a corner lot within a triangular area formed by connecting together the point of intersection of projected adjacent street face of curb lines (or, if no street curbs, what would be the normal street face of curb lines) and points on each of the projected street face of curb lines 30 feet from their intersection;

In all other zoning districts, the portion of a corner lot within a triangular area formed by connecting together the point of intersection or projected adjacent street face of curb lines (or what would be the normal street face of curb lines if no curbs exist) and points on each of the projected street face of curb lines 45 feet from their intersection.

C Street to Alley or Driveway Intersections

In all zoning districts, the portion of a lot within a triangular area formed by connecting together the point of intersection of the projected edge of a driveway or alley pavement (not the transition flare) and an adjacent projected street face of curb line (or what would be the normal street face of curb line if no curb exists) and points on the projected driveway or alley pavement edge (not the transition flare) and the projected edge of street face of curb line 20 feet from their intersection.

All paving designs shall be in compliance with these Dallas Development Code visual obstruction regulations.

D Corner Clip

For the purposes of this Manual, the use of the term "corner clip" means a triangular dedication of street or alley right-of-way.

Figure 4.26 provides an estimated corner clip for each street intersection combination per Section 4.4 Intersections of this manual. The estimated corner clip is based on an isosceles triangle-shaped clip having legs equal to the longest required dimension needed to cover the required curb return and a theoretical diagonal construction line measured 8 feet radially outward from the face of the curb at the center of the curb return (see Table 4.4). The required corner clip is a function of the curb radius and the buffer / landscaping zone width of the intersecting streets. The actual corner clip's shape and dimension requirements shall be determined on a case by case basis, based on the actual additional right-of-way needed for the proposed curb radius and barrier-free sidewalk construction.

For examples on the use of Table 4.4 see Appendix A.5 Street Centerline and Corner Curb Return Radii Determinations - Examples.

Table 4.4 Intersection Summary Street Without Median Intersecting Street Without Median

Intersecting Streets		Maximum Curb Return Radii (feet)	Typical Corner Clip C x C
Initial Street	Destination Street		
Principal Couplet	Principal Couplet	35	15' x 15'
Principal Couplet	Minor Arterial	45	25' x 25'
Principal Couplet	Community Collector	45	20' x 20' *
Principal Couplet	Residential Collector	30	10' x 10' *
Principal Couplet	Local [All except L-2-U(B)]	20	10' x 10'
Principal Couplet	Local [L-2-U(B)]	30	10' x 10'
Minor Arterial	Principal Couplet	35	15' x 15'
Minor Arterial	Minor Arterial	45	25' x 25'
Minor Arterial	Community Collector	30	10' x 10' *
Minor Arterial	Residential Collector	30	10' x 10' *
Minor Arterial	Local [All except L-2-U(B)]	20	10' x 10'
Minor Arterial	Local [L-2-U(B)]	30	10' x 10'
Community Collector	Principal Couplet	20	5' x 5' *
Community Collector	Minor Arterial	20	5' x 5' *
Community Collector	Community Collector	20	3' x 3' *
Community Collector	Residential Collector	20	3' x 3' *
Community Collector	Local [All except L-2-U(B)]	20	3' x 3' *
Community Collector	Local [L-2-U(B)]	25	4' x 4' *
Residential Collector	Principal Couplet	20	5' x 5' *
Residential Collector	Minor Arterial	20	5' x 5' *
Residential Collector	Community Collector	20	3' x 3' *
Residential Collector	Residential Collector	20	3' x 3' *
Residential Collector	Local [All except L-2-U(B)]	20	3' x 3' *
Residential Collector	Local [L-2-U(B)]	25	4' x 4'
Local	Principal Couplet	20	5' x 5' **
Local	Minor Arterial	20	5' x 5' **
Local	Community Collector	20	3' x 3' **
Local	Residential Collector	20	3' x 3' **
Local	Local	20	3' x 3' **

* Collector M-2-U requires a larger corner clip.

**Local M-2-U requires a larger corner clip.

4.3.4 Alignments

4.3.4.1 Horizontal Alignment

A General

Streets must be designed in relation to the Thoroughfare Plan, existing, proposed, parallel and cross streets, the terrain, streams, and other physical conditions. The arrangement of streets must provide for the continuity of streets and thoroughfares between adjacent properties. Especially when the continuity is necessary for the safe and efficient movement of traffic, pedestrians and bicycling, and / or utility efficiency and to ensure streets are multimodal. Local streets should be oriented in a manner that discourages through-traffic and allows the design of efficient drainage systems, utility systems and general street improvements.

The horizontal alignment of city streets and thoroughfares shall be designed to provide safe, continuous operation for motorists, bicycles and pedestrians while meeting the varying needs of the adjoining owners and the public. The horizontal alignment shall be designed to comply with the functional and dimensional classification requirements of the Thoroughfare Plan using the traffic requirements determined by the City and the design criteria provided in Section 4.2 Design Criteria. The various roadway classifications have certain horizontal and vertical geometrics to provide a safe and economical facility for use by the public.

B Horizontal Curves and Superelevation

The alignment of a city street or thoroughfare is based on the functional and dimensional classification of the street and is normally controlled by the alignment of the existing right-of-way or structures which cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing simple curves having radii which are compatible with the speed of vehicular traffic. To increase the safety and reduce discomfort to drivers traversing a curved portion of a street or thoroughfare, the pavement may be superelevated though most streets may be designed using a standard crown section without superelevation. Also, the intersection's sight distance must be considered to ensure safety in curved sections.

Curvature in the alignment of thoroughfares should be minimized to provide safe movement of large volumes of traffic. The lower target speeds and traffic volumes on local streets allow greater use of horizontal curves in the street alignment contributing an aesthetic value to urban residential neighborhoods.

Recommended minimum radii of curvature for various vehicle target speeds and pavement superelevations, without consideration of intersection sight distance requirements, are shown in Table 4.5. Restrictions on the minimum radius of curvature due to intersection sight distance requirements are provided in Table 4.7.

The following formulas were used in calculating the minimum radii of curvature and superelevations given in Table 4.5:

$$R_{min} = \frac{V^2}{15(e+f)} \quad \text{and} \quad e = \frac{V^2}{15 R_{min}} - f$$

e = rate of roadway superelevation (ft / ft)

f = side friction factor

V = vehicle speed (mph)

R_{min} = minimum street lane centerline radius of curve (ft)

These minimum radii of curvature are based on traffic consisting of typical present day automobiles operating under optimum weather conditions.

Other important considerations which must be addressed in the design of curves on city streets and thoroughfares include the location of intersecting streets, drives, bridges and other topographic features. Horizontal curves greatly affect the intersection sight distance, especially on the inside portion of the curves. Intersecting streets on the inside portion of curved streets have reduced visibility of oncoming traffic at the intersection, as compared to the sight distance provided by a straight roadway alignment.

The minimum centerline radius needed to provide a required intersection sight distance is dependent on the target speed, the pavement lane width, street section classification, and the pedestrian zone width. The narrower the lane and pedestrian zone widths, the less the area of visibility is for the motorist stopped at an intersection and thus, the larger the centerline radius required to provide the required visibility.

Table 4.6 shows the minimum centerline radii required for the various street section classifications to provide the desirable and minimum intersection sight distances given in Section 4.3.3 Visibility and Sight Distances. The specified "Desirable Minimum" centerline radii shall be used for the horizontal centerline radii where practical instead of the smaller radii determined from Table 4.5. If use of the "Desirable Minimum" radii from Table 4.6 is not practical, the "Safety Minimum" radii given in Table 4.6 shall be compared with the minimum centerline radii determined from Table 4.5 and the larger of the radii shall be used. The minimum centerline radius for a street must not be less than the "Safety Minimum" radius given in Table 4.6 unless additional sight easements are provided. Use of "Safety Minimum" radii requires approval of the Director.

If additional sight easements are provided, the required "Safety Minimum" centerline radius can be reduced in some cases. Table 4.7, Sight Easement Requirements Due to Intersection Sight Distances lists the street classification sections in which the "Safety Minimum" centerline radius can be reduced by providing additional sight easements. These sight easements are required along the inside portions of the curved right-of-way alignment in addition to the required street right-of-way and pedestrian zone widths.

Some street classification sections also require sight easements on the outside portions of the curved right-of-way alignment to achieve the reduced centerline radii noted with (²). This is due to the high target speeds required and narrow sidewalk clear zones provided. These street classification sections are noted with (²) in Table 4.6 with the reduced "Safety Minimum" radius allowed shown. For these cases, the outside curve sight easements shall be equal in width to the inside curve sight easements required.

In all cases, the minimum centerline radius must not be less than the minimum centerline radius determined in Table 4.5.

For examples on the use of Table 4.5, Table 4.6, and Table 4.7 see Appendix E Street Centerline And Corner Curb Return Radii Determinations - Examples.

Table 4.5 Minimum Centerline Radius for Thoroughfares

Superelevation Rate		Min Centerline Radius (ft) ¹ Target Speed (mph)						
(in/ft)	(ft/ft)	25	30	35	40	45	50	55
-1/2	-0.0417	210	340	530	780	1,120	1,700	2,260
-3/8	-0.0313	200	320	500	730	1,030	1,540	2,030
-1/4	-0.0208	190	210	470	680	950	1,400	1,830
-1/8	-0.0104	180	290	440	640	890	1,290	1,680
0	0	170	280	420	600	830	1,200	1,540
+1/8	+0.0104	160	260	400	570	780	1,110	1,430
+1/4	+0.0208	160	250	380	540	740	1,040	1,330
+3/8	+0.0313	150 ²	240	360	510	700	980	1,250
+1/2	+0.0417	150 ²	230	350	490	660	920	1,170

¹ Minimum centerline radius for Local L-2-U (B) section streets is 150 feet, for Local L-2-U(A) section streets is 200 feet, and for Local S-2-U and M-2-U section streets is 230 feet for residential zoned districts and 280 feet for all other zoned districts.

² Minimum centerline radius is 150 feet.

Table 4.6 Horizontal Curve Restrictions Due to Intersection Sight Distances

Classification Section	Target Speed (mph)	Left Side (ft)				Right Side (ft)			
		Desirable Min		Safety Min		Desirable Min		Safety Min	
		SD	R	SD	R	SD	R	SD	R
Local									
L-2-U(B)	25	235	460	110	150 ²	240	350	150	150 ²
L-2-U(A)	25	235	540	110	200 ³	240	360	150	200 ³
M-2-U	30	315	1,290	145	275	315	745	200	290
S-2-U	30	315	970	145	210	315	605	200	230
Residential Collector									
M-2-U	35	405	2,130	180	425	410	1,280	225	370
S-2-U	35	405	1,600	180	320	410	1,040	225	300
M-4-U ¹	35	405	1,500	180	310	410	985	225	280
Community Collector ⁴									
M-2-U	40	485	3,060	225	660	485	1,800	275	565
S-2-U	40	485	2,300	225	495	485	1,470	275	455
M-4-U ¹	40	485	2,220	225	480	485	1,390	275	430
Minor Arterial ⁴ (undivided)									
M-4-U	40	485	3,050	225	660	485	2,050	275	645
S-4-U	45	575	5,450	270	1,210	580	4,320	325	1,350
Minor Arterial ⁴ (divided)									
M-4-D(B)	40	485	3,050	225	660	500	1,640	275	475
M-4-D(A)	45	575	3,900	270	865	595	2,120	325	610
S-4-D	50	675	6,650	325	1,560	700	3,570	400	1,150
Principal Arterial (couplet ⁵)									
M-3-U	45	575	5,030	270	1,110	575	5,030	270	1,110
M-4-U	45	575	4,280	270	950	575	4,280	270	950
S-3-U	45	575	3,980	270	880	575	3,980	270	880
S-4-U	45	575	5,460	270	1,210	575	5,460	270	1,210
Principal Arterial (divided)									
M-6-D(B)	45	575	6,300	270	1,400	610	3,110	325	865
M-6-D(A)	50	675	6,040	325	1,420	710	2,850	400	880
S-6-D	55	780	7,330	375	1,710	825	3,500	450	1,020
S-8-D	55	780	7,770	375	1,810	840	3,290	450	910

¹ Striped for two lanes

² Minimum centerline radius for street set to 150 feet

³ Minimum centerline radius for street set to 200 feet

⁴ Collector thoroughfares which are designated with Minor Arterial sections with 4 lanes of traffic shall be designed to Minor Arterial Standards. Minor Arterial thoroughfares which are designated with Principal Arterial sections with 6 lanes of traffic (3 lanes in each direction) shall be designed to Principal Arterial Standards.

⁵ Applicable for oncoming traffic side on one-way couplet.

SD - Sight Distance

R - Radius

Table 4.7 Sight Easement Requirements Due to Intersection Sight Distances

Classification Section	Table 4.7 Radius (ft) (no crossfall)	Min Radius with Sight Easement (width in feet)				
		0	1	2	3	4
Community Collector						
M-2-U	600	660	595	565	535	565
M-2-U ²	600	660	595	540 ²	495 ²	460 ²
Minor Arterial (undivided)						
M-4-U ²	600	660	590 ²	540 ²	495 ²	455 ²
S-4-U ²	830	1,350	1,040 ²	915 ²	820 ²	750 ²
Minor Arterial (divided)						
M-4-D (B)	600	660	590	540	495	475
M-4-D (A)	830	865	785	715	660	-
S-4-D	1,200	1,560	1,360	1,210	1,150	1,150
S-4-D ²	1,200	1,560	1,360	1,210	1,100 ²	1,010 ²
Principal Arterial (couplet)						
M-3-U	830	1,110	965	860	780	710
M-4-U	830	950	850	770	705	655
S-3-U	830	880	790	720	660	-
S-4-U	830	1,210	1,040	915	820	750
Principal Arterial (divided)						
M-6-D (B)	830	1,400	1,170	1,020	905	865
M-6-D (B) ²	830	1,400	1,170	1,020	905	820 ²
M-6-D (A)	1,200	1,420	1,260	1,140	1,050	965
S-6-D	1,540	1,710	1,540	1,410	1,300	1,200
S-8-D	1,540	1,810	1,620	1,470	1,350	1,250

¹ Sight easements are required along the inside right-of-way curves only to achieve the above minimum centerline radii except for the M-4-U and S-4-U sections and for those cases footnoted below in which cases, sight easements are required along both the inside and outside right-of-way curves.

² This section requires sight easements along both sides of the street right-of-way to achieve reduced minimum centerline radii shown in parenthesis.

C Turning Lanes

Turning lanes are provided at intersections to accommodate left-turning and right-turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in advance of the intersection or to a safe speed for the turn if a stop is unnecessary. Single left-turn lanes at intersections shall be at least 10 feet in width. Left turn lanes shall provide a reverse curve transition for deceleration and adequate storage for turning vehicles. When turning traffic is too heavy for a single lane and the cross street is wide enough to receive the traffic, dual left turning lanes may be provided. Lane widths for dual left turning lanes should be at least 11 feet. Availability of right-of-way may limit locations where dual left-turning lanes are feasible. The standards and geometrics for most intersections involving left turn lanes are described in Section 4.4 Intersections.

The location of the median nose at the end of the left turn lane should be set such that left-turning traffic will clear the median nose while making a left turn. The median nose should also be placed such that no portion of the nose is located in any existing or proposed crosswalk. The back of the crosswalk is generally 12 feet from the face of the curb on the intersecting street.

The minimum storage length requirements “S” for left turn lanes at various type street intersections are provided in Table 4.12 and Table 4.13 of Section 4.4. The minimum storage requirements for left turn lanes serving driveways and mid-block median openings shall be 80 feet, and for local streets shall be 90 feet. Low traffic cases may warrant smaller storage requirements for driveways and certain local streets. Use of shorter storage lengths for left turn lanes must be approved by the Director.

Right turn lanes are provided to increase the vehicular capacity of an intersection by providing an extra lane exclusively for right turn movements. Dedicated right turn lanes shall not be less than 10 feet in width nor more than 12 feet wide. Lesser widths are preferred in areas of significant pedestrian traffic. Streets, with significant truck and bus volumes will need 11-foot and 12-foot right turn lanes. Right turn lanes shall provide at least 100 feet of storage for vehicles, and shall include a taper or reverse curve transition for deceleration.

Right turn and acceleration lanes may be required for certain driveway approaches to assist moving the accessing traffic off and onto the travel lanes of a street with a significant operating speed, such as arterials, some frontage roads, and some major collectors. Factors that may warrant the addition of right turn and acceleration lanes are development use, square footage and trip generation. The Traffic Safety Division of the Transportation Department shall review and approve the addition of all right turn and acceleration lanes.

The normal requirement for right and left turn lane reverse curve curb geometry for S-8-D, S-6-D, M-6-D (A), S-4-D and M-4-D (A) type arterial thoroughfares at non-principal arterial intersections shall be a 400-foot radius for curve #1 and a 200-foot radius for curve #2. The normal requirement for right and left turn lane reverse curve curb geometry for M-6-D (B) and M-4-D (B) type divided arterial thoroughfares at non-principal arterial intersections shall be a 300-foot radius for curve #1 and a 150-foot radius for curve #2. The radii required for left turn lane curb geometry is increased when an arterial thoroughfare intersects principal arterial and divided minor arterial thoroughfares. Details on required radii are provided in Table 4.12 and Table 4.13.

Additional details concerning left and right turn lanes on divided arterial thoroughfares are provided in the City of Dallas Standard Construction Details, File 251D-1.

4.3.4.2 Vertical Alignment

A Street Grades

The vertical alignment of city streets and thoroughfares shall be designed to ensure the safe operation of vehicles and allow access to adjacent property. A vertical alignment which is safe for vehicles depends on operating speed, maximum grades, vertical curves and sight distance. Other factors affecting vertical alignment include storm drainage, crown or crossfall and the relationship between pavement profile and the ground profile at the right-of-way line. The profile of the street or thoroughfare, particularly at its intersection with another profile, is of prime importance in providing a safe, comfortable riding surface to the motoring public. The intersection design of two arterials shall include grades which will result in a plane surface or at least a surface which approximates a plane surface. A motorist traveling on either thoroughfare shall be able to traverse the intersection at the target speed without discomfort. To accomplish a smooth transition, crossfall toward the median of one lane of each thoroughfare may be required. A storm drainage inlet may also be required in the median.

In presenting the grades of intersecting streets in the paving plans, profiles of all top of curbs (including median curbs) of a street shall be shown as a continuous grade through the intersection of the other street.

Minimum grades are as follows:

- Minimum longitudinal grades for streets and thoroughfares are required to insure proper flow of surface drainage toward inlets. The minimum desirable grade is 0.5%. Drainage from the adjoining properties must be maintained.
- Where valley gutters are used for intersecting drainage, minimum grade is 0.5% for cast-in-place concrete. Asphaltic concrete valley gutters are not permitted.

Maximum grades are as follows:

- Maximum longitudinal grades shall be compatible with the classification of street and the accompanying characteristics including the target speed, traffic conditions, and sight distance.
- Arterial thoroughfares must move large volumes of traffic at higher speeds, and flatter grades will better accommodate these characteristics. Truck and bus traffic on these type facilities often control traffic movement, particularly if steep grades prevent normal speeds. The normal maximum street grades allowed for City of Dallas streets are shown in Table 4.8. Steeper grades may be permitted for short lengths when restricted by topographical features or the alignment of the street.

Table 4.8 Normal Maximum Street Grades

Street Type	Normal Max Grade
Local Streets	10%
All Collector Streets	8%
All Arterial Thoroughfares	6%

Superelevation (Crossfall) requirements are as follows:

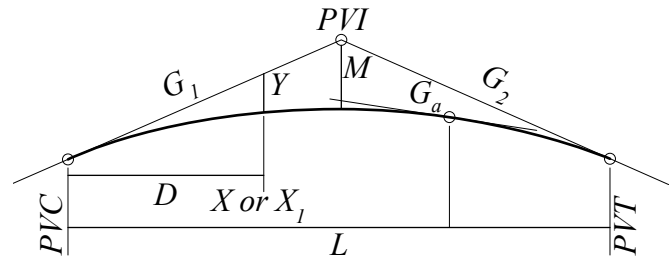
- Minimum crossfall for street and thoroughfare pavements are required to ensure proper flow of surface drainage to the gutter lines and storm drainage inlets. For longitudinal paving grades equal to or exceeding 1%, minimum pavement crossfall is 1/8 inch per foot (1%). For longitudinal paving grades less than 1% and at storm drainage inlets, the minimum pavement crossfall is 1/4 inch per foot (2%). The crossfall on divided arterials shall be equal to or greater than 6 inches across the traffic lanes between the gutter lines for each half of the thoroughfare.
- Maximum street pavement crossfall permitted is 1/2 inch per foot (4%) at any point in the roadway. Crossfalls should normally not exceed 1/4 inch per foot (2%).
- The standard street paving cross section for undivided streets is either the parabolic crown section or the “roof top” crown section where the street crossfalls from the pavement centerline down toward each gutter line. Elevation differences in excess of 0.2 feet should be avoided between gutter elevations on each side of the street for streets with parabolic crown pavement cross sections and must not exceed 6 inches. In cases where elevations are extreme between cross section points at the property lines, the street section may be transitioned to provide a pavement crossfall in the same direction for the full width of the street pavement. The street section should be transitional back to the standard street section as soon as the condition permits.
- Superelevation on horizontal curves may be advantageous for local streets traffic operations in specific locations, but in built-up areas the combination of wide pavement areas, proximity of adjacent development, control of cross slope, profile for drainage, frequency of cross streets, and other urban features often combine to make the use of superelevations impractical or undesirable. Therefore, superelevation usually is not provided on local streets in residential and commercial areas. Superelevations may be considered on local streets in industrial areas to facilitate operation.
- If superelevation is used, street curves should be designed for a maximum superelevation rate of 4%.
- For the minimum length of superelevation runoff the designer shall follow the AASHTO standards in the Geometric Design of Highways and Streets Manual, Chapter 3, section 3.3.8 Transition Design Controls.

B Vertical Curves

Design criteria for vertical curves along a street alignment shall comply with the latest version of the AASHTO Green Book for the classification and use of that street, subject to the following constraints and considerations.

When two longitudinal street grades intersect at a point of vertical intersection (*PVI*) and the algebraic difference in the grades is greater than 1%, a vertical curve is required. Vertical curves are utilized in roadway design to affect a gradual change between tangent grades and should result in a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The geometric elements of the parabolic vertical curve required in the design of pavement profiles are shown in Figure 4.15. Figure 4.16 provides the formulas for calculating vertical curves. The vertical curve shall be formed by a simple parabola and may be a crest or sag vertical curve. The six possible conditions for crest and sag vertical curves are shown in Figure 4.17.

Figure 4.15 Geometric Elements of Vertical Curve



M = Ordinate from *PVI* to curve (ft)

$A = G_2 - G_1$, The Algebraic difference in tangent grades where G_1 is the tangent grade at the reference point from which D or X is Measured

L = Length of curve in stations

Y = Ordinate from tangent to curve (ft)

D = Distance from nearest *PVC* or *PVT* to any point on curve

X = Distance from *PVC* or *PVT* in stations to any point on vertical curve

X_1 = Distance from *PVC* to lowest or highest point on vertical curve

G_a = Tangent grade at any point (%)

G_1 and G_2 = Tangent grades (%)

PVI = Point of vertical intersection

PVC = Point of vertical curvature

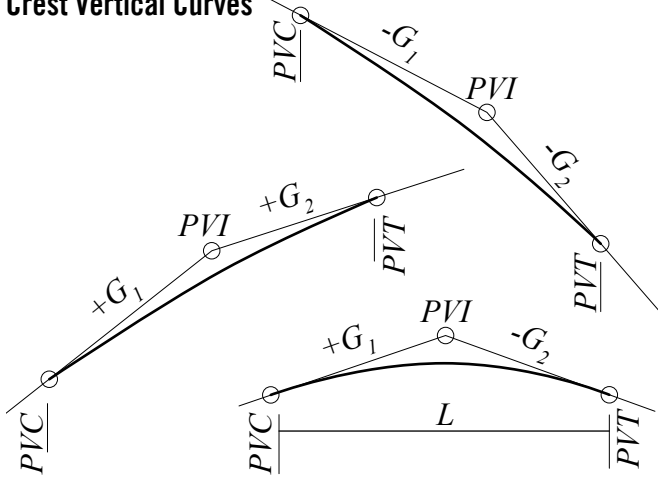
PVT = Point of vertical tangent

Figure 4.16 Vertical Curves Formulas

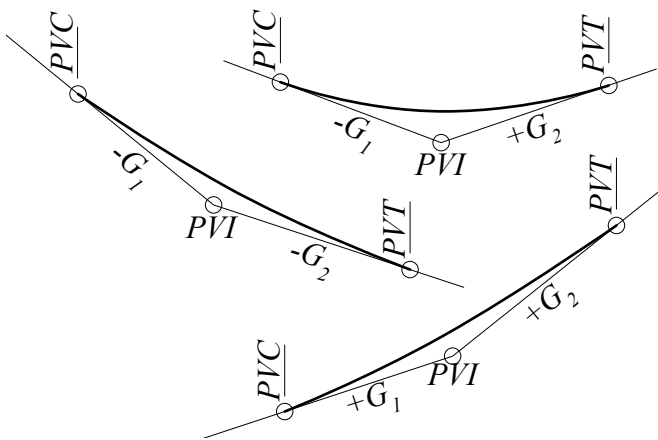
$$M = \frac{AL}{8} \quad X_1 = \frac{-LG_1}{A} \quad Y = D^2 \times \frac{M}{(L/2)^2} \quad G_a = G_1 + \frac{AX}{L}$$

Figure 4.17 Vertical Curve Types

Crest Vertical Curves



Sag Vertical Curves



C Stopping Sight Distance

When a vertical curve is required, it must not interfere with the driver's visibility over a certain length of street ahead, should sudden stopping be required. This length of street, called the stopping sight distance, should be sufficient to enable a person with a height of eye of 3.5 feet above the pavement surface and traveling at or near target speed to stop before reaching an object 6 inches in height which is in the pathway of the vehicle.

The minimum stopping sight distance is the sum of two distances: the distance traversed by a vehicle from the instant the driver sights an object for which a stop is necessary to the instant the brakes are applied and the distance required to stop the vehicle after brake application begins. The minimum safe stopping sight distances for the City of Dallas street types and target speeds are shown in Table 4.9. These sight distances are based on each target speed shown and wet pavement. The minimum length of crest vertical curve that provides a safe stopping sight distance for each street type may be calculated using the formula $L = KA$ (the values of K for a crest vertical curve are shown in Table 4.9).

Table 4.9 Minimum Length of Vertical Curve

Crest Vertical Curve			Sag Vertical Curve		
$L = KA$ where			$L = KA$ where		
L = Minimum length vertical curve required for safe stopping sight distance			L = Minimum length vertical curve required for comfort		
K = Horizontal distance in feet required to effect a 1% change in gradient			K = Horizontal feet required to effect a 1% change in gradient		
A = Algebraic difference in grade			A = Algebraic difference in grade		
Street Classification	Target Speed (mph)	Min Safe Stopping Sight Distance	Normal Crest Vertical Curve K		Normal Sag Vertical Curve K Recommended
			Min (ft)	Desirable (ft)	
Principal Arterial					
S-6-D & S-8-D	55	540	140	220	65
M-6-D (A)	50	460	107	160	54
M-6-D (B)	45	385	76	110	44
Minor Arterial (Divided)					
S-4-D	50	460	107	160	54
M-4-D (A), 11' lanes	45	385	76	110	44
M-4-D (B), 10' lanes	40	315	70	80	44
Minor Arterial (Undivided)					
S-4-U	45	385	76	90	44
M-4-U	40	315	70	80	34
Community Collector					
All	40	315	70	80	34
Residential Collector					
All	35	250	36	50	26
Local					
S-2-U & M-2-U, 36' wide pavement	30	200	24	30	20 ¹
L-2-U (A), 33' wide pavement	25	200	24	30	20 ¹
L-2-U (B), 26' wide pavement	25	200	24	30	20 ¹
CBD Streets					
Couplets, divided 4 - 8 lane, & 5 lane	45	385	76	90	44
Undivided 4 - 6 lane streets	40	315	70	80	40
All other streets	35	250	36	50	30

¹ Minimum K is 20

When a sag curve is required, the vertical curve shall be of sufficient length to provide a comfortable ride during the change in vertical direction. The minimum length of sag vertical curve that provides a comfortable ride may be calculated using the formula $L = KA$, (the values of K for a sag vertical curve are shown in Table 4.9). It is the policy of the City of Dallas to illuminate arterials; therefore, headlight distance is not a factor in the design of sag vertical curves on these facilities.

D Intersection Grades

Arterial street to arterial street intersections shall be designed to approximate a plane surface to provide a smooth ride for the driver at the target speed. See Section 4.3.4.2.A Street Grades.

For local streets that intersect arterial and collector thoroughfares, the grade of the local street from the principal arterial or collector street gutter shall not be more than 4% either up or down within the first 20 feet beyond the curb line of the principal street, except that in very hilly terrain a intersecting grade of up to a maximum of 6% may be considered. For all non-arterial street intersections of equal classification and for collector street intersections with arterial thoroughfares, intersection grade changes of more than 1% require vertical curves for transitioning to the intersection grades. Valley gutters shall not be used across collector and arterial streets to make grade changes.

4.3.4.3 Transitions to Existing Grade

A General

All projects require horizontal and vertical transitioning from new or proposed paving and grading to the elevations of existing pavement or natural ground. Areas which must be considered for transitions include the beginning and end of a project, intersecting streets, driveways, drainage ditches, raised crosswalks or intersections, pedestrian zones and adjoining properties. Transitions are also necessary when the new or proposed paving is wider than the existing pavement leading into or away from the proposed paving. When tapers are used for horizontal transition pavement, the following formulas shall be used to determine the minimum length (L) of taper required:

- For streets and thoroughfares with target speeds of 45 mph or greater, $L = W \times S$
- For streets and thoroughfares with target speeds less than 45 mph, $L = (WS^2)/60$

Where L is the minimum length of taper in feet, S is the target speed limit in mph, and W is the lateral shift of traffic in feet required in going from the new pavement to the existing pavement due to reduced or increased number of lanes or changes in the pavement lane widths.

B Pavement Transitions

Improved streets are those constructed of Portland Cement Concrete (PCC). Transitions to improved street pavement shall be designed as follows:

- Transitions to improved streets shall be constructed to the standard pavement thickness using PCC as required for City standard street and thoroughfare paving. The design criteria for improved streets as outlined in this manual shall be followed. Pavement widths and sections shall be adjusted in the transition to provide a smooth and safe pavement transition to existing street pavement sections using the target speed of the street or thoroughfare and the curb or edge of pavement radii which are not less than the centerline radii given in Table 4.5. When transitions to existing improved streets involve a reduction in the number of lanes, the total transition taper lengths shall be no less than that required in Section 4.3.4.3.A. Grades shall be designed to tie to existing street gutter and top of curb elevations. Plans shall show actual field shots on the existing top of curb, gutter flow lines and quarter points of the street pavement at the point of tie-in using the datum of the proposed paving plans.
- Full length standard street turnouts shall be provided when tying PCC streets to existing improved intersecting streets. Pavement removal and replacement shall be included in the paving design plans as required to provide standard paving design transitions and to maintain drainage. The pavement design shall include standard pavement connection details to the existing PCC pavement and base.
- Standard connection details include a doweled expansion joint at the end of proposed street turnouts using header expansion material and also dowel bars or reinforcing steel splices when connecting to existing PCC pavement and base, unless there is an existing concrete street header for connection. Standard concrete street headers shall be provided when connecting to improved full depth asphaltic concrete streets and to existing PCC pavement and base that is in too poor condition for doweled connections.
- Connections to existing resurfaced PCC streets should be made with standard 6 inch high curbs matching the existing top of curb elevation. Additional existing street pavement removal and hot mix asphaltic concrete transition overlay may be required to provide proper gutter drainage. Pavement and curb and gutter removal and replacement, milling and asphalt overlay shall be included in the proposed paving plans as required to maintain at least a 4-inch elevation difference between the top of curb and gutter in transition areas when tying proposed paving to existing resurfaced improved concrete streets.

Transition to unimproved streets shall be designed as follows:

- Standard concrete street headers shall be provided at the ends of proposed PCC streets when connecting to existing unimproved street pavement. Street headers shall be of standard length as required for the future improved pavement sections and transition grading and pavement shall be provided to connect to the existing pavement. Drainage transitions between street gutters and ditches shall be provided to maintain drainage.
- When drainage and right-of-way constraints permit, full length standard street turnouts shall be provided when connecting to intersecting unimproved streets. Drainage transitions shall be provided from street gutters to existing drainage ditches with any required drainage facilities to maintain drainage standards. Standard concrete street headers shall be provided at the ends of street turnouts. Street headers shall be of standard length as required for the future improved pavement section connection.
- Transitions to unimproved streets on either end of the new pavement or at intersecting streets which arise from an elevation difference or a difference in pavement width are generally constructed out of hot mix asphaltic concrete pavement at least six inches thick. On arterials, transitions to unimproved streets shall consist of at least 4 inches of asphaltic concrete fine-grade binder course under a 2 inch thick asphaltic concrete fine grade surface course. The transition shall extend a sufficient distance to eliminate “bumps” or uneven pavement and shall provide for a safe, smooth riding surface. Minimum and maximum grades as outlined in Section 4.3.4.2 Vertical Alignment shall be followed on the pavement transitions as well as the new or proposed pavement. Transition pavement shall also be of sufficient length and taper to provide for a smooth connection to existing pavement lengths shall be no less than that required in Part A of Section 4.3.4.3 Transitions to Existing Grade. Vertical curves shall be required for grade breaks on asphalt transition pavements exceeding 2%. The minimum centerline radii given in Table 4.5 shall be used in designing curb or edge of pavement radii for transition pavements.

Transitions to driveways and parking lot pavement shall be designed as follows:

- Requirements for transitions at driveways and parking lot pavements are provided in Section 4.5.8 Driveways and Curb Cuts.
- Adequate traffic control devices shall be provided at pedestrian zone ties to existing parking lots to provide for pedestrian and vehicular safety. Vehicular access to parking lots shall be limited to approved driveway or street access points. Curbs and / or fences may be required at

the property line or top of slope to prevent vehicles from entering the street or parking lot at unauthorized locations or to protect or provide for pedestrian safety.

- Transitions in parking lots shall be limited to what is required to provide a safe, smooth tie to the existing parking lot pavement. Pavement shall be replaced with similar pavement. Asphalt pavement shall be replaced with hot mix asphaltic concrete fine-grade surface course of 6 inch thickness. (Heavy commercial parking lots may require thicker pavement.) PCC shall be replaced with 6 inch thick “Hand Finish Class” concrete pavement. Parking lot transition grades shall be no flatter than 0.5% and no steeper than 8% or the existing parking lot grade, whichever is greater. Grade breaks shall not exceed 12% without vertical curves provided. Vertical curves shall be equal to or greater than 20 feet in length.

C Pedestrian Zone Transitions

Sloped transitions shall be designed as follows:

- The buffer / furnishing / curb zones that are adjacent to the new or proposed pavement must also be properly transitioned to natural ground at or beyond the property line with the appropriate slope easements or permissions. Sloping shall be utilized to make the transition whenever practical, however, the slope must not be steeper than 4:1 nor flatter than 1/4 inch per foot (2%) of fall (except across sidewalks) and care must be exercised in grading on private property. Steeper slopes may be approved by the Director when properly justified which shall include demonstrating that the slope will support native landscape without irrigation. Slopes steeper than 5:1 shall be contained within the right-of-way or permanent slope easements. Sloping shall be used to the greatest extent practical, and where grading needs to occur on private property, letters of permission to slope or slope easements must be obtained from the affected property owner. Also, slopes included must be properly stabilized.
- The preferred placement of sidewalks is away from the curb and near or next to the right-of-way line. Though less preferred but sometimes necessary in locations of significant topography changes across the right-of-way, sidewalks may be placed against the back of curb only if necessary to avoid excessive sloping on private property, and providing the standard 5-foot wide sidewalk and 1-foot wide strip of mildly-sloped buffer / furnishing / curb zone with crossfall of 1/4 inch per foot (2%) adjoining the sidewalk. Crossfall from 1-foot behind the sidewalk to the match with natural ground shall not exceed 3:1. See Section 4.5.3.4 Buffer / Furnishing / Curb Zone for details on buffer / furnishing / curb grading requirements.

- Intersection of driveways and sidewalks are the most common locations of severe cross-slopes for sidewalk users. The driveway design needs to accommodate the sidewalk to meet ADA and TAS requirements for longitudinal and crossfall slopes.

Retaining Walls shall be designed as follows:

- If sloping alone cannot be used because of conflicts with existing improvements or due to excessive right-of-way costs, other solutions which may be utilized include retaining walls and sidewalk curbs. Retaining walls shall not be used along undeveloped property, parks, schools, or recreational facilities, except as requested by the owner, but only when approved by the Director. Walls along parks, schools and recreational facilities shall include a pedestrian barrier such as fences for pedestrian safety. The barrier shall withstand a 200 lb concentrated load applied in any direction and at any point on the top rail, and shall also be designed to withstand a uniform load of 50 lb / ft applied horizontally to the top rail. Uniform loads are not to be applied simultaneously with the concentrated loads. Top rail height shall be 48 inches. The barrier shall be designed to prevent the passage of a sphere greater than 4 inches in diameter.
 - Integrated seat walls may be used as short retaining walls where pedestrian seating is desired and other site characteristics align with this street element.
 - The fencing materials must be compatible and complementary with the environment, project site, and community in which it is located. The fence shall be equal to or greater than 4 feet high, and of durable materials such as galvanized or painted steel or power coated aluminum posts, and fencing materials such as power coated aluminum or steel fencing with rail openings not greater than 4 inches, or galvanized or coated chain link fabric. In new construction, fence posts shall be mounted in embedded sleeves along the top of the wall. Where the fence is added along an existing wall, details will need to be developed for surface mounting using expansion anchors, or posts embedded in drilled holes, or some other structurally suitable method.
 - Walls and barriers shall be designed not to interfere or reduce the minimum sight distance at driveways, street and alley intersections.
 - Details for standard retaining wall and sidewalk curb designs are provided in the Standard Construction Details, File 251D-1. These cost effective standard wall designs shall be used whenever practical.
 - Retaining walls should be considered when grade differences between the proposed grades at the property line and the existing grade equals or exceeds 30 inches.
- The height of required retaining walls shall be kept to a minimum by sloping from behind the wall to the match point with existing ground. The minimum height for retaining walls is 6 inches from the proposed ground elevation at the base to the top of wall. The sloped grade above retaining walls shall generally be no steeper than 4:1 (25%), but no flatter than 1/4 inch per foot (2%).
- Two cost effective retaining walls for small to medium height applications are the sidewalk curb and the Type 6 retaining walls. When small retaining walls are necessary, the sidewalk curb retaining wall is the most cost effective. This retaining wall is used behind the sidewalk for heights up to 9 inches above the sidewalk surface. The standard Type 6 retaining wall is the most cost effective retaining wall for heights greater than 9 inches and less than 5 feet when sidewalks are being constructed. This wall is a sidewalk and wall combination design. The sidewalk is thickened and reinforced to serve as the wall footing.
 - When a guard fence is required at the top of the retaining wall for safety or security, the thicker Type 7 retaining wall section shall be used instead of the Type 6 retaining wall. The design provides inserts at the top for fence post embedment. The Type 7 retaining wall height can go up to 6 feet due to the thicker section design.
 - When a sidewalk is not to be used for the wall footing, the gravity wall design is the most cost effective retaining wall for wall heights greater than 9 inches and less than 3 feet in height. Thicker gravity wall sections are required when using a guard fence embedment at the top.
 - The Type 8 retaining wall is used in applications similar to the Type 6 and 7 wall when in driveway areas. The Type 8 wall is built integrally with the proposed reinforced concrete driveway throat, with additional driveway thickness required for the portion of the driveway within 1 foot of the retaining wall when the wall exceeds 3 feet in height. The driveway serves as the retaining wall footing providing an economical design. (See Standard Construction Details File 251D-1 for further details.)
 - When higher retaining walls are required, other standard retaining wall designs are provided in the Standard Construction Details. These designs are taken from the Texas Department of Transportation (TxDOT) standard wall designs. A low and a high footing pressure design is provided depending on the stability of the ground upon which the footing bears. The high footing pressure design is to be used when the footing will bear directly against unweathered, sound rock. The low footing pressure design shall be used in all other cases except for soft, spongy soils, in which case a geotechnical investigation shall be performed and special retaining wall design may be required.

- Some site conditions and projects will require modified or alternate retaining wall designs called special retaining wall designs. Special retaining wall and its structural design shall be submitted to the City project engineer with supporting calculations including the necessary geotechnical report.
- The following requirements shall apply to special retaining walls and their structural designs:
 - Retaining walls shall be designed to achieve a minimum safety factor of 2 against overturning and 1.5 against sliding, unless otherwise approved by the Director.
 - Design must meet TxDOT criteria for Stability, Eccentricity, Bearing Pressure, and Rotation.
- Retaining wall design for roadway construction shall consider the following parameters and criteria:
 - Allowable soil and / or rock bearing capacity. It should be verified that the wall footing is not constructed in close proximity to steep slopes, non-compact utility trench backfill or non-compact fill soils.
 - Surcharge loadings from adjacent structures (buildings, residences, etc.) and traffic live loads, either existing or proposed.
 - Hydrostatic pressure due to stormwater, groundwater, irrigation, etc.
 - Backfill requirements including provisions for drainage (drainage layer with perforated pipe or weep holes), clay cap and surface drainage to prevent surface water infiltration.
 - Uplift if applicable.
 - Resistance to sliding and overturning; the potential for future deterioration of materials at the toe of the structure and the subsequent decrease in passive resistance pressures should be considered. Sliding involves the lateral translation of a wall due to inadequate resistance to movement at the base of the wall. If resistance to sliding is not adequate, a key should be provided below the base of wall. The key should be designed using an appropriate passive resistance value for soil and / or rock. Overturning does not involve the soil under the wall but only the mass of the wall to resist the soil driving forces behind the wall. The wall has a tendency to overturn if the wall mass geometry is inadequate.
 - Location of slip plane; for proposed conditions, the design must ensure that the slip plane is not located below the wall footing. A safety factor against a global failure below the wall footing should be at least 2.0.
- Erosion at the ends of the wall, over top of wall, and undermining at the toe.
- Adequate room and right-of-way for construction of the footing and backfill.
- Placement of adequately spaced construction and expansion joints.
- Potential for impact or abrasion; gabions and similar materials should be avoided in areas subject to direct impact from debris or falling water.
- Maintenance requirements.
- Lateral loads from handrails, guardrails, and fencing including wind loads.
- Lateral loads due to on-site material or select fill. Depending upon backfill materials to be used, structural details of wall and acceptable tolerance for long-term lateral wall movements, the wall design should be based on either active pressures or at-rest pressures. If clay soils are to be used as backfill or if lateral wall movements are to be minimized, at rest pressures should be used.
- Specification requirements for backfill including backfill limits, gradation, plasticity index (PI) and compaction.
- Walls shall be designed not to obstruct intersection sight distance. (See Section 4.3.3 Visibility and Sight Distances)
- Top of wall elevations shall be designed to provide a minimum 1/4 inch per foot cross slope pedestrian zone grade between the top of wall and the property line but generally not more than a 4:1 slope.
- Drainage behind retaining walls shall be designed to release hydrostatic pressure build-up and prevent surface water from eroding out or undercutting the top of wall area.
- Adequate protection must be provided at the front of the footing to prevent erosion or undercutting the footing cover and foundation.
- When adjoining developed properties, the buffer / furnishing / curb zone slope between the top of wall and property line should be protected with block sodding or equal.
- Retaining walls shall be designed to provide for pedestrian and vehicular safety. Retaining walls, adjoining higher level walkways and parking lots shall be designed to provide barriers such as 9-inch high curbs and fences as required for safety.

- Wall height transitions shall be provided on both ends and whenever transitioning into sloping transitions and natural ground. The maximum wall height at end of wall transitions shall not be greater than 6 inches. The top of wall slope shall not exceed 4:1 unless additional slope protection is provided.

4.3.5 Medians and Median Openings

4.3.5.1 General

The required improved section for most principal arterials and some minor arterials include a median. (See Table 2.3, Section 2 Street Types of this manual.) A median is the raised portion of a divided roadway separating the traveled way for traffic in opposing directions. The principal functions of a median are to provide freedom from interference of opposing traffic, a recovery area for out-of-control vehicles, an area for speed changes and storage of left-turning vehicles, a barrier for minimizing headlight glare, and width for future lane widening if necessary.

The standard median width is 15 feet with a 5 foot wide median in left turn lanes, as measured from face of curb to face of curb. Transitions for left turn lanes will have a median width varying from 15 feet to 5 feet. Geometric details for median curbs and medians are provided herein and in the Standard Construction Details, File 251D-1.

Where a pedestrian refuge is required in medians by the Director, the minimum median width is 6 feet. See ADA and TAS requirements and the U.S. Access Board's "Accessibility Guidelines for Pedestrian Facilities in Public Right-of-Way."

All median areas which are less than 5-feet wide shall be paved with 4 inch thick non-reinforced concrete median pavement. Alternate paving materials and designs may be used upon approval of the Director. All concrete median pavement shall be constructed with a lug against the back of curb to prevent shearing of the curb.

Median slopes will vary depending on the type of roadway involved. Fall or rise in curb elevations across medians shall not exceed 1/2 inch per foot at any paving station. Differentials in curb elevations on narrow median strips may vary from 0 to 3 inches. Median backfill on the 15-foot median shall extend no more than 12 inches above the top of the low curb. All median backfill shall be sloped and graded to provide for positive drainage to the adjoining pavement. Hydromulching is normally provided on large slope areas where ground cover is advisable.

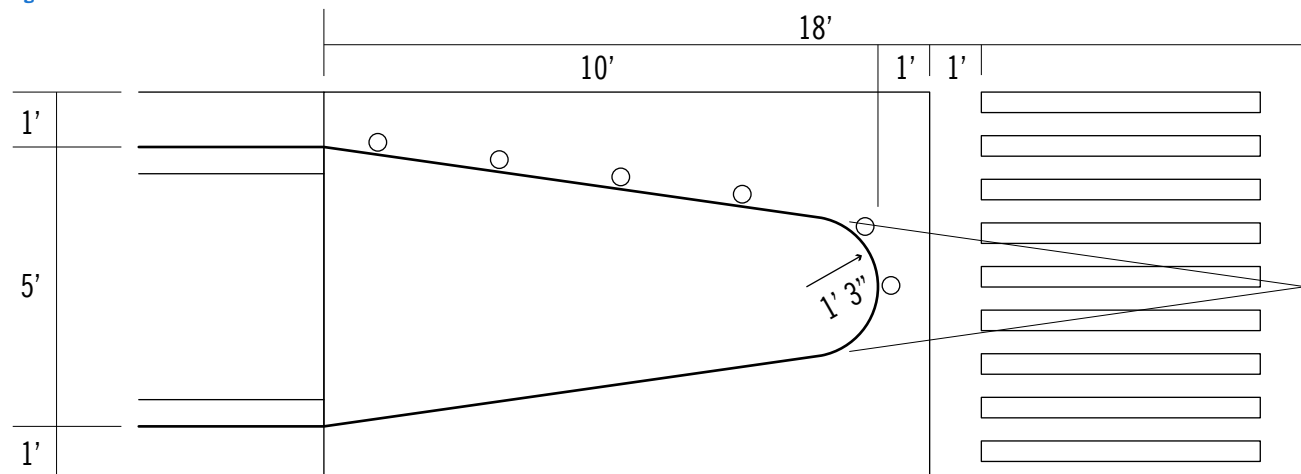
Items typically found in the median area include pedestrian refuge, grass and landscaping, street lights and street light conduit, traffic signals and signal conduit, traffic signs, pull boxes, signs and water meters. Trees, special landscaping, street furniture, signs, utility pole and appurtenances, irrigation systems, retaining walls and other miscellaneous structures should be located to provide at least 3 feet of clearance from outermost edge of structure to back of curb.

4.3.5.2 Median Openings

Warrants and restrictions on median openings are provided for in Section 3 Street Networks / Access Control of this manual. Unless approved otherwise by the Director, left turn lanes shall be provided on arterials at all intersections. The centerline of proposed median openings shall be located to line up with the centerline of the proposed streets or driveway turnouts to be served.

The minimum median opening width is 60 feet. Wider openings may be required in order to facilitate truck turning movements. The location of the median opening and the noses shall be designed to provide safe, efficient turning movements within the proper lane for access to driveways and intersecting streets to accommodate the WB-50 or SU design vehicle as determined by Table 4.1 of this manual. The appropriate design vehicle shall be used in the case of driveways. Geometric details for medians and left turn lanes are provided in Section 4.3.4.1.C Turning Lanes, and in the Standard Construction Details, File 251D-1.

Figure 4.18 Monolithic Median Nose



Standard monolithic median noses as represented in Figure 4.18 shall be provided at the ends of left turn medians. Standard designs for median ends and noses are provided for in the Standard Construction Details, File 251D-1. When crosswalks are not required at a standard intersection, the median nose shall be setback at least 2 feet from the projected face of curb or edge of pavement line of the intersecting street. Median noses shall also be set to provide adequate space for crosswalks when crosswalks are warranted. For usual intersection layouts, the median nose shall be set back 2 feet from the outside crosswalk line.

Intersections not at 90 degrees may require greater setback distances for median noses and crosswalks. For these cases, edges of crosswalks and median noses shall be designed to provide at least a 2-foot setback from the face of projected curbline or edge of pavement of the intersecting street to the edge of crosswalk or, the closest extremity of a stopped left turn vehicle at the end of the median nose. Details on crosswalk design are provided in Section 4.4.5.4 Crosswalks and Crossings of this manual.

Median openings shall be designed barrier-free at existing and proposed crosswalks in accordance with the ADA and TAS. See Section 4.4.5.8 for ADA and TAS Requirements of this manual for details.

4.3.6 Traffic Calming Elements

Paving design plans shall include required traffic control elements for the project and shall be reviewed and approved by the Public Works Department. Streets in Dallas shall be designed to meet the target speed. Traffic control elements are the combination of mainly physical measures that reduce the negative effects of motor vehicle use, will alter driver behavior and improve conditions for non-motorized street users. The immediate purpose of traffic calming elements is to reduce the speed of traffic to target speed (as specified in Section 4.2.2 Target Speed).

For major roadway construction and reconstruction projects, the geometric design of the roadway should be such that the excessive speed feel uncomfortable. Generally, constriction and visual complexity will slow down cars and improve safety.

The most important technique for controlling speed is having the appropriate width and numbers of lanes. Wider lanes tend to increase vehicle speed. Additional lanes, especially when traffic levels do not warrant them, will tend to increase speeds. Road Diets that eliminate under used lanes can effectively calm traffic.

The provision of bicycle and transit facilities can, in addition to improving transportation access, serve as traffic calming by narrowing the roadway and introducing additional visual elements into the street. Similarly, on-street parking is an effective traffic calming measure while it improves access and supports local businesses.

In addition to these strategies, the following traffic calming elements will be considered for travelway design on Dallas roadways:

- Lane Widths, to minimums per Figure 4.7
- Road Diets
- Center Medians / Islands
- Bikeways or Bike Lanes with Dividing Elements
- Transit Lanes
- On-street Parking
- Paving Treatments
- Shared Streets
- Roundabouts and Traffic Circles
- Curb extensions (at intersections)
- Chicanes: These are offset curb extensions that require vehicles to curve back and forth and reduce traffic speeds significantly. They also provide useful additional space to pedestrian zones. These may be supplemented with signage to indicate upcoming curves. The curves could range from 45 degree return angles to much subtler S-shapes.
- Midblock curb extensions (neck-downs): These help slow down traffic and increase space for pedestrians. They work well in conjunction with mid-block crossings and speed tables. They should be landscaped and may host other above-ground elements that typically belong in the buffer / furnishing / curb zone.
- Road humps: Typically 3 to 4 inches high and a 3 to 6 foot parabolic curve. These can reduce speeds to 15 to 20 mph. These may not be placed in front of driveways or access areas, or on emergency routes. Road humps require approval via a petition process and the proposed location must meet specific criteria established by the City. Petition documents are available from the Transportation Department.
- Speed Tables: Raised portions of the street that lift the entire wheel base of a car. They are typically 3 to 3.5 inches high and 22 feet long with ADA-compliant ramps and a flat top. These are typically used in conjunction with striped mid-block crossings or other striped crosswalks. They should not be placed near driveways or medians.

Success of these measures depends on achieving community support before they can be implemented. Typically, these items are used predominately on local streets and in commercial centers. The City's historical implementation process is based on person(s) of interest

petitioning for a project, which may involve payment of application fees, screening for eligibility and use, demonstration of community consensus, review and approval of the measure. Some degree of cost sharing may be required by the City. See the City's Dallas 311 website for requesting a city service for items such as road humps, rumble strips, street closures, signs, markings, and signals.

Additionally, some measures have limitations in their application. For example, road humps can only be used on local streets which are not emergency response routes. Most require community consensus and some require City Plan Commission and City Council approval which lengthens the timeframe in getting the measure implemented.

Shared streets, such as Woonerf streets in Section 2.4.7, can dramatically change motorist behavior and make streets safer and more welcoming. This street design method shall be applied when traffic volumes permit, in which pedestrian activity is high and vehicle volumes are low or can be accommodated at an alternate location.

4.3.7 On-Street Elements

4.3.7.1 Bikeways and Facilities

A General

Bike lanes are categorized under three umbrellas: (1) On-Street Shared, (2) On-Street Dedicated, and (3) Off-Street Bikeways. This manual provides general guidelines on design and selection of facility type. Refer to NACTO and Dallas Bike Plan Addendum for more detailed guidance on cross sections and treatments.

Bicycle facility types recommended by the Dallas Bike Plan can be categorized into these three umbrellas shown in Table 4.10:

Table 4.10 Bike Categorizations

	On-Street Shared	On-Street Dedicated	Off-Street Bikeways
Bicycle Boulevards	•		
Shared Roadways	•		
Climbing Lanes	•	•	
Cycle Tracks		•	
Paved Shoulder		•	
Shared Bus/Bike		•	
Shared Use Paths			•
Side Paths			•
Sidewalks			•

Where bike lanes are part of the complete street and the existing right-of-way condition provides limited pedestrian zone area for bike parking, some automobile parking spaces

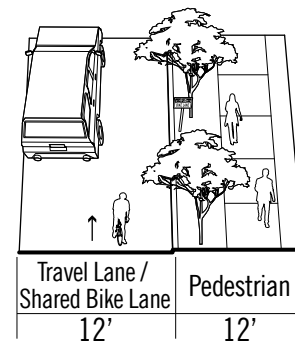
can be considered for conversion to “bike corrals” to provide for bike parking. Clearance considerations are required at fire hydrants, bus stops, loading zones, and above ground structures. When the Parking Zone is adjacent to bike lanes, design parallel parking and provide a solid white line separating the bike lane from the parking.

B On-Street Shared

On-Street Shared bicycle facilities allow bicycles and cars to share the same lanes as shown in Figure 4.19. For the safety and comfort of bicyclists, these are only recommended on streets with 1 lane in each direction or 2 lanes one-way, less than 30 mph target speeds, and an average daily traffic of less than 1,500. General design guidelines are provided here.

- Streets may have parking on one or both sides.
- Lanes shall be marked with shared bike lane signs. Refer to TMUTCD.
- Roadside signage shall be employed to indicate shared lanes.

Figure 4.19 On-Street Shared Bike Route



C On-Street Dedicated

On-Street Dedicated bicycle facilities are exclusive lanes for bicycle travel or shared with buses at street grade, but separated from general traffic lanes. See Figure 4.20 for typical configurations for dedicated bike lanes. These are recommended where roadways have up to 3 lanes in either direction and target speeds of 30 to 40 mph, and where the Bicycle Facility Level of Service (LOS) as defined in the Highway Capacity Manual, 6th Edition, 2016 (Chapter 24) requires dedicated bike lanes. General guidelines include:

- It is recommended for bicycle lanes to be between parking lanes and the pedestrian zone, but where required due to existing conditions, dedicated bicycle lanes may be between parking lanes and car lanes.
- Bicycle lanes are recommended on the right side of the travelway, in the same direction of car travel. However, where desired for connectivity or other purposes, two-way bike lanes on a one-way street may be permissible. Left-side bike lanes may also be used on one-way streets.

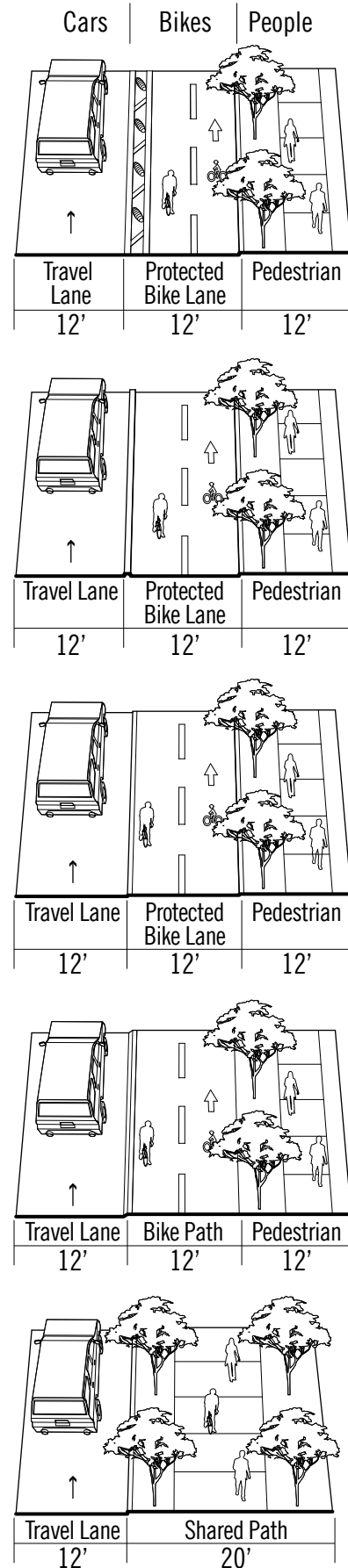
- Dedicated bike lanes must be a minimum of 5 feet with or without on-street parking and a preferred width of 6 feet in both cases, which may include the gutter pan.
- Bicycle lanes may be separated minimally by a 6-inch white line, preferably with a distinctive pavement treatment such as green paint.
- Bicycle lanes shall have a minimum 2-foot wide buffer on arterials and collectors (higher volumes, speeds of 35 mph or greater) using wide parallel white stripes or parallel stripes with diagonal stripes in between at a minimum of 2 feet wide.
- Bicycle lanes may be protected using physical barriers such as bollards, armadillos, minimum 6-inch curbs or landscaping. These are recommended where bicycle ridership is high, adjacent traffic volumes or speeds are high, and at intersections to provide visible barriers for motorists.
- Where separate from curbside bus lanes, bicycle lanes should be placed to the right of the bus lanes and be routed behind bus stops in islands.
- Pavement signs and roadside signage should be employed for “BUS AND BIKE ONLY” or “BIKE ONLY”.

D Off-Roadway Public Bike Lanes

Off-Roadway Bike Lanes are those located in the parkways of streets or in public easements outside of the roadway curb lines. These Bike Lanes are recommended for use with streets with target speeds of 40 mph or greater because they are physically separated from motorized vehicles and are not placed within the roadway section. These may be shared with pedestrians on trails or parkways. Design guidelines include:

- Off-Roadway Bike Lanes may be on the same level as the pedestrian zone but separated into their own lane.
- Where sharing with pedestrians, bike lanes should have a minimum width of 8 feet in one direction, and preferably a width of 10 feet. Two-way off-street bike lanes shared with pedestrians must be a minimum of 12 feet wide.
- Where separate from pedestrian travel, one-way bike lanes must have a minimum width of 8 feet and two-way bike lanes must have a minimum width of 12 feet. Pedestrian clear zone must be a minimum of 5 feet wide and preferably wider.
- Shared pedestrian and bike lanes must be marked as such on the pavement and using roadside signs.
- Separated bike lanes from pedestrian lanes must be marked with “BIKE ONLY” pavement markings.

Figure 4.20 Dedicated Bike Lanes and Facilities



4.3.7.2 Transit and Streetcar

A Principles

Transit is a critical component of urban streets. Incorporating transit facilities tends to benefit the City by creating pedestrian street activity with transit stops which draws people together at transit nodes and during travel to their destinations.

The primary modes of public transit in Dallas consist of streetcars, light rail, and buses. Streetcar lanes should be designed to be shared with cars and buses. Light rail requires infrastructural design and implementation which is led by DART. Bus lanes and properly sized and placed transit facilities make bus travel faster, more reliable, and simplifies conflicts and traffic flow. Bus lanes may be permanent or peak-only dedicated lanes if critical mass of bus traffic volume is present, or they may be shared with other modes of transportation. Successful implementation of safe, convenient, and cost-effective bus facilities creates more demand for buses, increasing bus volumes. Specific design guidelines for facilities are outlined below. For more detailed guidelines, refer to NACTO's Transit Street Design Guide.

B Bus Lanes

Curbside bus lanes shall be designed as follows. Coordination with DART shall occur in the design of bus lanes, location of pedestrian boarding and alighting accommodations, and placement of transit signage.

- Pavement sections where buses stop for passengers or dwell for schedule purposes shall be assessed to determine if a heavier pavement section is required to meet an expected 30-year life.
- Curbside bus lanes shall be marked by colored paving, "bus-only" pavement markings and other roadside signage. Refer to TMUTCD for markings and signage.
- Curbside bus lanes should be placed to the right of travel lanes on one-way or two-way streets, adjacent to curbs and preferably on streets without parking lanes.
- If curbside lanes are only dedicated bus lanes during peak times, provide regulatory signage that states the time periods of dedicated use by buses.
- Curbside bus lanes create the least conflict with turning vehicles on streets with few driveways and curb cuts. Where turn volumes are high, bus stops shall be on the far side and the parking lane between the bus lane and curb can be used as a turn lane at intersections.
- If parking lanes are present, vehicles may cross bus lanes to park but may not use the bus lanes for travel.
- Stops and shelters in the pedestrian zone require sufficient width in the buffer / landscape zone, usually 8 to 10 feet wide.

- Bus lanes shall be a minimum of 11 feet in width (12 feet preferred).
- Bus lanes may be shared with bike lanes. In such cases, the minimum lane width shall be 12 feet; 13 to 15 feet wide is preferable.
- When retrofitting streets, space can be dedicated to bus lanes by removing a median, a travel lane or a parking lane.

Median bus lanes are dedicated lanes that are expensive to build and are recommended where bus volumes are 20-30 buses per hour or more. They shall be designed as follows:

- Median bus lanes should be marked by pavement coloring, "bus-only" pavement markings and other signage at the middle of the roadway. Median bus lanes may also be physically separated from other vehicle lanes using a curb, bollards or landscaping, if space allows. Refer to TMUTCD for markings and signage.
- Median bus lanes can be one or two lanes on one-way or two-way lanes respectively, with bus stops in pedestrian islands.
- Where streetcars are running in the center lane and light rails are present, it is recommended that buses share the center lanes with them.
- Median bus lanes are recommended over curbside lanes for streets with turning volumes of 60% or higher, property access of 40% or higher, or where parking lanes exist along the curb.
- Dedicated bus lanes should be a minimum of 11 feet in width and not shared with bicycles or other modes of transportation.

Shared bus lanes are shared with cars and other modes of transportation. These are most common for streets with low bus traffic volumes, less than 10 buses per hour, as they are the least expensive method to accommodate buses. They shall be designed as follows:

- Shared lanes should be marked by pavement markings and roadside signage. Other pavement design may be used to signify shared lanes to make a more pleasant street for pedestrians. Refer to TMUTCD for markings and signage.
- Shared lanes are recommended on both one-way and two-way streets with bus stops on the right side of the travel lanes.

4.3.7.3 On-Street Parking

On-street parking should be maximized on mixed-use streets and residential streets. Please refer to the Dallas Complete Streets Design Manual for On-Street Parking design guidelines. See Figure 4.21.

On-street parking, whether its denoted as standard spaces or accessible spaces, shall not be included as part of the required number of parking spaces for any project or project area, unless approved otherwise by the Director. All required parking spaces for a project are required to be provided off-street; see Section 3.5.

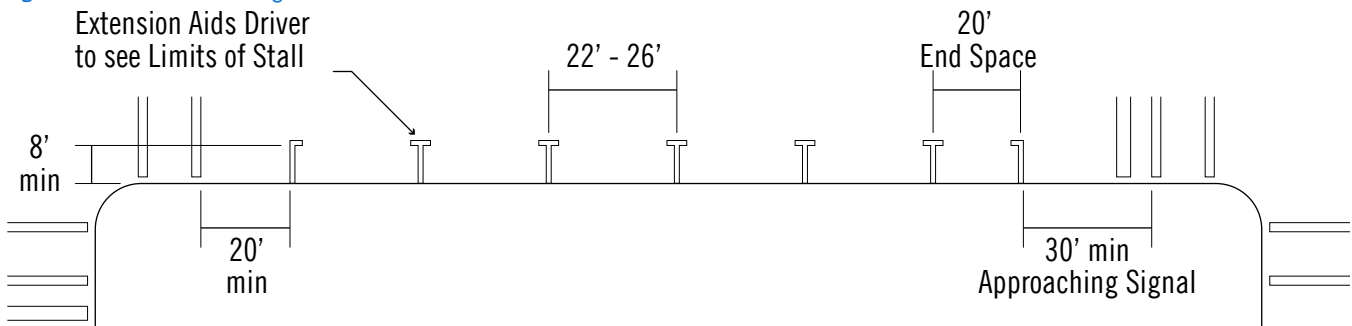
Where on-street public convenience parking is provided in commercial districts and at civic buildings, accessible on-street parking spaces may be included in the total provided for the project or project area, if approved by the Director. The total required number of accessible spaces shall be in accordance with the table in ADAAG Section 4.1.2(5)(a). See TAS Section 4.6 for Parking and Passenger Loading Zones for accessibility requirements. Accessible spaces shall not be smaller in width or length than that specified by the local jurisdictions for other spaces. Any on-street accessible spaces shall be provided at locations with minimum street and public sidewalk slope to the extent that this is consistent with reasonable dispersion within the overall project area in which they are provided.

Accessible on-street parking spaces shall comply with the following provisions. Parallel parking spaces are preferred where incorporated into new construction. Perpendicular and angled parking are not preferred options.

- Parallel Parking Spaces** A 60-inch wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. The parallel access aisle shall connect at the head or foot of the parking space to a 60-inch wide minimum perpendicular access aisle which shall extend the full width of the parking space. A public sidewalk curb ramp complying with Section 4.4.5.8 of this manual shall connect the access aisles to the continuous passage. Two parallel parking spaces may share a perpendicular access aisle. The driving lane shall not encroach on any required crosswalk or access aisle (See Figure 4.22 and Figure 4.23).

- Exception:** Where the width of the public pedestrian right-of-way between the curb and boundary of the public right-of-way is less than 12 feet, a parallel access aisle is not required in parallel parking spaces.
- Perpendicular Parking Spaces** A 60-inch wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. A public sidewalk curb ramp complying with Section 4.4.5.8 ADA and TAS Requirements of this manual shall connect the access aisle to the continuous passage. Two perpendicular parking spaces may share an access aisle (see Figure 4.23).
- Angled Parking Spaces** A 60-inch wide minimum parallel access aisle shall be provided at street level the full length of the accessible parking space. A public sidewalk curb ramp complying with this Section 4.4.5.8 ADA and TAS Requirements of this manual shall connect the access aisle to the continuous passage.
- Van-Accessible Parking Spaces** Where perpendicular or angled parking is provided, one in every eight accessible parking spaces within the projected area, but not less than one, shall be served by a parallel access aisle that is 96 inches wide minimum.
- Coordination with and approval by the Transportation Department is required for using perpendicular, angled, and van-accessible parking spaces.
- Signage** Accessible parking spaces shall be designated as reserved by a sign that complies with ADAAG Section 4.30.7. Spaces complying with the previous criteria shall contain an additional sign “Van Accessible” mounted below the symbol of accessibility. Signs shall be located so they cannot be obscured by a vehicle parked in the space.

Figure 4.21 On-Street Parking Dimensions



Manual on Uniform Traffic Control Device (MUTCD)

Figure 4.22 Accessible On-Street Parallel Parking

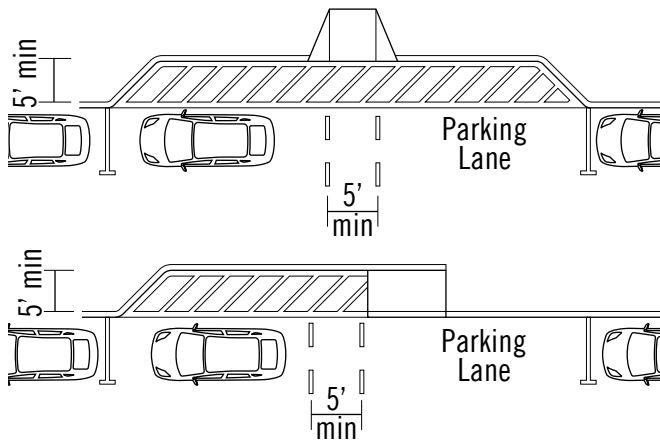
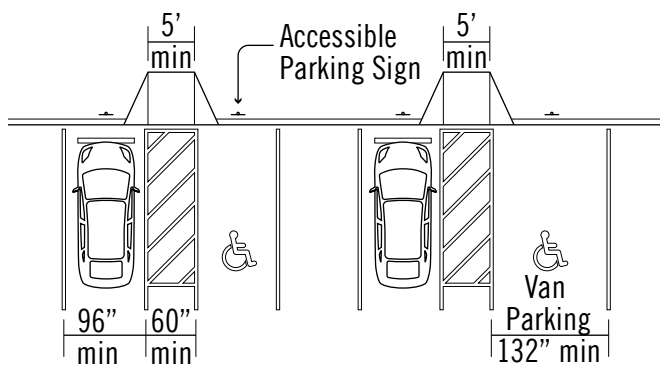


Figure 4.23 Accessible On-Street Perpendicular Parking



4.3.7.4 Parking Meters

Parking meter controls shall be 42 inches maximum above the finished public sidewalk. Controls and operating mechanisms shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls shall be no greater than 5 lbs.

Where parking meters serve accessible parking spaces, a stable, firm, and slip resistant clear ground space a minimum of 30 inches by 48 inches shall be provided at the controls and shall comply with ADAAG. Handicap spaces should not be metered.

See Section 4.5.6.8 Parking Meters and Pay Stations for additional requirements.

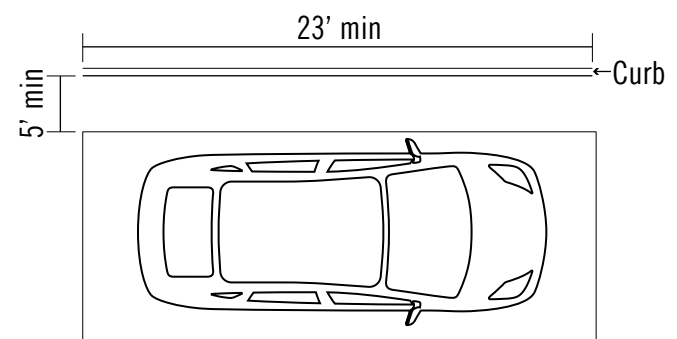
4.3.7.5 Passenger Loading Zones

Each passenger loading zone shall provide a parallel access aisle at least 5 feet wide and 23 feet long adjacent and parallel to the vehicle pull-up space (see Figure 4.24). Signage complying with ADAAG shall be provided.

Where a continuous curb separates the access aisle and vehicle space, a public sidewalk curb ramp complying with Section 4.4.5.8 of this manual shall be provided outside the area of the access aisle and connecting to it.

Where a single passenger loading zone serves multiple vehicle pull-up spaces (e.g. at transportation facilities), additional public sidewalk curb ramps shall be provided at reasonable intervals and shall be located to minimize travel distance and maximize availability during heavy use.

Figure 4.24 Access Aisle at Passenger Loading Zone



4.3.8 Alleys

Section 2.2.8 Alleys and Table 2.3 Street and Thoroughfare Geometric Standards of Section 2.3 Dimension Classification of this manual addresses the dimensional requirements for alleys. Alleys are generally constructed with a 3-inch inverted crown for drainage, and to prevent potential bumper drag problems. A 6-inch inverted crown may be used as required for increased drainage capacity when integral curbs cannot be utilized provided driveway grades accessing the alley do not exceed 8% grade. If driveway grades exceed 8%, a 10-foot vertical curve shall be provided for these driveways when accessing alleys with 6-inch inverts or alternately, a transition to a 3-inch invert shall be used with integral curbs to prevent potential bumper drag problems.

The maximum grade for alleys is 8% within 30 feet of an intersection with a street and 14% elsewhere, unless otherwise approved by the Director. The minimum grade is 0.5%, unless otherwise approved by the Director. Changes in grade shall not exceed 10% at street intersections without providing vertical curves. Changes in grade, at all other locations, shall not exceed 3% without providing vertical curves.

The horizontal geometric standards for alleys are shown in the Standard Construction Details, File 251D-1. All curves, turnouts, or other changes in alignment for alleys in residential areas must conform to the minimum turning radius for a single unit truck (SU Design Vehicle) as shown in Figure 4.2. Alleys to be built in commercial areas shall be designed to accommodate larger collection vehicles. These alleys will require individual consideration to determine design standards. Additional restrictions affecting the horizontal alignment of alleys are provided in Section 3 Street Networks / Access Control of this manual.

Where alley drainage is collected in inlets in advance of its intersection with a street, the alley pavement shall be warped from the center invert in the alley to the inlet throat or grate so that runoff can be positively captured by that inlet. The designer shall detail the grades of this pavement transition, and if necessary, define a sag point in the alley to achieve capture of runoff without unintended flow into the street. See additional requirements in the Drainage Design Manual.

Alleys that will function as fire lanes in commercial properties (fire apparatus access road) shall be designed in accordance with the City of Dallas' Public Works Department, Fire Department, and the International Fire Code latest edition design requirements.

4.3.9 Utilities

For utility considerations within the Street Zone, see section 4.5.9 Utilities. The requirements of utilities within both Pedestrian Zones and Street Zones are covered in Section 4.5.9.

4.4 INTERSECTIONS

4.4.1 General

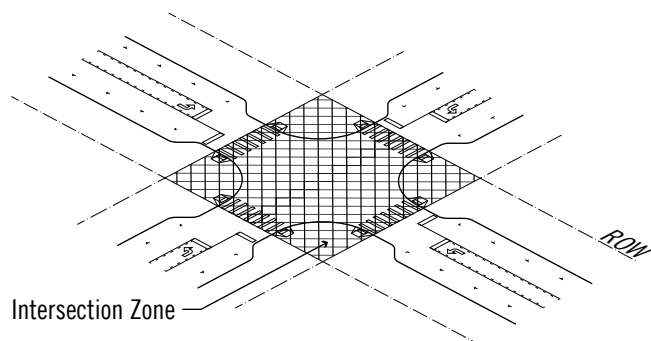
The following regulations govern the alignment of intersections:

- All streets must intersect as close to a right angle as permitted by topography or other natural physical conditions. A street shall not intersect with another street or railroad at an angle greater than 105 degrees or less than 75 degrees, unless otherwise approved by the Director.
- An intersection should not have more than four intersecting street approaches.
- If the intersection has more than four street approaches, it will be a special design which requires the design engineer to coordinate and collaborate with City staff as the design is developed.

Additional regulations governing the alignment of intersections are provided in Section 3 Street Networks / Access Control of this manual.

See Figure 4.25 for a graphic representation of the intersection zone of a street.

Figure 4.25 Intersection Zone



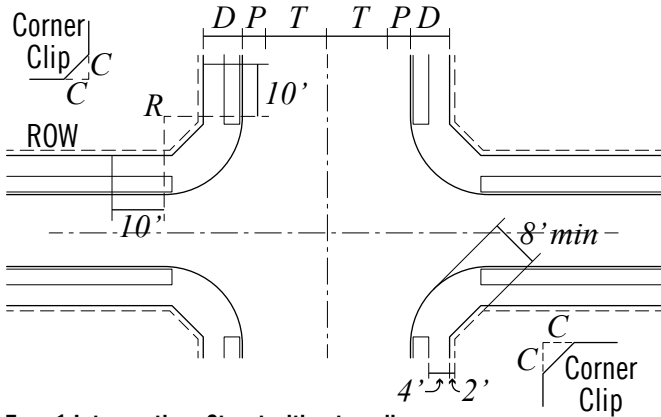
4.4.2 Standard Intersections

The standard street intersection is defined as the at-grade intersection of arterial, collector, or local streets at or near right angles. The various geometries at street intersections including pavement widths, lane widths, curb radii, median widths, turning lane data, crossfall, crown height and other features differ according to the classifications and sections of the intersecting streets. The three basic standard intersection types include the Type I intersection - "Street Without Median Intersecting Street Without Median", Type II intersection - "Street With Median Intersecting Street With Median" and Type III intersection - "Street With Median Intersecting Street Without Median". See Figure 4.26.

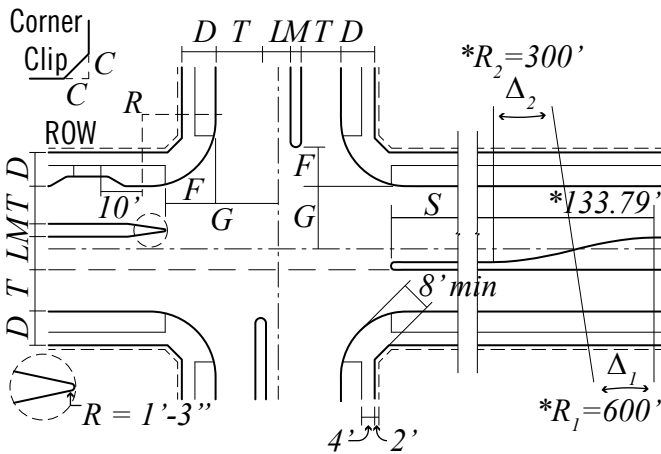
Figure 4.26 shows the standard dimensional and geometric requirements for most of the possible street classification and section combinations for each of the three basic standard intersection types. Each illustration shows the layout of the type of street intersection and gives the street section data. Tables 4.11, 4.12, and 4.13 provide the typical intersection curb return radii requirements. The required intersection curb return radii depend on the classifications of both intersecting streets and the direction of the turning movement, and project-specific assessment of traffic volumes and distributions by vehicle types, design and control vehicle determinations, and establishing the target speed for design.

The tables define the turning movement direction by "initial street" (the street on which the turning movement begins) and by "destination street" (the street onto which the traffic is turning.) Also, right-of-way corner clip requirements that are required at intersections are shown and designated by the "C x C" columns.

Figure 4.26 Intersection Types



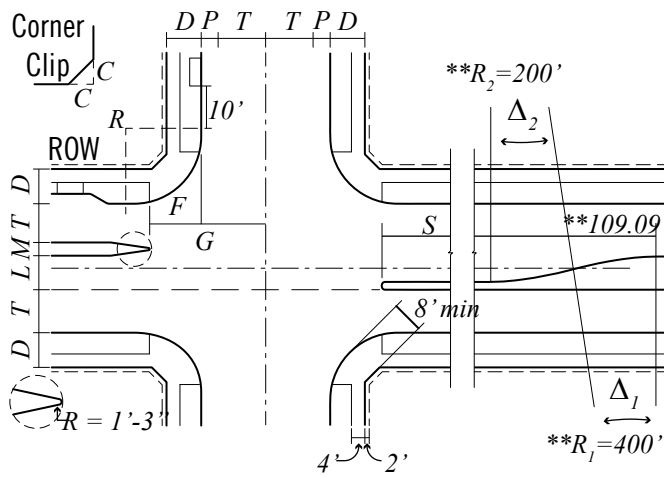
Type 1 Intersection- Street without median intersecting Street without median



Type 2 Intersection- Street with median intersecting Street with median

* Curve 1 Data
 $\Delta_1 = 8^\circ 32' 57''$ $R_1 = 600'$ $T = 44.85'$ $L = 89.53'$

Curve 2 Data
 $\Delta_2 = 8^\circ 32' 57''$ $R_2 = 300'$ $T = 22.42'$ $L = 44.76'$



Type 3 Intersection- Street with median intersecting Street without median

** Curve 1 Data
 $\Delta_1 = 10^\circ 28' 31''$ $R_1 = 400'$ $T = 36.67'$ $L = 73.13'$

Curve 2 Data
 $\Delta_2 = 10^\circ 28' 31''$ $R_2 = 200'$ $T = 18.33'$ $L = 36.57'$

D - Parkway Width
P - Parking Way Width
T - Travel Way Width
L - Left Turn Width
M - Median Width
F - Corner Radius
G - Turn Radius
S - Storage Length

4.4.2.1 Initial vs. Destination Streets

Table 4.11 Type I Intersection

Intersecting Streets		R	C x C
Initial Street	Destination Street		
Principal Arterial	Principal Arterial	35'	15' x 15'
	Minor Arterial	35'	20' x 20'
	Community Collector	35'	20' x 20'
	Residential Collector	30'	10' x 10'
	Local [Except L-2-U (B)]	20'	10' x 10'
	Local [L-2-U (B)]	30'	10' x 10'
Minor Arterial	Principal Arterial	35'	15' x 15'
	Minor Arterial	35'	20' x 20'
	Community Collector, Residential Collector, and Local [L-2-U (B)]	30'	10' x 10'
	Local [Except L-2-U (B)]	20'	10' x 10'
Community Collector	Principal Arterial and Minor Arterial	20'	5' x 5'
	Community Collector, Residential Collector, and Local [Except L-2-U (B)]	20'	3' x 3'
	Local [L-2-U (B)]	25'	4' x 4'
Residential Collector	Principal Arterial and Minor Arterial	20'	5' x 5'
	Community Collector, Residential Collector, and Local [Except L-2-U (B)]	20'	3' x 3'
	Local [L-2-U (B)]	25'	4' x 4'
Local	Principal Arterial, and Minor Arterial	20'	5' x 5'
	Community Collector, Residential Collector, and Local	20'	3' x 3'

Table 4.12 Type II Intersection

Intersecting Arterials		S	R	C x C
Initial Street	Destination Street			
Principal	Principal	200'	-	-
S-8-D, S-6-D & M-6-D (A)	S-8-D, S-6-D & M-6-D (A)	-	30'	11' x 11'
S-8-D, S-6-D & M-6-D (A)	M-6-D (B)	-	35'	17' x 17'
M-6-D (B)	S-8-D	-	30'	13' x 13'
M-6-D (B)	S-6-D & M-6-D(A)	-	35'	17' x 17'
M-6-D (B)	M-6-D (B)	-	35'	25' x 25'
Principal	Minor	150'	-	-
S-8-D & S-6-D	S-4-D & M-4-D (A)	-	35'	18' x 18'
S-8-D & S-6-D	M-4-D (B)	-	35'	19' x 19'
M-6-D (A)	All Sections	-	35'	23' x 23'
M-6-D (B)	All Sections	-	40'	31' x 31'
Minor	Principal	150'	-	-
S-4-D & M-4-D (A)	S-8-D, S-6-D & M-6-D (A)	-	30'	12' x 12'
S-4-D & M-4-D (A)	M-6-D (B)	-	35'	17' x 17'
M-4-D (B)	S-8-D	-	30'	10' x 10'
M-4-D (B)	S-6-D & M-6-D (A)	-	35'	13' x 13'
M-4-D (B)	M-6-D (B)	-	35'	20' x 20'
Minor	Minor	150'	-	-
S-4-D	S-4-D & M-4-D (A)	-	35'	20' x 20'
S-4-D	M-4-D (B)	-	35'	22' x 22'
M-4-D (A)	All Sections	-	35'	21' x 21'
M-4-D (B)	All Sections	-	35'	25' x 25'

Table 4.13 Type III Intersection

Intersecting Streets		S	R	C x C
Initial Street	Destination Street			
Principal Arterial (Divided)	Principal Arterial	-	-	-
All Sections	S-4-U & M-4-U	200'	30'	12' x 12'
All Sections	S-3-U & M-3-U	200'	35'	15' x 15'
Principal Arterial (Divided)	Minor Arterial	-	-	-
S-8-D, S-6-D & M-6-D (A)	All Sections	150'	35'	20' x 20'
M-6-D (B)	All Sections	150'	40'	25' x 25'
Principal Arterial (Divided)	Community Collector	-	-	-
S-8-D, S-6-D & M-6-D (A)	All Sections	100'	35'	20' x 20'
M-6-D (B)	All Sections	100'	40'	25' x 25'
Principal Arterial (Divided)	Community Collector	-	-	-
S-8-D, S-6-D & M-6-D (A)	All Sections	90'	30'	10' x 10'
M-6-D (B)	All Sections	90'	35'	16' x 16'
Minor Arterial (Divided)	Residential Collector & Local	-	-	-
All Sections	S-4-U & M-4-U	150'	25'	9' x 9'
All Sections	S-3-U & M-3-U	150'	30'	11' x 11'
Minor Arterial (Divided)	Principal	-	-	-
S-4-D & M-4-D (A)	All Sections	150'	35'	20' x 20'
M-4-D (B)	All Sections	150'	40'	25' x 25'
Minor Arterial (Divided)	Collectors & Local	-	-	-
S-4-D & M-4-D (A)	All Sections	90'	25'	8' x 8'
M-4-D (B)	All Sections	90'	30'	9' x 9'

S - Storage

R - Typical Corner Curb Return Radius

C x C - Typical Corner Clip

A Design Engineer shall check that the intersection curb radii and corner clip values work with the selected target speed, design vehicles, and control vehicles for the project.

4.4.3 Intersection Design Intent

The key to a successful intersection is managing conflicts. Different movements and different modes will cross. A good intersection carefully locates all the conflict points, makes them visible, easy to understand, and manages them. In designing an intersection, consideration must be given to how all users will experience it. The tools for sharing this experience are not limited to road markings, signage, and signals. The basic geometry of the intersection is probably the most important — and most durable — way of managing conflicts. Urban design too, plays an important role — materials and streetscape will shape the behavior of everyone using the intersection.

Intersections are not merely functional. They are gateways to the city, to neighborhoods and public spaces.

4.4.4 Intersection Types

4.4.4.1 Major Intersections

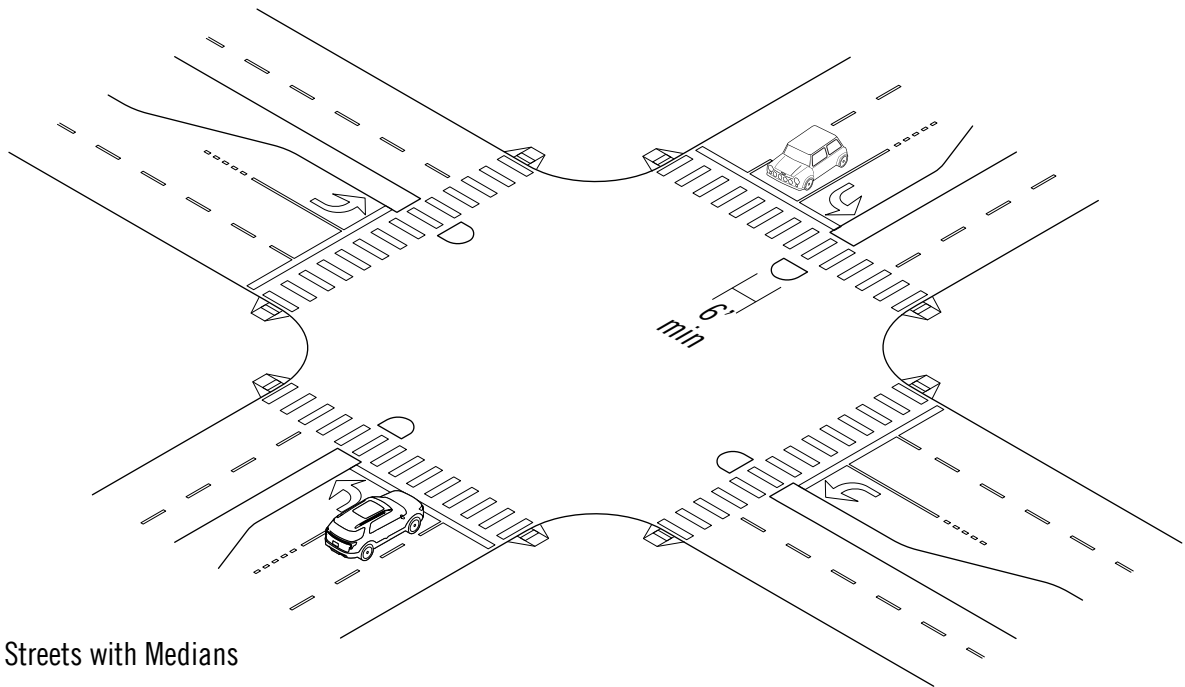
Major intersections are where two roads with 4 or more lanes intersect. These intersections can be uncomfortable for pedestrians and bicyclists due to lengths of crossings, and have signal timing cycles of more than 2 minutes. Corner radii are large at these intersections allowing faster turns by passenger-sized vehicles and to facilitate truck and transit vehicles.

Roads at major intersections should be evaluated for lane and road diets so excessive space can be reallocated to pedestrians and bicyclists. Potential strategies for creating safer crossings for pedestrians and bicyclists include:

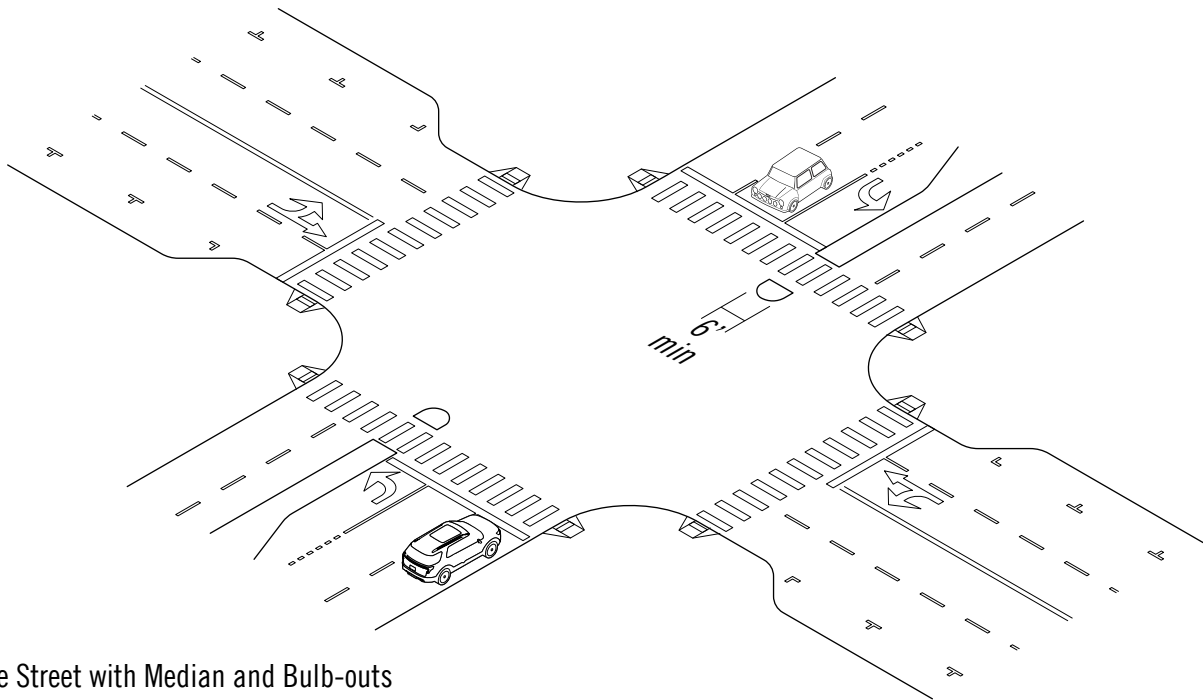
- Median or pedestrian refuge island to break up the crossing
- Curb extensions to reduce the crosswalk length
- Adding Leading Pedestrian Intervals (LPI) in signal timing to give pedestrians a head start on the crossing (per TMUTCD 4E.06)
- Full signalization or designated mixing zones for bicyclists
- 2-stage turn queue boxes for bicycle left turns
- Transit signal priority
- Daylighting for improved sight distances (NACTO - Visibility / Sight Distance)

See Figure 4.27 for usual intersection types.

Figure 4.27 Intersection Types

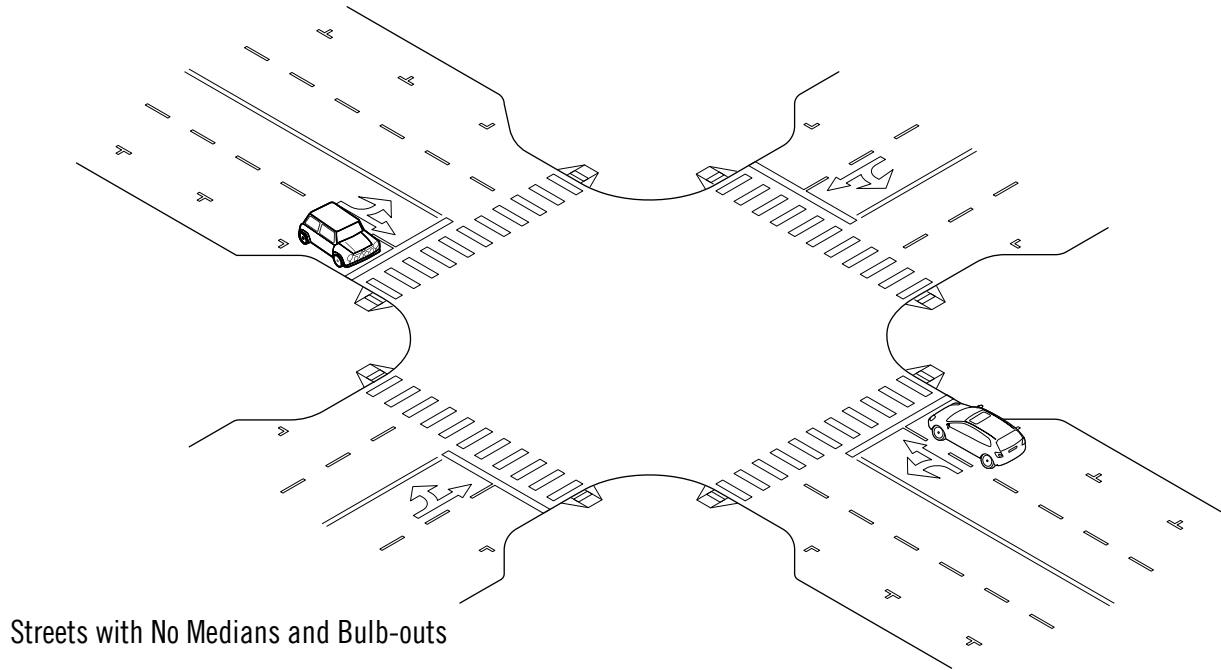


Two Streets with Medians

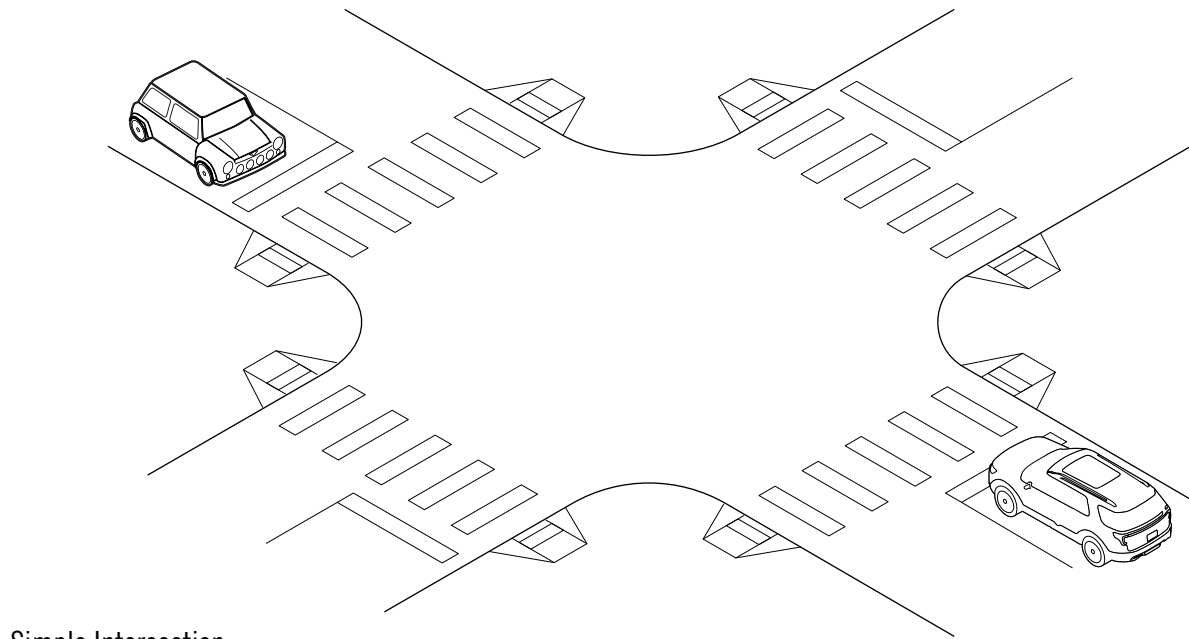


One Street with Median and Bulb-outs

Figure 4.27 Intersection Types (continued)

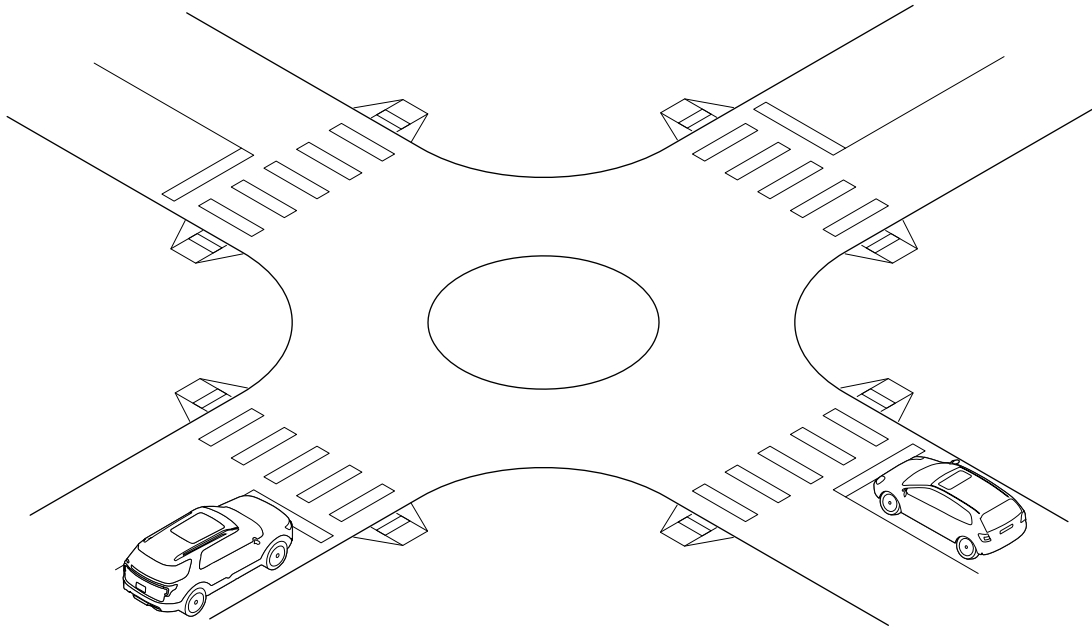


Streets with No Medians and Bulb-outs

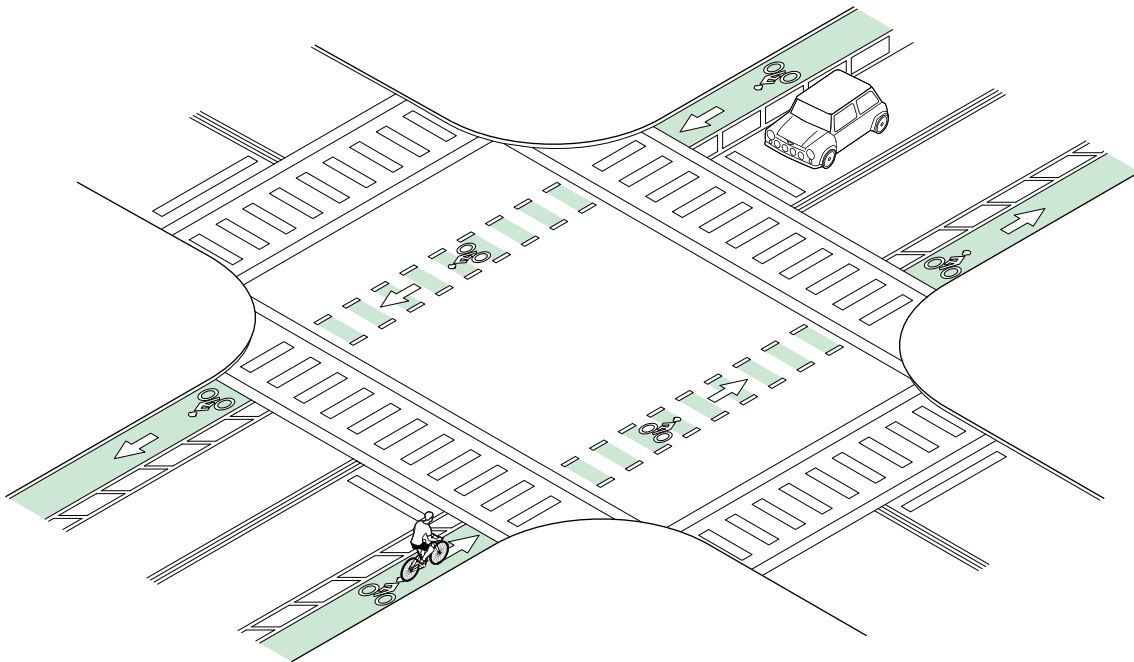


Simple Intersection

Figure 4.27 Intersection Types (continued)

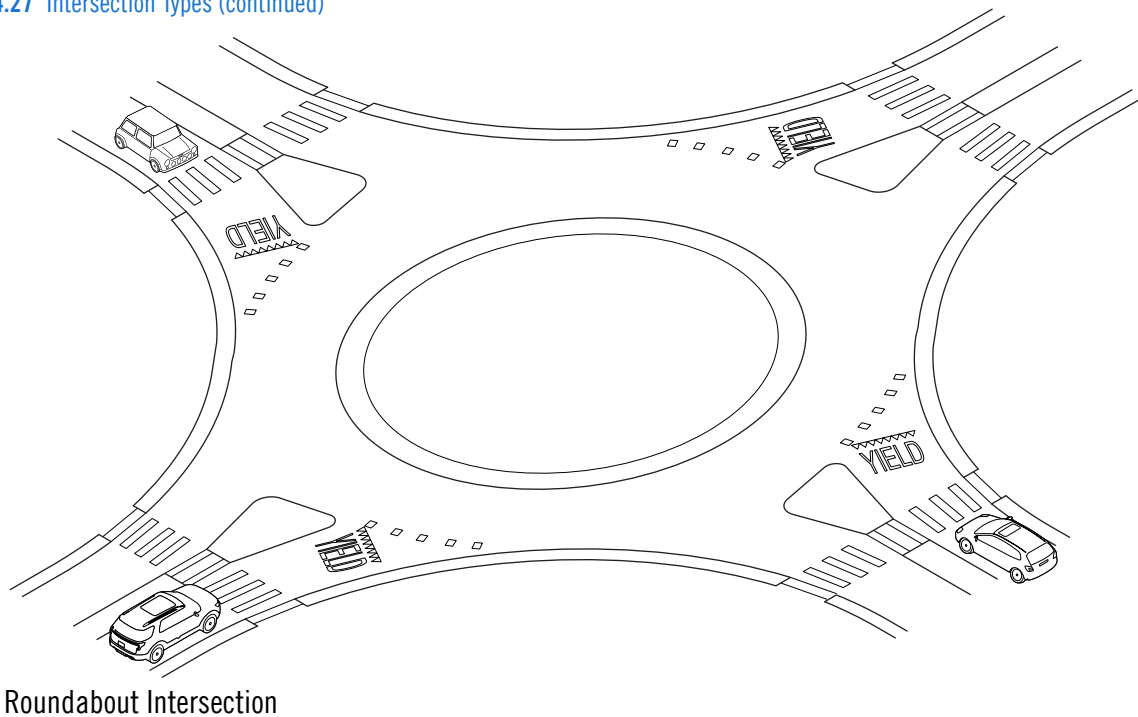


Traffic Circle



One Street with Bike Lanes

Figure 4.27 Intersection Types (continued)



Roundabout Intersection

4.4.4.2 Major and Minor Intersections

Where a major street intersects a minor street, pedestrians and bicyclists traveling on the minor street can be discouraged from crossing the major street due to travel speeds and design of the crossings. Additionally, vehicles turning at high speeds onto minor streets from a major street, may compromise the safety of pedestrians, bicyclists and motorists.

Traffic volumes on the major road should be evaluated to identify if unsignalized, marked crossings can be employed. Potential strategies for improving major and minor street intersections include:

- Raised crossings on the minor street to improve visibility of pedestrians to slow down motorists turning from the major street onto the minor street
- Curb extensions to minimize crossing distance and reduce curb radii
- Coordinated signal timings to minimize delays for motorists on minor street while crossing major street
- Coordinated and shortened signal cycles
- All-way stop signs on long unsignalized corridors
- Pedestrian refuge islands on major street

4.4.4.3 Raised Intersections

Raised intersections raise the entire four direction intersection to be flush with the pedestrian zone. These are best used at low speed and low volume street intersections. Consider the potential for vehicles to "off track" when turning at intersections, resulting in encroachments over, across, and into pedestrian or bike occupied zones or areas at raised intersections. Design considerations include:

- Ramps leading up to raised intersections must be ADA-compliant.
- Curb extensions to protect pedestrians.
- Employ signs to ensure motorists yield to pedestrians and bicyclists.
- Added elements for pedestrian safety which may include bollards, planters, or other items, but these elements cannot obstruct sight lines of motorists or pedestrians.

4.4.4.4 Complex Intersections

Complex intersections are those that include more than four approaches or intersect at greater or less than 90 degrees. For example, these can be Y-shaped, X-shaped, five-way, or a grid pattern meeting a circle among others. Design of complex intersections should be aimed at creating approaches as close to 90 degrees as possible. Excess space at acute corners can be used as public space. Consider breaking up complex intersections into multiple simpler ones.

4.4.4.5 Rail Crossings - Light Rail, Heavy Rail, and Streetcar

Rail owners and / or operators within the City of Dallas include Dallas Area Rapid Transit (DART), the Burlington Northern Santa Fe (BNSF), the Union Pacific Railroad (UPRR), McKinney Avenue Transit Authority (MATA), and short line railroads such as the Dallas, Garland & Northeastern Railroad (DGNO). Further, coordination may also be required with passenger operators such as Amtrak for intercity rail service, and the TRE commuter rail line. These rail owners and operators may have specific standards and requirements that must be applied where their tracks cross streets. Special considerations come into play where DART or MATA tracks are placed in or parallel to traffic lanes.

The designer shall verify railroad company requirements for the design and construction of railroad crossings. Such requirements shall be obtained and included in the design plans and specifications. Street improvements will be approved by the City's project engineer, but concurrence must also be obtained from the railroad owner and include coordination with any other rail operators as needed.

Pavement grades must be designed to match the existing top of rail elevations at railroad crossings. Typically, the City's responsibility is to perform the paving improvements up to the railroad header on each side of the railroad crossing. Crossing improvements between the railroad headers are generally performed by the railroad, but may be required hereunder if directed by the City with concurrence from the rail owner / operator. Precast concrete crossing panels are preferred at street crossings, and shall extend wide enough to include adjacent pedestrian crossings. The paving design shall provide temporary designs, details and sequence of construction to ensure proper maintenance of traffic across the railroad crossing until the railroad crossing improvements are accepted and will be maintained by the railroad.

Rail crossings shall also include railroad crossing gates, signage, warning lights and bells for the safety of motorists, bicyclists, and pedestrians. For the safety of pedestrians at rail crossings, incorporate the use of fenced, staggered, crossings that encourage pedestrians to pause and look for approaching trains. Designs shall also comply with FRA quiet zone requirements.

Intersections, alley access, and commercial driveways shall be at least 100 feet from a rail crossing right-of-way. A center median shall be provided in the approach to a rail crossing. Exception: Existing commercial and residential driveways that are limited to "right-in and right-out" only movements, and properties which have no other street frontage for access, are allowed within 100 feet but no closer than 20 feet of the existing railroad right-of-way. See related requirements in Section 3.2.4.3.

To provide for the improved mobility of both motorists and transit, coordinated traffic signal timing work may be required by the City. This requires significant joint effort between street designer and the railroad operator / owner. The parameters which may warrant coordinated signal timing includes a principal or arterial street that contains significant traffic volumes, and has one or more signalized intersections in close proximity to the rail crossing. Work includes traffic signal timing study which integrates rail operations into its models for traffic flow on streets and through intersections with the objective of providing the best possible level of service (LOS) through each intersection. The Designer shall verify whether any nearby intersection traffic may queue into rail crossings, and if so, shall provide a remedy of that condition. Design documents would show the required ductwork, wiring, points of integration with the rail operator's signal system, and the new signal timing settings. Separate work is likely required by the rail operator within their right-of-way. After construction work is done, tested, and integration complete, the City would closely monitor traffic operations and tweak the traffic signal settings to incrementally improve street operations.

4.4.4.6 Roundabouts

Roundabouts have the potential to reduce traffic speed, delay, and risk of collisions at an intersection. They can be evaluated and considered for use at uncontrolled intersections of two streets. Refer to Section 4.4.5.3 Roundabouts for more information.

4.4.4.7 Dead-End Streets

A standard turnaround must be provided in the design of dead-end streets over 150 feet. Streets with temporary dead ends shall provide for a temporary turnaround. Typically, the standard turnaround is circular. The minimum radius for the circular turnaround is 50 feet for the right-of-way and 43 feet 6 inches for the pavement measured to the back of the curb. The alternate T-shaped turnaround may be provided when specifically approved by the Director. The length of permanent dead end streets must not exceed 600 feet, as measured along the dead-end street centerline from the block corner to the center of the cul-de-sac. The length of a permanent dead end street may be extended upon specific approval of the Director. A traffic sign advising motorists of the dead end street must be provided at the beginning street intersection.

Cul-de-sac Alternative. With approval of the Director, the design engineer may propose a U-shaped street with a landscaped island where the dead end street is less than 150 feet in length. Travel lanes shall be at least 24 feet wide pavement measured from face of curb. The curved U portion of the street shall meet City requirements for access by control vehicles, fire trucks, and other service vehicles.

Pedestrian Connections at End of Dead End Streets. Where dead end streets are not closed off by buildings but about or open to common areas, trails, or other public spaces, the designer shall assess the need for pedestrian connections from the dead end street, present such findings to the City for review and concurrence, and if deemed viable or warranted, shall provide pedestrian connections to the project limits. See related requirements in Section 3.2.7.

4.4.5 Intersection Design Elements

4.4.5.1 Special Intersection Paving & Treatments

A Visual Treatments

Intersections serve as a transition between street types or neighborhoods. A variation in the paving and treatment of the intersection serves as a visual cue for change. Types of treatments include:

Colored asphalt or concrete, pervious pavement, and stamped patterns, may be used to delineate continuous pedestrian walkways across intersections. These may be used in addition to striping, but not as a substitute. Paint or thermoplastic may be used as a technique to separate bicycle or transit lanes. For more applications and consideration guidelines for special paving, refer to Complete Streets Design Manual. Any pavement treatment used must be sustainable and durable. Refer to Section 5 of this manual for more guidance on pavement structure.

Visual treatments must also include application and use of regulatory roadway markings and signage as is required by the TMUTCD. The City requires that designers and its contractors use thermoplastic for final / permanent roadway markings; paint or self-adhesive markings are appropriate only for temporary applications during construction or reconstruction.

B Intersection Grades

Arterial street to arterial street intersections shall be designed to approximate a plane surface to provide a smooth ride for the driver at the target speed. See Section 4.3.4.2.A Street Grades.

For local streets intersecting arterial and collector thoroughfares, the grade of the local secondary street from the principal arterial or collector street gutter shall not be more than 4% either up or down within the first 20 feet beyond the curb line of the principal street, except that in very hilly terrain a intersecting grade of up to a maximum of 6% may be considered. For all non-arterial street intersections of equal classification and for collector street intersections with arterial thoroughfares, intersection grade changes of more than 1% require vertical curves for transitioning to the intersection grades. Valley gutters shall not be used across collector and arterial streets to make grade changes.

4.4.5.2 Traffic Control Devices

A General

Design plans shall include required traffic control devices for the project. All traffic control device plans shall comply with the TMUTCD and be reviewed and approved by the Traffic Safety Engineering Division of the Transportation Department. Traffic control devices typically used within the City of Dallas include traffic signals, pavement markings, buttons, signage, and road humps. Combinations of items may be used for the project design depending on the particular circumstances.

Intersections which warrant placement of a traffic signal will be identified by the Traffic Safety Engineering Division of the Transportation Department. Specific requirements for the signal shall also be identified. The Traffic Safety Engineering Division shall provide comments and requirements for specialized signage and markings. Pavement markings, signage, and buttons are the commonly utilized traffic items. Streets from residential collector to principal arterial generally require utilization of these items. Standard layouts are shown in the Standard Construction Details, File 251D-1. Special requirements will follow the recommendations of the Traffic Safety Engineering Division.

B Uncontrolled

Uncontrolled intersections are those where no traffic control devices are provided to determine the right-of-way of traffic.

Uncontrolled crossings are not permitted where the roadway:

- Is an arterial or collector roadway
- Has an ADT of more than 1,000 vehicles per day
- The target speed exceeds 35mph

Refer to the Complete Streets Design Manual for guidance on uncontrolled crosswalk design.

- An ADT less than 3000 (Low Volume)
- Target speeds less than 20 mph (Low Speeds)
- 1-2 lanes (Right-of-way clarification is not warranted)
- Written request for uncontrolled crossing and approval given by the Director

C Stop-Controlled

Stop-controlled intersections are easiest for pedestrians to cross because motorists and cyclists are required to stop, which provides opportunity to see pedestrians and reduce pedestrian wait time. STOP sign installation requires that specific warrants are met, as described in the TMUTCD.

In general, STOP signs may be appropriate if one or more of the following conditions exist:

- Where the application of the normal right-of-way rule (yield to those already in the intersection or those approaching from the right) would not provide compliance with the law
- A street entering a highway or through street
- An unsignalized intersection in a signalized area
- High speeds, restricted view, or crash records indicate a need for control by a STOP sign
- Additional criteria can be found in the TMUTCD

Other criteria can be found in Section 2B.07 in the Texas Manual on Uniform Traffic Control Devices.

D Signalized

The Dallas Traffic Management Center remotely controls over 1,360 signals in Dallas. The system can scan all traffic signals within 12 seconds for the status of equipment failure, as well as monitor, coordinate, and adjust the signals to improve traffic flow and pedestrian safety. Changes to the signalized intersections shall be based on an engineering study.

All new signal installation and signal upgrade projects shall contain signals for motor vehicles and pedestrians. Additionally, bicycle signals and transit signals should be considered where appropriate. Signal phasing and timing should be designed to meet the unique needs of all users at the intersection. By optimizing signal phasing and timings, multiple modes are able to move safely and comfortably through the intersection with limited conflicts and delay.

Signalized intersections shall conform to the latest version of the TMUTCD, Highway Capacity Manual (HCM), and the Institute of Transportation Engineer's (ITE) Traffic Signal Timing Manual. The TMUTCD contains specific warrants for installation of a traffic signal at an intersection. The Dallas Transportation Department reviews and approves all proposed signal designs.

E Signal Timing

In general, signal timings should be shortened and coordinated with pedestrian and bicycle signals. Longer cycles create greater fluctuations in traffic volumes that are undesirable because pedestrians may use a lag in vehicle volumes to cross the street out of turn. Traffic signals should be timed to the target speed.

Proper optimization of a traffic signal system is performed by a traffic engineer or the City's Transportation Department. The process includes taking an inventory of the system, collecting traffic and pedestrian volume data, reviewing intersection safety, and updating signal timing software.

F Turning Lanes

Refer to Section 4.3.4.1.C Turning Lanes for more information.

4.4.5.3 Roundabouts

Roundabouts have been demonstrated to reduce collisions and improve traffic flow when compared to most signalized intersections. Therefore new intersections or major rehabilitation projects at intersections should be analyzed for roundabout installation. Intersections with more than four approaching streets may also good candidates for roundabouts. However, they are not recommended where they can create greater vehicle delay or increase difficulty for pedestrians navigating around or across the intersection. Pedestrians should never need to enter into or cross traffic lanes around the central circle.

Design of roundabouts should use the methodologies and requirements of the latest version of AASHTO Green Book and National Cooperative Highway Research Program (NCHRP) Report 672, Roundabouts: An Informational Guide, Second Edition. Achieving a proper roundabout design is built around these principles:

- Provide slow entry speeds and uniform speeds throughout the roundabout by using deflection.
- Provide the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume, and lane continuity.
- Provide smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes.
- Provide adequate accommodation for the design vehicles.
- Design to meet the needs of pedestrians and cyclists.
- Provide appropriate sight distance and visibility.

Roundabouts can be designed with markings, raised islands, or plantings. They shall be designed to allow a 15-foot clearance from the closest corner. Roundabouts shall be designed with speeds lower than 25 mph and they shall allow pedestrian and bicycle crossings when used in urban areas. Roundabouts shall be designed with "YIELD" signs for vehicles entering the roundabout. Depending on the roundabout speed and volume, bicycles shall be given the opportunity to either share the traffic lanes around roundabouts or follow the marked pedestrian paths with clear wayfinding signage. On roadways with higher speeds and volumes or multiple lanes, it will be necessary to safely route cyclists around the perimeter of the roundabout.

The spatial requirements of roundabouts are significant, especially if the designer must provide for one or more large vehicle types. Incorporating roundabouts into a pre-existing built environment can be difficult, but in new or redevelopment areas, placement is much easier to achieve.

4.4.5.4 Crosswalks and Crossings

A Crosswalk

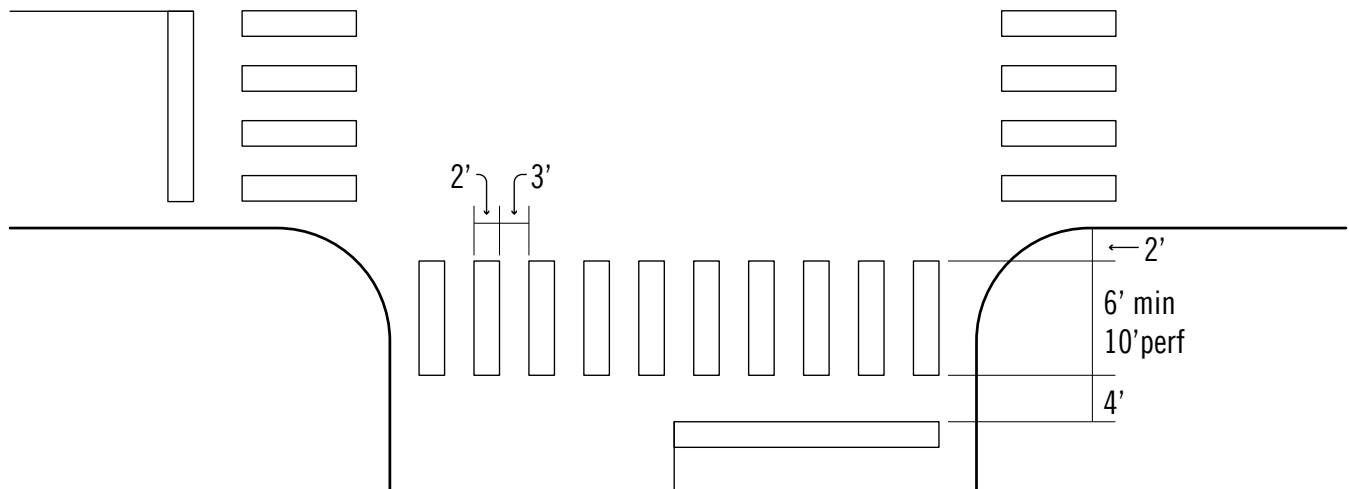
Provision for pedestrian traffic during and after construction is required on most City paving projects, especially in the Central Business District (CBD) and in the vicinity of high pedestrian traffic generator properties.

Along the street, extra signage and consideration of advance warning devices can significantly increase pedestrian safety where pedestrians cross vehicle and bike zones. Pedestrian centric locations warrant more curb extensions, wider sidewalks and / or pedestrian waiting zones, and higher levels of illumination than other parts of commercial and residential streets.

Crosswalks are normally warranted at signalized intersections, at schools, hospitals, parks, cultural facilities and other locations generating high pedestrian traffic volumes. The Traffic Safety Engineering Division of the Transportation Department shall approve the location of all proposed crosswalks. For information on warrants and restrictions on median openings, and design of crosswalks in median openings, see Section 3 Street Networks / Access Control and Section 4.3.5 Medians and Median Openings of this manual.

The standard crosswalk width is 10 feet, but may be smaller (but not less than 6 feet), or larger based on need (usually not more than 20 feet). The graphic shall be continental as shown in Figure 4.28, and typically oriented 90-degrees to travel lanes. The inside crosswalk line is normally placed 2 feet from the face of projected curb or edge pavement of the intersecting street. Required standard markings and details are provided for in the Standard Construction Details, File 251D-1. Crosswalks shall be designed to be barrier free in accordance with the Federal Americans with Disabilities Act. See Section 4.5.5.8 ADA and TAS Requirements of this manual for details.

Figure 4.28 Crosswalk Standards



Special crosswalks may require use of special designs as well as nonstandard materials. Nonstandard materials and designs shall not be used unless specifically approved by the Director. Typically, construction of nonstandard designs with nonstandard materials will require a “special maintenance agreement” between the City and the sponsoring entity. Plan / profile and special section details shall be provided with dimensions, pavement structure, reinforcing, special paving materials and patterns, construction limits clearly shown and special notes controlling the work. The design shall provide for maintenance of pedestrian, vehicular traffic and any needed

consequences of construction. Special materials shall extend no closer than 12 inches from the face of curb to allow for a standard concrete gutter and good construction practice.

B Standard Pedestrian Crossing Design Guidelines

When pedestrian street crossings are provided at, above, or below street grade, they shall comply with the following provisions as deemed applicable and be connected to the continuous passage:

Crossing Controls shall be designed as follows:

- New crosswalks at signalized intersections shall be equipped with pedestrian countdown signals and shall cycle in shorter time periods to avoid delays. However, signal lengths shall be long enough for pedestrians to cross the entire intersection in one cycle, even if pedestrian islands are provided.
- Controls shall be raised from or flush with their housings and shall be a minimum of 2 inches in the smallest dimension. The force required to activate controls shall be no greater than 5 lbs.
- Location. Controls shall be located as close as practicable to the public sidewalk curb ramp serving the controlled crossing and shall permit operation from a clear ground space.

- Mounting Height. Pedestrian-actuated crossing controls shall be a maximum of 42 inches above the finished public sidewalk.
- Clear Ground Space. A stable, firm, and slip-resistant area a minimum of 30 inches by 48 inches and complying with ADA guidelines Section 4.2.4.1 and shall be provided to allow for a forward or parallel approach to the controls. Where a parallel approach is provided, controls shall be within 10 inches horizontally of and centered on the clear ground space. Where a forward approach is provided, controls shall abut and be centered on the clear ground space.

Marked Crossings shall be designed as follows:

- Marked Crossings shall be delineated in materials or markings that provide a visual contrast with the surface of the street.
- Crossings will usually be 10 feet wide, or as wide as the approaching sidewalk, but may be up to 20 feet wide in areas of high pedestrian traffic
- Crosswalks shall be of a continental configuration using highly visible white longitudinal lines parallel to traffic flow meeting the requirements of TMUTCD. Longitudinal lines 24-inch wide separated by 36-inch gaps are preferred. Coordinate layout of crosswalk markings with TMUTCD Section 38.18 and City staff.
- Align markings to avoid wheel tracks to minimize wear of stripes by traffic.
- Enhanced crosswalks can be considered but all non-standard materials must be approved by the Director.
- Crosswalks shall align with the sidewalk clear zone.
- Where appropriate, bike boxes shall be provided 8 feet in advance of the crosswalk perpendicular to the travel lane. Where bike boxes are not necessary, an advance stop bar for motorists shall be provided 8 feet in advance of the crosswalk.

Islands shall be designed as follows:

Islands are recommended where pedestrians must cross 3 or more traffic lanes.

- Raised islands in crossings shall be cut through level with the street or have public sidewalk curb ramps at both sides and a level area 48 inches long minimum and a minimum of 36 inches wide or as wide as the connecting sidewalk (whichever is wider). If the island or median is wider than 17 feet, ADA compliant ramps and landings are recommended to raise the crossing to the level of the median.
- Crossing islands which provide refuge in streets for pedestrians shall not be less than 6 feet in length

from island curb face to curb face, and shall typically be the same width as the crosswalk and align with that crosswalk.

- A “nose” is recommended for the raised island to extend past the cut through crossing to guide vehicles away from awaiting pedestrians.

Pedestrian Overpasses and Underpasses shall be designed as follows:

- Where a public sidewalk is provided on a grade-separated overpass or underpass, changes in level shall be accomplished by a ramp or elevator complying with ADA guidelines Section 4.8 or 4.10, respectively. Stairs serving an underpass or overpass shall comply with ADA guidelines Section 4.9.
- Special consideration is required at bridge and facility underpasses. Paving grades must be designed to provide a clearance of at least 16.5 feet or more between all points of the pavement travelway and the overlying lowest portion of the structure. A clearance of at least 17.5 feet must be provided over state roadways (TxDOT Roadway Design Manual). Additional clearance may be required when sags between steep grades occur at underpasses. TxDOT has greater clearances for routes which are part of the Texas Highway Freight Network (THFN); use those TxDOT standards and requirements in its Roadway Design Manual when crossing over THFN roadways. Due to structural constraints, special drainage designs may also be required when pavement sag areas occur below the crossing. Some projects may include structural design of the crossing which allows more flexibility in setting the structure grades to compliment the pavement grade design.
- Greater clearances are required over railroad facilities. The clearances required by the railway agency shall be used for crossings over their facilities.

C Mid-Block Crossing

A mid-block crossing is a pedestrian crossing that is not located at a roadway intersection.

Recommended locations for mid-block crossings include mid-block transit stops, parks, plazas, mid-block passageways and high pedestrian volume building entrances. An engineering study is required to evaluate if there is enough pedestrian demand for a mid-block crossing. Specific warrants provided in the TMUTCD must be met in order to have a signalized mid-block crossing.

Uncontrolled intersections and mid-block crossings shall aim to maximize safety for all users by providing the following:

- Clear sight lines
- Daylighting levels to make the crossing as visible as possible, especially at night

- Regulatory and warning signage
- Marked crosswalks as determined by an engineering study (see Crosswalk Markings at Uncontrolled Locations)
- Traffic calming strategies
- Stop lines for vehicles 20 to 50 feet away from crossings
- Pedestrian islands where appropriate
- Raised crossings where appropriate. These are recommended where connecting to a plaza or other destinations. These should have ADA-compliant ramps leading up to the crosswalk and should be striped as a crosswalk. They serve the functions of a speed bump as well as a crossing.

D Curb Ramps

Where site infeasibility precludes the installation of a public sidewalk curb ramp complying with all provisions of Section 4.4.5.8, the maximum accessibility feasible shall be provided, according to each of the following special technical provisions:

- Curb ramps are also known as barrier free ramps (BFRs).
- Public sidewalk curb ramp type shall be determined by existing public right-of-way width and the existence of other site constraints, in the following recommended priority: (i) perpendicular, (ii) parallel or combined, and (iii) diagonal. A projected built up public sidewalk curb ramp is permitted in alterations to public rights-of-way where other designs cannot be accommodated.
- Where public pedestrian right-of-way width is less than 36 inches, a parallel public sidewalk curb ramp and landing in width of the existing public pedestrian right-of-way shall be provided. (ADA Section 4.7.3)
- Landings shall be provided and shall comply with the following special technical provisions: (ADA Section 4.8.4)
 - Where public pedestrian right-of-way width is insufficient to accommodate a perpendicular public sidewalk curb ramp with a top landing 48 inches in length, a top landing of the maximum feasible length and a minimum length of 36 inches shall be provided.
 - Where site infeasibility precludes a parallel public sidewalk curb ramp with a bottom landing 60 inches in length, a bottom landing of the maximum feasible length and a minimum length of 48 inches shall be provided.
 - Where site infeasibility precludes a landing slope of 1:50 in any direction, the slope perpendicular to the curb face shall not exceed 1:50.

- Where site infeasibility precludes a landing slope of 1:50 when measured perpendicular to the curb face, the minimum feasible slope in each direction shall be provided.
- Slope (ADAAG Section 4.7.2)
 - Where public right-of-way width is insufficient to accommodate a landing and perpendicular public sidewalk curb ramp with a maximum running slope of 1:12, the minimum feasible running slope between 1:12 and 1:10 is permitted for a rise of 6 inches maximum.
 - Where public right-of-way width is insufficient to accommodate a landing and perpendicular public sidewalk curb ramp with a maximum running slope of 1:10, the minimum feasible running slope between 1:8 and 1:10 shall be permitted for a rise of 3 inches maximum.
 - Maximum slope permitted for public sidewalk curb ramp shall be per statements above when measured from a level plane as shown in Figure 4.38 but shall not be required to exceed 72 inches in length.
 - Where compliance with requirements for cross slope cannot be fully met due to site infeasibility, the minimum feasible cross slope shall be provided.
- Surfaces
 - Existing gratings and similar appurtenances that comply with Section 4.5.9.3.A Placement of Utilities and 4.5.9.3.B Major Underground Utilities may be located in public sidewalk curb ramps or landings if site infeasibility precludes their relocation during alterations.

E Bridges

All street and thoroughfare bridges shall be designed in accordance with “LRFD Bridge Design Specifications”, latest edition adopted by the American Association of State Highway and Transportation Officials (AASHTO) using HL-93 loading. Bridge deck concrete shall be at least “Hand Finish Class” concrete as provided for in Item 303.3.3.COD: Mix Designs of the Addendum to the NCTCOG Public Works Construction Standards. The standard street pavement width shall be maintained on the bridge. For divided arterials, one bridge shall be provided for each traffic direction to reduce bridge costs in the median area. Concrete barrier railing shall be provided at the interior median areas for vehicular safety. Typically, two feet shall be provided from edge of interior lane to the face of the concrete barrier railing / edge of structure. Long bridges may require embedded street light and traffic signal conduits to provide required street lighting and traffic signal interconnect.

Sidewalks shall be provided on both sides of bridge structures for pedestrian access. Outside curb height shall be increased to 7½ inches. Parapet walls, rails or barriers to separate vehicular traffic and pedestrians shall be assessed on a case-by-case basis and where provided shall be by authorization of the Director. Structural approach slabs shall be provided with armor expansion joints to control expansion / contraction movements. Some design details for approach slabs, parapet walls, sidewalks, rail and concrete median barriers are provided in the Standard Construction Details, File 251D-1. Additional details shall be included in the design to provide a complete set of paving and structural plans.

The requirements of the City of Dallas Drainage Design Manual, section 4.4.5.4 Crosswalks and Crossings, and other related requirements of this manual shall govern the design. For more information on standard analysis and design of bridges in Texas refer to the TxDOT Bridge Design Manual.

4.4.5.5 Corner Curb Radii

Curb radii considers both the actual radius and the effective radius. The actual radius refers to the curvature along the curb line while the effective radius refers to the curvature that vehicles follow when turning, which may be affected by on-street parking, bicycle lanes, medians and other roadway features.

The design for curb radii is controlled by the right turn movement and is determined using the minimum radius requirements for the appropriate design vehicle as given in Table 4.1 and Figure 4.2. The design vehicle is required to stay in its lane on the approach and to be able to comfortably complete the turn onto its half of the intersecting street without hitting curbs or encroaching into oncoming traffic lanes.

For areas with high pedestrian activity and low volumes of traffic, a curb radius of 10 feet shall be employed where feasible. The absolute minimum allowable curb radius is 5 feet which may be used with Director approval. The desired maximum effective curb radius is 35 feet for large vehicles. Curb radii should be designed with the smallest possible design vehicle for that street. Larger vehicles and emergency vehicles must be able to make turns without encroaching into pedestrian zones or pedestrian islands, however, they may encroach into adjacent or opposite travel lanes if needed. Larger curb radii are recommended in industrial streets or streets with a larger design vehicle, where inadequate curb radii can cause vehicles to encroach into the pedestrian zone.

Streets and thoroughfares often intersect at angles less than 90 degrees. The curb return radii required to fit the minimum paths of the design vehicles are larger than those for standard 90 degrees intersections. Presented in Figure 4.2 are drawings which show design data for the

P, SU and WB-50 Design Vehicles. Special intersections shall be designed using this data and the principles provided in Section 4.4 Intersections, of this manual.

4.4.5.6 Bicycle Treatments

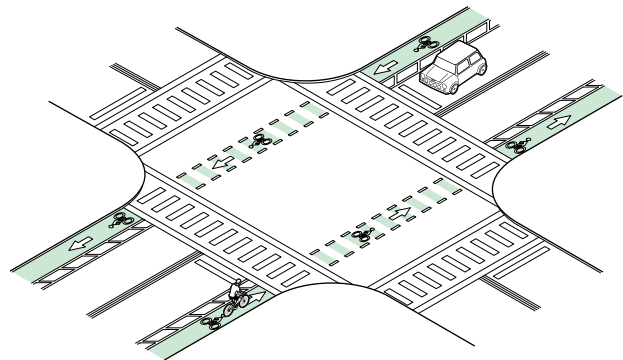
A General

Treatments recommended by the Dallas Bike Plan include coloring the pavement across intersections in bike lanes, providing bike boxes, and guidance on how to transition between different facility types. In addition, where feasible, the following intersection treatment options shall be provided: median refuge, two-stage turn queue box, intersection with turn lanes, bridges and tunnel treatments, and floating bus stops. Refer to NACTO's Urban Bikeway Design Guide for more detailed guidance on application and treatment at intersections.

B Crossing Markings

Crossing markings shall be used at intersections with bike facilities on both sides of the intersection. See Figure 4.29. In case a bike facility does not continue on the other side of an intersection, crossing markings shall not be used.

Figure 4.29 Crossing Markings



Across intersections, the intended path of travel of dedicated lanes may be indicated using, at a minimum, dashed white lines. Additionally, dashed white lines may be used with solid green pavement coloring for the lane, dashed green coloring, or elephant's feet markings instead of dashed white lines.

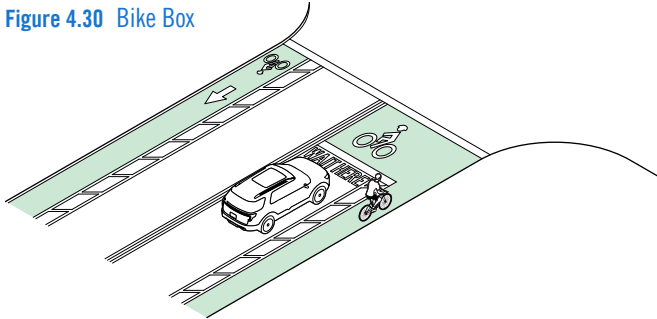
C Bike Boxes

See Figure 4.30 for a representation of a bike box at an intersection approach. Bike boxes are:

- Recommended for use on roads with high bike ridership and / or frequent left and right turns.
- 10 feet minimum and 16 feet preferred length of box should be placed at the head of one or more travel lanes in one direction for bicyclists to wait in.
- Must be marked using white transverse lines and pavement bike markings.

- May optionally be colored green in the box. If green is used, bike lane leading up to the box should also be colored for 50 to 75 feet and the lane continuing across the intersection shall also be colored.
- Should be used in conjunction with “NO TURN ON RED” and “YIELD TO BIKES” signs for motor vehicles.

Figure 4.30 Bike Box



D Median Refuge

Where median refuge is provided for bicyclists, the following criteria shall be adopted:

- Recommended on high volume or wide roadways, especially with existing medians, or where pedestrian refuge exists.
- Raised island shall be 6 feet minimum width and length, though the preferred width is 8 feet.
- Raised curb shall be outlined in reflective white or yellow paint.
- Where provided, shall be at street pavement grade with cut through for bikes, strollers, and wheelchairs. See Figure 4.31.

Figure 4.31 Crosswalk Refuge

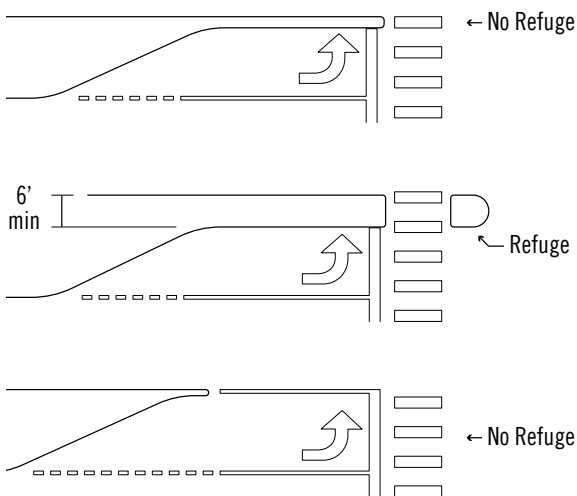
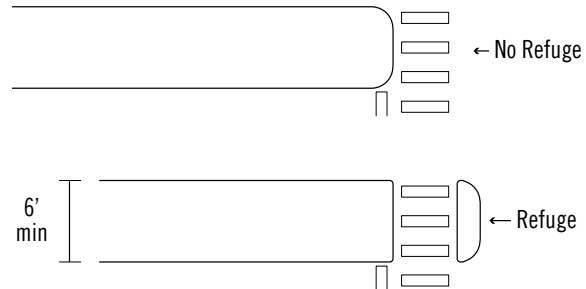


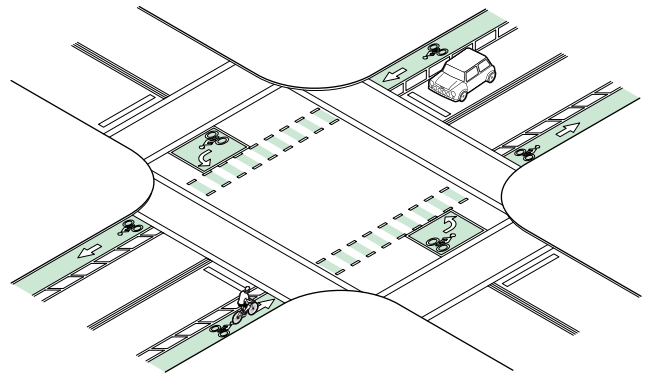
Figure 4.31 Crosswalk Refuge (continued)



E Two-Stage Turn Queue Boxes

- Recommended where a large demand for left turns from a right side facility exists.
- Must be designated by a marked white box with bike stencil and turn arrow inside. Coloring the pavement green inside the box is recommended. See Figure 4.32.
- Placed in the intersection in potential configurations shown in the diagram.
- Turning box shall allow for through bike lanes.

Figure 4.32 2-Stage Turn Box

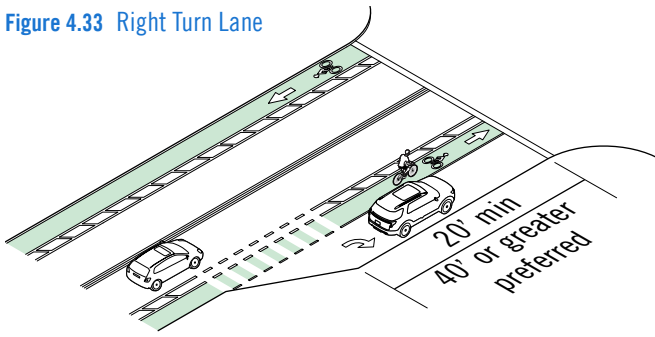


F Turning Lanes

Turning Lanes are recommended where turn only lanes exist or are added on the side the bicycle facility is placed on. See Figure 4.33.

- Where dedicated signals are used for bicycles, a car lane may become turn only without crossing the bike lane.
- Where dedicated signals are not used, cars may need to cross the bicycle lane into an auxiliary turn only lane. In such a case, the bike lane should become dashed white lines to allow cars to cross.
- Where cars are allowed to cross bike lanes, a “BEGIN RIGHT TURN LANE, YIELD TO BIKES” sign should be used, TMUTCD R4-4.
- Right turn lane length shall be at least 20 feet in length, but expected turn lane queues may require significantly greater lengths.

Figure 4.33 Right Turn Lane



G Mixing Zone

- Recommended where space restrictions do not allow a turn-only and minimum bike lane to coexist at an intersection, or where lanes are not turn-only but host a large volume of turning traffic.
- The bike lane should widen to a minimum 9 feet to accommodate turning vehicles.
- Shared Lane Markings and Turn-Only pavement markings shall be employed for mixing zone.
- Bike lane solid white stripe shall be changed to dashed white stripe to indicate merging area where vehicles may cross into the mixing zone.
- YIELD TO BIKES signage should be used to indicate bicycle priority in mixing zones

H Floating Bus Stops

- Recommended where bus volumes are high or where bus stops occur frequently.
- A floating bus stop shall be provided for curbside bus stops so bike lanes can be diverted behind the bus stops. Refer to Section 4.5.6.6 Bus Stops for more information.
- In addition to intersection treatments, flow of all modes of transportation must be carefully controlled to avoid conflicts.

I Dedicated Bicycle Signals

- Recommended for large intersections where the time taken to clear the intersection is much greater for bikes than cars, or where an off-street bike facility becomes an on-street facility.
- Phasing on dedicated signals may be used to give bikes a head start and enter the intersection with pedestrians. For guidance on clearance intervals, refer to NACTO Urban Bikeway Design page 97.
- Signals may be manually or automatically actuated.

J Bike Detection

- Recommended in place of manual actuation for the convenience and safety of bicyclists. Also, on streets with low vehicle traffic, a signal may not turn green if detecting methods are not sensitive enough to detect bicycles.
- Detection shall be placed or targeted where bicyclists intend to queue or travel.
- Induction loop may be embedded in the pavement per the Dallas Bike Plan recommendation.
- Video detection aimed at bicycle approaches may be employed.

4.4.5.7 Key Transit Treatments

Any on-street accommodations for transit shall be coordinated with the transit provider and shall meet their design standards for their proposed equipment. The following requirements shall be considered as guidance and minimum acceptable standards, where applicable and feasible to incorporate into the street.

A Controls

Turn restrictions should be strategically applied at intersections to reduce conflict as needed. Options for turning controls include:

- Right and left turns may be prohibited entirely on curbside or center transit lanes.
- Right turns may use a shared right-turn lane for trucks, cars and buses with transit signal prioritization discussed below.
- Right turns may use a right turn pocket for trucks, cars and buses in the parking lane where parking is present.
- Left turns for buses from curbside lanes may be made by entering adjacent travel lanes.
- Left turns for buses from center lanes require dedicated signals.
- Right turns for buses from center lanes may be made by entering adjacent travel lanes as long as the lane to right of the lane the bus is occupying is a right turn only lane.

B Geometric Design

At street intersections where all modes of transportation intersect, pavement treatments should prioritize pedestrians, bicycles, transit and cars in that order. Pedestrian pavement markings and other treatments should be continued across the vehicle and transit lanes. Treatments and geometries may be as follows:

1. Curb Radii

Buses require an effective radius of 20 to 30 feet depending on lane widths and target speeds. Curb radii should be designed to be as small as possible for pedestrian safety and comfort. Where curb extensions are desired for pedestrian crossings, a bus must be allowed to encroach into the oncoming travel lane or the middle lanes.

Streetcars require a centerline radius of 45 to 82 feet depending on the length and design of the streetcar.

2. Pavement Treatment

Shared right turn lane:

- Colored transit lanes can be dashed for 50 to 100 feet prior to the intersection to indicate where cars may enter the transit lane to make a turn. Alternatively, the color may be removed entirely where the turn lane is used by buses and vehicles.
- Pavement markings should indicate “RIGHT TURN ONLY” and “EXCEPT BUSES” so cars may only enter to turn. Refer to TMUTCD R3-7R and R3-1B.
- The rest of the transit lane, where color is solid, should have “BUS ONLY” pavement markings.

Right turn pocket:

- Recommended where right side transit lanes are followed by a parking lane before the pedestrian zone.
- Parking zone may be used as a turn pocket for 120 to 160 feet ahead of an intersection.
- 115 to 160 feet of the transit lane may be dashed ahead of an intersection to permit cars to cross the transit lane into the right turn pocket.
- The right turn pocket should be a minimum of 11 feet wide to accommodate turning buses and trucks. If the right turn pocket is primarily used by vehicles other than buses, it can be a minimum 10 feet wide; 11 feet is preferred.

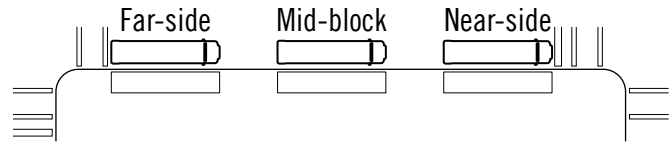
3. Bus Stations and Stops

Bus stop locations along a block may be in three locations as shown by Figure 4.34 and described as follows:

- Far-side: right after an intersection, far from the approaching intersection.
- Mid-block: in the middle of a block.
- Near-side: close to the approaching intersection.

City preference is for far-side placement of bus stops.

Figure 4.34 Bus Stop Placement



Bus stop locations in the roadway may be:

- In line with the bus lane such that the bus stops in its travel lane. Where the bus lane is adjacent to the pedestrian zone, the bus stop should be placed in the buffer / furnishing / curb zone. Where the bus lane is separated from the pedestrian zone with a parking lane, the bus stop should be located on a curb extension or abutting a bus bulb in the parking lane.
- Transition right from the transit travel lane into the parking lane or an additional storage area along the pedestrian zone or island.
- Where a dedicated bike lane separates a dedicated or shared bus lane from the pedestrian zone, an island is recommended for the bus stop location.

Bus stop design elements:

Platform lengths for a standard 40-foot transit bus should follow the guidelines in Table 4.14. Pull-out minimum length is for a loading / unloading zone outside the travel lane.

Table 4.14 Bus Stop Design

Stop Position	Bus bulb min length	Pull-out min length
Far-Side	45'	90' (140' after right turn)
Mid-Block	35'	120'
Near-Side	35'	100'

Platform height may be level with the pedestrian zone, at street level, or level with boarding (especially for light rail). In all cases, waiting and boarding areas and ramps should comply with ADA and TAS requirements.

Bus stop elements may include:

- A covered shelter with or without seating
- Uncovered seating
- Daylighting
- Wayfinding
- Fare vending
- Bike parking
- Landscaping
- Passenger queue management (for high transit demand stops or depots)

4.4.5.8 ADA and TAS Requirements

All street elements, especially those at intersections, which fall under the purview of the Americans with Disabilities Act (ADA) and the Texas Accessibility Standards (TAS) shall fully comply with those regulations and guidelines.

A Public Sidewalk Curb Ramps

Sidewalks leading to curb ramps to cross a street are considered as primary public accessible paths in the pedestrian zone.

B Types of Public Sidewalk Curb Ramps

A public sidewalk curb ramp and level landing complying with the Standard Construction Details, File 251D-1 and this section 4.4.5.8, shall be provided wherever a public sidewalk crosses a curb or other change in level and each street crossing and where otherwise required in this section and shall be connected to a continuous passage in each direction of travel.

Public sidewalk curb ramps shall comply with ADA guidelines Section 406, Curb Ramps.

The perpendicular public sidewalk curb ramp and landing is the preferred design and shall be provided wherever the sidewalk and street curb geometry permits. Example graphics are shown in Figure 4.35, Figure 4.36, and Figure 4.37. In special circumstances, single (i.e., diagonal or depressed corner) public sidewalk curb ramps serving two street crossing directions may be permitted. Such special ramp design shall be included with the paving design as required by the City. Built-up (i.e., projected) public sidewalk curb ramps are not permitted in new construction. Design details for standard public sidewalk curb ramps are provided in the Standard Construction Details, File 251D-1.

Figure 4.35 Public Sidewalk Curb Ramps (corner)

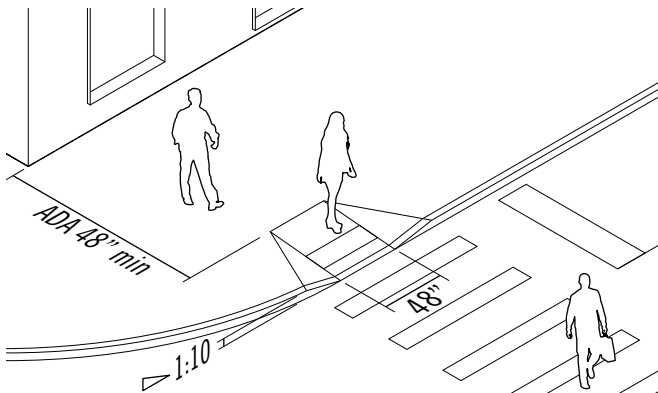
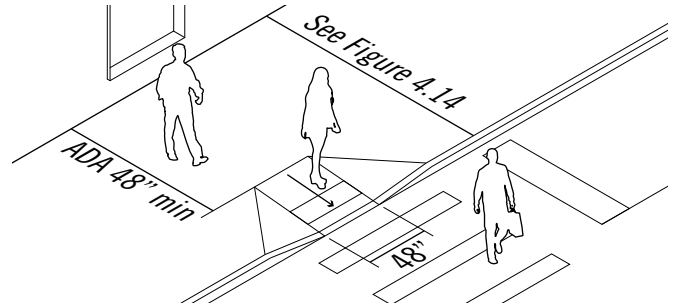
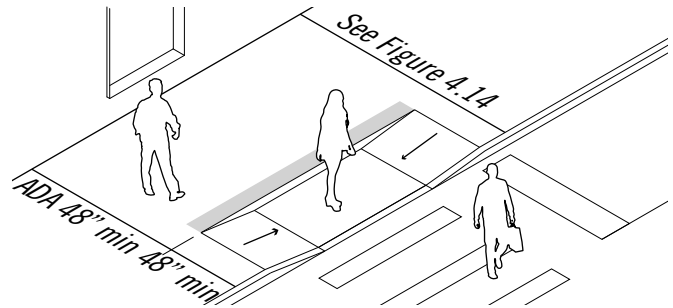


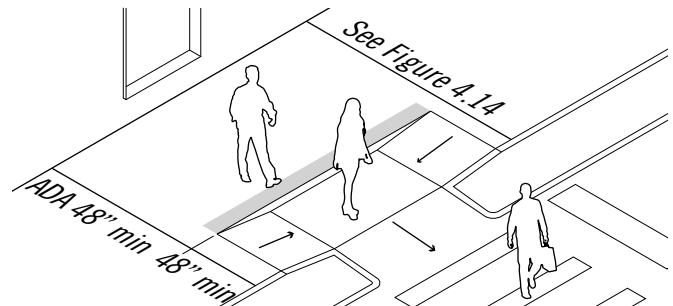
Figure 4.36 Public Sidewalk Curb Ramps (mid-block)



(A) Perpendicular Public Sidewalk Curb ramp

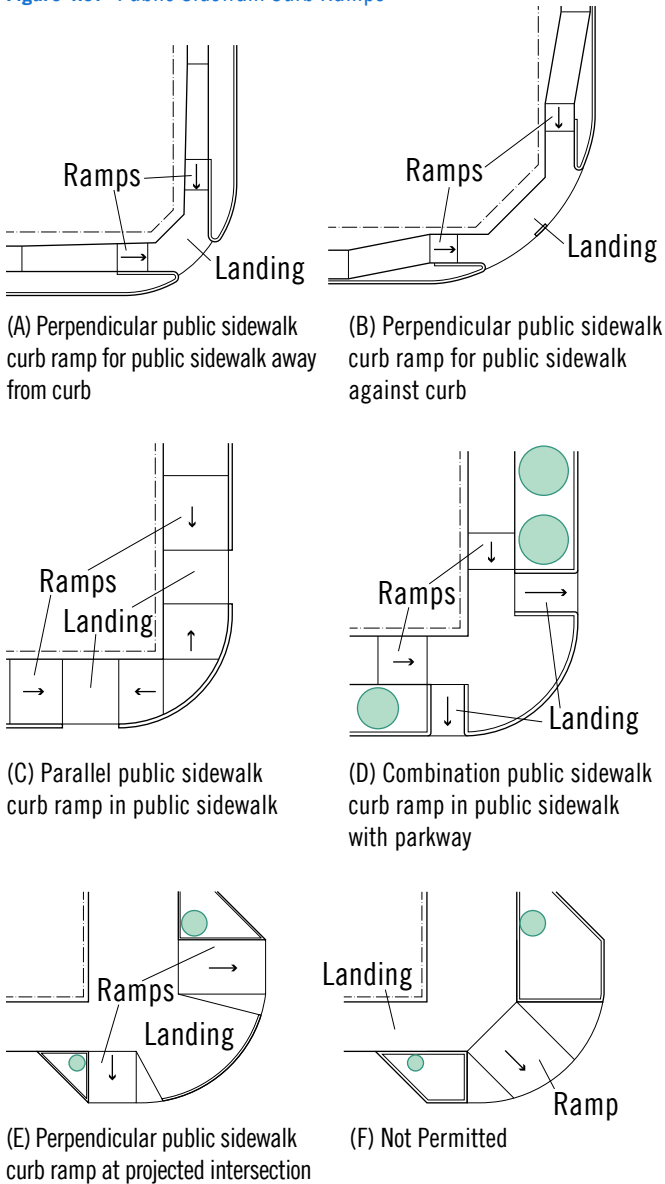


(B) Parallel Public Sidewalk Curb ramp



(C) Perpendicular / Parallel Public Sidewalk Curb ramp

Figure 4.37 Public Sidewalk Curb Ramps



Exception: Where public pedestrian right-of-way width established by local or State regulation, guideline, or practice will not accommodate a perpendicular public sidewalk curb ramp and landing complying with this Section of 4.4.5.8.B, a parallel public sidewalk curb ramp with a level landing at its bottom shall be provided instead of a perpendicular public sidewalk curb ramp (see Figure 4.37 (B)). At marked crossings, the landing at the bottom of the ramp run shall be wholly contained within the markings (see Figure 4.37 (A)). A combination of parallel and perpendicular public sidewalk curb ramps and landings may also be provided (see Figures Figure 4.37 (C) and Figure 4.38).

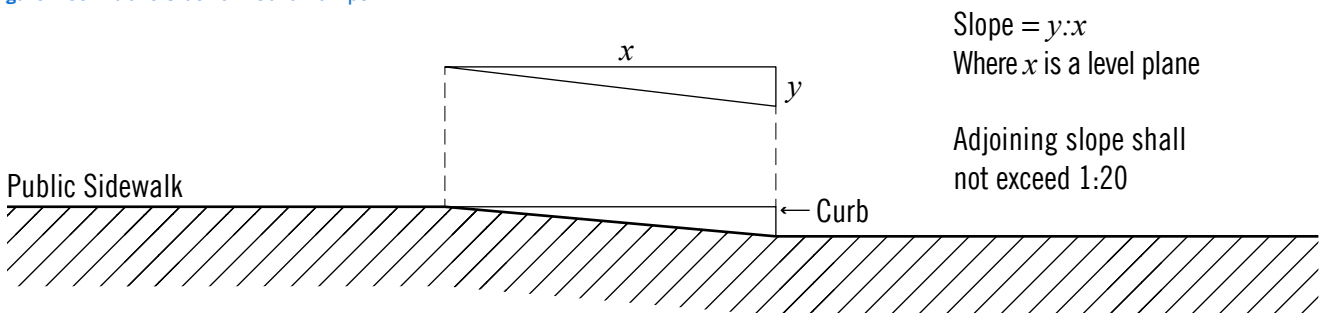
Width shall be designed as follows:

- Public sidewalk curb ramps shall be 48 inches wide minimum, exclusive of flared sides.

Landings shall be designed as follows:

- Where a perpendicular public sidewalk curb ramp is provided, a landing the width of the public sidewalk curb ramp shall be provided at the top of the ramp run (see Figure 4.37). The slope of the landing shall not exceed 1:50 in any direction. The landing shall be 48 inches minimum in length and shall connect to the continuous passage in each direction of travel.
- Where a parallel public sidewalk curb ramp is provided, as permitted in the exception commentary of Section 4.4.5.8.B., a landing the width of the parallel public sidewalk curb ramp and a minimum of 60 inches in length in the direction of the ramp run shall be provided at the bottom of the parallel public sidewalk curb ramp. The slope of the landing shall not exceed 1:50 in any direction. At marked crossings, the required landing at the bottom of the parallel public sidewalk curb ramp shall be wholly contained within the markings.
- Where parallel and perpendicular public sidewalk curb ramps are combined to serve a street crossing, as permitted in Section 4.4.5.8, the landing required for the perpendicular public sidewalk curb ramp may be coincident with that provided for the parallel public sidewalk curb ramp.

Figure 4.38 Public Sidewalk Curb Ramps



Slope shall be designed as follows:

- The minimum feasible running slope shall be provided for any public sidewalk curb ramp and shall be measured from a level plane, as shown in Figure 4.38. The maximum running slope of any public sidewalk curb ramp shall be 1:12. The maximum cross slope of any public sidewalk curb ramp shall be 1:50.
- Exception: A parallel public sidewalk curb ramp allowed by the exception commentary of Section 4.5.5.8.B, shall have a maximum slope of 1:12 when measured from a level plane as shown in Figure 4.38 but shall not be required to exceed 96 inches in length.

Edges shall be designed as follows:

- Where a side of a perpendicular public sidewalk curb ramp is contiguous with a public sidewalk, it shall be flared with a slope of 1:10 or flatter. A perpendicular public sidewalk curb ramp may have a returned side or flare of any slope when not contiguous with a public sidewalk or where protected by a guardrail or other barrier.

Surfaces shall be designed as follows:

- The surface of a public sidewalk curb ramp shall be stable, firm and slip-resistant. Gratings and similar access covers shall not be located on public sidewalk curb ramps or landings. The surface of a perpendicular public sidewalk curb ramp or the landing of a parallel public sidewalk curb ramp shall contrast visually with adjoining public sidewalk surfaces, either light-on-dark or dark-on-light.
- Detectable Warnings. Except at driveways and alleys, all public sidewalk curb ramps shall have a detectable warning to warn the visually impaired pedestrians before encountering the ramp and the crossing. Per ADAAG 4.29.2, the detectable warnings shall consist of raised truncated domes. The color of the truncated domes should visually contrast with the adjoining surface, whether it be light-on-dark or dark-on-light. For more information on truncated domes on walking surfaces refer to ADAAG 4.29.2 and the corresponding Appendix.

Transitions shall be designed as follows:

- Transitions shall be flush and free of abrupt changes. Counter slopes of adjoining gutters and road surfaces connecting to the full width of a public sidewalk curb ramp shall be 1:20 (5%) maximum for a distance of 24 inches as measured from the base of the public sidewalk curb ramp or landing edge at the street (see Figure 4.37). Gratings or similar access covers shall not be located in the area at the base of the public sidewalk curb ramp or landing.

Drainage inlets and their curb transitions require:

- Strategic placement relative to curb ramp locations.
- Placement upstream of curb ramps to minimize flow across ramp openings.
- Setting of proper gutter grades to minimize sediment build-up at a ramp.

Obstructions shall be avoided:

- Public sidewalk curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

4.4.5.9 Traffic Barriers

A General

Traffic barriers shall be provided on all streets that have paralleling alleys. The traffic barriers shall be located along the right-of-way line between the street and alley, to separate the alley from having direct access to street and vice-versa.

The traffic rated barriers shall be of a material and construction approved by the Director. Additional details are provided in the Dallas City Code, Section 51A-8.618 Traffic Barriers.

B Bollards

Bollards are permanent or temporary posts or objects used to create an aesthetic boundary between different modes of transportation and realms of the street. The main function of bollards is to provide a visual traffic guide or marked boundary that protect pedestrians, bicyclists, buildings, and specified areas from vehicular access. Bollard selection and design is dependent on assessing safety and security needs while also considering site context, traffic control and aesthetic design factors.

Refer to Complete Streets Design Manual for more information regarding the use and application of bollards.

Table 4.15 Bollard Design Guidelines

Bollard Design Requirements	
Spacing	<p>Maintain a minimum of 3 feet (preferably 4 feet) spacing between the bollards from the furthest protrusion to account for safe passage of disabled pedestrians. When protecting a utility or other object that does not require pedestrian egress, spacing can be much closer, if necessary.</p> <p>Spacing should not be wider than 5 feet to cover the minimum width of a standard car. If your purpose is to prevent other types of vehicle access, always consider the minimum width of the vehicle.</p>
Size	Diameter sizing between: 3½ to 8 inches
Height	<p>Minimum Height = 30 inches</p> <p>Maximum Height = 48 inches, but may be higher if directed by the City</p>
Style/Type	<p>Passive (Fixed)</p> <p>Active (Operable)</p>
Material	<p>Concrete (with and without reinforcement)</p> <p>Steel or cast iron</p> <p>Stone or granite</p>
Color	Typical: Safety Yellow, White, or Black
Barrier Layout	<p>Maintain a constant clear path of 8 feet or 50% of the sidewalk, whichever is greater.</p> <p>Any object placed on the curb should be at least two feet from the curb line to allow for door opening and to facilitate passenger vehicle pick-up and drop-offs.</p>
Standard Details	See Dallas Water Utilities Steel Guard Post Detail (Oct. 2010)
Other	<p>To fit with urban landscape or aesthetics</p> <p>Strength – ASTM Crash Certified Bollard (for High-Level Security Bollards); select K-rating requirement appropriate to the application</p>

Planters may be used as bollards if material selections, size, and mass provide the required security, safety, and separation criteria.

Bollards shall not be placed within an area intended as a roadway clear recovery zone.

4.5

PEDESTRIAN ZONE

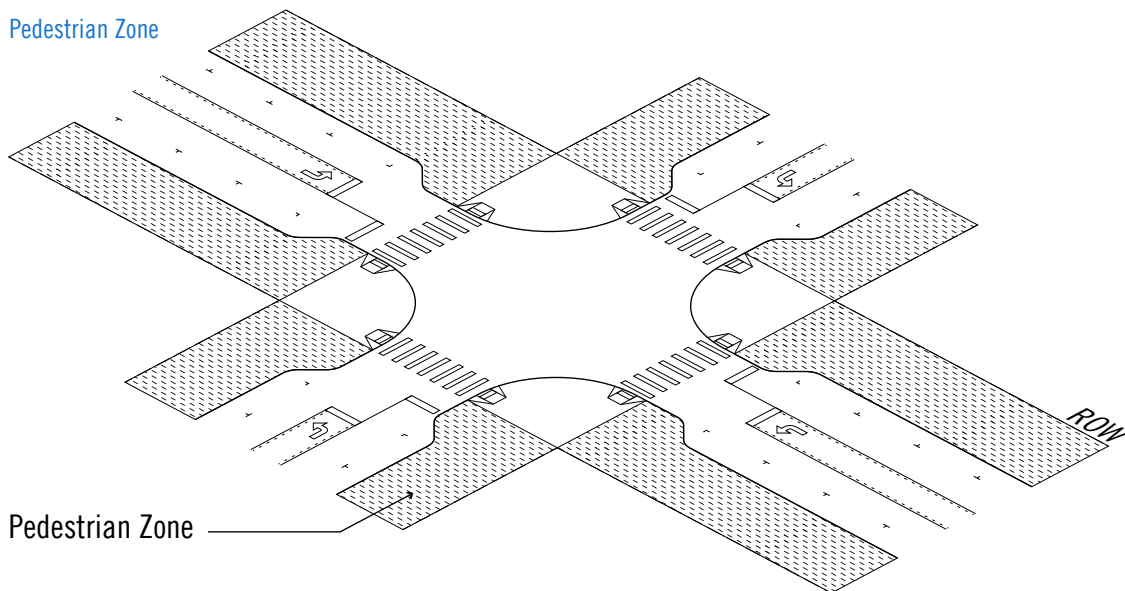
4.5.1 Urban Design Intent

The pedestrian zone is the space between the back of curb and private property / right-of-way line.

The pedestrian zone serves many roles. It is an essential path that gets pedestrians from one place to another. It is the front door access for homes and businesses. It is a place where deliveries happen, where people exit from parked cars, park their bikes, and wait for buses. It is what road users see as they pass through an area, and what residents and employees see from their windows. It can house above and below ground utilities, storm drainage infrastructure, traffic signal cabinets, parking meters, light poles, trees and signs. In many areas, a great pedestrian zone is a social place where people experience the city, meet each other, and linger. It has benches and sidewalk cafes. It can be a little park, a respite from the City.

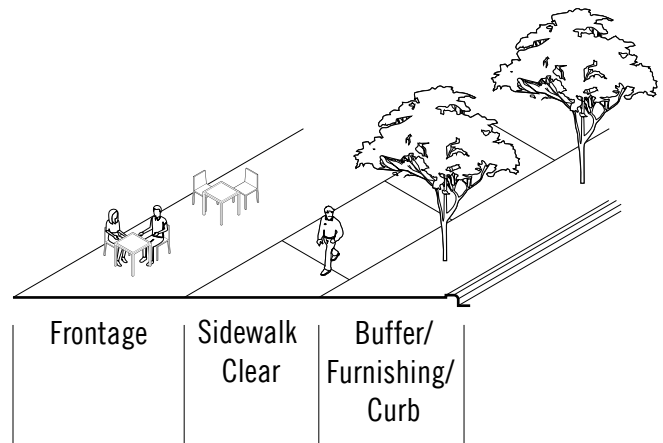
Roadways in the City of Dallas have pedestrian zones that serve all of these purposes and also feel unified and integrated. A pedestrian zone must be functional, and should also be an attractive, welcoming place.

Figure 4.39 Pedestrian Zone



Within the pedestrian zone, the designer shall strive for consistency of materials and finishes across block faces, within a district, or neighborhood, and avoid scenarios where each property or development phase is developing and planning to build its own unique streetscape. This gets down to the materials and finishes of street components such as sidewalks, light poles and fixtures, landscaping, and street furnishings. It is very undesirable to create a disjointed public through-way.

Figure 4.40 Pedestrian Zones



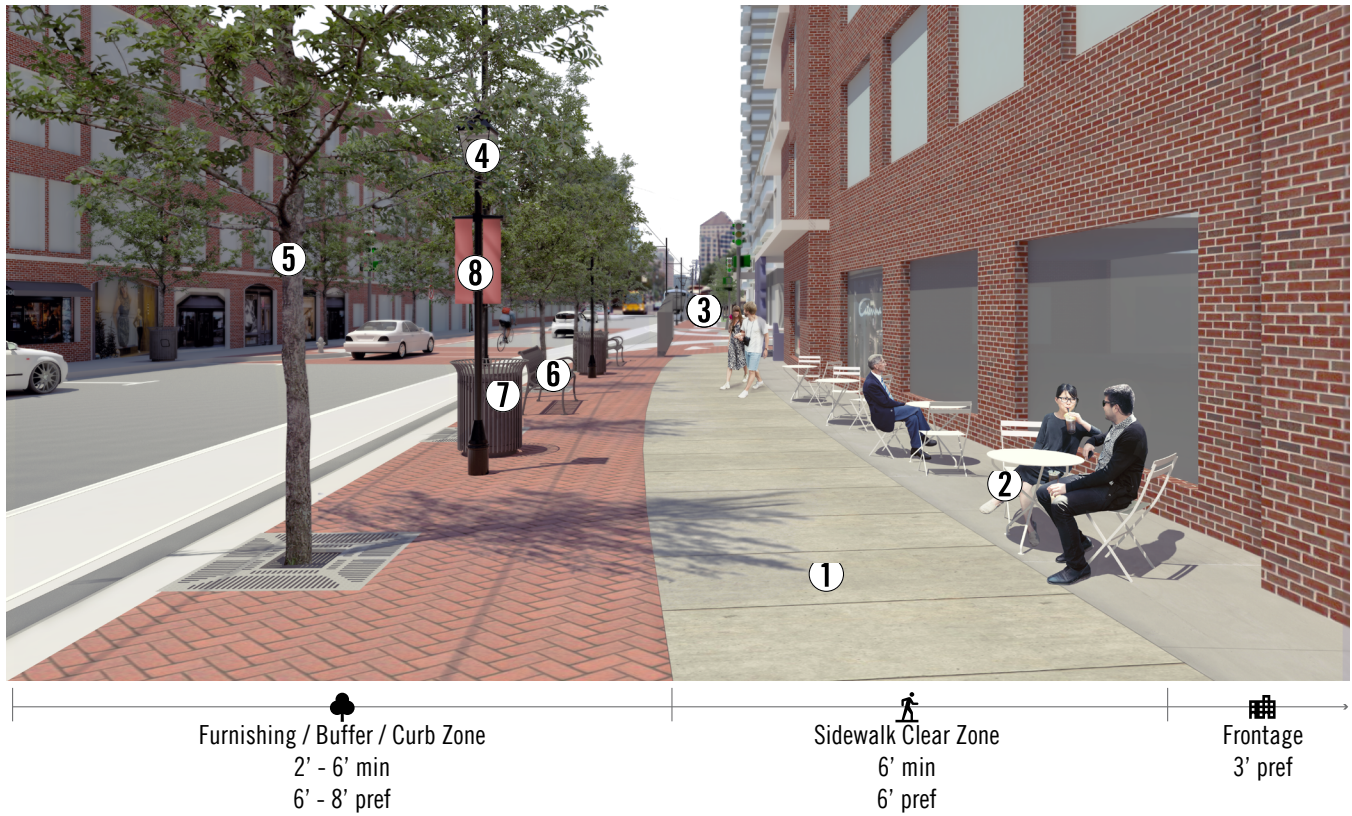
The pedestrian zone is divided into three zones: the frontage zone, the sidewalk clear zone, and the buffer / furnishing / curb zone. The three zones are explained in Section 2.5.2 Pedestrian Zone.

4.5.2 Pedestrian Zone Types

4.5.2.1 Intent

The design of a pedestrian zone should respond to its adjacent land uses.

Figure 4.41 Pedestrian Zone: Mixed-Use Contextual Street Type



4.5.2.2 Mixed-Use Type

Pedestrian zones adjacent to high density mixed uses should have frontage zones that allow doors to swing open without infringing on sidewalk clear zones as well as retail displays, cafe style seating, and benches. Sidewalk clear zones should be wide enough to support high volumes of pedestrian activity - both through travelers and retail consumers accessing adjacent buildings. They should provide wide buffer / furnishing / curb zones to host art, signage, bike racks, benches, wayfinding and other elements for pedestrians to engage along their walk. These pedestrian zones should be designed to encourage people to spend time in and along the streetscape. Where transit stops are intended, the buffer / furnishing / curb zone should be even wider to accommodate sheltered stops and queues of people waiting for the bus or train.

Key Features:

- ① Wide sidewalks
- ② Outdoor cafe and restaurant seating
- ③ Transit shelters
- ④ Street and pedestrian lighting
- ⑤ Street trees and landscape
- ⑥ Benches
- ⑦ Trash and recycle receptacles
- ⑧ District banners

Additional features may include:

- Bike racks
- News rack enclosures
- Pet waste stations
- Wayfinding

Figure 4.42 Pedestrian Zone: Commercial Contextual Street Type



4.5.2.3 Commercial Type

Pedestrian zones adjacent to commercial spaces should provide a sidewalk clear zone wide enough to support high volumes of pedestrian traffic. Streets with transit stops require wider buffer / furnishing / curb zone to accommodate sheltered stops. They should also be designed with public art, benches, street lights, trees, and wayfinding signage to enhance the pedestrian experience. Additionally, this space may be used for utilities, bike racks, stormwater elements, trash and recycling, parking meters and other above ground elements.

Key Features:

- ① Sidewalks
- ② Street and pedestrian lighting
- ③ Street trees and landscaping
- ④ Banners

Additional features may include:

- Trash and recycle receptacles
- Bike racks
- Benches
- Transit shelters
- Information kiosks, signage and wayfinding

Figure 4.43 Pedestrian Zone: Residential Contextual Street Type



Furnishing / Buffer / Curb Zone
2'-5' min
7'-10' pref

Sidewalk Clear Zone
4' min
5' pref

4.5.2.4 Residential Type

Pedestrian zones adjacent to residential areas should be composed of the sidewalk clear zone, and buffer / furnishing / curb zone. However, residential land uses do not require frontage zones. Ideally, there should be pervious ground on either side of the sidewalk. Where space is limited, the sidewalk may be directly adjacent to the building or property line, but provide pervious ground between sidewalk and roadway. Residential pedestrian zones should have sufficient lighting to ensure pedestrian comfort but are not intended for high volumes of pedestrian traffic or activity.

Key Features:

- ① Sidewalks
- ② Transit shelters
- ③ Street and pedestrian lighting
- ④ Street trees and landscaping

Figure 4.44 Pedestrian Zone: Industrial Contextual Street Type



4.5.2.5 Industrial Type

Pedestrian activity is limited in industrial areas but pedestrian zone design should not be overlooked, especially if the streets are used as through streets for adjacent land uses or for children going to schools that are in or adjacent to the neighborhood. Industrial pedestrian zones must have the sidewalk clear zone, and buffer / furnishing / curb zones, but the frontage zone is optional.

Key Features:

- ① Sidewalks
- ② Street lighting
- ③ Street trees

Additional features may include:

- Transit shelters
- Trash and recycle receptacles

Figure 4.45 Pedestrian Zone: Parkway Contextual Street Type



4.5.2.6 Parkway Type

In the interest of preserving the green feel of park areas, these pedestrian zones should not include many above ground elements but should have wide landscaped areas on either side of the sidewalk clear zone. Shared use paths alongside the roadway are permitted in lieu of sidewalks.

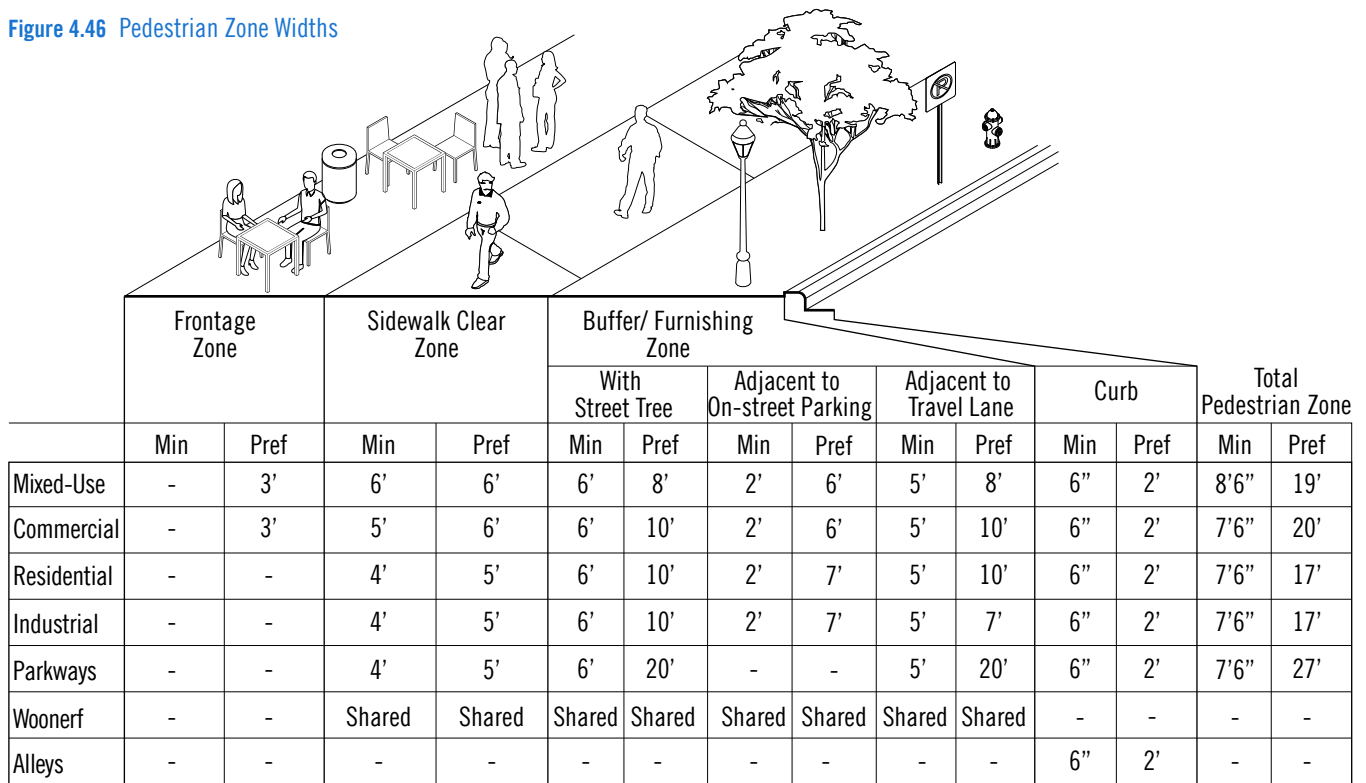
Key Features:

- ① Wide sidewalks
- ② Street and pedestrian lighting
- ③ Street trees and landscape

Additional features may include:

- Bike racks
- Transit shelters
- Trash and recycle receptacles
- Benches
- Signage and wayfinding
- Pet waste stations

Figure 4.46 Pedestrian Zone Widths



It is recommended to have at least 5 feet of sidewalk clear width to accommodate two people walking side by side or allow two wheel chairs to pass each other. In maintaining the minimum sidewalk clear width, the landscaping should not intrude into the sidewalk space. TIF or PID district requirements may differ from the above table.

4.5.3 Pedestrian Zone Widths

4.5.3.1 General

The character of a street, the quality of the walking experience, the success of the businesses on it, and the value of the surrounding neighborhood are greatly influenced by the width of the pedestrian zone. The width of the pedestrian zone should be determined by the context and use of a street. An 11-foot dimension from property line to back of curb is the minimum that will provide a preferred pedestrian experience. Areas with street facing businesses and moderate pedestrian volumes may need 15 to 20 feet or more. Every element in this zone – the pedestrian path itself, landscaping, and street furniture – benefits from more space. This zone must also accommodate many other elements, including signs, poles, and utility cabinets, which all require space.

All areas, elements, and facilities intended for pedestrian access, circulation, and use that are constructed, installed, or altered in the public right-of-way and are subject to the State and Local Title II regulations of the ADA, shall comply with this section, the Standard Construction Details, File 251D-1, PROWAG standards, and with applicable provisions of ADAAG Sections 4.1 through 4.35 that are not otherwise specified in this section. Sidewalk clear zones must be designed to the

minimum dimensions provided here and in the Complete Streets Design Manual. Under no circumstances can pedestrian zones be designed to be less than minimum ADA standards. However, some requirements outlined here are greater than ADA requirements with the intent to fulfill the vision of the Complete Streets Design Manual.

4.5.3.2 Frontage Zone

Frontage zones, though not required where space is limited, are preferred to be 3 feet wide where possible. These zones take into account the fact that people will not walk immediately adjacent to a wall and provide space for racks, displays, and other items that tend to accumulate in front of buildings. A 3-foot frontage zone allows for there to be less conflict between doors and the sidewalk clear zone. Not providing a frontage zone where a building faces the sidewalk effectively narrows the pedestrian clear zone.

In undeveloped areas along a street, crossfall slope from one foot behind the sidewalk to the property line shall not exceed 3:1 to provide for stability of the sidewalk and effective maintenance within the street right-of-way.

In developed areas along the right-of-way, the sidewalk shall connect with and provide the necessary pedestrian access to all adjacent properties. Between these sidewalk connections, landscaping or hardscape materials should be considered and applied.

4.5.3.3 Sidewalk Clear Zone (New Construction)

A General

The sidewalk clear zone is the clear unobstructed space where pedestrians walk along the street. 5 feet is the minimum space in which two people walking in opposite directions can pass. 6 feet is more comfortable, and allows two people to easily walk side by side. In busy commercial and retail districts, 8 to 12 feet allows groups of people to walk easily. Clear zones should be designed to fit the function and character of the street. The clear zone may vary from block to block based on pedestrian concentrations. PID, TIF, and Commercial districts will require wider clear zones, but even single family residential streets may warrant wide sidewalks based on factors like proximity to parks and schools. However, changes in clear zone width within a block, should be minimized to avoid obstructing pedestrian flow.

Where provided, sidewalk clear zones shall contain a continuous passage. The continuous passage shall connect to accessible routes provided on adjacent sites. Public sidewalks and the continuous passage within them shall comply with the following requirements:

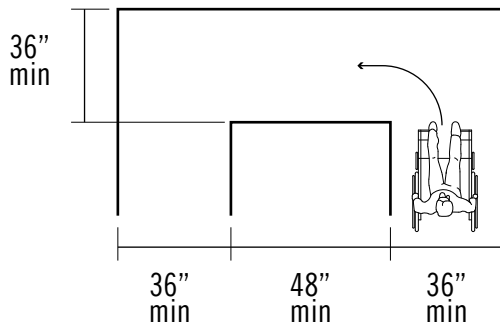
B Width

The width of a sidewalk shall be set as follows:

1. In compliance with ADA requirements, the minimum clear width of a sidewalk clear zone shall be no less than 36 inches. If a person in a wheelchair must make a turn around, the minimum clear width of the sidewalk clear zone shall be as shown in ADAAG 4.2.3 Wheelchair Turning Space – Figure 3. See Figure 4.47 that represents this minimum width.

Figure 4.47 Accessible Route and Changes in Level

90° Turn (a)



2. Public sidewalks less than 60 inches continuous width shall provide passing space at reasonable intervals not to exceed 200 feet. Passing space shall provide a 60-inch by 60-inch minimum clear space and may be provided at driveways, at building entrances, and at public sidewalk intersections.
3. In addition to minimum ADA requirements, the City of Dallas requires greater minimum clear dimensions for the sidewalk clear zone to account for protruding objects; see Figure 4.48 Protruding Objects. Any exceptions to the sidewalk width requirements must be approved by the Director.

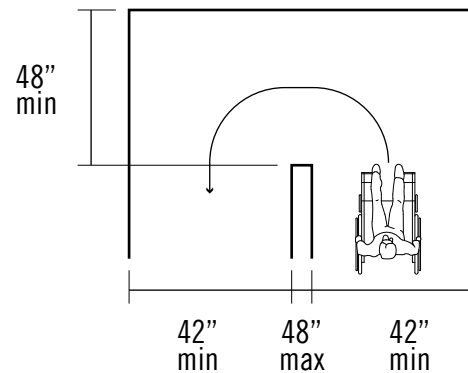
The Director may grant a waiver to reduce the sidewalk zone width and the minimum clear zone width, for either a portion of the development or the entire development if the Director determines that the minimum width cannot be provided because of the preservation of trees, presence of utilities, insufficient right-of-way, or other mitigating factors.

C Slope

The slope of a sidewalk shall be set as follows:

1. Sidewalk designs shall provide the minimum feasible running slope for sidewalk clear zones consistent with slopes established for adjacent roadways. Where feasible, running slopes for sidewalk clear zones shall not exceed 5% and must be consistent with ADA requirements. However, waivers can be obtained where sidewalk slopes exceeds 5% to match roadway grades. Running slopes for ties to leadwalks (walks leading to buildings on adjacent properties) must meet ADA requirements or as otherwise allowed due to certain

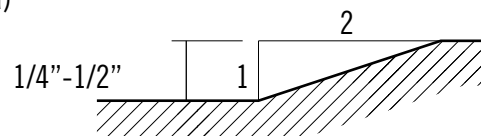
Turns Around Obstructions (b)



Changes in Level (c)



(d)



uses, such as other accessible routes being provided to the facility, or steep existing sidewalk grades and terrain. The minimum running slope allowed is 0.5%. Positive surface drainage must be provided in all sidewalk designs. Consideration shall be given to surface drainage which may cross or enter the sidewalk from adjacent properties, and how that surface drainage will be handled to minimize its impact to pedestrians.

2. Crossfall across sidewalks shall be at least 1/8 inch per foot (1%) slope but should not exceed 1/4 inch per foot (2%) except in barrier free ramp areas. Where sidewalk intersections serve two directions of pedestrian travel, the slope in any direction at the landing or intersection shall not exceed 1/4 inch per foot (2%). Sidewalk transitions and landings shall be provided as required. Where public sidewalk intersections in the public right-of-way serve two directions of travel, the slope in any direction shall not exceed 1:50 (20%). For details concerning barrier free ramps and permissible grades, see ADA requirements.

D Changes in Level

Level changes shall be handled as follows. See Figure 4.47.

1. Changes in level up to 1/4 inch may be vertical and without edge treatment.
2. Changes in level between 1/4 inch and 1/2 inch shall be beveled with a slope no greater than 1:2 as shown in ADAAG 4.3.3 – Figure 7(d) Accessible Route Changes in Level.
3. Changes in level greater than 1/2 inch shall be accomplished by means of a public sidewalk curb ramp that complies with ADAAG Section 4.8 Ramps, or an elevator that complies with ADAAG Section 4.10 Elevators.

E Surfaces

Sidewalk surfaces shall be designed as follows:

1. Surfaces of public sidewalks shall be stable, firm, and slip-resistant and shall lie generally in a continuous plane with a minimum of surface warping. Refer to Section 5 Pavement Structure for specific guidelines on surface design.
2. It is preferred that utility vaults and lids not be located in sidewalks, but wherever this occurs the covers and lids shall be slip resistant and meet all other applicable accessibility requirements per TAS and ADA. Bare metal lids including "diamond plate" are not considered slip resistant.
3. Gratings in public sidewalks shall have spaces no greater than 1/2 inch wide in the directions of traffic flow and shall not be located in the sidewalk clear zone.

4. Where sidewalk clear zones cross rail systems at grade, the surface of the continuous pedestrian crossing shall be governed by the rail owners, such as UPRR and DART. Where sidewalk clear zones cross intersections or driveways, their surface treatment should express continuity of the pedestrian travel zone. Refer to Section 4.4 Intersections and Section 5.2 Pavement Design for guidelines on surface treatments at intersections. See the City of Dallas Standard Construction Details, File 251D-1, and refer to the Driveway Approach Details.
5. Where necessary to provide a sidewalk clear zone complying with Section 5 Pavement Structure, public sidewalk surfaces may be warped or blended. Where compliance with requirements for cross slope within the sidewalk clear zone cannot be fully met due to site infeasibility, the minimum cross slope feasible shall be provided. Site infeasibility is defined as existing site development conditions that prohibit the incorporation of elements, spaces, or features that comply with the minimum requirements for new construction and are necessary for pedestrian use. Existing gratings and similar appurtenances that comply with Section 4.5.3.3 may be located in the sidewalk clear zone if site infeasibility precludes their relocation during alterations.
6. Where counter slopes of existing adjoining gutters and road surfaces exceed 1:20 (5%), newly installed public sidewalk curb ramp surfaces may be slightly crowned and projected beyond the curb face provided the leading edge at the street surface can be smoothly blended and sides are flared, without abrupt drop-offs.
7. Sidewalks shall be continuous and level across driveways.

F Alterations

Alterations of sidewalk shall be treated as follows:

1. If existing areas, elements, or facilities intended for pedestrian circulation in an existing developed public right-of-way are altered they shall comply with this subsection.
2. Alterations to individual elements shall comply with the applicable requirements set forward by Section 4.5.3.3 of this manual, consistent with the following requirements. The Director may approve lesser standards when justified or where new work needs to conform to existing improvements.
3. No alterations shall be undertaken that decrease or have the effect of decreasing the accessibility or usability of existing pedestrian areas, elements or facilities.
4. If alterations to existing public sidewalks, public sidewalk curb ramps, or pedestrian street crossings,

when considered together, amount to a reconstruction of a block, intersection, or other substantial segment of the pedestrian circulation network in the public right-of-way, the entire segment, to the maximum extent feasible, shall be upgraded to comply with provisions for new construction.

5. No alterations of an existing pedestrian area, element, or facility shall impose a requirement for greater accessibility than that which would be required for new construction.
6. Alterations to a public sidewalk, public sidewalk curb ramp, or pedestrian street crossing in the public right-of-way shall be made so that adjacent segments of the continuous passage are readily accessible to and usable by individuals with disabilities, unless such alterations are disproportionate to the overall alterations in terms of cost and scope (as determined under criteria established by the Attorney General).
7. Exception: In alteration work, if site infeasibility precludes compliance with the standards of new construction in Section 4.5.3.3 of this manual, the alteration work shall provide accessibility to the maximum extent feasible. Any elements or features of the public pedestrian right-of-way that are being altered and can be made accessible shall be made accessible within the scope of the alteration.

G Temporary Work

Construction and repair work within the public right-of-way that affects pedestrian circulation elements, spaces, or facilities shall comply with the following provisions:

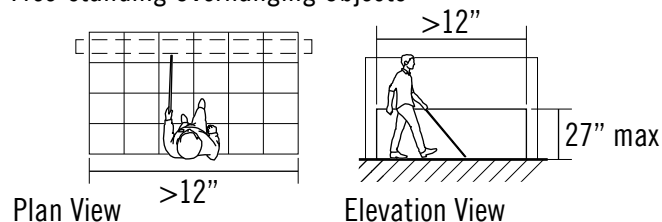
1. Construction sites in the public right-of-way shall be provided with barriers to warn of and protect from hazards on the pedestrian circulation network. Pedestrians shall be given advisory warning of upcoming work zones.
2. Where a temporary alternate circulation path is provided, it shall comply with ADA requirements, the minimum clear width of a sidewalk clear zone shall be equal to or greater than 36 inches and shall be clearly marked. Provide alternative routes that are not unreasonably long or circuitous.
3. Requirements for detours from the City of Dallas Traffic Barricade Manual shall be satisfied in correlation with TMUTCD – Part 6: Temporary Traffic Control.
4. Pedestrian circulation and routes shall be maintained during construction and repair work within the public right-of-way and on private property for public pedestrian routes, or alternative paths shall be provided.

H Hazards

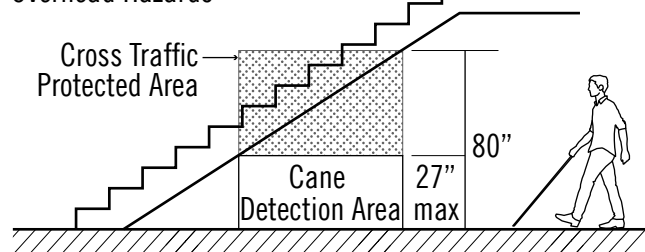
Design work shall address and provide solutions to hazards encountered in sidewalk clear zones. Hazards may include protrusions, overhangs, and barrier objects. See Figure 4.48 that shows typical hazard conditions.

Figure 4.48 Protruding Objects

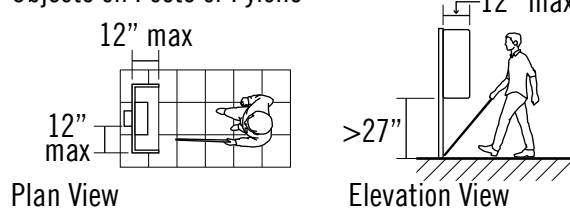
Free-standing Overhanging Objects



Overhead Hazards



Objects on Posts or Pylons



ADA Guidelines

4.5.3.4 Buffer / Furnishing / Curb Zone

The width of the buffer / furnishing / curb zone is determined by multiple factors. The buffer separates pedestrians from vehicular traffic. Therefore, streets with high traffic speeds and no on-street parking should have wider buffer zones for this purpose. The buffer / furnishing / curb zone accommodates landscaping; more space allows for healthier trees and more variety in planting (see Section 4.5.4 Landscape) The buffer can include sustainable drainage elements, which can be more functional with more space. The buffer / furnishing / curb zone also provides room for people to gather, benches, and public art; more space will provide more options for all of these activities. Thus, the width of the buffer is an important urban design decision.

The top of buffer / furnishing / curb zone elevations must not be greater than the elevation of the existing ground at the property line unless the property line is in the floodplain or cross drainage is away from the street and some other

means is available to address storm water runoff and ponding of water. The top of curb elevation should generally be at least 2 inches below the existing ground elevation at the property line and in flat areas (street grades less than 1%) at least 6 inches to insure proper parkway cross slope and street drainage is maintained.

The buffer / furnishing / curb zone must be sloped in such a manner that stormwater will drain toward the street from adjoining properties and provide erosion control. The crossfall slope of a buffer / furnishing / curb zone shall not be more than 1/4 inch per foot (2%) at all points. The crossfall slope shall not exceed 1 inch per foot (8%) between the back of curb and the edge of sidewalk clear zone. For additional details on sloped transactions and retaining walls in the buffer / furnishing / curb zone, see Section 4.3.4.3.C Pedestrian Zone Transitions.

Public sidewalks shall be raised to curb height (usually 6 inches above street gutter line) or separated from vehicular ways by curbs, which shall be continuous except where interrupted by driveways, alleys or connections to ADA accessible elements.

See Section 4.5.6 regarding other items in the furnishing zone, particularly Section 4.5.6.12 for utilities.

The curb does not accommodate any other functions and should not be counted in the width of any of the other zones defined in Section 2.5 Zones.

Exception: Public sidewalks may be constructed along undeveloped frontages of rural roadways without a curb if approved by the Director.

4.5.4 Landscape

4.5.4.1 General

Trees and planting provide opportunities to define and integrate the character of pedestrian zones with adjacent urban open space edges and street zones. They can provide shade, buffer pedestrians from passing vehicles, reduce stormwater runoff, and provide aesthetic enhancements or other benefits. However, to provide these benefits, these green components must survive an unnatural, harsh environment with reflective heat, pedestrian traffic, vehicular traffic, and a highly paved condition. The selected landscaping must not be a nuisance and still be practical to maintain. The proper use, design, and composition of each component from the soils up, is essential to the landscape viability.

This section will present landscaping within the urban right-of-way including:

- How it benefits the public.
- Where opportunities exist to apply various types of landscape applications.

- What guidelines and constraints should be examined for each application.
- What special consideration should be given to the use of trees in the right-of-way due to their size and considerable impact to the streetscape.
- How maintenance is pivotal to the safety and vitality of the public's investment.

4.5.4.2 Considerations

All new projects that significantly impact public and private streets in Dallas should follow the guidelines listed in Section 1.4 Standards. In addition, projects should consider the following:

A Reviews and Approvals

Installation of all plantings within the public right-of-way must be reviewed and approved by City of Dallas Public Works Department and Building Inspection, and other agencies depending on project applicability - Texas Department of Transportation, North Texas Tollway Authority, Dallas Area Rapid Transit, Trinity River Authority, and Dallas County Public Works.

B Benefits of Landscape

Planting and landscape features within the public right-of-way has been shown to provide significant benefits. Generally, these benefits increase exponentially as the size of the plant increases; this is particularly true for trees. There are measurable physical, social and economic values that a thriving, well maintained landscape generate to its locale. Good landscaping has the potential to improve our quality of life through the following:

- Capture carbon dioxide and produce oxygen
- Reduce the urban heat-island effect, decreasing energy costs related to air temperatures
- Absorb and clean stormwater
- Create opportunities for community and social interaction.
- Provide bird and pollinator habitat opportunities
- Make streets appear narrower to drivers, thereby causing them to drive slower, and enhancing safety
- Create a positive aesthetic that attracts customers to local businesses
- Increase the value of adjacent properties
- Make streets and neighborhoods more attractive and livable

C Challenges with Landscape

Planting and landscape features within the public right-of-way can have adverse effects if the following items are not considered:

- Effort required to establish the landscaping.
- Long Term Maintenance; identify entities performing the maintenance.
- Is irrigation required?
- Who supplies and pays for the irrigation water?
- Who maintains the irrigation system, if it was required?
- How will roots and / or branches impact the right-of-way?
- Likelihood of landscaping elements encroaching into the various zones, impairing sight distances as they grow, blocking store fronts.
- Will the landscaping natural debris impact sidewalks, drainage facilities, bike lanes, or parking lanes?
- How will the landscaping improvements be affected by weather, strong winds, hot summers, or freezing temperatures?

The design plans shall adequately address the above considerations as they apply to the project and in coordination with the City to address long term operations and maintenance.

D Opportunities for Landscape Application

Landscape opportunities exist within the right-of-way along collector streets especially in commercial, institutional, and residential areas with medium to high pedestrian and vehicular use. For the purposes of this manual, the vehicular and pedestrian usage of the right-of-way are designated as “street zones” for primary vehicular use; “pedestrian zones” receive primarily pedestrian use.

The opportunity for the addition of trees and plantings occurs within street zones and pedestrian zones, which are described in Section 2.5 Zones. Each zone sets criteria for specific applications of trees, plantings, and sustainable drainage measures. Opportunities for landscape applications in street and pedestrian zones follow while noting the guidelines and constraints for each. Sizes and locations of trees and plants are dictated primarily by vehicular clearance requirements, visibility triangles at intersections, and sight lines over plants for cyclists, pedestrians, and vehicles.

E Guidelines and Constraints for Landscape Use

In the setting of streets, parkways, and expressways, the placement of trees and other plants has a direct bearing on safety and the cost of maintenance. Landscaping along the buffer and medians are an effective way to improve the safety and accessibility of arterial streets. For pedestrians, a landscaped median decreases the total crossing width of the street.

Plants, excluding tree canopies, in the public right-of-way should not infringe upon the roadway or sidewalk beyond the planting bed. Careful consideration must be given to above- and below-ground constraints, such as utilities, vaults, and other obstructions that may limit the ability to plant. In particular, avoid planting trees directly over water and sewer lines, and near steam lines.

Overhead Utilities. Dallas is served by many overhead power and communication lines, and many of these aerial lines will remain for the long term. Redevelopment provides an opportunity for possible modification of these lines to an underground configuration which can greatly improve the aesthetics of the area. This is encouraged where economically feasible and where site conditions allow the addition of at grade transformers and wiring. For guidance and constraints for landscape use on existing utilities that remain, such as ONCOR overhead electrical and communication lines, refer to Appendix F. In addition, refer to Article X – Sec. 51A-10.104 for tree distance requirements from overhead electrical line.

Underground Utilities. Existing underground utilities, basements and vaults impact placement of trees and other site furnishings depending on locations and depth relative to the finished grade of the pavement. Trees may need to be planted in tree planters with raised walls to provide adequate clearances over underground utilities, smaller species of tree may be selected with a shallow root system, or planting beds with no trees may be the best application. Spacing of trees will be determined by study of the survey for available distances between underground obstructions and utility main and feeder lines. The available planting locations will determine a pattern relative to other furnishings, light poles, utility poles, and access points.

Landscape Related Utilities. Trees requiring subdrainage provisions shall consider the feasibility of connection of new drain lines to existing or proposed storm inlets or main line. Irrigation allowances for plant establishment will require points of connection to new or existing water meters with new pressurized main lines to be sleeved and snaked around existing utilities, footings, and other obstructions, and buried at required depths per codes.

Sight Lines. Trees and other plantings must not block sight lines at intersections for drivers, cyclists, pedestrians, and traffic control devices. Landscaping in medians and at intersections should not obstruct the visibility between pedestrians and approaching motorists. Trees should be placed so that they minimize dark spots from street lights and should not be placed to obstruct sight lines identified as “visibility triangles” in the Dallas Development Code (Section 51A, 4.602). For more discussion on “visibility triangles”, refer to Section 4.3.3 Visibility and Sight Distance.

Tree Preservation. Care should be taken to preserve existing, healthy trees as much as possible, and integrate them into the street design. Refer to Article X of the Dallas Development Code regarding tree conservation and replacement (mitigation) for trees within and outside the right-of-way.

Other site conditions that will influence the use of plant material includes drainage, slopes, available water supply and soils. Refer to the discussion of soil treatments in Section 4.5.5 Landscape Elements.

F Street Zones

Table 4.16 Street Zone Landscape Applications

Pedestrian Zones	Turf Grass	Planting Beds ¹	Large Shrubs	Small Trees	Medium & Large Trees	Sustainable Drainage Measures ⁴	Remarks
Buffer/Furnishing Zone Planting application can apply to pedestrian zone edges of parkways, boulevards, neighborhood connector streets, downtown commercial, downtown mixed-use street types, and industrial street settings.	• ²	•		•	•	•	At least 3 feet of clearance from outermost edge of landscape structure to back of street curb; tree canopies must be: greater than 8 feet above sidewalks, 17 feet above/over street/roadway/drive lanes, 8 feet above/over adjacent bike lane or parking area, trunks should be at least 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches; trees and plantings must not block sight lines at intersections for drivers, cyclists, and pedestrians.
Curb Extensions/ Bulb-outs 8 feet wide min.	• ³	•		•	• ⁷	• ⁵	Tree canopies must be: greater than 8 feet above sidewalks, provide clear canopy height, and located 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches within visibility triangles; trees and plantings must not block sight lines at intersections for drivers, cyclists, and pedestrians.
Plazas (Off-street & On-street) Open spaces that adjoin the pedestrian zone.	•	•	•	•	•	• ⁶	Tree canopies must be: greater than 8 feet above sidewalks, 17 feet above/over street/roadway/drive lanes and on-street plaza use areas, 8 feet above/over adjacent bike lane or parking area, trunks should be at least 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches within visibility triangles; trees and plantings must not block sight lines at intersections for drivers, cyclists, and pedestrians.
Pocket Park Small areas that may adjoin the pedestrian zone.	•	•	•	•	•	• ⁵	Tree canopies must be: greater than 8 feet above sidewalks; height of ground plane plant materials will not be greater than 30 inches within visibility triangles.
Parklets Small extensions or expansion of the pedestrian zone that occupy former parking; temporary or long term.	•	•	•	•	•	• ⁶	Tree canopies must be: greater than 8 feet above sidewalks, 17 feet above/over street/roadway/drive lanes and on-street plaza use areas, 8 feet above/over adjacent bike lane or parking area, trunks should be at least 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches within visibility triangles; trees and plantings must not block sight lines at intersections for drivers, cyclists, and pedestrians.

¹ Shrubs, Yuccas, Hesperaloe, Orn. Grasses, Perennials, Groundcover, Stone aggregates, and River Rock

² Shrubs, Yuccas, Hesperaloe, Orn. grasses, Perennials, and Groundcover only

³ + Boulders

⁴ Rain Gardens, Bioretention Areas, Bioswales, Bioretention Swales, and Tree-box Filters

⁵ Rain Gardens, and Bioretention Areas only

⁶ Rain Gardens, Bioretention Areas, and Tree-box Filters only

⁷ For wide bulb-outs

G Pedestrian Zones

Table 4.17 Pedestrian Zone Landscape Applications

Street Zones	Turf Grass	Planting Beds ¹	Small Trees	Medium & Large Trees	Sustainable Drainage Measures ²	Stone Aggregate/ River Rock	Remarks
Lane Dividers Planting areas between traffic lanes.	•	•				•	Restrictive maintenance area, use of hardy or native smaller plants that maintain width and height, do not need shearing to meet size requirements, reflected heat tolerant, wind tolerant, drip irrigation use only allowed where site lines are required, height of plant materials will be no greater than 30 inches.
Medians 6 feet wide min.	•	•	•	•	•		Must allow enough room for a pedestrian and a wheelchair to meet within a pedestrian refuge while crossing the street. Tree canopies must be: greater than 8 feet above sidewalks, 17 feet above / over street / roadway / drive lanes, trunks should be at least 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches within vehicular visibility triangles, and should not obstruct visibility between pedestrians and approaching motorists.
Roundabouts/ Traffic Circles Large central island allowing more visually conspicuous landscape; improve the aesthetics of the area while complementing surrounding streetscapes.	•	•			• ³	•	Minimize introducing hazards to the intersection such as: trees, tall planting material, large boulders or rocks; avoid obscuring the form of the roundabout or the signing to the driver, particularly in higher speed environments; maintain adequate sight distances; clearly indicate to the driver that they cannot pass straight through the intersection; discourage pedestrian traffic through the central island; and help blind and visually impaired pedestrians locate sidewalks and crosswalks; height of ground plane plant materials will not be greater than 30 inches within vehicular visibility sight lines; plants shall be able to withstand harsh environment; plantings and surface materials should require minimal maintenance due to limited access; slope shall not exceed 6:1; irrigation runoff should be considered to prevent slippery pavements.
Freeways, Exit & Entry Ramps, Frontage Roads, & Gateways Trees and planting beds used in major public corridors.	•	•	•	•	•		Tree canopies must be: greater than 8 feet above sidewalks, 17 feet above / over street / roadway / drive lanes, trunks should be at least 5 feet from back of curb; height of ground plane plant materials will not be greater than 30 inches within vehicular visibility triangles, and should not obstruct visibility between pedestrians and approaching motorists.

¹ Shrubs, Yuccas, Hesperaloe, Orn. Grasses, Perennials, Groundcover

² Rain Gardens, Bioretention Areas, Bioswales, Bioretention Swales

³ Rain Gardens & Bioretention Areas only

Sustainable Drainage Measures

Refer to Drainage Manual for plants and soils; must comply with visibility triangles for plant heights above top of curb elevation, and clearance restrictions.

Definition of Terms

Rain Gardens- Depressed planter beds with diverse plant types

Bioretention Areas- Depressed planter beds with diverse plant types

Bioswales- Linear channels with grass or planted vegetation

Bioretention Swales- Linear rain gardens or bioretention areas with grasses or planted vegetation

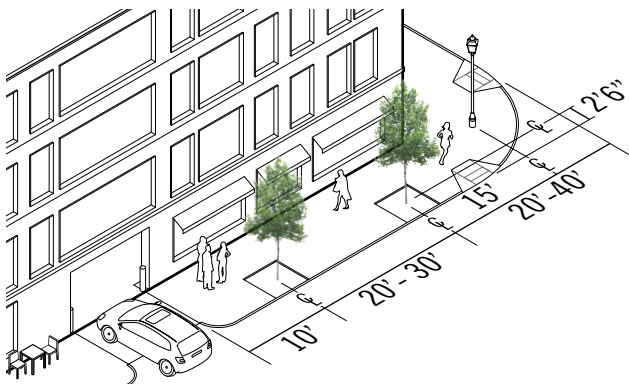
Tree-box Filters- Small bioretention planters with the tree size based on allotted root zone area

Figure 4.49 Shade Trees Spacing and Offset

Large Stature Shade Trees



Medium Stature Trees



Short Stature Ornamental Trees

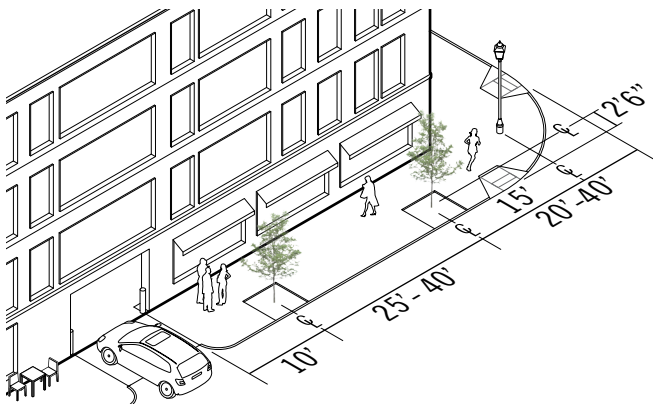


Table 4.18 Tree Spacing and Offsets

	Short Stature Ornamental Trees	Medium Stature Trees	Large Stature Shade Trees
On-Center Spacing	10' - 20'	20' - 30'	25' - 40'
Offset from Back of Curb*	2' 6" min	2' 6" min	2' 6" min
Offset from Light Poles*	10'-15'	15'	15'
Offset from Driveways, Fire Hydrants, Loading Zones*	10' min	10' min	10' min
Offset from Intersections* (Reliant on traffic direction)	20'	20' - 40'	20' - 40'

* To Tree Centerline

4.5.4.3 Use of Trees

Opportunities for trees in various landscape applications are listed above. Specific considerations for tree usage in the right-of-way follows.

A Design and Benefits of Trees

Street trees can be used to serve a variety of urban design functions. Based on their location, arrangement, and spacing trees can:

- Frame, define, and accentuate spaces.
- Emphasize linearity and long views.
- Create a ceiling and sense of enclosure.
- Provide needed shade and filtered light.
- Reinforce the rhythm of a street-wall.
- Provide human scale in tall or open environments.
- Add texture, connection to nature, and seasonal interest.
- Contribute to a unique sense of place.

Deciduous trees are an ideal form of shade, providing protection on hot summer days while allowing heat and light to penetrate during cold winter months. Trees can also calm traffic by narrowing the apparent width of the roadway.

Street trees should be used in thoughtful compositions that respect the overall street context, local environment, and adjacent land uses.

B Siting and Spacing of Trees

Trees should be planted in locations that provide the best conditions for growth within the width of the pedestrian zone. This could mean planting along residential streets, or clustering trees in open planting areas on wide sidewalks or in urban open spaces. Large, contiguous planting areas should be employed where feasible to enable large canopy shade trees to reach maturity.

Street tree plantings should strive for continuity along a street while respecting adjacent uses. Each tree should complement and not interfere with first floor uses, entryways, cafés, or other activities in the pedestrian zone. Consideration should be given to the existing and proposed locations of pedestrian and street lighting; overhead and underground utilities; and street furnishings. Trees should not be planted in loading zones or within 10 feet of bus stop landing zones. Tree limbs should be pruned to maintain sight lines and required clearances over pavements. With proper application and considerations all of these elements can function together efficiently.

C Street Trees and Street Types

Street trees shall be considered in every street design project. Specific considerations for tree spacing and type selection follows.

1. Parkway are lined with continuous green spaces for trees, either on the sides or in the median. If sufficiently wide, green spaces provide an excellent rooting environment for large stature shade trees. Street trees should be planted no more than 40 feet apart to help create a continuous canopy. Species of a similar size, scale, and form should be planted along the length of the road for consistency and to maximize visual impact. Avoid monocultures, as disease and insects may destroy street trees along an entire street.
2. Trees on Boulevards are planted at regular intervals in a formal pattern with street lights, emphasizing linearity and long perspective views. The pattern draws the eye to the horizon or to an important terminus, such as a prominent building, park, or feature. Trees are planted in the Buffer / Furnishing / Curb Zone and are usually surrounded by pavement. Modern planting techniques using Landscape Elements such as tree planters, structural soils, and tree root zone soil support systems should be used to provide sufficient soil volume where applicable. Large-stature shade trees of similar size, scale, and form are typically planted 25 to 30 feet apart to create a continuous canopy.
3. Neighborhood Connector Streets are similar to Boulevards but are less formal. Trees should be planted where they can best survive using appropriate Landscape Element applications.

4. Neighborhood Main Streets benefit enormously from planted trees of various types. Visual preference studies have found that commercial districts with shade trees are consistently preferred over commercial districts without trees. Shade trees create the sense of an outdoor room and make streets more comfortable for sitting, café dining, window browsing, and socializing. Different species can be used in clusters to highlight special areas and create a sense of place.
5. Large canopy shade trees are attractive and add value to homes on Neighborhood Residential Streets. They help keep homes cool in the summer while allowing light and heat to penetrate in colder months. The branches also have the benefit of tempering winter winds and providing summer breezes. Street trees should be spaced far enough apart to allow light to reach front lawns and gardens. Trees should be planted in parkways close to private front yards to maximize rooting space.
6. Downtown Commercial and Downtown Mixed-Use Street Types require trees that can adapt to low light depending on building heights, street width, and street orientation. Where there is insufficient rooting depth due to underground utilities, raised tree planters can be considered.
7. Trees in Industrial settings must to be able to withstand drought and harsh conditions resulting from heavy traffic, green-house gas (GHG) emissions, and heat island effects from surrounding parking lots. Where possible, trees should be set back from the street and planted using applications of Sustainable Drainage Measures (Drainage Manual) between the paved lots and the sidewalks. Tree species that can uptake and remove urban stormwater runoff contaminants and air pollutants should be considered wherever possible.
8. Trees with low canopies can obscure business fronts and are discouraged in commercial areas. Low canopies or high shrubs can hide pedestrians from motorist's view and can cause safety and security concerns for pedestrians and law enforcement.

D Choosing the Right Tree

Tree selection needs to address the ability of the tree to mature in a given microclimate, as well as the trees' ability to meet design objectives. Scale and form are key design considerations. Consider the tree's anticipated mature canopy height, spread and required root zone, which will affect the clearance for pedestrians, bike lanes, parking, buses, overhead and underground utilities.

Trees must conform to Article X of the Dallas Development Code, Landscape and Tree Conservation Regulations and, when applicable, comply within the applications of Sustainable Drainage Measures in the Dallas Drainage Manual (Appendix G - Materials Matrix).

Large trees play a critical role in the urban forest ecosystem, and offer a unique presence on city streets. Providing sufficient rooting space is a challenge. However this does not limit plantings to medium and small trees; even small trees will suffer in a limited rooting environment. Given all the uncontrollable variables in a street it is worth taking a chance that a shade tree will survive in less than ideal conditions. Appropriate details should be used to enable trees to grow without roots rising to the surface and deforming sidewalks.

Choosing a tree for the right habitat can help minimize conflicts with adjacent infrastructure. For example:

- Shallow rooted species should be considered near sanitary sewer or storm drain pipes
- Short stature ornamental trees should be considered under overhead wires
- Tree species with narrow upright growth patterns should be selected for use next to roadways
- Trees with deeper roots and small trunk flares should be used adjacent to pavements
- Match the tree's required root zone area to available soil and planting area

Other considerations for selecting the right tree include: the scale and form; sight line requirements; the type of microclimate; tolerance to drought and insects; inundation; resistance to vehicular emissions and salt; the ability to remediate pollutants; and the amount of maintenance. From an aesthetic perspective, spring flowers, fall color, the quality of light and shade, and the abundance of fruit, nuts, and leaf litter should also be considered.

E Root Environment for Street Trees

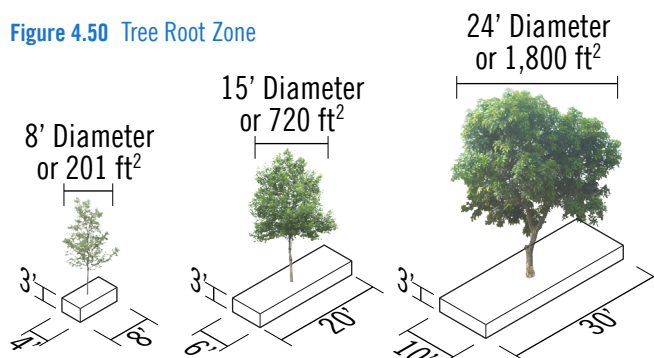
A tree's canopy size is directly related to its environment and the volume of soil available for roots - referred to as "required root zone". Providing sufficient rooting soil in a dense, urban environment can be costly, but is worthwhile given the unique benefits that mature large and medium trees provide. See Figure 4.50 for required tree root zone sizes.

Tree roots do not survive well in highly compacted soil because it lacks the void spaces needed for air and water to circulate. Roots in compacted soil will migrate toward the surface for air and water, causing sidewalks to crack and heave.

When the rooting space is severely constrained, the tree roots will grow to capacity, and then the tree will decline and die. Trees need approximately 2 cubic feet of soil per square foot of canopy area. For example, a tree growing in a constrained 3'x8' area by 4-foot pit would be expected to reach about an 8-foot diameter canopy before becoming

stressed and showing signs of decline. If the tree has access to soil outside the pit, the canopy can grow much larger. Refer to Article X, Sec. 51A-10.104, "Soil and Planting Area Requirements," for minimal criteria. Refer to Landscape Elements for applications of Structural Soils for Trees and Tree Root Zone Soil Support Systems.

Figure 4.50 Tree Root Zone



F Maintenance

Maintaining landscape plantings on Dallas' streets is challenging. In downtown and high development areas, sidewalk space is at a premium and the hard surfaces required to support concentrated activity can be hostile to trees and other plantings. Soil compaction, lack of rooting space, poor soils, intense reflective heat and drought, temperature fluctuations, physical damage, and even air pollution and litter all put stress on plants. These guidelines seek to balance the benefits of a healthy landscape with the realities of limited space and the ongoing need for care and maintenance.

Site design and species selection should correspond to the anticipated level of maintenance a planting will receive following installation including skill level, available equipment and frequency. Planting areas should be designed to provide sufficient space for personnel to maintain them. Such design considerations may include, among other things, paths within or surrounding the planting areas. Tree height and overall shape should be properly maintained to prevent interference with overhead and adjacent utility lines such that the utility company's tree trimming crews do not determine the final shape of the tree.

Maintenance should include an appropriate level of watering, weeding, pruning, cultivating, and waste removal. Repair of minor washouts, mulching, soil replacement, plant replacement and other horticultural operations may also be necessary. Any existing invasive plants that cannot be removed or outbreaks of new invasive species will have to be managed through ongoing maintenance. Selecting plants that are drought tolerant, are disease resistant, compete well, and have the appropriate form at maturity will reduce maintenance needs.

Newly installed plants require consistent maintenance throughout their growing season in order to become established and thrive. Establishment periods vary, but generally, watering and weekly maintenance is needed for the first year. Typically, a one-year landscape maintenance requirement is attached to the landscape installer's contract. Allow about 1 year of watering and maintenance for every inch of tree caliper to fully establish the tree root system and to remove branches impeding the use of the pedestrian and vehicular zones.

For a detailed, but not exhaustive list of maintenance items reference Appendix H - Recommendations for Maintenance: Tree / Plant Health, Aesthetics, Design Performance and Safety. This list provides recommendations for scope of work and frequency for maintaining trees, plant materials, trimming, treatments, fertilizing, mulching, mowing, irrigation, aggregates, trash, site furnishings, graffiti and hazardous material removal, drainage inspection with cleaning and testing, light fixture outages, and more.

Maintenance within public right-of-way could be handled by several entities.

- The City of Dallas has responsibility for landscape maintenance within the street medians, unless the median maintenance is covered by or through one of the TIFs or PIDs within the City.
- Typically, TxDOT has responsibility to maintain right-of-way of freeways and state highways that traverse the City.
- NTTA has responsibility to maintain right-of-way of tollroads which they operate within the City.
- Private land owners have primary responsibility to maintain the portion of the public right-of-way outside the curb line that is adjacent to their property and up to the back of curb.

Other plantings within the public right-of-way are encouraged but require coordination with appropriate agencies and could require a maintenance agreement with the City.

4.5.5 Landscape Elements

4.5.5.1 Plants

Plants for the urban right-of-way include trees, shrubs, yucca, hesperaloe, ornamental grasses, groundcovers, turf-grass and perennials. A successful planting design will match plants with existing site conditions and anticipated site use to achieve an aesthetically pleasing, functional, and long-lived landscape. Species selection must be guided by a comprehensive site analysis of the

natural and built environment as well as the maintenance plantings are anticipated to need and receive. Plant selections should provide diversity of species and avoid monoculture, where possible, to prevent plant loss due to the risk of diseases, species blight, and pests. Native and drought tolerant plants are the most dependable performers. Care should be taken not to include invasive plants as defined by various Texas organizations on texasinvasives.org and by the USDA Plant Data base at plants.usda.gov.

Plant specification should follow the 251D-1 Standard Details and Specifications, and, whenever possible, plants should be sourced from a nursery within 500 miles of the project site and grown in similar soil and plant hardiness zone conditions. Dallas is located on United States Department of Agriculture (USDA) Plant Hardiness Map - Zone 8a with temperature lows at 10 to 15 degree F, and borders close to 7b where temperature lows are 5 to 10 degrees F.

Attention should be given to plants' color, form, foliage, and texture and how those elements can be combined to create year-round interest. Careful consideration should also be given to the forms and heights plants will reach at maturity and how they interact with other design elements, such as seating, signage, signals, light fixture placement, bikeways, roadways, and relation to branching clearance heights over walks. They are not to exceed 30 inches in height such that the plants cannot block visibility to both pedestrians and motorists. Plant species and size classifications shall be selected from Article X of the Dallas Development Code – Landscape and Tree Conservation Regulations, and the Drainage Manual for Sustainable Drainage Measures applications. All species selection must be reviewed by the City Arborist and the City Urban Forester during the review process.

In addition, ensure the following:

- Bark, "gorilla hair", or other floatable mulch is not planted where it will quickly migrate into the street drainage system or clog surface planter drain inlets.
- Plants near the street do not grow over 30 inches or under 8 feet; as this hides pedestrians from drivers.
- Minimize dense growth or growth of the wrong height that can potentially hide criminal activity and lessen the feeling of security.
- Ensure the tree wells or other landscaped areas do not pose as tripping hazards; particularly if they are under-maintained.

Plant selection and placement also should be influenced by the principles of pedestrian and user safety as defined in CPTED (Crime Prevention Through Environmental Design) and as evaluated by local police officials.

4.5.5.2 Surface Finishings

The finished grade of planters / planting beds need protection to prevent compaction of the root zone and to provide permeability for air and water. The specific planting application and location will influence the choices of the materials. Considerations such as maintenance, migration of material, replenishment of material, access to check and monitor irrigation and drainage, stability and ADA accessibility with no tripping hazards for pedestrian access (if required), opening allowances for tree trunk growth, exposure of tree root flare, and securing tree grates to ensure they are not vandalized, need to help finalize the choice.

Topdressings and Other Surface Treatments include:

- Mulches
- Aggregates
- River Rock
- Tree Grates (only if maintained properly)
- Pavers on support systems

4.5.5.3 Soils Selection and Management

A Overview

Proper soil selection and management of healthy soils—soils that have a high organic content and plenty of pore space—support healthier trees and plants and promote more groundwater recharge and better filtration of stormwater in urban areas. Healthy soils are critical to plant health and root development. Soils in urban conditions have been modified by grading, and / or construction compaction, and provide minimal nutrients for plant utilization. Heavily compacted soils act almost like pavement, absorbing little water, and supporting less biological activity than well aerated soils. Mechanically aerating compacted soils can help restore porosity; the addition of soil amendments, such as mature compost, improves aeration and helps retain soils moisture. Soil maintenance should be part of an operation and maintenance plan for urban vegetation.

New street trees and plantings in paved areas present an opportunity to use engineered soils to grow larger and healthier landscape and to clean and recharge significant volumes of stormwater runoff. Design details for planting street trees and implementing vegetated stormwater management techniques are found in the following sections. In all of these applications, careful selection of soil type and providing maximum root zone soil volume should be priorities.

In constrained situations where existing street trees cause sidewalk heaving or where space is limited, consider using engineered soils or structural soil cell systems. Structural (or engineered) soils shall be designed to meet the load bearing requirements of urban streets while still maintaining adequate porosity and organic content to support healthy vegetation. Some engineered soils also contain materials that specifically retain moisture. Structural soils allow the placement of ample, healthy soil beds beneath sidewalks and parking areas. Trees and plantings can be grown in dense urban settings with open soil areas and paved surfaces above the root systems, provided there is a way for water to enter the structural soil mixture.

Structural soils require irrigation (passive or active) to support a variety of plant types. Overflow drains may be necessary depending on the characteristics of the surrounding soils. Structural soil applications can both provide a healthier environment for plants, and better capture, filter, and recharge of stormwater.

As an alternative, soil support systems with designed soil media can be used to provide appropriate soil volumes.

B Planting Media

Soils in urban conditions have been modified by grading and / or construction compaction, and provide little nutrients for plant utilization. Based on the testing lab recommendations, soils can be amended with mature organic compost, nutrients, organic fertilizer, microorganisms and mycorrhizal fungi to restore poor-quality soils to “living” soil for vibrant root growth. Existing compacted soils should be loosened to integrate the amendments and to allow tree and plant root penetration. Planting media and amendments are best applied in street and pedestrian zone applications where there is less pavement constraint and more soil volume for trees and other plantings. Refer to Article X for open soil depths and dimensions for minimum cubic feet of soil volume for each tree size.

Soil volume also affects plant health. It is, therefore, important to maximize soil volume and choose plants that grow well in the available soil volume. Where pavement is necessary in close proximity to trees, consider incorporating structural soils, or tree root zone soil support system to provide greater rooting volume. Use of these systems can occur under walks and adjacent bike or parking lanes.

For Sustainable Drainage Measures planters, refer to Drainage Manual for planting media and flow rates for each type of planting application.

Adhere to the following guidelines:

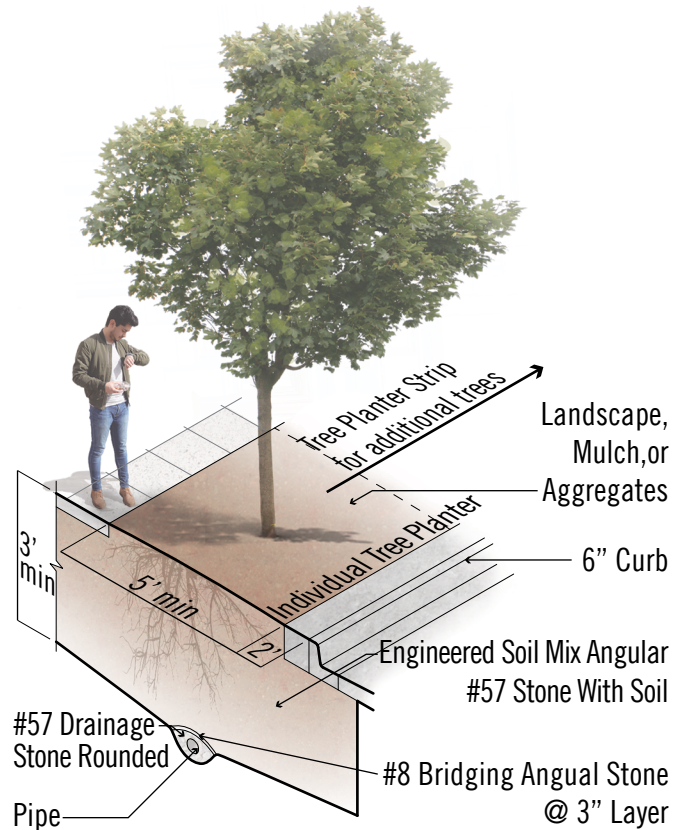
- Determine soil quality by testing its texture, pH, organic content, permeability, nutrients, and bulk density.
- Preserve existing soils that are capable of supporting healthy plants.
- Provide testing of stockpiled soils prior to reuse to determine how much organic amendment will be required to restore the soil to its pre-disturbance condition.
- Do not work the soil if it is frozen or sodden.
- Loosen compacted soil (bulk density of >1.4 grams per cubic centimeter) with mechanical tools and by integrating expanded shale and compost. (Use pneumatic excavation within tree-protection areas to preserve roots).
- Remove all extraneous debris from soils and subbase soils.
- If new soil is required, construction specifications should include detailed information on desired soil characteristics, and criteria for incorporation of soil amendments as required.
- Vegetated Stormwater Management - Sustainable Drainage Measures planters: refer to Drainage Manual for planting media and flow rates for each type of planting application.

C Structural Soil for Trees

Structural soil consists of designed, tested, and controlled planting media composed of graded gravels, soil and a stabilizing agent to keep the mixture from separating. Structural soil can be compacted to support sidewalks and hardscape while allowing tree root growth. As a supportive growing media, structural soil provides an integrated, root penetrable, high strength pavement system allowing for an extended tree root zone volume under adjacent pavements. Greater soil volume provides for larger trees to be installed. Single excavations can be provided for 1 tree in a tree well opening with required underdrain and root zone soil volume. Continuous trenches of structural soil, for connected tree planting strips, allow for linear installations of trees that can share the required underdrain system and soil volume. Depth of this media ranges from 24 to 36 inches depending on the tree species and depth of their roots. As a supportive and stable media, structural soil is well suited for installation around existing utilities or with new utility routing adjacent to tree locations.

See Figure 4.51 for a graphical representation for structural or engineered soil arrangement in a planter strip.

Figure 4.51 Engineered or Structural Soil



D Tree Root Zone Soil Support Systems

Providing root zone soil volume with the correct soil structure allows healthy tree growth next to load designed roadways and sidewalks, and can be provided by a structural soil support system. Load-bearing soil cells prevent soils in tree planters from becoming compacted by pressures of surrounding hardscapes. These modular units are assembled into a skeletal framework (or matrix) with over 90% void space to provide large volumes of soil within the tree planter or pit for healthy growth of roots, while supporting pavement loads. Utilities can be routed under and through the cells by providing service ducts for the required underdrain system, irrigation sleeves and lines, or other utilities.

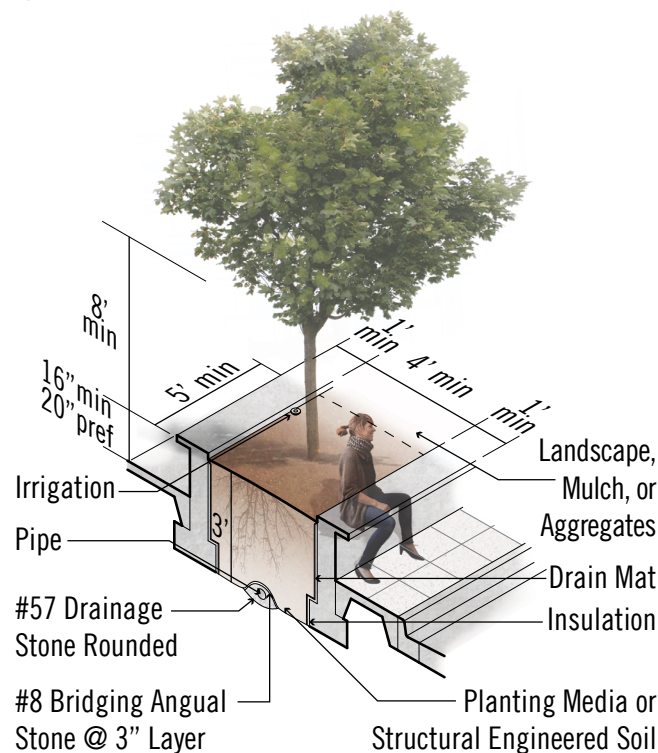
The structure of the designed soil media specific to this application, to fill the cells, requires the arrangement of soil particles including silt, sand, and clay that aggregate together, and void pore space between the aggregates. Tree growth and fertility are influenced by soil structure, as it defines whether the tree will have rootable soil available and affects the movement of air, water, and other nutrients required by the tree. The soil media should be designed specifically to meet the requirements of the

proposed trees and plantings per their species, location and application. This system is most efficient and best applied for linear tree plantings with tree well openings or linear connected tree planter strips.

E Raised Tree Planter

Raised planters allow trees to be planted above the elevation of existing underground utilities, and provide both a seating opportunity and open soil area with root zone soil volume for trees and understory plants to establish. Tree planters should not obstruct the pedestrian zone and should only be used in sidewalks of generous width to avoid creating a hazard. Planters provide seating at heights between 16 and 24 inches, with 20 inches being the preferred height. This additional height above the walk helps small or medium canopy trees meet the branching clearance of 8 feet over public sidewalks. See Figure 4.52 for a graphic description of these elements. Since tree roots occur in the top \pm 18 inches of soil, then tree growth is strictly limited by the size of the raised planter bed. For this reason, smaller stature trees should be selected to fit the area of the planter based on the plant selection criteria, open soil area provided, and planting media soil volume for root zone development.

Figure 4.52 Raised Tree Planter



Tree planters sharing a linear planting area allows minimization and consolidation of excavation, underdrains, surface drains, planting media, and irrigation. Due to the temperatures and sensitivity of roots to freeze damage, at the raised walls, it is recommended that 1.5 inch minimum rigid insulation be placed at the back of the planter wall to

create a barrier between the wall and the soil. Additional vertical drainage mat may be applied at the wall or to protect the insulation to provide supplemental drainage to the underdrain system.

Architectural finishes on the planter walls can visually tie in with adjacent buildings, pavement finishes, and coordinate with streetscape elements or other site furniture to provide a family of furnishings. Planter wall caps should be stable, provide a comfortable width for seating, and should integrate skateboard deterrents to prevent damage to the seating / cap edge.

F Additional Requirements

The following are additional requirements and elements to consider that impact the landscape design of a pedestrian zone.

1. Drainage

Surface inlets and underdrain piping are required in most urban soils in Dallas due to soil types and urban compaction. Soils need to drain to prevent anaerobic conditions which cause rotting of plant root systems, and to prevent surface water from standing for 24 hours, allowing mosquitoes to breed. Refer to Drainage Manual for criteria for in-situ infiltration or percolation testing to determine the infiltration capacity of the existing soils under proposed planters or tree pits. Existing soils not providing adequate drainage will require an underdrain system.

Planter drainage systems should be designed and tied to adjacent storm inlet structures in renovation projects, or piped to trunk lines tied to new utility structures. Slotted underdrain piping combined with a gravel drainage layer allows drainage and cleanout maintenance. Surface drains shall be raised dome atrium type grates to prevent clogging and should be spaced, along with clean-outs, to provide access for pipe inspection and maintenance. For Vegetated Stormwater Management – Sustainable Drainage Measures planting features, refer to Drainage Manual for criteria for infiltration and drainage systems.

2. Sleeving

Provide underground sleeving for irrigation water and low voltage electrical pulls / feeds between planters, sidewalks, vehicular drives and roadways, and to points of connection.

Additional electrical sleeves may be required to run lighting into planter beds for specialty or seasonal lights.

Extend sleeves beyond the back of curb, into planter areas, or into tree planter with additional pipe to provide location marker.

3. Irrigation

New plantings require supplemental watering until they are fully rooted into the ground and established. Article X requires irrigation of all code required planting. Typically, an irrigation system is utilized to provide a controlled amount of water supplied to the plants based on plant types, sizes, soils, solar exposure, wind, micro-climate, and water requirements. Application of the water by efficient rotary, spray, stream, bubbler or drip, shall provide for full coverage of all plant materials for establishment, maintenance of health and appearance.

Preference shall be made to drip and bubbler zones for sustainability objectives, where feasible and practical.

Trees require a much longer period of irrigation to establish their root systems. Use of bubbler emitters, drip tubing rings, and pop-up stream bubblers provide good coverage of the root ball at a rate required by the tree's larger root system. Planting beds will require permanent and / or temporary irrigation depending on the plant system to be installed.

Sustainable Drainage Measures planting applications will require irrigation to establish and, dependent on species, may adjust to annual rainfall events such that the system can be turned off, or used periodically during drought to "green up" the plantings. Due to regular inundation of these sustainable drainage features, pop-up type heads may be easier to visually maintain and access for cleaning of filters.

Efficient or ET Controllers shall be chosen for the specific project application and may be dependent on availability of power source or secured location for the controller cabinet. Solar type controllers require little sunlight and can be mounted on poles like parking meters, or can be part of an in-ground concrete meter box lid. Due to vandalism, moisture and freeze sensors shall be mounted on an 8-foot minimum height pole, and are required as part of the irrigation system by the City of Dallas Water Conservation Ordinance. Where electricity is not available to power a controller, solar powered and battery operated valves are available.

Drip irrigation is the most efficient source of water application via slotted tubing installed in the surface soil layer and directly over the plant's root system.

Irrigation system design requires multiple discipline coordination. If gray water sources are used, such as underground or above ground detention tanks, then additional design considerations must be taken for the specialized equipment's requirements and locations. The firm or individual designing the irrigation system must be licensed with the State and comply with all local and State codes.

4. Tree Well Edges – Barriers

Tree wells or root barriers are used to restrict or redirect root zone growth where large root systems need to be contained or are prohibited. Use of these may cause tree root systems to be one-sided which can result in potential root failure issue especially with heavy straight line winds. Contained tree wells may stunt the ultimate growth of the tree, so choosing the correct tree species and size relative to the well's root zone soil volume is important. Proper root barrier applications need to be considered for mature tree size relative to adjacent structures, utilities, or other constraints.

Types of root barriers include, but are not limited to:

- Concrete
- Polyethylene root barriers liners
- Polyethylene water barrier liners

5. Underground Detention

Underground stormwater storage systems are a practical way to achieve substantial flow volume and rate reduction in dense urban development areas. These systems are sized by the amount of stormwater runoff to detain, the size of the site or area, and the elevations of tie-in points. More storage can be achieved by using a series of interconnected pipes or a single large storage vault.

The design of these systems requires involvement by an engineer to determine the area of runoff, the size of the storage structure, and the points of connection for overflow and restricted release of the stormwater. These features can additionally be designed to provide for non-potable gray water use for supplemental irrigation in lieu of potable water, though this will require use of an irrigation pump to pressurize the system, and longer storage of the water until weather requires start-up use of irrigation. Refer to the Drainage Design Manual – Section 6.4 for more information regarding underground detention.

Figure 4.53 Above Ground Elements



4.5.6 Above-Ground Elements and Street Furnishings

4.5.6.1 General

Most above-ground elements in the pedestrian zones should be placed in the buffer / furnishing / curb zone, unless noted otherwise. Figures 4.53 and 4.54 show a wide variety of above ground elements which could be expected along a street. These objects need to be coordinated with each other to allow ADA and TAS compliance where needed. For example, audio / visual crosswalk signaling equipment or push buttons for crossings must provide clear space in front to allow everyone to access them. Lighting poles, trees and other elements must not conflict with each other. Additionally, vertical elements must stay out of visibility triangles of vehicle drivers. Refer to Section 4.4.5.5 Corner Curb Radii for visibility requirements.

Privately-owned above-ground and below-ground elements, including building components and appurtenances, will require the owner to obtain a license agreement or right-of-way permit from the City before placement of those items in the right-of-way.

Objects projecting from walls (e.g., signs, fixtures, telephones, canopies) with their leading edges between 27 and 84 inches above the finished public sidewalk shall protrude no more than 4 inches into any portion of a sidewalk clear zone. Objects mounted with their leading edges located less than 27 inches or more than 84 inches above the finished public sidewalk may project any amount provided that they do not reduce the required continuous passage along the sidewalk clear zone.

Where provided for pedestrian use or operation, fixed street furnishings installed on or adjacent to a public sidewalk and accessed from the public pedestrian right-of-way shall be connected to the continuous passage and shall comply with the applicable following provisions:

4.5.6.2 Drinking Fountains

Where drinking fountains are provided, they shall be accessible to individuals who use wheelchairs in accordance with ADAAG Section 4.15 and to those who have difficulty bending or stooping. This can be accomplished by the use of a “hi-lo” fountain; by providing one fountain accessible to those who use wheelchairs and one fountain at a standard height convenient for those who have difficulty bending, or by such other means as would achieve the required accessibility for each group.

Drinking fountains may be appropriate for streets with high volumes of pedestrian traffic, like mixed-use streets or parkways. They are recommended to be placed every several blocks so they are not too frequent. On parkways, it is recommended to provide two fountains – (1) people and (2) pets.

4.5.6.3 Fixed Seating, Tables, and Benches

Cafe extensions into the frontage portion of a pedestrian way are encouraged on commercial streets. Café extensions require a minimum of 6 feet of pedestrian clear zone with a minimum 4-foot wide pedestrian clear zone path to the entry door.

Figure 4.54 Above Ground Elements



Where fixed seating and tables are provided at a single location, at least 5%, but not less than 1%, shall comply with ADA guidelines Section 4.32.

Where fixed benches are provided at a single location, at least 50% shall have a back and armrests. A 30 by 48-inch clear ground space for wheelchair access shall be provided at one end of at least one bench at each location where fixed benches are provided.

- Benches must not exceed three feet in length between dividers to discourage people from sleeping on benches. An armrest may be provided in the middle for the same purpose.
- Bicycle racks and benches must be constructed of steel metal (stainless steel, powder coated steel, galvanized steel, powder coated aluminum), concrete or other weather resistant material.

The following considerations apply to seating areas in the public right-of-way.

- Seating should be affixed in such a way that it is not easily damaged or removed. Care should be exercised to ensure that seating does not interfere with entrances to buildings, heavily used loading zones, parked vehicles, access to fire hydrants, and other potential conflicts.
- Seating should accommodate a minimum of two people. Seating can be integrated into buildings, building frontages, and raised tree planters.

- Seating should be situated (by facing each other or facing the sidewalk) to enable pedestrians to view street activity while being outside of the immediate flow of pedestrian traffic, and should be buffered from noise and vehicle exhaust whenever available. Where possible, seating should provide a sense of protection to the person seated.
- Movable seating should be considered in plazas, street parks, or other areas with a desire for flexibility.
- Benches at bus stops with no shelter should be located at the edge of the sidewalk and should face the street.

Figure 4.55 Bench Requirements

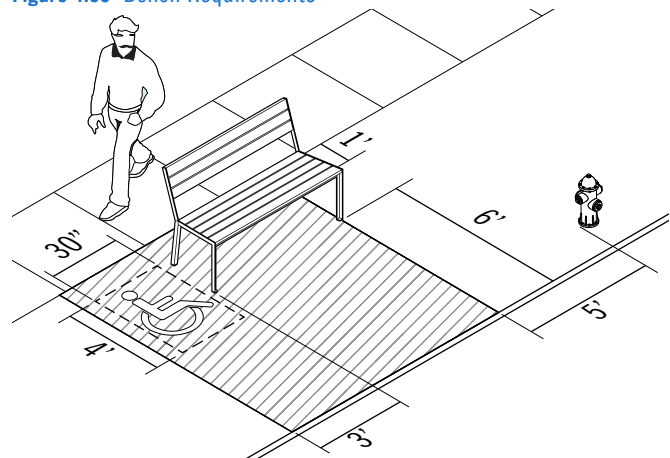


Figure 4.56 Above Ground Elements



The following clear widths must be maintained when installing benches. See Figure 4.55.

- 3 feet minimum on either side of the bench
- 5 feet minimum from fire hydrants
- 2 feet recommended clearance from all utilities and utility appurtenances
- 5 feet minimum, ideally 6-foot clear path in front of the bench when located at the edge of the sidewalk, facing the curb.
- Where the back of the bench abuts a building, wall, or other obstruction, a 1-foot minimum clear width should be provided for maintenance and debris removal.

4.5.6.4 Bicycle Racks

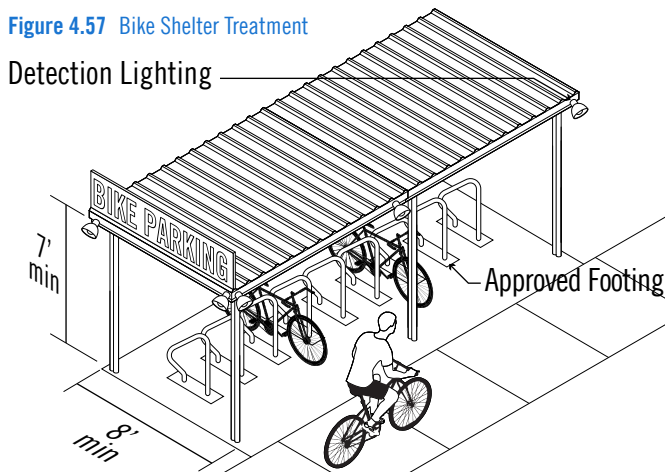
Bicycle parking is identified as an implementation project in the Dallas Bike Plan, and bicycle parking has been installed as part of the DART Station Access Program. The City of Dallas issues licenses for private installation of bicycle racks in the right-of-way. Other relevant requirements related to bicycle parking (in addition to these guidelines) are provided in the Dallas City Code, Chapter 43.

Other criteria include:

- The rack should be affixed to a paved surface.
- The rack should support the frame of the bicycle at two points (in consideration of different frame sizes and styles).
- The rack should be simple and easy to use.
- The rack should allow easy locking of the frame and, preferably, both wheels.
- The rack should be placed so that bicycles park parallel to the curb or building frontage, or angled if there is additional space available while still meeting the minimum clearances.
- The rack should meet ADAAG to be detected with a cane.

Also see related dimensional criteria which is stated in Dallas City Code Section 43-125.

Figure 4.57 Bike Shelter Treatment



4.5.6.5 Bicycle Shelters

Street types such as mixed-use with wide sidewalks are appropriate to consider for bicycle shelters. Ideally, they should be located within sight distance or close proximity to significant building entrances or transit stations. Where possible, bicycle parking shelters should provide weather protection for as many parked bicycles as possible. Shelter foundation and structural elements must meet required structural and loading requirements. See Figure 4.57 for a typical bike shelter.

Design guidelines include:

- Located within 50 feet of the main entrance to the building or transit station to encourage use of the shelter.
- A minimum of 8 feet wide and a minimum of 7 feet from floor to ceiling (if a bicyclist is expected to enter the shelter to lock the bike to a rack); the length of the shelter depends upon the number of bicycle racks the shelter is designed to accommodate.
- Placed so that, when occupied, bicycles do not intrude into the pedestrian clear zone.
- Bicycle shelter installation on pavers requires approved footing and pavers to be on sub-slab to prevent settlement or tripper edges.
- Bicycle shelters should be located in well-lit areas. Passive detection lighting should be provided in areas of low ambient light.
- Signs should be used to help direct bicyclists to shelters.
- Roof drainage should flow away from entry points into the shelter. Provide positive drainage away from the shelter. Slope shelter "floor" to prevent accumulation of rainwater.

4.5.6.6 Bus Stops

Bus stop facilities shall be designed to comply with DART's standards. Where a bus stop pad or bus shelter is provided, it shall comply with ADAAG Section 10.2.1(1) or Section 10.2.1(2) respectively. Figure 4.56 shows a possible arrangement of a bus shelter at a bus stop with connecting walk and bike rack area.

The DART 2030 plan recommends adding amenities to the vast majority of bus stops in Dallas by 2030. During the complete streets planning process, an assessment of all bus stops in the project area should be taken to determine which stops are eligible for upgraded amenities. All bus stop upgrades should be coordinated with DART.

Stops should be visible, providing a clear sight line between bus operators and users of the system. Simple stops without shelters are appropriate for lower volume routes. Amenities may include benches, trash and recycling receptacles, shelters, lighting, bicycle racks, bus schedules, maps, real-time next bus arrival information, newspaper boxes, and public art.

- DART buses are up to 40 feet in length. In general, bus stops should be a minimum of 60 feet in length (80 feet long if midblock).
- The pedestrian through zone of the sidewalk should extend to the curb at stops so that passengers may access the sidewalk directly from the bus doors.
- Area lighting shall be assessed at bus stop locations so that an adequate level of lighting is provided on the adjacent sidewalk, at the shelter, and on the roadway in front of the stop. See Section 6, Street Lighting, and Section 6.1.5 Recommended Illumination Levels for Miscellaneous Systems for required light levels at bus stops.
- The area on the sidewalk where passengers load and unload (board and alight) at bus doors is called the landing pad. The landing pad at the front of the bus stop must provide a clear zone 5 feet long, parallel to the curb, and a minimum of 8 feet deep. The landing pad should consist of ADA accessible surface materials such as concrete.
- Trees shall not be planted within landing pad and front and back door zones of a bus stop. When street trees are desired near or within bus stops, DART should be consulted.
- Bus stops should be set back a minimum of 5 feet from crosswalks. Where feasible, a 10-foot setback is preferred.
- Where possible, trash and recycling receptacles should be placed to the front of the bus stop, at a minimum of 18 inches from the landing pad, a minimum of 3 feet away from benches, and in the shade. They should also be anchored to the pavement to deter theft.

Refer to Section 4.4.5.7 Key Transit Treatments for more information on bus stops and shelters design.

4.5.6.7 Bus Shelters

Transit shelters should be provided on all key bus routes if sidewalk space allows. The I-STOP program installs solar-powered bus shelters with lighting at all new bus shelter locations. When providing a bus shelter, the bus stop must comply with ADA Section 10.2.1.

Bus Shelter shall meet DART's Design and Construction Standards. Coordinate with DART in selection and siting of new bus shelters, or modification or replacement of existing shelters.

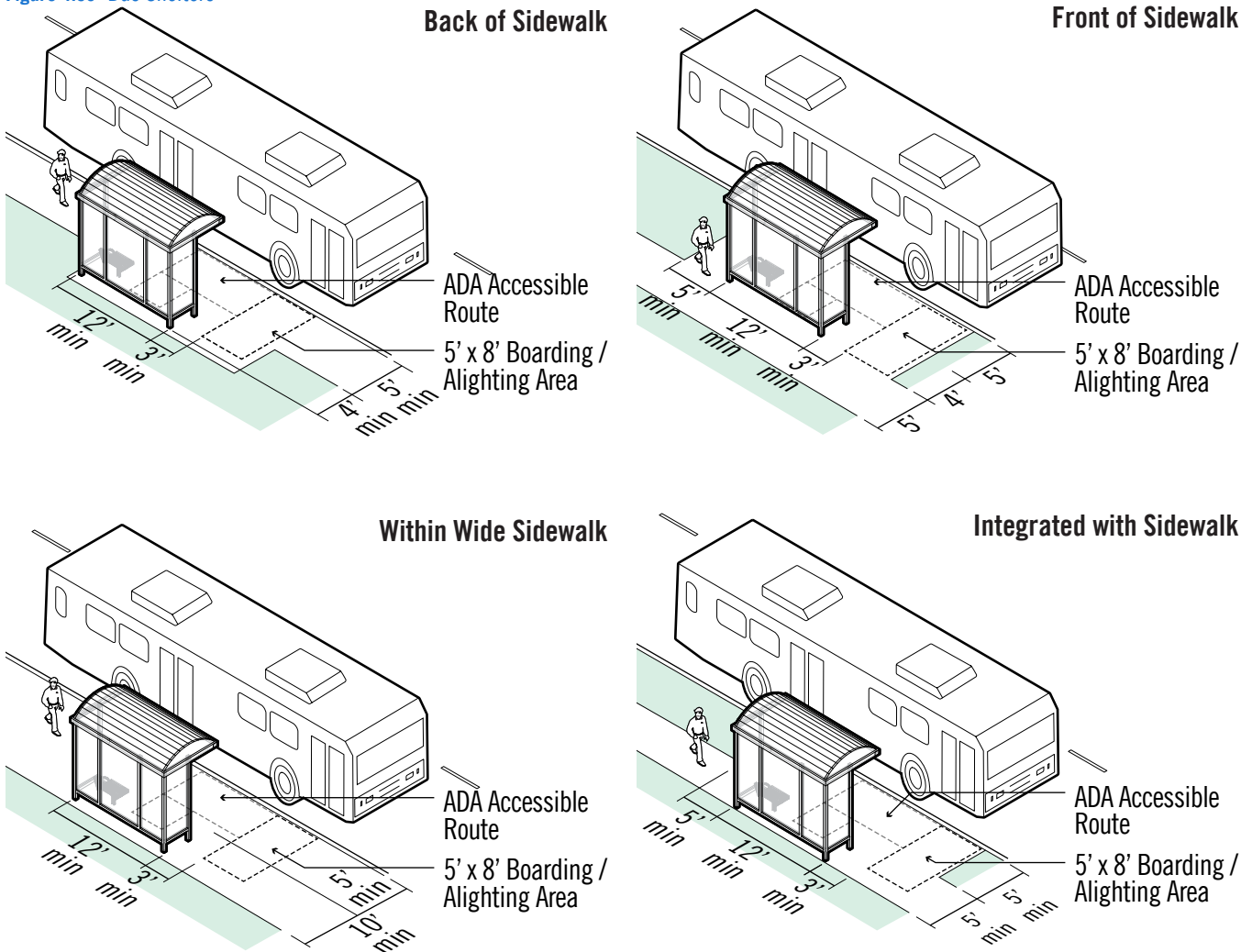
Shelter placement must allow for unobstructed loading, unloading and unimpeded pedestrian through movements on the sidewalk. See Figure 4.58 for possible arrangement of bus shelter placement at a stop.

The following minimum clear widths for shelter placement must be maintained:

- 1 foot from the building face
- 4 feet from the back of curb
- 15 feet from crosswalks at nearside bus stops for visibility.
- 1 foot from any ground obstruction (i.e., manhole, tree pit, sign)
- 10 feet from fire hydrants
- 3 feet from the landing pad (maximum 25 feet to the right of the landing pad)

Refer to Section 4.4.5.7 Key Transit Treatments for more information on bus stops and shelters design.

Figure 4.58 Bus Shelters

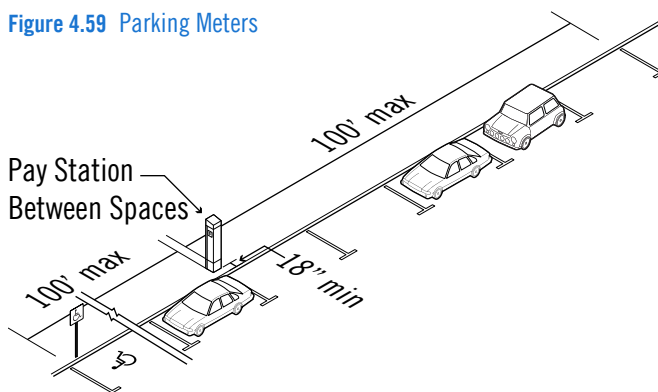


4.5.6.8 Parking Meters and Pay Stations

A General

In many parts of the City where on-street parking is present, motorists are required to pay at meters or pay stations. Dallas, like many other cities, is moving towards smart parking technologies, which enhance parking information, achieve desired turnover levels, optimize parking space occupancy, consolidate single parking space meters to multispace pay stations, improve operational efficiency, and reduce maintenance costs. Dallas is working to consolidate single space parking meters to multispace pay stations in the Downtown core to reduce streetscape clutter and to achieve the objectives above. See Figure 4.59 that shows a typical location for a pay station.

Figure 4.59 Parking Meters



B Guidance

Satisfy design criteria and regulations in the Dallas Development Code Chapter 28 – Motor Vehicles and Traffic, Sections 103 -114 and the following conditions:

- All meters and pay stations should be located in the buffer / furnishing / curb zone at a minimum of 18 inches from the curb; meters may not be placed in the pedestrian zone. If meters or pay stations are centered 18 inches from the curb, ensure they are located between parking spaces to avoid conflict with vehicle doors.
- Typically, one pay station should be provided for every 8 to 10 parking spaces, centered in the middle of these spaces. This spacing typically puts pay stations no greater than 80 to 100 feet from the farthest parking space. A clear path should provide access to and from parked cars to the pay station.
- In some cases, such as where there are fewer than 16 spaces on a block face, it is possible to only provide one pay station in the middle or two pay stations placed equidistant from each corner of the block. Street trees, utilities, and other street furniture elements may also dictate where pay stations can be installed.

C Standards / Requirements

The Dallas Police Department is responsible for managing the parking meters in the City of Dallas per the Parking Program. The designer shall coordinate with the Dallas Police Department on any existing or proposed parking meters.

4.5.6.9 Trash and Recycling Receptacles

DART owns and maintains many trash receptacles for public use where a bench or shelter is present. Additional trash receptacles may be placed as DART's Adopt-A-Can program whereby the entity that requests the trash receptacle is required to maintain it. Private receptacles shall not be located within the right-of-way or impair pedestrian or public use of the right-of-way.

Criteria include:

- Must meet preselected style requirements.
- Must have a secured removable covered lid.
- Lid must be self-closing.
- Must use 30, 40, or 55 gallon liners and be keyless.
- 5 feet minimum from fire hydrants.
- 1 foot minimum from any in ground obstruction, i.e., manhole, tree planting area, etc.
- 3 feet minimum from other street furniture.
- 5 feet minimum, ideally 6 feet, from pedestrian through zone.

4.5.6.10 Newspaper Racks

In Dallas, newspaper racks are licensed and their number and placement per block is determined on a case-by-case basis. Some districts have special design standards that must be met. In general, curb extensions, transit stops, and other seating areas are ideal locations for newspaper racks. See Chapter 51A of the Dallas City Code for additional detailed guidance.

4.5.6.11 Pedestrian Wayfinding and Signage

Where provided for pedestrian use, informational and directional signage and street identification signs shall comply with ADAAG Sections 4.30.2, 4.30.3, and 4.30.5. Where bus route identification signs are provided on or adjacent to a public sidewalk, they shall comply with ADAAG Section 10.2.1(3).

A Banners

- Beautification banners and banners for special events are allowed on street light poles, when permitted by the City Special Events office and by the pole owner.
- A rendering of the proposed banner and its location must be presented to the City for approval.

B Kiosks

- Kiosks may be permitted outside of the sidewalk clear zones and in the buffer / furnishing / curb zones, or the frontage zones.
- They may also be located in curb extensions or near transit stops. At a minimum, kiosks should be placed at least 7 feet from the stop, typically downstream. Their placement should not interfere with loading or unloading. They should be placed in a manner to allow pedestrians to easily access and read the panels.
- Placement of kiosks should:
 - Ensure appropriate sidewalk clearances (minimum 5 feet).
 - Preserve sight visibility for motorists.
 - Maintain 18 inches clearance from back of curb.
 - Be no more than 18 inches from sidewalk zone if buffer / furnishing / curb zone is wider than 7 feet 6 inches.
 - Not obstruct more than 50% of a retail display window if this is the only display window of the affected business.
 - Not block scenic views.
- Kiosks should include bulletin boards or an enclosed case for display of information.
- As a gateway element, the kiosk should include the neighborhood, commercial district, street, or park name, a map, and other pertinent information.
- Kiosks should have details and features coordinated with other street elements and should have a similar architectural character.

C Public Art

Public art shall be approved by the Office of Cultural Affairs and placed frequently along commercial and mixed-use streets in the landscape zone. Public art is recommended to be included in public plazas, pocket parks, buffer / furnishing / curb zones, and potentially used as diverters in the street.

4.5.6.12 Utilities

Utilities in the streetscape consist of utility poles, overhead wires, surface-mounted utility boxes, traffic signal boxes, utility mains, laterals, vaults, valves, etc. The Dallas Water Utilities (DWU) standards shall be followed and any deviations from DWU standards shall be identified for review and approval.

Well-organized utility design and placement can lead to:

- Safety and accessibility for the public.
- Minimization of streetscape clutter to achieve a cohesive streetscape design.
- Protect critical public mains while maximizing space for plantings.
- Improved efficiency of utilities and integrated alignment with stormwater facilities, street furnishings, and street lighting.
- Reduced cutting and trenching.
- Possible reduction of long-term street and sidewalk closures.
- Reduced long-term maintenance conflicts and potential costs.
- Improved pedestrian safety, quality of life, and right-of-way aesthetics.

Utilities should be designed and constructed to minimize disruption to the pedestrian travelway, potential planting, and site furnishing locations, while maintaining access for maintenance and emergencies. DWU has established criteria for its utility design in its Development Design Procedure and Policy Manual. DWU's general goal is to minimize its impacts to trees within the public right-of-way, easements, and private property. This goal extends from the short-term planting of the tree and the long-term repair of its utilities. Within public right-of-way, DWU policy is to provide separation between trees and their utility mains which varies from 5 feet to 15 feet depending upon tree species and size. Design engineers shall refer to that document where existing or proposed DWU-related water and wastewater assets. Where this may not be possible, Designers shall coordinate with City staff in DWU and Public Works to arrive at a suitable solution.

The following guidelines apply to utilities in the public right-of-way:

- Utilities should be located underground, wherever possible, as opposed to overhead or surface-mounted.
- Large (greater than 8 square feet) utility vaults such as network or transformer vaults, and conduits running

the length of a City block, should be located in the roadway or parking lane when access requirements allow said utility installation.

- Small utility vaults (less than 8 square feet), water meters, wastewater cleanouts, DWU meter vaults, DWU manholes, DWU valves, gas valves, and gas vaults should be located in the curb zone.
- Utilities should be consolidated to the extent feasible for efficiencies and to minimize disruption to the streetscape.
- Franchise utility vaults and boxes should be located outside of the furnishing zone whenever possible to maximize the number and size of tree planter openings and the ability to connect tree planter openings into continuous strips. Vaults or boxes shall not intrude into the visibility triangles or interfere with ADA accessible routes.
- Major utilities (sewers, gas and water meters and mains, manholes and utility vaults, and utility poles) should be installed at least five feet, and fire hydrants at least ten feet, from the edge of existing or proposed tree planter openings.
- Minor utilities (laterals, vaults, valves, etc.) should be installed at least three feet from the edge of new or existing tree planter openings.
- Utility laterals should run adjacent to, not directly under, potential site furnishing and tree planting locations wherever possible (such as through driveways or between tree planter openings).
- Subsurface utility conduits should avoid running under the length of the planting area to minimize root interference.

4.5.6.13 Lighting

Design plans shall include street light foundations, conduit and pull boxes required for the project. Because street lighting offers increased roadway safety and ease of operation, the City of Dallas requires street lighting on all arterial roadways. See Section 6 Street Lighting.

Thoroughfares that are divided by a median generally allow the location of the street lights and conduit in the median area. Street lighting on undivided thoroughfares must be accomplished by installing combined street / pedestrian light fixtures with poles, or by adding lights to existing or proposed utility poles in the buffer / furnishing / curb zone. Criteria for items such as spacing, foundation type, conduit, power sources, etc. are in Section 6 Street Lighting. These items shall be shown on the plans. All street lighting designs shall be approved by the Street Lighting Division before being used on City projects.

4.5.6.14 Other Elements

Where provided, other fixed street furnishings intended for pedestrian operation or use, such as information kiosks, fire alarm boxes, fixed trash receptacles and similar elements, shall comply with ADAAG Section 4.27.

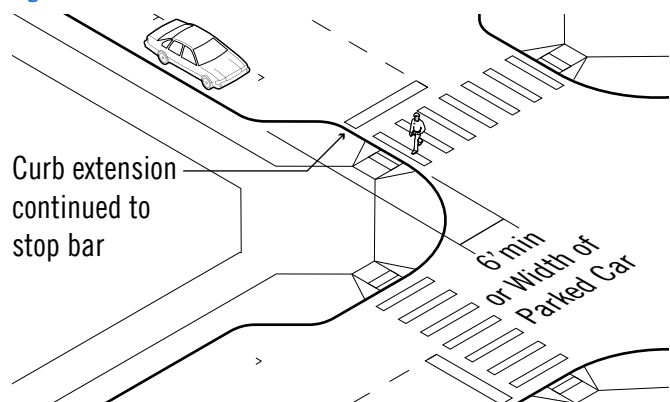
4.5.7 Curb Extensions

Curb extensions, also known as bulb-outs, are visual and physical reductions of roadway and extensions of pedestrian zones. They can calm vehicle traffic, especially on long blocks and can provide location for mid-block pedestrian crossing. Other possible uses include planting or stormwater management.

Curb extensions are encouraged on block corners and mid-blocks of streets where on-street parking exists. See Figure 4.60 for a graphic of a curb extension.

Geometrically, the minimum width of curb extensions is 6 feet, or the width of a parked car. More clearance may be provided to allow for car door openings adjacent to the drive lanes. The length is a minimum of the width of the crosswalk, including the curvature of the bulb-out but can vary based on the curb extension's intended use. Curb extensions can be raised to the curb height of the pedestrian zone or they can be at the same elevation as the street zone, delineated by markings or planters. In all cases, parking in or along curb extensions must not be allowed. The minimum curb radius at intersections shall accommodate the target speed and design vehicle for that intersection in the right lanes, and control vehicles within the travel lanes as required by Section 4.2.1. Refer to Section 4.4 for specific guidelines on turn radii. Where the curb extension connects to a crosswalk, the curb extension should provide an ADA compliant landing as discussed in Section 4.4.

Figure 4.60 Curb Extensions

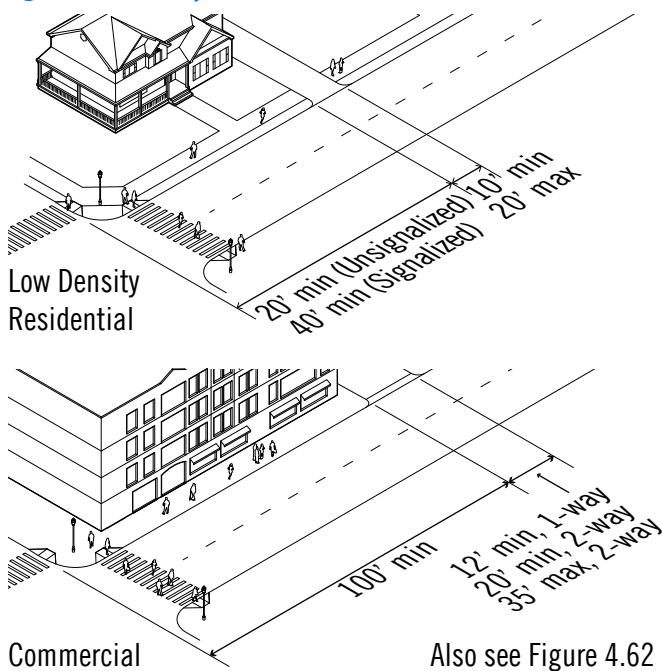


4.5.8 Driveways and Curb Cuts

4.5.8.1 General

Design of driveways and their connections to streets shall comply with applicable requirements of the Dallas Development Code, the City's Standard Construction Details File 251D-1, the Off-Street Parking and Driveways Handbook, the Drainage Design Manual, and any other regulatory standards. Figure 4.61 provides a representative graphic for a residential and a commercial driveway with distances to the nearest intersection and driveway width.

Figure 4.61 Driveways and Curb Cuts



4.5.8.2 Horizontal Layout

Driveway turnouts shall be provided to maintain access to adjoining properties in accordance with the access control requirements given in Section 3 Street Networks / Access Control. Generally, driveway turnouts and connections are provided at existing driveway access points. The number of driveways should be minimized to reduce disruptions in the pedestrian zone. Some adjustments may be required in locations and numbers of driveway connections provided to comply with access control requirements, to serve joint owners and provide access to median opening(s). Usually, driveway approaches shall be designed to line up on the centerline of existing driveways. See Section 4.4.4.5 regarding driveways on streets that cross a railroad. Driveway consolidation should be evaluated where driveway edge to edge spacing is less than 50 feet.

Driveway approaches including turnout curb transitions shall be located entirely within the frontage of the property served by the approach. The driveway edge shall be located equal to or greater than 5 feet from each side of the property line (Dallas City Code, Sec. 43-86). The angle of the driveway approach with the curb line shall not be less than 45 degrees (Dallas City Code Sec. 43-87). No portion of any driveway shall be located within 3 feet of any fire hydrant, electrical pole, or any other surface public utility (Dallas City Code, Sec. 43-140). The City reserves the right to locate driveway approaches on City projects for the convenience of the City to meet access needs and to require relocation of conflicting surface public facilities to provide the 3 feet of clearance.

Driveways and intersecting streets across the street may influence the location for driveway approaches. Offsets of opposing driveway approaches must be designed to avoid conflicting left-turn movements. The location of existing and future median openings shall also be considered. See Section 4.3.52 regarding the alignment of driveway approaches at median openings.

Driveways which intersect streets at or near 90 degrees are preferred. Angled driveways are not preferred. See Figure 4.62. Driveway curb returns or curb projections should not restrict the ability of adjacent properties to gain driveway access along their frontage.

One-way driveway approaches shall be designed to encourage proper use. Use of angle driveway approaches or other channelization designs should be considered. Consider the following when defining the entrance and exit approaches:

- Location of one way entrance and exits shall be evaluated to minimize disruption to the pedestrian and street traffic.
- Angle of a driveway approach in relation to the road shall be such that a vehicle entering or leaving the driveway may do so in an orderly and safe manner and with minimum of interference to pedestrian and roadway traffic.
- Based on the direction of traffic flow, establish the entrance driveway approach prior to the exit driveway approach for a corresponding single driveway along the street.
- Where the access driveway approach and roadway pavement meet, flaring of the approach may be necessary to allow safe, easy turning of vehicular traffic.
- Satisfy design criteria stated in Dallas Development Code (Sect. 51A-8.607) for driveway approaches.

Driveways shall be designed to provide safe sight distance and stopping sight distance for pedestrians in sidewalks; vehicles and bicyclists on the roadway in accordance with the standards in Section 4.3.3 Visibility and Sight Distances. Locating driveway approaches on the inside of horizontal curve sections of thoroughfares should be avoided. Driveway grades, sloping and retaining walls must be designed to provide an unobstructed visibility for a distance no less than the minimum required for the street section type and target speed involved.

Driveways shall be designed to provide proper drainage from adjoining properties to the street and not exceed the conveyance of the designed drainage capacity in the street. Off-street drainage collection systems may be required to limit surface drainage. Designer cannot exceed the street surface drainage capacity and will meet dry lane requirements given in Section 3 Roadway Drainage Design of the Drainage Design Manual. The driveway approach turnout at the point of tie to the street curb shall not be located within the pavement transition warp-down to a curb inlet, typically 10 feet from the edge of the inlet. Driveway approaches on unimproved streets shall be designed to not block drainage. Drainage structures shall be designed as required to maintain road side ditch drainage. Driveway culverts shall be designed per Section 3.7 Culvert Hydraulic Design of the Drainage Design Manual. The minimum pipe size and material requirement for a driveway culvert is Reinforced Concrete Pipe – 18-inch diameter.

The standard driveway turnout used on City paving projects is the “dustpan” shaped turnout. For low and medium density residential properties with driveway turnouts on local and collector streets, the standard length for wings for driveway turnouts is 7 feet, as measured along the face of curb from the projected edge of driveway throat line. When driveway throats are 15 feet in width or greater, the wing length may be reduced to 5 feet on local and collector streets. The standard length of wings for driveway turnouts serving high density residential / commercial properties on local, collector and arterial streets is 10 feet.

The alternate radius driveway turnout may be used instead of the standard dustpan shaped turnout when existing driveway turnouts in that neighborhood are radius turnouts or for special situations when approved by the Director. The minimum radius for local and collector streets is 5 feet. The minimum radius for arterial streets is 10 feet. The design shall provide adequate curb return radii to serve the design vehicle so that turning movements are made within the proper lanes without encroachment upon oncoming traffic, curbs, sidewalks or buffer / furnishing / curb zones. For large truck design vehicles, increasing the curb return radius up to 30 feet or more may be more effective than increases in the driveway width.

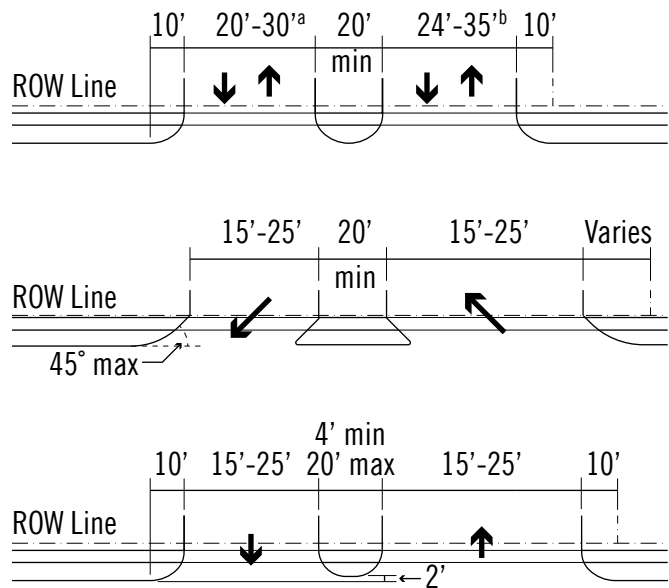
Details for the geometric layout of driveway turnouts for various zoning and access cases are given in Figure 4.62 including minimum and maximum driveway throat widths. Details for the design of standard dustpan shaped and

special radius curb return driveway turnouts are provided in the Standard Construction Details, File 251D-1.

Driveway throat widths should not be designed too wide. Approach widths should match the existing driveway throat widths with the following exceptions. The minimum approach width for two way operation in low to medium density residential uses is 10 feet and for other uses is 20 feet. The maximum driveway approach throat width is 30 feet except for commercial driveways with WB-50 design vehicle type trucks where the recommended maximum width is 35 feet.

Figure 4.62 Driveway Standards

1. High Density Residential / Commercial Uses:



- a. For High Density Residential 2-way Driveways: 20' min, 24' normal, 30' max width
- b. For Commercial 2-way Driveways: 24' min, 24' normal, 35' max width
- c. Angled One-way Driveways are Not Preferred
- d. Driveway widths exceeding max standards require special approval
- e. Driveway approaches for heavy commercial serving regular truck and bus traffic require special curb return radii design.

2. Low / Medium Density Residential Uses:



- a. Driveway approaches on Local and Collector Streets Wings - 7' min (5' min for driveways widths 15' or smaller)
- b. Driveway approaches on Arterial Streets Wings - 10' min
- c. Min Driveway spacing is 20' require special curb return radii design.

4.5.8.3 Driveway Grades

The minimum driveway grade within the street right-of-way is set using 1/4 inch per foot (2%) rise above the top of curb to the property line. The minimum driveway grade on a project will depend on the pedestrian zone width and height of curb. The elevation of a driveway at the right-of-way line shall be no lower than 2 inches above the top of curb to ensure proper street drainage is maintained.

The maximum driveway grade permitted within 10 feet of the gutter line is determined by the street pavement crossfall at the driveway. The grade break at the gutter line, and at any point within 10 feet of the gutter line, must not exceed 12% unless a vertical curve is provided. This is necessary to avoid car bumper drag from occurring. Streets with a 1/4 inch per foot crossfall to the gutter (-2%) will limit the maximum driveway grade to 10%. Streets with 1/2 inch per foot crossfall to the gutter (-4%) require a maximum driveway grade of 8%, while streets with a 1/4 inch per foot crossfall away from the gutter line (+2%) require a maximum driveway grade of 14%. When sidewalks are involved, barrier-free sidewalk construction requires that driveway grades not exceed 8% as measured from the gutter to the proposed outside edge of sidewalk. The cross slope of the sidewalk cannot exceed 2%.

When driveway construction or reconstruction must occur more than 10 feet from the gutter or beyond the street right-of-way, the usual maximum grade permitted is 14%. Greater driveway grades may occasionally be required due to steep existing driveway grades and terrain. Driveway grades shall be designed as mild as feasible to maintain adequate access and limit excessive removal costs. Grades in excess of 14% must be specifically approved by the Director. The maximum change in grade without a vertical curve is 12% for 10 feet.

Driveways shall be profiled for distances at least 25 feet outside the right-of-way to ensure adequate replacement design.

Since the ADA and TAS require barrier-free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveway(s). Sidewalks must meet accessibility requirements across driveways.

4.5.9 Utilities

4.5.9.1 General

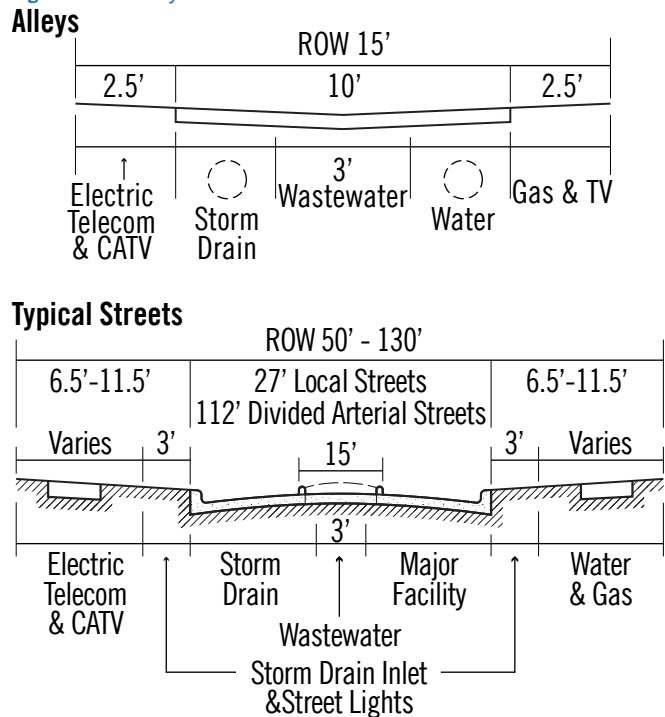
Utility designs need to consider existing and future utility installation, maintenance, repair and replacement requirements. Installation of new and replacement of existing utility lines by directional drilling methods require space considerations and need to avoid existing underground lines and structures. As utility needs increase and change, the impact within the public right-of-way and adjacent portions of private property have become noticeable. These new facilities

should not negatively affect pedestrian paths and facilities or the street's landscaping, especially established landscaping, in those corridors. As existing and new utilities age, they will ultimately need to be replaced in the future, so utility designs need to take into account future access to those utilities for repair and replacement and try to optimize the utility design. Shifting the location and burden of utility corridors from the pedestrian zone into the street zone may be preferred.

4.5.9.2 Requirements

When utility design is included in the scope of the project design, utility alignments shall be designed in the zones indicated in Figure 4.63 wherever possible. Figure 4.63 represents utility allocation zones for City streets and alleys, and is an agreed upon designation between DWU and Public Works. Reference is made to the DWU Water and Wastewater Procedures and Design Manual for specific design practices as it relates to water and wastewater mains in public right-of-way.

Figure 4.63 Utility Zones



Design of any utilities shall be in compliance with that utility owner's requirements and other regulatory entities such as the Texas Commission on Environmental Quality. If these alignments are impractical, or if the construction is to be in the Texas Department of Transportation right-of-way, a cost effective alignment shall be developed through coordination with the City project engineer.

The coordination of underground utilities in new or re-platted subdivisions shall be the responsibility of the developer. The developer shall follow the same guidelines as the utility companies in coordinating utility locations. Guidelines for

utility company design and construction coordination are provided in the City's Utility Location and Coordination Policy. Copies are available through the Utility Coordination Section.

On all paving design projects, all existing above and below grade utilities, shall be located and shown in plan and profile. Plans shall clearly show the source(s) of the information used to locate underground facilities. The locations and dimensions of all existing telephone poles, power poles, and all other utilities located on or above the surface, such as water meters, check valve assemblies, valves, manholes, vaults, structures, etc. in close proximity to the limits of the construction shall be determined or verified.

The actual horizontal and vertical location of all underground utilities shall be determined where they cross any part of the proposed storm drainage or wastewater systems. Utilities crossing the proposed storm drainage or wastewater systems which may be in conflict or which may clear the systems by less than one foot shall be exposed, whether under existing pavements (concrete or asphalt), grassed buffer / furnishing / curb zones or other cover. Probing will not be acceptable. Shots and field ties to the project horizontal and vertical control shall be made at these exposed utility locations. Excavation shall be made with coordination or at the direction of the utility company. After the necessary ties are made, the excavation shall be properly backfilled and compacted in accordance with City and utility standards. Any pavements, irrigation lines, or ground cover that have been damaged during excavations shall be promptly restored to equal or better than existing conditions. DWU shall be contacted immediately when damage to water or wastewater mains and services has occurred.

The project designer shall determine from the utility companies their proposed improvements for all utilities either on the surface, below the surface, or above the surface that will or might affect the project, and shall show those proposed improvements on the paving and drainage plans in both plan and profile views. Public water and wastewater improvements require review and approval from DWU and shall comply with DWU standards and policies.

4.5.9.3 Joint Utility Design

As long as other utilities are not materially affected, utility mains and storm drains may be placed either in curvilinear alignment or in straight segments on curvilinear streets.

Wastewater mains should be in straight segments. If curves are justified by physical limitations, the minimum radius of curve and maximum deflection angle of pipe are to be restricted to 80% of the manufacturer's recommendation (as per the DWU Water and Wastewater Design Manual).

If significant changes in storm drainage or joint contract utility alignments are necessary during construction, all agencies

whose facilities are or might be affected at the present or in the future shall be notified prior to making the design plan revision.

Alignments for utility designs shall comply with the utility zones discussed in Section 4.5.9.2 Requirements, whenever possible.

A Placement of Utilities

The following guidelines shall be used in the design of joint water utility facilities and utilities (when part of the design contract) for those cases in which the designated zones cannot be used. Specific details of design of DWU utility mains and related appurtenances shall comply with the DWU Water and Wastewater Procedures and Design Manual.

1. Locations in roadway under existing pavement that is to remain are to be avoided insofar as reasonably possible. All practical alternatives, including but not limited to, full use of the buffer / furnishing / curb zone, placement under sidewalks, and utilization of median strip and joint use of trenches shall be employed to avoid placing utility facilities under existing pavements. When placement in the roadway is necessary, the following guidelines shall be observed:
 - Placement of non-pressurized systems under pavement is satisfactory if adequate space is not otherwise available.
 - Locations under curb and gutter areas of roadway are generally reserved for storm drainage facilities.
 - Outside lane (adjacent to curb) shall be used insofar as possible for facilities placed under pavements.
2. Wastewater and storm drainage lines shall have priority because of gravity flow characteristics. Non-gravity systems shall be installed parallel to and at elevations which do not interfere with gravity flow systems.
3. Gas and water lines shall be located on the north and east side of street right-of-way.
4. Electrical and communication lines shall be located on the south and west sides of street right-of-way.
5. Reservation of right-of-way space shall be made only for facilities which are definitely planned by the respective utility. In all cases, facilities shall be placed to minimize the total utility space required.
6. Storm drainage facilities and utilities shall be placed consistently within the respective standard roadway zones (Figure 4.63), where standard right-of-way is available but the roadway is unimproved.
7. The 3-foot area behind the curb shall be reserved for storm drainage facilities, street lighting and traffic control equipment.

B Major Underground Utilities

Major underground facilities are defined as follows:

- Those involving multiple duct lines.
- Water and wastewater lines 12 inches or larger in diameter. Location of water mains 16" and larger shall meet DWU standards.
- Electrical cable systems of 69 kv or higher.
- Gas mains 8 inches in diameter or larger, or high pressure gas mains of any size.
- Storm drainage facilities.
- Buried electrical lines over 400V.

In general, construction plans for major underground installations shall be complete, and shall contain the following information:

Plan Requirements include:

- Locations of all proposed construction.
- All existing facilities that the proposed construction would cross.
- All parallel lines within street right-of-way shall be dimensioned.
- Dimensioned references, including all parallel lines within street right-of-way, shall be dimensioned to monument points in streets, property lines in alleys, and easements.
- Topography shall be provided which is applicable either by plan, notes, or the use of aerial photographs.

Profile Requirements include:

- Elevations of proposed construction shall be given at 100 foot intervals, at points of conflict, and at vertical and horizontal curves.
- Surface grade elevations shall be provided for the entire length of the project, not just at 1/2 mile streets and mile streets.
- Depth of underground facilities crossed by the proposed installation shall be shown.
- Depth of parallel underground facilities within the rights-of-way shall be shown.
- Elevation datum shall be City of Dallas and so indicated on the plans. (Public Works Department, Survey and Records Section, will have elevation information.)
- Plan elevation of future facilities, if furnished by the utility.

As-built or record drawings shall be prepared on all major underground installations.

In addition to record information, major utilities shall be surveyed where visible. If directed or required by the City, major utilities may require precise positive location by pot-holing or other methods.

C Minor Underground Utilities

Minor underground facilities are defined as all other proposed underground facilities not included as major underground facilities.

Construction plans for minor underground installations shall be complete and contain the following information:

Plan Requirements include:

- Locations of all proposed construction.
- All existing facilities that the proposed construction would cross or parallel in public right-of-way.
- Dimensional ties to monument points in streets or to property lines in alleys and easements shall be provided.

Profile Requirements include:

- Depth of proposed installations shall be provided by notes on the drawings, such as 6 inches below finished grade.
- Profile sections at conflicts shall be provided.

As built or record drawings shall be prepared as required.

Joint water utility designs shall be in compliance with the Texas Commission on Environmental Quality regulations as currently amended and published by the State. Water utility designs shall also be in compliance with the Dallas Water Utilities (DWU) Water and Wastewater Procedure and Design Manual, DWU Standard Drawing for Water and Wastewater Construction, City of Dallas Addendum to NCTCOG Public Works Construction Standards, all as currently amended and adopted by the City. Drafting for design plans shall be in compliance with the DWU Drafting Standards for Water / Wastewater Pipeline Projects, as currently amended. In case of conflict, the most restrictive requirements shall apply.

All joint water utility designs shall be coordinated and approved by the Dallas Water Utilities relocations engineer.



A blue-tinted photograph of a city street scene. In the foreground, there is a concrete sidewalk with a utility cover. In the background, a person is walking across the street. A street lamp and utility poles are visible against a hazy sky.

SECTION 5

Pavement Structure

The pavement structure design varies based on facility type, street conditions, material options, and other design factors. The main design purpose is to ensure the applied vehicle loads are distributed adequately to the subgrade. This section establishes the criteria and process for designing pavement structures and its subgrade on site specific soils.

5.1 GENERAL

Factors which influence the performance of street and thoroughfare pavement include the subgrade upon which the pavement structure rests, the quality of materials used to construct the pavement, thickness of the pavement, and the type and amount of traffic using the facility. In designing a pavement which will provide a reasonable degree of performance during an expected life, some of these factors can be predetermined. The load bearing capacity of the subgrade can be determined by performing a soils engineering investigation of the site for a proposed pavement. Soil borings made along the alignment, laboratory analysis of soil samples, and recommendations for pavement design shall be provided in the geotechnical report. The strength of the pavement shall also be established by specifications and quality control during construction. A reasonable estimate can be made of the traffic including the number of equivalent 18-Kip single axle wheel loads (ESALs) anticipated during the expected life of the pavement. Of primary importance in determining traffic loading is the amount of truck and bus traffic expected on the street or thoroughfare during the design life.

Although the subgrade and traffic vary for different locations, the plasticity index (P.I.) of the subgrade, the street or thoroughfare classification (Local, Minor Arterial, etc.), and location of the thoroughfare in relation to industrial, heavy commercial, and bus routes and facilities reflect to a degree these factors.

Pavement designs accompanied by calculations and data based on accepted pavement design procedures shall be made by the designer in such cases for consideration by the City Public Works Department. The accepted pavement design procedure for these conditions shall be American Association of Highway and Transportation Officials (AASHTO) with justification provided for the input values.

5.2 PAVEMENT DESIGN

5.2.1 Design Approach Strategy

The recommended approach to street pavement design shall be to make the following determinations and assessments, in this order.

- 1 Based on an established roadway geometry that has previously been reviewed and has concurrence from the Department of Public Works, conduct a geotechnical investigation for design of the street and its utilities, drainage facilities, and other elements based on the requirements identified in Section 5.2.2 below. That geotechnical report should provide a summary of project soils information, results of laboratory testing, and recommendations for the street pavement section and other design elements that are dependent upon soil characteristics and values.
- 2 The street pavement section is inclusive of the rigid concrete pavement slab, subgrade, and underlying supporting soil and rock strata. In consultation and coordination with the street designer, the geotechnical engineer shall assess whether the Minimum Street Pavement Design Sections presented in Table 5.4 will adequately meet the needs and requirements of the project for pavement support and life, and if not, recommend one or more suitable sections that achieve the requirements in this manual.
- 3 After the pavement section(s) is determined, the design engineer shall meet with the Department of Public Works to review the results of the geotechnical investigation, its recommendations, and the proposed pavement section(s) for use on the project. The final selected pavement section(s) for use on the project requires concurrence between the design engineer and the Department of Public Works.
- 4 Final plans and specifications for street pavement design shall comply fully with the above design approach process and other applicable requirements which are defined in this manual and other referenced documents.

5.2.2 Geotechnical Engineering Report

A Geotechnical Investigation Report shall be prepared and submitted to the City of Dallas Department of Public Works prior to or with the first submittal of the Construction plans. Any updates or supplemental geotechnical reports shall be submitted to Public Works within 10 business days of their completion. The Geotechnical Investigation report shall include, but is not limited to the following items:

1. Provide definition of the underlying geologic formation(s) that are in the project limits.
2. Determine approximate depth to competent rock or unweathered shale, where needed for roadway structures such as bridges or is less than 10 feet below proposed profile grade of the roadway and the rock may affect subgrade design.
3. Provide location of borings in report and construction plans.
4. Borings shall be placed along the street centerline for right-of-ways 60 feet wide or less. Borings shall be placed on alternating sides of right-of-way (if accessible) on streets with right-of-ways greater than 60 feet.
5. Maximum spacing between borings is 500 feet along the centerline of the proposed alignment and at key locations (such as intersections of existing / future streets, high use or heavy truck loaded driveways, etc.)
6. Depth of borings shall be 10 feet minimum or 5 feet into rock, whichever occurs first. These depths shall be taken from the lower of the proposed pavement grade or existing grade. Greater depths are required in areas of unfavorable soil conditions or in areas of significant cuts and fills (greater than 5 feet).
7. Borings to be sampled continuously to a depth of 6 feet and at 2 feet intervals thereafter.
8. Cohesive samples shall be obtained using 3-inch nominal diameter push tubes.
9. Cohesionless soils (sands and gravels) will be sampled and evaluated in-situ using the Standard Penetration Test (SPT).
10. Shale or rock shall be evaluated in-situ using Texas Department of Transportation (TxDOT) cone penetrometer, or NX coring, as appropriate.
11. Groundwater conditions shall be evaluated.
12. Boreholes shall be backfilled. If settlement of borehole occurs, the geotechnical engineer is responsible for additional backfill.
13. Soluble sulfate test needs to be conducted for soil to prevent formation of ettringite which causes heaving of pavement.
14. Subgrade stabilization by lime or cement shall be based on the geotechnical report recommendations. Use of lime or cement is dependent in part on the PI of the soil.
15. Flexible base conforming to TxDOT Item 247 or NCTCOG Item 301.5 may be used as an alternative to lime or cement stabilized subgrade. Flexible base shall be Grade 2 or better.
16. Recommendations for alley subgrade design must consider the water that seeps under concrete pavement from backyards that drain to the alley. Provide recommendations for lime or cement treatment to prevent pavement heaving due to this water and native soil conditions. Flexible base is an acceptable alternative subgrade material in lieu of lime or cement treatment of native soils.
17. Consider and recommend use of horizontal and vertical barriers, more than just lime or cement stabilized subgrades. Barriers may be considered in the presence of utilities and large vegetation.
18. Account for truck and bus traffic volumes and loads on pavements around schools, loading docks, commercial and industrial properties, and other areas that may have unique traffic loadings.
19. Where soil conditions are variable and the conditions can reasonably be delineated, provide distinct design alternatives for pavement and subgrade for the range of Plastic Indices of soils: 0 to 15, 15 to 25, 25 to 45, greater than 45.
20. Describe soil and ground water conditions as they relate to the construction and long term performance of the roadway. Address seasonal changes in ground water tables and soil moisture conditions.
21. Address constructability and magnitude of anticipated movement with and without dowel bars
22. Consider alternative earthwork preparation methods to reduce the potential movement of the pavement and design considerations in expansive soils
23. Provide recommendations for earthwork operations, subgrade preparation, and roadway pavement testing.

24. Provide recommendations for soil shrinkage resulting from excavation and recompaction operations.
25. Provide recommendations for reducing the impact of large trees on long-term roadway performance.
26. Reports shall be signed and sealed by a licensed professional engineer or geologist, as appropriate.

5.2.3 Design Criteria

5.2.3.1 General

The standard material for construction of City streets, alleys and sidewalks is Portland Cement Concrete (PCC). The standard City design criteria requires a 30 year design life for new concrete streets using the City's concrete mix designs. The City's concrete mix designs for streets are specified in The Addendum to the NCTCOG Public Works Construction Standards section 303.3.4.2.COD: Standard Classes of Pavement Concrete under "Machine Finish" and "Hand Finish" classes of concrete. These two mix designs have been specified to provide 28 day compressive strength of 4000 psi for "Machine Finish" mixes and 4500 psi for "Hand Finish" mixes. Specific mix design test results can be submitted to support the use of different compressive strength design input values.

The standard concrete street design accounts for streets with heavy truck and bus traffic using state-of-the-art Equivalent 18 kip Single Axle Load (ESAL) design. The subgrade support capabilities of cement stabilization and cement treated base (CTB) are used in designs supporting heavy traffic loading.

The following design criteria sets the minimum required standard pavement structure designs.

5.2.3.2 Pavement Design Process

Unless approved otherwise by the Department of Public Works, all pavement designs shall be rigid pavement consisting of PCC slabs reinforced with deformed reinforcing steel. Sawed contraction joints shall be made not later than 24 hours after concrete placement, but much sooner in warm or hot weather. Expansion joints shall be provided with load transitioning smooth dowel bars provided. All construction, contraction and expansion joints shall be sealed.

The design team's civil and geotechnical engineers shall develop rigid pavement design using the procedures established in the 1993 AASTHO Guide for Design of Pavement Structures. This design procedure is available in automated forms, the AASHTO DAR-Win 3.1 program and is consistent with the process outlined in Chapter 8 of TxDOT's Pavement Manual (2018).

Traffic loading, computed as ESALs, shall be assessed per the requirements of Section 5.2.3.3.

All soil subgrades beneath proposed pavements shall be lime or cement treated to the depth required per Section 5.2.3.4 Subgrade Design. Alternatively, flexible base may be substituted for lime or cement treated subgrade soils.

Using the procedures set forth above, the computed concrete slab thickness shall be determined and rounded up to the nearest full inch. The minimum slab thickness is 6-inches, and the maximum thickness is 12-inches. Where computed slab thickness exceeds 12-inches, discussion with the Department of Public Works personnel shall occur. This may involve consideration of improvement of sub-soil and subgrade conditions, review of traffic loading projections, and other site specific matters.

The designer shall coordinate with and refer to the City's 251D-1 Standard Construction Details, the City's Addendum to the NCTCOG Public Works Construction Standards, and the NCTCOG Public Works Construction Standards – North Central Texas, for its requirements for 28-day concrete strength, reinforcing steel, and other components in preparing the pavement design recommendations and final design plans and specifications.

5.2.3.3 Traffic Loading

Absent any other specific guidance from the City, the following traffic loading parameters shall be used in the pavement analyses and design:

Annual Traffic Volume Compound Growth Rate	1.025
Truck Percentage	0.163%
Design Life:	30 years
Terminal Serviceability Index:	2.25
Reliability:	85%

Pavement design studies require that all traffic data (buses, heavy trucks, automobile, etc.) be converted to 18-kip Equivalent Single Axle Loads (ESALs). Approximately 2,500 cars are equivalent to one (1) ESAL, whereas one (1) bus is equivalent from one (1) to five (5) ESALs depending on the thickness of the pavement and whether the bus is empty or fully loaded.

The following assumptions shall be used in the pavement analyses for traffic loading:

1. Traffic Counts: Historical traffic counts shall be collected from available sources – City of Dallas, TxDOT, NCTCOG, and other sources. If available from historical data, the designer shall review the distribution of vehicle types (passenger vehicles, trucks, buses) to determine historical ESAL counts

from which to make a projection. Counts of current traffic conditions, to include a distribution by vehicle types, shall be made to enter into the assessment for roadway traffic loading conditions. The analysis shall include an assessment of future traffic using traffic projection data and guidance from the City, TxDOT, NCTCOG or other sources.

2. The standard AASHTO truck vehicle types shall be the SU vehicle and WB-50 vehicle unless conditions dictate otherwise, such as at certain industrial or warehouse type land uses where vehicle types may be larger, heavier, etc.
3. Additionally, bus traffic loading shall be assessed and considered for the specific streets or sections of streets being considered for design. Coordination is required with DART and any other public or private entities (such as Greyhound or hotel shuttle services) causing bus traffic to occur. DART's bus fleet (in 2018) consists of 30' and 40' low floor coaches manufactured by NABI, NFI, and Proterra. Specific discussion regarding existing, proposed, or planned routes of buses must be made and documented. Headways (intervals of bus frequency) and duration of service need to be known to establish volume of bus traffic. Bus loading conditions shall be assessed. Streets in areas of concentrated bus traffic (bus transfer facilities, light rail stations, bus terminals, etc.) need detailed assessment as buses near these locations tend to be more heavily loaded than those in more distant boarding and alighting locations.

The equivalent bus loading per bus vehicle shall be determined for each street classification on a case-by-case basis based on the bus operator's current and proposed plans. Some bus routes or portions thereof may be mostly empty, half-full, or full. ESAL determinations shall be made from this data collection and analysis.

4. Unless more specific data is available, the designer may assume that the portion of traffic called Truck / Bus traffic is distributed as follows:
 - Buses comprise 50%
 - WB-50 trucks comprise 25%
 - SU vehicle trucks comprise 25%
5. Unless more specific data is available, the remaining portion of the vehicular traffic is distributed as follows:
 - Cars comprise 50% with average loading of 2,000 lbs. on the front and rear axle.

- Pickup trucks and SUV vehicles comprise 50% with average loading of 2,000 lbs. on the front axle and 4,000 lbs. on the rear axle.

6. Calculations are based on the total traffic volume and percentage of heavy truck / bus traffic using the procedure given in AASHTO Guide for Design of Pavement Structures.

5.2.3.4 Subgrade Design

Table 5.1 Soil Subgrade Parameters, Table 5.2 Modified Modulus of Subgrade Reaction for Local Streets, and Table 5.3 Modified Modulus of Subgrade Reaction for Collector and Arterial Streets give the subgrade design parameters that are applicable to design of pavements. For the Dallas area, clays are by far the predominant native material type and are assumed herein. These parameters vary with the Plasticity Index of the clay soils and the street types noted below.

Where other soil types are determined to be present on a project, additional analysis may be required and consultation with City Public Works staff in determining the subgrade designs.

Table 5.1 Soil Subgrade Parameters

Subgrade Soil:		Clay
Classification by USCS:		CH
Classification by AASHTO:		A-7-6
Proof Rolled Subgrade:		5 150 pci
(1)	California Bearing Ratio (CBR):	
(2)	Modulus of Subgrade Reaction (k) compacted to 95% Standard Proctor density at -2% to +4% of optimum moisture	

Table 5.2 Modified Modulus of Subgrade Reaction for Local Streets

(1)	<u>For Subgrade Soil Plasticity Index (P.I.) greater than 15:</u> Using a 6-inch lime treated subgrade (% of Lime determined by Geotechnical Report) for residential zoned districts and 8-inch lime treated subgrade (% of Lime determined by Geotechnical Report) for non-residential zoned districts, compacted to 98% Standard Proctor density at -2% to +4% of optimum moisture:	200 pci
(2)	<u>For Subgrade Soil P.I. equal to or less than 15:</u> Using an 8-inch lime treated subgrade (% of Lime determined by Geotechnical Report) compacted to 98% Standard Proctor density at -2% to +4% of optimum moisture:	200 pci

Table 5.3 Modified Modulus of Subgrade Reaction for Collector and Arterial Streets (excluding streets with heavy truck and / or bus traffic conditions)

(1)	<u>For Subgrade Soil P.I. greater than 45:</u> Using an 8-inch cement stabilized subgrade with a subgrade design and cement rate determined by a testing laboratory, compacted to 98% Standard Proctor density at -2% to +2% of optimum moisture:	350 pci
(2)	<u>For Subgrade Soil P.I. equal to or less than 45 but greater than 25:</u> Using an 8-inch cement stabilized subgrade using 10% Portland cement by dry weight of soil, compacted to 98% Standard Proctor density at -2% to +2% optimum moisture:	350 pci
(3)	<u>For Subgrade Soil P.I. equal to or less than 25 but greater than 15:</u> Using an 8-inch cement stabilized subgrade using 8% Portland cement by dry weight of soil, compacted to 98% Standard Proctor density at -2% to +2% optimum moisture:	350 pci
(4)	<u>For Subgrade Soil P.I. greater than 45:</u> Using an 8-inch cement stabilized subgrade using 6% Portland cement by dry weight of soil, compacted to 98% Standard Proctor density at -2% to +2% optimum moisture:	350 pci

The City's addendum to the NCTCOG Public Works Construction Standards provide the details and requirements for installation of the lime treated and cement stabilized subgrade. The requirements for cement modified subgrade is provided in the Standard Specifications under Item 4.9 "Portland Cement Modification of Subgrade Soils."

5.2.3.5 Alternate Substitutions for Subgrade Preparation

Subgrade Deletion Substitutions.

1. Lime treated subgrade - Where the pavement section has been designed using a lime treated subgrade and lime is deleted at the request of the Owner or Contractor and approved by the City's Project Engineer and supported by the Geotechnical Engineer, a minimum of 6-inch thick flexible base shall be placed on the compacted in-situ subgrade to provide a non-erodible base under the PCC pavement.
2. Cement stabilized subgrade - Where the pavement section has been designed using a cement stabilized subgrade and cement is deleted at the request of the Owner or Contractor, approved by the City's Project Engineer, and supported by the Geotechnical Engineer, a minimum 6-inch thick flexible base shall be placed on the compacted in-situ subgrade to provide a non-erodible base under the PCC pavement.

3. Cement treated base - Where the pavement section has been designed using Cement Treated Base (CTB) and CTB is deleted at the request of the Owner or Contractor and approved by the City's Project Engineer, and supported by the Geotechnical Engineer a minimum 4-inch thick flexible base shall be placed on the compacted in-situ subgrade to provide a non-erodible base under the PCC pavement.

Treatment Additive Substitutions.

1. Lime in lieu of cement - If a substitution is made in the treatment additive, whereby lime is used in lieu of cement (where cement has been specified), the pavement thickness shall be increased by at least one inch (1").
2. Cement in lieu of lime - If a Contractor proposes cement in lieu of lime to expedite construction (where lime has been specified), the rate of cement required shall be based upon testing of site soils for the proposed roadway pavement.
3. Performance requirements - Cement modification when used as a substitute for lime shall be performed in accordance with NCTCOG Public Works Construction Standard Item 301.3. "Portland Cement Treatment" and as amended in the City of Dallas Addendum to the NCTCOG Specifications. No pavement thickness reduction shall be allowed for substitution of cement for lime stabilization. If subgrade stabilization is not performed and the pavement thickness is increased accordingly, the upper eight (8) inches of subgrade soil must be compacted at -2% to +4% of optimum moisture to a minimum of 98% Standard Proctor density (ASTM D698).

5.2.3.6 Granular Subgrade Soil Considerations

Cement stabilization shall be used for all subgrade soil conditions (lean clay, fat clay, or granular soils) where a cement stabilized subgrade has been specified for design unless an alternate substitution has been approved by the City. If an alternate substitution for cement stabilization has been approved, the concrete pavement section shall be increased appropriately as described above.

As a minimum, the following requirements must be met. Project specific soil conditions may require different and greater levels of subgrade stabilization than the following, and this will require supporting engineering analysis and documentation.

- For the "Normal Design" case, cement modification shall be performed in accordance with the City's Addendum to the NCTCOG Construction Standards, Item 301.3.5.COD: "Cement Stabilization of Subgrade Soils" as required in Table 5.4 and to the depth required (having a P.I. of 15 or less) for all arterial streets and

thoroughfares to help prevent possible subgrade pumping at the joints during the life of the street.

- The "Heavy Duty Design" case requires cement stabilization of the subgrade in accordance with the City's Addendum to the NCTCOG Construction Standards, Item 301.3.5.COD: "Cement Stabilization of Subgrade Soils" as required in Table 5.4 and to the depth required with a subgrade P.I. up to 45 for collectors, arterial streets and thoroughfares.

5.2.3.7 Steel Reinforcement and Pavement Joints

Minimal steel reinforcement is required for all standard concrete street pavements. Steel reinforcement and the various standard jointing requirements are provided in The Public Works Department Standard Construction Details, File 251D-1.

5.2.3.8 Street Classification and Design Case

Table 5.4 shows the minimum required pavement thickness and subgrade treatment requirements for certain soil conditions and for various street and thoroughfare types and traffic loading design cases within the City. The classification of the street must be determined and the appropriate traffic loading design case of "Normal" or "Heavy Duty" be selected. Coordination with the Department of Public Works can help establish the street classification and help determine which traffic loading design case is applicable. The traffic loading design case shall be determined by the design consultant and approved by the City project engineer during the early stages of the Preliminary Design phase of the project.

5.2.3.9 Subgrade Treatment for Street Design Sections

The approximate plasticity index (P.I.) of the subgrade soil is also required to select the appropriate pavement structure for the project. A soil investigation shall be required including obtaining soil borings, classifying the soils encountered and determining the strength and physical properties of the underlying and supporting soils system in the laboratory by means of Atterberg Limits, optimum moisture content, penetrometer compressive strength readings, and unit dry weight. For each soil classification encountered, the liquid limit shall be determined, the plasticity index shall be calculated, and depending on the proposed elevation of the subgrade and on whether the plasticity index is less or more than the critical value shown, the subgrade design shall be treated as shown in Table 5.4.

For subgrades on proposed fill sections, the subgrade soil shall be assumed to be equal to the predominate type of subgrade soil encountered on the project unless the Atterberg characteristics of the subgrade soil used for fill are specified in the plans.

For estimate purposes, 8-inch thick 10% cement stabilized subgrade shall be calculated as requiring 72 lbs. of cement per square yard. 8-inch thick 8% and 6% cement stabilized subgrade shall be calculated as requiring 63 lbs. and 52 lbs. of cement per square yard, respectively. 8-inch thick 4% cement modified subgrade shall be calculated as requiring 35 lbs. of cement per square yard.

Quantities of lime required for lime treated subgrade are dependent on the results of the Atterberg Limits testing, in-situ soil density and the depth of stabilization required. The rate of lime specified for lime treated subgrade shall be an adjusted rate above the laboratory determined theoretical rate to allow for construction tolerances. Typically, the adjusted rate of lime shall be no less than 4% commercial hydrated lime per dry weight of subgrade soil (for 6-inch depth treatment, use 22 lbs. per square yard; for 8-inch depth treatment, use 29 lbs. per square yard) for subgrade soils having a liquid limit less than 50, the adjusted rate shall be no less than 6% for clay subgrade soils having a liquid limit of 50 or greater (for 6-inch depth treatment, use 32 lbs. per square yard; for 8-inch depth treatment use 41 lbs. per square yard).

5.2.3.10 Arterial Thoroughfare Minimum Design Parameters

The following traffic loading and pavement design parameters are used in the minimum pavement designs for Arterial Thoroughfares as shown in Table 5.4.

A Principal Arterials

	Case 1 Principal Arterial (Normal Design)	Case 2 Principal Arterial (Heavy Duty Design)
Total Traffic Volume (Two Way)	25,000 VPD ¹ 12,500 VPD ²	40,000 VPD ¹ 20,000 VPD ²
Traffic Lanes	6-Lane Divided Roadway	
Pavement Width	2 at 33 feet (face curb-to-face curb)	
Heavy Truck / Bus Traffic	2% (½ truck & ½ bus)	10% (½ truck & ½ bus)
Traffic (Design Lane)	8,450,000 18 kip ESAL	67,365,000 18 kip ESAL
Concrete Compressive Strength	-	4,000 psi

Table 5.4 Minimum Street Pavement Design Sections

Facility Type	Pavement Width	Usual Crown	P.I. = 15 or less	P.I. Greater than 15	Base Pavement	Minimum Concrete Pavement Thickness	Asphalt Concrete Pavements
Alley	10' Min	3" Invert	6" Compacted	8" Compacted	None	6"	Not Permitted
Sidewalks Away from Curb	4' Min	None	Compacted	Compacted	None	4"	Not Permitted
Sidewalks Against Curb	5' Min	None	P.I. 18 or less: Compacted	Greater than 18: 6" select or lime	None	4"	Not Permitted
Local Streets							
Residential Zoned Districts							
Local, L2U(B)	26'	4"	6" Compacted	6" Lime Treated or > cement Modified	None	6"	Not Permitted
Local, S2U	36'	6"	6" Compacted	6" Lime Treated or Cement Modified	None	6"	Not Permitted
Non-Residential Zoned Districts							
Local, S2U	36'	6"	8" Compacted	8" Lime Treated or Cement Modified	None	8"	Not Permitted
Collector Streets							
Normal Design							
Residential (S2U)	36'	6"	8" Compacted	8" Lime Treated or Cement Modified	None	8"	Not Permitted
Community (S2U)	36'	6"	8" Compacted	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Heavy Duty Design (Heavy Truck / Bus Traffic)							
Community (S2U)	36'	6"	<3> 8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	10"	Not Permitted
Community (M4U*) * Striped for two lanes	40'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	10"	Not Permitted
Minor Arterials							
Normal Design							
Type M4U	40'	6"	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S4U	44'	6"	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S4D	2-24'	1/4" Ft. cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Heavy Duty Design (Heavy Truck / Bus Traffic)							
Type M4U	40'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S4U	44'	6"	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S4D	2-24'	1/4" Ft cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Principal Arterials							
Normal Design							
Type M6D(A)	2-33'	1/4" Ft cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted

Facility Type	Pavement Width	Usual Crown	P.I. = 15 or less	P.I. Greater than 15	Base Pavement	Minimum Concrete Pavement Thickness	Asphalt Concrete Pavements
Type M6D(B)	2-30'	1/4" Ft cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S6D	2-36'	1/4" Ft cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Type S8D	2-48'	1/4" Ft cross slope	8" Cement Modified (4%)	8" Lime Treated or Cement Modified	None	9"	Not Permitted
Heavy Duty Design (Heavy Truck / Bus Traffic)							
Type M6D(A)	2-33'	1/4" Ft cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type M6D(B)	2-30'	1/4" Ft cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S6D	2-36'	1/4" Ft cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
Type S8D	2-48'	1/4" Ft cross slope	8" Cement Stabilized (6%)	8" Cement Stabilized (8%-10%)	None	11"	Not Permitted
CBD Streets							
Standard Design	As Required	6" or 1/4" / Ft.	6" Compacted	6" Compacted	4", 650 psi CTB	10"	Not Permitted
Alternate Design	As Required	6" or 1/4" / Ft.	8" Cement Treated (10%)	8" Cement Treated (10%)	None	10"	Not Permitted

Notes:

- Concrete pavement as specified by Public Works Addendum to the Standard Specification 5.8.1.1.
 - Alley pavement is specified as either:
 Machine Finish Class - test strength is 4000 psi compressive strength at 28 days after placement, or
 Hand Finish Class - test strength is 4500 psi compressive strength at 28 days after placement.
 - Sidewalk pavement is specified as sidewalk, separate curb and gutter, and (4) inch thick median pavement class - test strength is 3000 psi compressive strength at 28 days after placement.
 - Street pavement is specified as either
 Machine Finish Class - test strength is 4000 psi compressive strength at 28 days after placement or
 Hand Finish Class - test strength is 4500 psi compressive strength at 28 days.

Machine and Hand Finish classes of concrete mix designs have been designed to provide an ultimate compressive design strength of at least 6000 psi.
- Standard subgrade compaction under alley and street pavement is 98% standard proctor density at minus 2% to plus 4% of optimum moisture to the depth specified. See Paving Design Manual Section 5.02.01, "Standard Design Criteria" and 5.02.06, "Alleys" for details concerning compaction and treatment requirements. Alternate acceptable substitutions for subgrade stabilization when approved by the City are as follows:
 6" or 8" lime stabilization = 1" reinforced concrete pavement
 8" cement stabilization (10%) = 1.5" reinforced concrete pavement

- Standard subgrade compaction for sidewalks against the street curb is 95% of standard Proctor density within minus 2% to plus 4% of optimum moisture content. For sidewalks away from the curb, the standard subgrade compaction is 90% of standard Proctor (ASTM D698). See Paving Design Manual section 5.02.05 "Sidewalks" for compaction and subgrade requirements.
- Cement stabilized subgrade shall require subgrade stabilization in accordance with Public Works Addendum Specification Item 4.9(A) "Cement Stabilization of Subgrade Soils" at the following rate of cement content of dry weight of soil:

 6% for subgrade soil P.I. equal to or less than 15;
 8% for subgrade soil P.I. equal to or less than 25 but greater than 15;
 10% for subgrade soil P.I. equal to or less than 45 but greater than 25;
 At a rate to be determined by the testing laboratory for subgrade soil P.I. greater than 45.
 - Cement modified subgrade shall provide a cement application rate as follows:
 4% for subgrade soil P.I. equal to or less than 15.
 When substituted for Lime Treatment in subgrade soils having a P.I. greater than 15, the rate shall be at established by testing of site soils to reduce the soil P.I. to less than 15.
 - Above requirements are per the Public Works Addendum effective at time this manual was prepared. Future versions of the Addendum shall supersede these requirements.
 - Asphalt Concrete Pavement permitted with the approval of the Public Works Director.

B CBD Pavement Sections

Roadway Class	Thoroughfare
Design Vehicle	Equivalent City Bus
Estimated Bus Traffic	
Monday - Friday	60 buses per hour for 8 hours 30 buses per hour for 8 hours 15 buses per hour for 8 hours
Saturday & Sunday	30 buses per hour for 8 hours 15 buses per hour for 8 hours 5 buses per hour for 8 hours
Pavement Widths	
(1) 3-Lane Roadway	33 feet (face curb-to-face curb)
(2) 4-Lane Roadway	44 feet (face curb-to-face curb)
Traffic (Design Lane)*	17,700,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi min

C Minor Arterials

	Case 1 Minor Arterial (Normal Design)	Case 2 Minor Arterial (Heavy Duty Design)
Total Traffic Volume (Two Way)	18,000 VPD ¹ 9,000 VPD ²	25,000 VPD ¹ 12,500 VPD ²
Traffic Lanes	4-Lane Undivided Roadway	
Pavement Width	40' and 44' (face curb-to-face curb)	
Heavy Truck / Bus Traffic	2% (½ truck & ½ bus)	10% (½ truck & ½ bus)
Traffic (Design Lane)	7,400,000 18 kip ESAL	54,133,000 18 kip ESAL
Concrete Compressive Strength	-	4,000 psi

5.2.3.11 Collector Street Minimum Design Parameters

The following traffic loading and pavement design parameters are used in the minimum pavement designs for Collector Thoroughfares shown in Table 5.4:

	Case 1 Residential Collector*	Case 2 Community Collector (Normal Design)	Case 3 Community Collector (Heavy Duty Design)
Total Traffic Volume (Two Way)	5,000 VPD ¹ 2,500 VPD ²	7,000 VPD ¹ 3,500 VPD ²	7,000 VPD ¹ 3,500 VPD ²
Traffic Lanes	2-Lane Undivided Roadway		
Pavement Width	36' and 40' (face curb-to-face curb)		
Heavy Truck / Bus Traffic	72 buses per day ¹ 30 buses total ²	5% (½ truck & ½ bus)	20% (½ truck & ½ bus)
Traffic (Design Lane)	1,310,000 18 kip ESAL	7,830,000 18 kip ESAL	33,310,000 18 kip ESAL
Concrete Compressive Strength	-	-	4,000 psi min

*Residential Collectors are based on twice as much bus traffic loading as Case (2) Local Streets in Section 5.2.3.12 of this manual.

5.2.3.12 Local Street Minimum Design Parameters

The following traffic loading and pavement design parameters are used in the minimum pavement designs for Local Streets shown in Table 5.4:

	Zoned Districts		
	Residential		Non-Residential
	Case 8 Local Street (Not on Bus Route)	Case 9 Local Street (On Bus Route)	Case 10 Local Street**
Total Traffic Volume (Two Way)	2,500 VPD ¹ 1,250 VPD ²		
Bus Design Vehicle	Equivalent City Bus		
Traffic Lanes	1-Lane Roadway with 2 parking lanes 2-Lane Roadway with 1 or 2 parking lanes		
Pavement Width	26 feet and 36 feet (face curb-to-face curb)		
Heavy Truck / Bus Traffic	4 buses per day	36 Buses per day ¹ 15 Buses total ²	
Traffic (Design Lane)	125,000 18 kip ESAL	658,000 18 kip ESAL	1,310,000 18 kip ESAL
Concrete Compressive Strength	4,000 psi min		

* Residential Collectors were designed based on twice as much bus traffic loading as Case 2 Local Streets in section 5.2.4 of this manual.

** Case 3 Local Streets were designed based on twice as much traffic loading as Case 2 Local streets to account for truck traffic.

¹ Weekdays

² Weekends

5.2.4 Sidewalks

The City's concrete mix design for sidewalks is specified in the City's Addendum to the NCTCOG Public Works Construction Standards, Item 303.3.4.2.COD: Standard Classes of Pavement Concrete under "Sidewalks, and 4 inch thick median pavement" class of concrete, providing a minimum compressive strength of 3,000 psi after 28 days. Section details are provided in Table 5.4. Sidewalks, designed for pedestrian traffic only, shall be reinforced and a minimum of 4 inches thick. Barrier free ramps shall be reinforced. Sidewalks and barrier free ramps which are exposed to vehicular traffic, including driveways crossing sidewalks, shall be designed thick enough to carry the expected traffic loading for a 30 year life. When vehicular traffic loading is expected, sidewalk and barrier free ramps design thickness shall not be less than 6 inches. Barrier free ramps require special consideration since they are at street intersections and could experience occasional vehicular loading.

The minimum thickness of barrier free ramps when exposed to incidental vehicular loadings at intersections shall not be less than 6 inches. Provide adequate subgrade support when incidental vehicular loadings are expected.

For sidewalks positioned next to the right-of-way and separated from the street pavement by a landscaped parkway buffer, the subgrade shall be compacted to a density of at least 90% of Standard Proctor density at a moisture content of from -2% to +4% of optimum moisture content, as determined by ASTM D698, before placement of concrete sidewalk. The subgrade treatment for sidewalks against the curb shall be (1) six inch thick lime treated soil or (2) six inch thick select backfill, if the subgrade P.I. is greater than 15. The subgrade for all sidewalks against the curb shall be compacted to at least 95% of Standard Proctor density at a moisture content of from -2% to +4% of optimum moisture content, as determined by ASTM D698, before placement of sidewalk pavement.

Reinforcing, jointing, subgrade requirements and other standard requirements and details for sidewalks and barrier free sidewalk ramps are provided in The Department of Public Works Standard Construction Details, file 251D-1, in the NCTCOG Public Works Construction Standards as currently amended by the City's Addendum to the NCTCOG Public Works Construction Standards, and in the Public Works Department special provisions.

5.2.5 Alleys

The City's concrete mix design for alleys is specified in the City's Addendum to the NCTCOG Public Works Construction Standards, Item 303.3.4.2.COD: Standard Classes of Pavement Concrete under "Hand Finish" classes of concrete, providing a minimum compressive strength of 4500 psi after 28 days. Section details are provided in Table 5.4.

The subgrade for alleys shall be recommended by the Geotechnical Engineer of record based on the result of a soil investigation performed for the individual alley. The Geotechnical Engineer shall investigate and recommend appropriate treatments as needed if the plasticity index (P.I.) of the subgrade soil is greater than 15, and it becomes necessary to perform subgrade treatment. The option of using flex base shall be included in the geotechnical investigation and recommendation. The recommendation for the subgrade treatment shall include at least two treatment options, depth of treatment, and the standard subgrade compaction requirements, as determined by ASTM D698, before placement of concrete alley pavement.

Reinforcing, jointing and other standard requirements and details for alley pavement are provided in The Department of Public Works Standard Construction Details, File 251 D-1, in the NCTCOG Public Works Construction Standards as currently amended by the City's Addendum to the NCTCOG Public Works Construction Standards, and in Public Works Department special provisions.

The following traffic loading and pavement parameters are used in the pavement analysis and standard design for alleys stated in Table 5.4:

Total Traffic Volume	500 Vehicles Per Day (VPD)
Traffic Lanes	One Lane
Pavement Width	10 feet
Garbage Truck Traffic	Assumed 3 trucks per week
Trash Truck	8 kip single axle and 32 kip dual single axle
Traffic (Design Lane)	64,876 18 kip ESAL

5.3 ALTERNATIVE PAVING DESIGN

5.3.1 General

The designer shall perform a special pavement analysis and prepare a site-specific pavement design in lieu of selecting a design from Table 5.4 when there are circumstances which warrant a unique design, such as where existing soils are of the Eagle Ford Shale or Taylor Marl Shale Formations. The special pavement analysis and pavement design shall be performed in accordance with the most current version of AASHTO Guide for Design of Pavement Structures. Alternate pavement designs shall be based on Section 5.2.3.3 Traffic Loading. Soil testing data, design parameter values used and calculations shall be submitted to the Department of Public Works with the proposed pavement structure design for review and approval.

Certain recognized factors which may warrant a special pavement analysis and alternate design of street and thoroughfare pavement are as follows.

5.3.2 Traffic Loadings

One of the important factors influencing the design of pavement structure is the magnitude and number of load applications expected during the life of the pavement. For Traffic Loadings, meet the requirements stated in Section 5.2.3.3 Traffic Loadings. Each of the applicable minimum pavement sections indicated in Table 5.4 for shall be assessed, and the traffic loadings noted in Sections 5.2.3.10, 5.2.3.11, and 5.2.3.12. If actual traffic data, including traffic volume frequency, frequency of heavy bus and truck traffic or total 18-kip Equivalent Single Axle Loads (ESAL's) exceeds the design parameters, an alternate pavement design shall be performed using actual traffic data which shall include bus and truck loading conditions.

5.3.3 Subgrade Soils

Refer to Section 5.2.3.4 for minimum subgrade design requirements.

A special pavement analysis shall be performed and an alternate pavement design may be required by the designer when proposed pavements involve subgrades within the outcropping of the Eagle Ford Shale or Taylor Marl Shale Formations. This is due to the potential for high soluble sulfate concentrations within the Eagle Ford Shale and Taylor Marl Shale Formations and the resulting potential for "Lime Induced Heave" associated with lime or cement stabilization. Recent research studies performed by the University of Texas at Arlington regarding "Lime Induced Heave" on subgrade soils of the Eagle Ford Shale Formation show that a potential for "Lime Induced Heave" is indicated by a soluble sulfates content of 2,000 mg / kg or larger (threshold limit). A concentration of 5,000 mg / kg indicates a high probability for "Lime Induced Heave". A level of 10,000 mg / kg indicates that a serious problem with "Lime Induced Heave" could occur during and / or after construction. Therefore, soluble sulfates concentrations above the threshold limit indicate the probability for "Lime Induced Heave" if the subgrade soils are treated using lime or cement.

Also, within the Eagle Ford Shale Formation, subgrade soil may contain highly plastic bentonitic clay. These clays characteristically do not respond well to lime or cement treatment.

These types of soils are highly expansive, and experience significant shrinking and swelling with changes in soil moisture. Subgrades involving bentonitic clay require special pavement analysis and alternate pavement designs to provide adequate subgrade support and limit differential pavement deflections to acceptable levels.

Based on available geologic data, approximate mapped limits of probable Eagle Ford Shale and Taylor Marl Shale outcrops within the City of Dallas are shown within the dashed lines and shaded areas on Figure 5.1. For projects located within these mapped limits, a special pavement analysis shall be performed. If adverse soil conditions are confirmed to exist at the recommended subgrade elevation, a recommended project or site specific pavement design shall be provided by the designer for approval by the Department of Public Works.

Recommended paving designs should include the following:

- Consideration of the minimum pavement sections for the street as given in Table 5.4.
- Equivalent substitution for any required subgrade treatment. Acceptable substitutions include 4 inch thick cement treated base or asphaltic concrete.
- A waterproof barrier at the subgrade level to seal off the subgrade from potential infiltrating water.
- Removal of any unsuitable subgrade soil, proof rolling, and compaction to required densities. Details for proof rolling, removal of unsuitable material and subgrade preparation are given in the City's Addendum to the NCTCOG Public Works Construction Standards.
- Drainage catchment facilities such as french drains when potential surface and subsurface water sources are present which can infiltrate the subgrade. Catchment facilities shall capture the intruding water outside of the proposed subgrade area and seal off the water from the subgrade.

In general, drainage catchment facilities should provide the following:

- A horizontal alignment outside of the subgrade zone plus one foot. The edge of trench for catchment facilities shall be at least one foot behind the back of curb line.
- The typical section of the catchment facility shall provide at least a two foot wide trench with a sturdy plastic type waterproof barrier lining in the trench bottom and up the trench sides to the top of collection pipe. Materials subject to being easily torn should be avoided.
- The trench shall have a rounded rock embedment of thickness not less than 4 inches and a perforated PVC collection pipe having a diameter no less than 4 inches.
- The trench bottom, sides and top shall be lined with a nonwoven reinforcing geotechnical fabric suitable for drainage applications and shall totally encapsulate the embedment, pipe and rock backfill material providing at least a 12 inch overlap.
- The trench shall be backfilled with rounded rock up to the grade necessary to capture the drainage.
- A clay cap of at least 8-inch thickness shall be provided over the trench and the top of ground shall be graded as required for the paving sections.

- The flow line of the collection and main pipes shall be equal to or greater than 30 inches below the top of proposed curb at any location.
- The drainage catchment facility shall be designed to gravity drain and shall tie into existing storm drainage conduits, inlets or structures; mainlines may cross under the subgrade from one side of the street to the other only when a suitable outfall structure is not available. In such cases the trench requirements above shall apply except that the main pipe shall be non-perforated PVC pipe and at least one foot of clay cap shall be provided below the proposed bottom of prepared subgrade and over the trench.

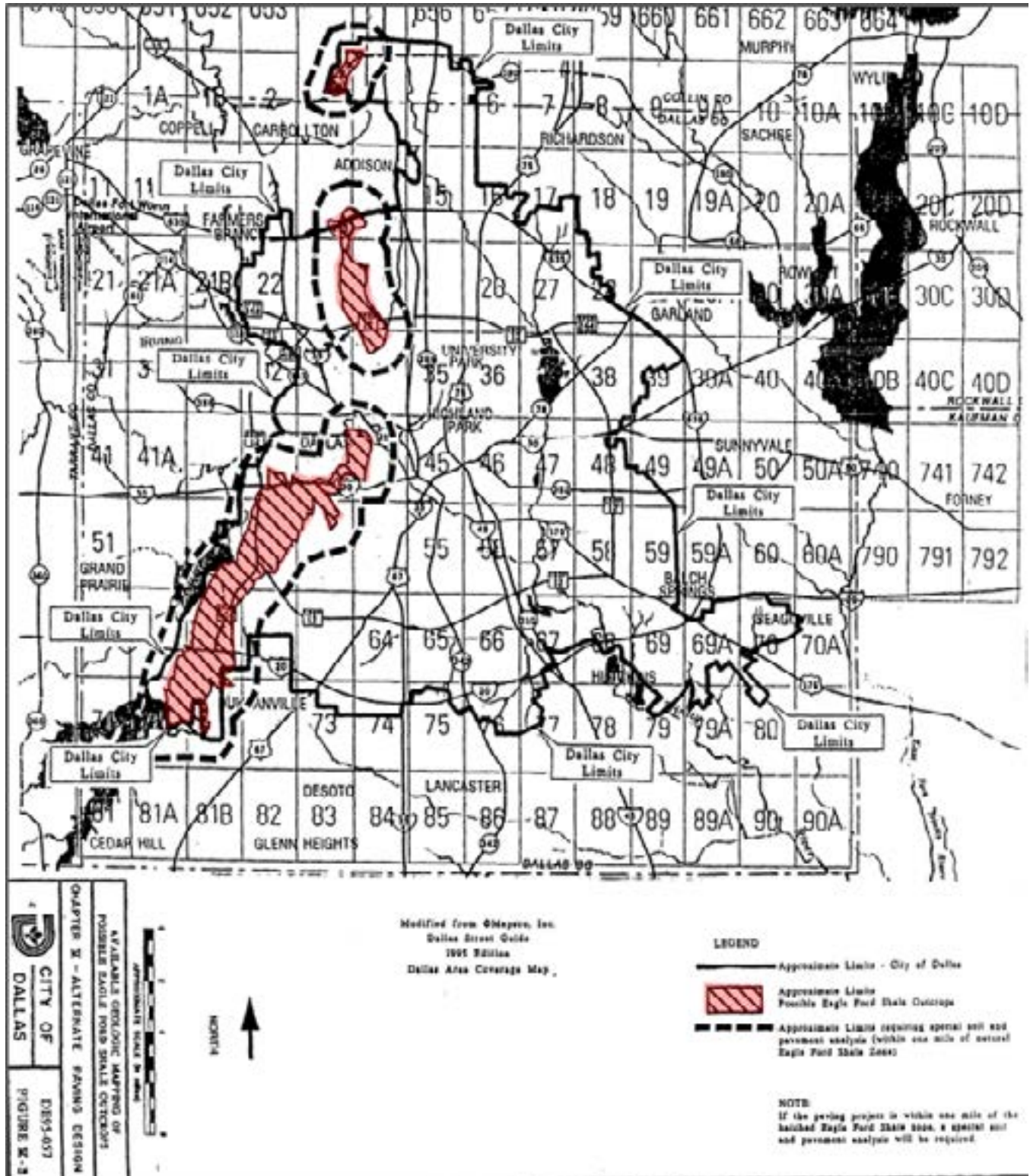
5.3.4 Pavement Widening

Pavement widening projects may require a special pavement analysis and alternate pavement subgrade design. If the subgrade soil P.I. exceeds 20, a special pavement analysis shall be performed by the designer and, if warranted, the designer shall design a special pavement subgrade and submit both to the City Project Engineer for approval.

Clay soils overlain by existing deteriorated pavement are usually very moist and at or near optimum moisture levels with low swell potentials (low potential vertical rise (PVR) value). On the other hand, clay soils in unpaved areas (such as interior medians where widened pavement sections are to be constructed) are usually much drier and potentially expansive (high PVR value). Therefore, when existing pavement sections are widened or when old pavement is removed and replaced with a widened section, differential upward pavement deflections can occur over short distances in a transverse direction (across the width) due to non-uniformity of subgrade moisture conditions. Longitudinal cracks and separations can develop as a result of large differential movements if the ground movements exceed flexural capacity of the reinforced pavement sections.

Due to varying conditions described above, sample borings shall be drilled along the proposed alignment to determine the differential PVR between the existing paved and unpaved areas as part of the project soils investigation. Sample borings shall be drilled on a 1000 foot spacing along the existing pavement and on a 500 foot spacing along the proposed (unpaved) area for pavement widening. Moisture content tests, hand penetrometer tests and swell tests shall be performed to determine the differential soil PVR along the proposed alignment. If the differential PVR exceeds two (2) inches, the designer shall propose an alternate pavement subgrade design that shall reduce the differential PVR to less than two (2) inches. Additional borings at the same spacing shall be made with associated testing after the contract has been awarded to a contractor and notice to proceed has been given to confirm the differential PVR and validate the proposed pavement subgrade design.

Figure 5.1 Eagle Ford Soil Formation Map



1 INTRODUCTION
 2 STREET TYPES
 3 NETWORKS / ACCESS
 4 GEOMETRIC DESIGN
 5 PAVEMENT
 6 STREET LIGHTING
 7 CONSTRUCTION PLAN
 APPENDICES

5.4 PAVERS AND OTHER MATERIALS

5.4.1 Appropriate Use

Paving in streets and walks can consist of traditional materials such as concrete, but using other materials can enhance the aesthetic of public spaces in a city, give circulation a stronger sense of place, and provide some hierarchy of public spaces. Special paving treatments can be selected from a range of options including unit concrete pavers, bricks, textured and colored concrete, including natural stone pavers, and concrete with exposed or special aggregate or other finish treatments.

Special paving can be a functional stormwater element as well as an aesthetic enhancement, when designed as permeable paving. Permeable unit concrete pavers can provide both function and aesthetic appeal. Permeable asphalt and concrete change the surface drainage function but do not greatly enhance the overall aesthetics of the site.

The selection of materials is crucial to its specific location and use. The three basic settings are within roadway travel lanes where the pavers will be subject to traffic loadings, sidewalk and plaza locations where the primary user will be pedestrians, and hardscape areas such as medians where neither vehicles nor pedestrians will usually occupy those areas.

Design details shall be prepared to define a complete system which provides stability and durability. Interlocking of paver materials is preferred over those that do not interlock in some fashion to achieve a stronger pavement which will last longer with less maintenance. When using proprietary products, the designer shall incorporate detailing into the proposed special paving system.

In all locations within public rights-of-way, the materials must perform for the serviceable life of the street (30 years or more) without significant degradation or requiring ongoing maintenance by the City.

Design detailing must also address the needs of ADA compliance in areas of crosswalks or walkways, and any special requirements where bicycles or other non-motorized or motorized modes of travel are allowed.

Where development areas are overlain with a PID, TIF or other some other entity that will provide these enhanced elements and the long term maintenance of them, the feasibility of their selection and application is greater as the City does not have the budget to maintain at a high level the aesthetic materials which could be chosen.

The designer must recognize that in the street zone, the special paving may become marred over time by tire marks, grease and oil accumulations, dirt and grime. A maintenance and cleaning program must be funded by an entity other than the City and is considered necessary to maintain the aesthetic of the special paving. Use of colored pavements shall be "full depth" and extend through the pavement material.

5.4.2 Design

5.4.2.1 Roadway Travel Lanes

Roadway travel lane areas will require a rigid support slab to transfer the loads of traffic from the special paving to the subgrade. A factor in design of the special paving support system shall be the requirement to provide the 30 year minimum service life of the pavement with little or no routine maintenance being required by the City. Reinforced concrete is required for support of special paving. Edge conditions where special paving transitions to the usual concrete or asphalt paving surfaces must be considered. That interface is normally the initial point of failure of the special paving system. Strong edge support is necessary.

The design will also need to consider the placement of regulatory pavement markings, such as lines, stop bars, crosswalk lines, etc., as required by the Texas MUTCD and the City of Dallas. Special paving should be designed so that pavement markings do not break up the aesthetics of the design. Designs that interfere with the placement of pavement markings will not be approved.

Where special paving will also be used by pedestrians, such as for crosswalks, the requirements of ADA and TAS will apply.

5.4.2.2 Pedestrian Zone

In pedestrian zones, special paving must meet the normal requirements for accessibility per ADA and TAS, slip resistance, and durability.

Unlike roadway areas, a rigid support slab beneath the special paving may not be required, but is recommended for long term stability of the special paving area.

Consideration shall be given to growth of trees over time and the impact that the tree trunks and root systems can have on adjacent special paving.

Special paving in pedestrian zones may include unit concrete pavers, bricks, textured and colored concrete, including natural stone pavers, and concrete with exposed or special aggregate or other finish treatments. Other suitable materials may include decomposed granite and similar finishes depending upon the location and use, but not as construction material for the primary accessible path in highly developed areas.

5.4.2.3 Hardscape Areas (Not Subject to Pedestrians and Vehicle Traffic)

Hardscape areas within this section are those areas which are not intended for normal use by pedestrians and vehicle traffic. Such hardscape areas may include medians, median noses, or side slope treatments along and within roadways. Hardscape in this category is usually used to achieve an improved aesthetic, to prevent long term surface erosion, or to minimize maintenance which would otherwise be required for landscapes in those areas.

The special paving in these areas can be of a coarser texture than would work for pedestrian areas. The support system beneath and interlocking the pavers shall be designed for the intended purpose. For median and median nose applications, consideration shall be made for encroachments thereon by errant vehicles, including heavy trucks.

5.4.2.4 Alternate Fire Lane Pavement

For fire lanes on private property which may not be used as usual driving lanes, owners and engineers may consider alternative pavement materials with review and approval by the Fire Department. Alternative pavements may possibly include grass-crete type products, permeable pavements, and similar non-traditional materials to better fit into the character of the development. Specific alternative pavement sections shall be designed based on site specific soil conditions with load carrying sections fully capable for all fire apparatus which the Fire Department may require. All usual requirements for fire lane geometry, width, grade and location relative to buildings, drives, fire hydrants, FDCs, and other elements shall apply.

Any additional requirements or features which the Fire Department deems appropriate and necessary shall be provided. Additional features may include elements for clearly indicating and marking the fire lane, including lighting or reflective devices, edge treatment, etc.

The property owner is responsible for long term operation and maintenance of all alternative fire lane pavements and appurtenances, including any corrections, modifications, or enhancements which the Fire Department may determine are necessary based on its annual fire life safety inspections of private property.





SECTION 6

Street Lighting

Street lighting serves a purpose in safely guiding drivers and pedestrians at a time of day with limited natural light. The objective of this section is to establish design criteria which accomplishes safety goals, limits design variations, while also allowing lighting to enhance activation of spaces during nighttime hours.

6.1 STREET LIGHT DESIGN

6.1.1 General

The primary goal of street lighting is to enhance vehicular (motorized and non-motorized), pedestrian, and transit safety. The benefits of the defined lighting design requirements are uniformity of appearance, reduction of replacement components that must be stocked, and minimized costly duplication of design effort. The lighting designer should also consider potential adverse lighting impacts on adjacent properties when locating street lighting fixtures.

Street lighting systems can be owned and maintained by entities other than the City of Dallas. Examples of such entities include ONCOR, DART, and private developments. Street lights owned and maintained by entities other than the City of Dallas are required to meet or exceed the design criteria within this document.

Construction of new thoroughfares usually includes the installation of twin luminaires mounted on a single steel pole at a height of 32 feet and located in the median spaced at 200-foot intervals. Typically, when new thoroughfares are constructed, the contractor installs conduit and foundations for street lighting in accordance with plans reviewed and approved by the City. ONCOR then completes the installation of the street light hardware and wiring. The street light poles remain the property of ONCOR. Consequently, the City incurs no initial capital outlay associated with installing the street light poles and wiring.

Street lights shall be installed on all dedicated public streets in new subdivisions at the time of development. Developments that install underground electrical distribution receive "Town and Country"-style post-top lights from ONCOR at no charge. If the developer decides to use a different type of street light than the ONCOR standard, the developer must pay ONCOR the difference in installation costs. If a developer requests lighting levels above City standards, the developer pays the City of Dallas in advance for the installation cost of the additional street lights and the operation and maintenance costs (at current rates) for a period of 20 years. Designers shall contact the Street Lighting Section of the Transportation Department for more information on standards for street

lighting in new subdivisions. All street lighting plans for public streets in new developments must be reviewed and approved by the Street Lighting Section prior to being issued for construction.

6.1.2 Roadway Classifications

Lighting requirements are based primarily on the type of roadway, roadway surface classification, and traffic volume. Therefore, lighting classifications are tied to the type of street or pedestrian area being illuminated. Descriptions of street and pathway types are listed below. However, the designer should note that more in-depth information on roadway and trail types is available in Chapters 2 and 3 of this manual.

- **Arterial:** That part of the roadway system that serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation and important roadways connecting with adjacent jurisdictions.
- **Collector:** Roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas.
- **Local:** Local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property. They make up a large percentage of the total street system, but carry a smaller proportion of vehicular traffic.
- **Sidewalk:** A paved or otherwise improved area for pedestrian use, located within public street rights-of-way, which also contain roadways for vehicular traffic.
- **Pedestrian Walkway:** A public walk for pedestrian traffic, not necessarily within the right-of-way of a vehicular traffic roadway. Included are skywalks (pedestrian overpasses and bridges), pedestrian tunnels, and walkways giving access through parks or block interiors.
- **Bikeway:** Any road, street, path, or way that is specifically designated as being open to bicycle travel, regardless of whether such facilities are designed for the exclusive use of bicycles or are to be shared with other transportation modes.

Lighting designers must also understand the road surface classifications shown in Table 6.1 to determine the lighting design requirements. Coordination may be required with civil engineers designing the roadways and/or contractors constructing the roadways to verify the road type and surface classification.

Table 6.1 Roadway Surface Classifications

Class	Q_o	Description	Mode of Reflectance
R1	0.10	1 Portland cement concrete road surface. 2 Asphalt road surface with a min of 12% of the aggregates composed of artificial brightener (e.g., Synopal) aggregates (e.g., labradorite, quartzite) [Not normally used in Texas]	Mostly Diffuse
R2	0.07	3 Asphalt road surface with an aggregate composed of a minimum 60% gravel [size > 0.4"].	Mixed (diffuse and specular)
R3	0.07	4 Asphalt road surface (regular and carpet seal) with dark aggregates (e.g. trap rock, blast furnace slag); rough texture after some months of use (typical highways).	Slightly Specular
R4	0.08	5 Asphalt road surface with very smooth texture.	Mostly Specular

Note: Texas roadways typically do not include brightening agents.

Pedestrian activity must be classified appropriately to complete a lighting analysis. The amount of pedestrian activity is typically associated with the abutting land use. The nighttime pedestrian classification levels and the land uses they are generally associated with are shown as follows:

- **High:** Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are mixed-use communities and developments, retail areas, near theaters, concert halls, stadiums, and transit terminals. (Over 100 pedestrians per hour)
- **Medium:** Areas where lesser numbers of pedestrians utilize the streets at night. Typical are office areas, blocks with public and government facilities, apartments, neighborhood shopping, industrial parks, and streets with transit lines. (10 to 100 pedestrians per hour)
- **Low:** Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban streets with single family dwellings, very low density residential developments, and semi-rural areas. (10 or fewer pedestrians per hour)

The choice of appropriate pedestrian activity level for a street is an engineering decision. If needed, one hour pedestrian counts can be taken during the first hour of darkness on selected days to establish the estimated average pedestrian counts. A section of typical land use can be sampled by counting one or two representative blocks, or a single block of unusual characteristics can be counted, perhaps at a different hour, such as discharge from a major event.

Designers shall consult with City staff in the Street Lighting Section of the Transportation Department regarding the installation of pedestrian-scale street lighting for a specific project.

6.1.3 Illumination Standards

6.1.3.1 Reference Standards

- ANSI/IES RP-8-14 Roadway Lighting
- ANSI/IES RP-22 11 Tunnel Lighting
- ANSI C136.10 Locking type photo control devices and match receptacles.
- ANSI C136.41 Dimming control between an external locking type photo control and ballast or driver.

6.1.3.2 General

This section provides information on illumination terminology, required light levels, uniformity requirements, and depreciation requirements. Also included are guidelines for installation on streets, at intersections, bus stops, railroad crossings, and parking lots.

Street light location and mounting heights shall be selected to provide the required illumination and uniformity levels, minimize adverse impacts on adjacent properties, and improve pedestrian and vehicular safety.

6.1.3.3 Roadway Illumination Terminology

- **Color Rendering Index:** A measure of light quality emitted by a fixture.
- **Electrolier:** The complete assembly of pole, mast arm, and luminaire.
- **Illuminance:** The amount of light striking a surface.
- **Luminaire:** The assembly that houses the light source and controls the light it emits. It consists of the hood, reflector, and glass globe or refractor.

6.1.3.4 Roadway Illumination Levels

The illuminance method of lighting design shall be used for analyzing required roadway illumination levels. The maintained average illumination on horizontal surfaces shall not be below what is shown in Table 6.2. The table is a reference from ANSI RP-8 Roadway Lighting.

Table 6.2 Illuminance Method

Pedestrian Conflict Area	Pavement Classification [Min Maintained Avg Values (<i>lux / fc</i>)]			Uniformity Ratio (E_{avg}/E_{min})	Veiling Luminance Ratio (L_{vmax}/L_{avg})
	R1	R2 & R3	R4		
Arterial					
High	12 / 1.2	17 / 1.7	15 / 1.5	3	0.3
Medium	9 / 0.9	13 / 1.3	11 / 1.1	3	0.3
Low	6 / 0.6	9 / 0.9	8 / 0.8	3	0.3
Collector					
High	8 / 0.8	12 / 1.2	10 / 1.0	4	0.4
Medium	6 / 0.6	9 / 0.9	8 / 0.8	4	0.4
Low	4 / 0.4	6 / 0.6	5 / 0.5	4	0.4
Local					
High	6 / 0.6	9 / 0.9	8 / 0.8	6	0.4
Medium	5 / 0.5	7 / 0.7	6 / 0.6	6	0.4
Low	3 / 0.3	4 / 0.4	4 / 0.4	6	0.4

Abbreviation Definitions:

lux = Luminous Flux (lumens/m²)

fc = Foot-Candle (lumens/ft²)

E = Horizontal illuminance

E_{avg} = Minimum maintained average horizontal illuminance at pavement

E_{min} = Minimum horizontal illuminance at pavement

L_{vmax} = Maximum veiling luminance

L_{avg} = Minimum maintained average pavement luminance

The illumination levels established are not intended to cover special situations or to preempt engineering judgement for any particular design project. The lighting levels shown in Table 6.2 represents the lowest average illumination levels that are considered appropriate for the roadway classifications shown.

6.1.4 Sidewalk, Pedestrian Walkway, and Bikeway Illumination Levels

Sidewalks, pedestrian walkways, and bikeways have been separated into categories based on their pedestrian activity level and proximity to a continuously lighted roadway. The designer shall ensure that the roadway lighting provides the appropriate lighting levels along attached and separated pedestrian walkways and bikeways. Supplemental lighting may be required to ensure pedestrian facilities are adequately illuminated,

particularly where there is separation between the pedestrian area and the roadway. Lighting levels for attached and separated sidewalk and walkway categories shall not be below the levels shown in Table 6.3 when paralleling a roadway with continuous lighting.

Table 6.3 Illuminance Values for Pedestrian Areas

Pedestrian Activity Level	Conflict Area	E_{avg} (<i>lux / fc</i>)	E_{vmin} (<i>lux / fc</i>)	Uniformity Ratio (E_{avg}/E_{min})
High	Mixed Vehicle and Pedestrian	20 / 2.0	10 / 1.0	4
High	Pedestrian Only	10 / 1.0	5 / 0.5	4
Medium	Pedestrian Areas	5 / 0.5	2 / 0.2	4
Low	Rural/Semi-Rural Areas	2 / 0.2	0.6 / 0.06	10
Low	Low Density Residential (≤ 2 dwelling units/acre)	3 / 0.3	0.8 / 0.08	6
Low	Medium Density Residential (2.2 - 6 dwelling units/acre)	4 / 0.4	1 / 0.1	4

Abbreviation Definitions:

lux: Luminous Flux (lumens/m²)

fc: Foot-Candle (lumens/ft²)

E_{avg} : Minimum maintained average horizontal illuminance at pavement

E_{min} : Minimum horizontal illuminance at pavement

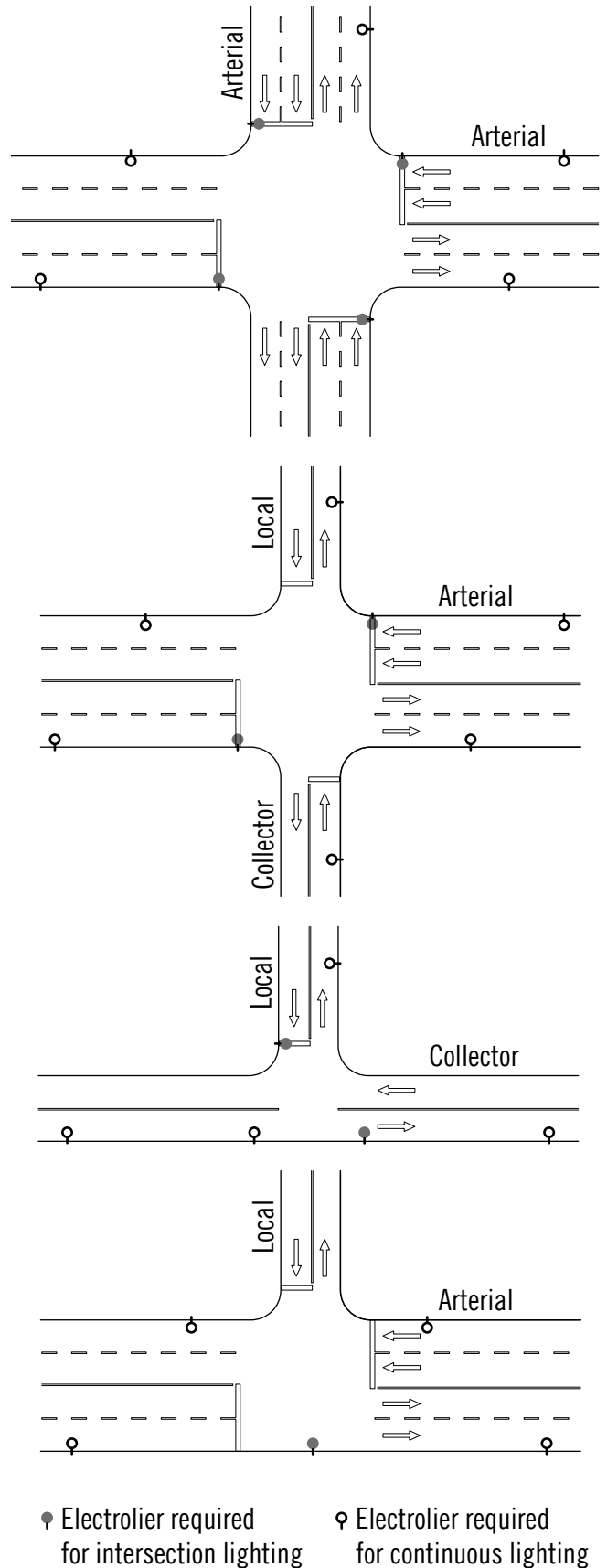
E_{vmin} : Minimum vertical illuminance at 5 ft above pavement

6.1.5 Recommended Illumination Levels for Miscellaneous Systems

- Stairways: Minimum average illumination level shall be 4 lux (0.4 fc) with a uniformity ratio of 4:1.
- Mid-Block Crosswalks: Crosswalks traversing roadways in the middle of blocks without signalization should be provided with additional illumination. Minimum average illumination level shall be 34 lux (3.4 fc) with a uniformity ratio of 3:1.
- Railroad Crossings: Minimum average illumination level shall be 9 lux (0.9 fc) with a uniformity ratio of 4:1. Illumination area shall extend to 100 feet before the railroad crossing and end 100 feet beyond the railroad crossing.

- **Bus Stop:** Minimum average illumination level shall be 25 lux (2.5 fc) with a uniformity ratio of 3:1.
- **Tunnels:** For road sections in a tunnel configuration, lighting must be designed to meet visibility requirements for day and night conditions. The in-depth process of creating a tunnel design is described in IES RP-22, Tunnel Lighting. Designers must follow the IESNA (Illuminating Engineering Society of North America) requirements and submit the analysis results to the City for review and approval.
- **Bridges:** Illumination levels on bridges shall be the same as for Roadway, per Section 6.1.3.4, unless directed otherwise by the City.

Figure 6.1 Typical Intersection Lighting



6.1.6 Intersection Illumination

Proper intersection lighting is a critical design component because of the numerous pedestrian and vehicular conflict points at intersections. In order to increase pedestrian visibility, electroliers shall be placed on the far right of the intersection to silhouette pedestrians for the direction of major traffic flow. Such an electrolier location provides an increased level of illumination through the intersection where conflicts occur.

Electroliers should be placed equidistant to each side of the intersection with sufficient spacing to provide the desired level of illumination at the intersection. At channelized intersections, a minimum of two electroliers shall be used so that the near left unit provides illumination of curb faces in the intersection. Figure 6.1 shows lighting configurations that will maximize pedestrian visibility at intersections. Table 6.4 provides intersection illuminance and uniformity criteria.

Table 6.4 Illuminance for Intersections

Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification (<i>lux / fc</i>)			Uniformity Ratio (E_{avg} / E_{min})
	High	Medium	Low	
Arterial/Arterial	34 / 3.4	26 / 2.6	18 / 1.8	3.0
Arterial/Collector	29 / 2.9	22 / 2.2	15 / 1.5	3.0
Arterial/Local	26 / 2.6	20 / 2.0	13 / 1.6	3.0
Collector/Collector	24 / 2.4	18 / 1.8	12 / 1.2	4.0
Collector/Local	21 / 2.1	16 / 1.6	10 / 1.0	4.0
Local/Local	18 / 1.8	14 / 1.4	8 / 0.8	6.0

Abbreviation Definitions:

lux = Luminous Flux (lumens/m²)

fc = Foot-Candle (lumens/ft²)

E_{avg} = Minimum maintained average horizontal illuminance at pavement

E_{min} = Minimum horizontal illuminance at pavement

6.1.7 Metering Requirements

The designer shall carefully evaluate whether all electrical loads in a particular area should be fed from one meter or if multiple meter connections should be used. If the same agency is paying for the energy bill, only one load center should be installed whenever economically feasible.

Once the required number of meters is determined, the designer shall contact the servicing utility to coordinate meter base location and hook-up procedure. It is recommended, though not required, to provide contact information on the design drawings for the servicing utility representative working on the project.

6.1.8 Luminaire Spacing and Height

The spacing of streetlights is often influenced by the location of existing utility poles, block lengths, driveways, property lot lines, proposed and existing trees, and a variety of other site specific items.

- Along arterials, the use of higher wattage fixtures at long spacing and high mounting heights is generally superior to the use of small lamps at closer spacing and lower mounting heights. Higher mounted luminaires provide greater coverage, better uniformity, and a reduction of glare, but they do so at lower illumination levels.
- Along collector and local roads, higher wattage lamps and mounting heights should not be used as they provide more illumination than is needed over the roadway and result in undesirable spillover light onto private property.

The designer should avoid placing luminaires in locations where the light would bother residential users or conflict with other utility services. In residential zones, including governmental and commercial uses such as hospital and hotels, shielding may be necessary to limit the spill-over of light onto and into adjacent residential buildings.

6.1.9 Luminaire Requirements

LED luminaires must be used for all new street lighting systems

Luminaire color temperature shall be between 3,500 Kelvin and 4,000 Kelvin with a minimum color rendering index of 80. Light distribution types shall be selected based upon the best alternative to meet the lighting requirements while minimizing light trespass onto adjacent areas. It is expected that most projects will utilize Type 3 distribution to illuminate the roadway and adjacent pedestrian areas.

Due to rapidly changing LED street lighting technology, designers should consult with staff in the Street Lighting Section of the Transportation Department on selecting the appropriate street light fixture for a specific project.

6.1.10 Luminaire Control

Street lighting shall be photocell controlled. Photocell is allowed to be mounted on top of a light fixture or adjacent to the source providing power to the lighting circuit. All light fixtures shall be provided with a 7-pin receptacle meeting ANSI C136.10 and ANSI C136.41 requirements. These receptacles are to allow the City of Dallas to take advantage of technological advances in controllability and monitoring in the future. Photocell must be a minimum of 8 feet above finished grade and pointed to the north. Confirm photocell operation and provide shielding as necessary if adjacent light sources disrupt proper operation.

6.1.11 Light Poles

Details concerning street light poles and street light pole foundations can be found in the Public Works Department Standard Construction Details File 251D-1.

Existing wood poles may only be used for mounting of streetlights, if approved by the owner of the poles and the City.

6.1.12 Voltage Drop

The maximum allowable voltage drop to any street light fixture shall be 5 percent. The voltage drop calculation must account for the entire circuit from the utility service to the furthest light fixture from the power source on the circuit. The voltage drop calculation must be included on the street lighting design drawings submitted for review to the City of Dallas Street Lighting section of the Transportation Department.

City-owned poles are serving multiple secondary functions, and that is expected to continue. Electrical power design shall consider and provide power for these secondary functions and capabilities including security cameras, communications, wireless data, and other smart technologies available or envisioned likely at the time of design. Coordinate with City staff regarding these needs and accommodations before final designs are prepared to define a list of project-specific requirements.

6.1.13 Pole Attachments

The City may allow third parties to use municipal poles for supplemental purposes such as antenna for data networks, communications, wireless services, etc. Please refer to information and documents which are available through the City's Right-of-Way Management division that include the City's "Small Cell Design Manual", related application forms, license agreement ("Service Pole Attachment Agreement"), installation and maintenance requirements, and other related information. Municipal pole use for these supplemental purposes requires written approval from the City in advance of such uses.



The background of the page is a blue-tinted photograph of a city street corner. On the left, there is a large, dark building. In the foreground, a street sign on a pole is visible, with the word 'GREEN' partially legible. The overall scene is slightly out of focus, emphasizing the text overlaid on it.

SECTION 7

Construction Plan Preparation

Plans are essential in defining the specifics of the project site and effectively organizing construction work. This section discusses requirements for the preparation and submittal of construction plans required by the City of Dallas for public and private development. This section also defines the criteria for each phase of the project and provides recommendations for typical sheet types.

7.1 GENERAL

Paving plans for construction of street, alley, and thoroughfare improvements in the City of Dallas, except those prepared for subdivisions shall be prepared in accordance with the Public Works Department procedures. The work required to prepare construction plans is normally divided into three phases: (1) Conceptual Design Phase, (2) Preliminary Design Phase, and (3) Final Design Phase. The Conceptual Design phase is normally performed as part of the design contract.

Plans submitted for subdivision construction shall be adequate to allow for review of design, special details (if required), and construction requirements. See Table 7.1 for a list of Construction Plans acceptable for both public and private developments in the City of Dallas.

The following shall be used in the preparation of construction plans for the network of street types, location of street intersections, median openings, alleys and driveway approaches that affect access to streets from adjoining properties.

Table 7.1 Construction Plans (Typical Organization)

City File # (Typ)	Sheet List Type
311 / 411	Cover Sheet
070 - 075	Final Plat
311	General Notes
	Quantity Summary
	Demolition Plan
	Barricade Plan
	Horizontal Control/Dimensional Control
	Pedestrian Facilities Plan
	Grading Plan
	Erosion Control Plan
	Erosion Control Details
	Paving Typical Section
	Paving Plan/Paving Plan and Profiles
	Paving Profiles (if applicable)
	Temporary Pedestrian Circulation Plan and Details
	Structural Plans and Details (if applicable)
	Traffic Signal Plans (if applicable)
	Sleeving, Striping and Signage Plan
Roadway Cross-Sections (if applicable)	
Roadway and Traffic Details (not covered by standards)	
313	Landscape, Hardscape and Irrigation Plans
	Landscape, Hardscape and Irrigation Details (not covered by standards)
421	Horizontal Control/Dimensional Control
	Drainage Area Map
	Drainage Calculations
	Storm Sewer Plan/Storm Sewer Plan and Profiles
	Storm Sewer Profiles
Drainage Details (not covered by standards)	
411	Horizontal Control/Dimensional Control
	Water and Wastewater Plan/Water and Wastewater Plan and Profiles
	Water Profiles (if applicable)
	Wastewater Profiles
Water/Wastewater Details (not covered by standards)	

Notes:

1. Use Dallas Drainage Design Manual for Storm Drainage Systems within the City of Dallas (421 Plan Sheets)
2. Use City of Dallas Water and Wastewater Procedures for Mains owned and operated by Dallas Water Utilities (411 Plan Sheets)

7.2 CONCEPTUAL DESIGN PHASE

7.2.1 General

The horizontal roadway layout or alignment is extremely important and is the basis of the conceptual design.

If the alignment is not already set, an alignment study shall be completed which consists of developing, reviewing, and comparing alternate alignments which meet the requirements of the proposed roadway. Areas to be reviewed and considered include, but are not limited to:

- Right-of-way requirements
- Thoroughfare functional classification
- Access requirements
- Traffic Control impacts
- Right-of-way costs
- Neighborhood service impacts
- Environmental impacts (floodplain, wetlands, noise, and aesthetics)
- Park services impacts (if adjoining or in Park property)
- Utility impacts
- School impacts
- Thoroughfare Plan requirements
- Dallas Bike Plan requirements

A 320R drawing with the proposed locations of the vertical control (bench marks) and the proposed location and stationing of the survey baseline shall be submitted to the Public Works Survey Division for review. The 320R is a “Roll Drawing”, meaning it shall be plotted on a single roll of plotter media, at a scale which allows for clear reading of all symbols and text. Upon approval, all horizontal and vertical control depicted on the 320R drawing shall be

established and marked in the field in accordance with the procedures outlined in Appendix A.3 and the Plan Production Workflow procedures shown on the City of Dallas Public Works website.

All surveying shall be referenced as being of three general categories:

1. Control Surveys
2. Boundary Surveys
3. Topographic Surveys

All City of Dallas Department of Public Works projects generally require all three types of surveys. Exceptions shall be approved by the Project Manager and the Office of the Chief City Surveyor on a case-by-case basis and must be in writing.

Stationing of Survey Baselines shall increase West to East and South to North, unless existing conditions require otherwise. Any deviation from this format must be approved by the Office of the Chief City Surveyor. Street stationing shall have station 10+00 at the intersection of the street centerlines where the project begins. Alley stationing shall have station 10+00 at the intersection of the centerline of the alley with the street right-of-way line projected. Alley centerlines and stationing shall extend back to the intersection with the centerline of the commencing street and show reference lines along the street centerline.

The established horizontal and vertical control shall be utilized in all subsequent surveying, whether boundary or topographic. Upon approval by the Public Works Survey Division, the 320R drawing shall be used to produce the final Horizontal and Vertical Control drawing for each project.

NOTE: No design shall begin unless an approved 320R drawing has been obtained from the Office of the Chief City Surveyor. This applies to any phase of design, whether conceptual, preliminary, proposed or final.

The Conceptual Design Phase has no requirement for parcel maps, Field Notes (the aggregation of documents comprised of the metes and bounds description and all associated drawings), or other final design phase submittals.

7.2.2 City Council Approval

Any property acquisition for right-of-way, whether street or alley, will require approval of the Dallas City Council. Any street design in the Central Business District or for a street on the City of Dallas Thoroughfare Plan which requires property acquisition may require a Council Alignment Map. Such maps are designated 221D, and a unique

number appended to this designation will be assigned by the Office of the Chief City Surveyor.

A Council Alignment Map represents a boundary survey, overlaid on the most current aerial photography and containing a Centerline of Proposed Alignment, paving layout and lane configurations, all Right-of-Way/Property Boundary lines and proposed acquisition parcels, referenced to the Centerline of Proposed Alignment with each proposed acquisition parcel given a unique sequential number and the area of each parcel shown. All dimensions and geometry necessary to define the Centerline of Proposed Alignment shall be labeled on the Council Alignment Map, and all proposed acquisitions shall have linear dimensions shown.

The Centerline of Proposed Improvement shall be monumented with iron rods or Mag Nails with caps or washers labeled "CENTERLINE" at each station, PC, PT, PI, PRC or PCC along the limits of the alignment.

The drafting standards required by the City of Dallas Department of Public Works shall be provided by the Office of the Chief City Surveyor, containing all line colors, levels, weights, line styles and typical symbols.

7.2.3 Deliverables for Conceptual Design Phase

The following are typical submittals for the Conceptual Design Phase:

1. 320R Roll Drawing(s)
2. Survey Control Data (level loop, Horizontal Control data)
3. Limits of Construction
4. Conceptual Design Report covering:
 - a Scope of Work (including project limits, project needs and purpose)
 - b Budget and funding sources
 - c Project constraints
 - d Cost estimate
 - e Right-of-way impacts and acquisitions
 - f Neighborhood or business impacts
 - g Environmental Impacts
 - h Utility impacts and issues

7.3 PRELIMINARY DESIGN PHASE

7.3.1 General

The preliminary design phase is the development of the project in sufficient detail to allow review by the Department of Public Works for compliance with design standards and to establish final criteria and details.

Preliminary Design may not commence until an approved Horizontal and Vertical Control drawing is released by the Project Manager. The established Horizontal and Vertical control shall be utilized and referenced in all subsequent surveying, whether boundary or topographic, and in all design. At the discretion of the City of Dallas, topographic surveys may be performed using aerial photogrammetry, LIDAR, or other scanning methods. Copies of all field observation data shall be furnished to the Project Manager to be reviewed by the Office of the Chief City Surveyor. All record documents acquired to establish the Right-of-Way / Boundary shall be provided to the Office of the Chief City Surveyor before a Horizontal & Vertical Control drawing will be approved. Copies of the level loop used to establish the Vertical Control (bench marks) shall be provided to the Office of the Chief City Surveyor before a Horizontal & Vertical Control drawing will be approved. Any and all information conveyed to the Office of the Chief City Surveyor shall be sent directly to the Project Manager to be forwarded to the Office of the Chief City Surveyor. All survey work shall conform to the requirements shown in Appendix A.3 and the Plan Production Workflow procedure shown on the City of Dallas Public Works website.

If the paving project includes storm drainage improvements, the hydraulic design of the proposed storm drain shall be accomplished based on procedures and criteria outlined in the City of Dallas Drainage Design Manual.

The design engineer shall establish the scope, schedule and coordinate the geotechnical investigations required to establish the project design.

7.3.2 Survey Requirements

The following requirements apply to surveys:

1. Almost all City of Dallas projects will require a property boundary survey. If the property lines are not well established, the project may be built on private property. Projects that have the potential to disturb the area near the edge of the right-of-way or property boundary, typically within ten feet, shall have recent boundary survey. Using fence lines or other surface improvements is not reliable for determining boundaries.
2. Boundary descriptions shall be prepared by a professional Land Surveyor and shall be based upon a recent boundary survey. All boundary surveys must comply with the Texas Professional Land Surveying Practices Act and General Rules of Procedures and Practices (most current publication), and the City of Dallas Field Note Guidelines.
3. Survey control, both horizontal and vertical, must be established on-site for all projects.
4. All vertical control (bench marks) must be based on the City of Dallas Bench Mark Network.
5. Bench marks may only be established using Differential Leveling (this includes Digital Electronic Levels). The use of Trigonometric Leveling or Global Positioning System observations to establish bench marks will not be accepted.
6. A copy of the Level Loop run to establish elevations for Project bench marks must be submitted to the Office of the Chief City Surveyor before a final Horizontal and Vertical control drawing will be approved. If additional control, whether horizontal or vertical is required, all data (including a supplemental level loop) shall be submitted to the Office of the Chief City Surveyor for review.
7. All plan sets must include a Horizontal and Vertical Control drawing, produced in accordance with City of Dallas Standards, signed and sealed by a Texas Registered Professional Land Surveyor, and submitted to the Survey Division for review.
8. The Horizontal and Vertical Control drawing must show and contain a narrative description of all project bench marks.
9. A Survey Baseline must be established and monumented for all alignment surveys in compliance with City of Dallas Standards.

10. The Horizontal and Vertical Control drawing must contain the following for all abutting properties: street address, names of all owners and recording information, block number, lot number and additional name and recording information (if platted), and property dimensions.
11. The horizontal datum for all City of Dallas projects must be the North American Datum of 1983. Vertical datum must be based on the City of Dallas Bench Mark Network (NGVD 1929).
12. The Basis of Bearings shall be the North American Datum of 1983, Texas North Central Zone 4202, Realization of 2011 (or latest Realization).
13. The final Horizontal and Vertical Control drawing must be approved by the Office of the Chief City Surveyor before the 65% design submittal phase.

7.3.3 Preliminary Plans

For preliminary construction plans, all sheets shall be set up for 11-inch by 17-inch format and shall be legible. Lettering shall be sized at a minimum 1/8" or 11 font equivalent to be easily read. Each plan sheet shall show the revision date and print date for that sheet. Plans shall include the following:

- Cover Sheet
- Quantity Summary Sheet
- Horizontal and Vertical Control Sheet
- Typical Paving Section and Detail Sheet (including General Notes)
- Paving Plan and Profile Sheets
- Paving Cross Sections
- Drainage Area Map
- Drainage Plan and Profile Sheets
- Drainage Cross Sections (if required)
- Erosion Control Plan

Other items which may be required include a sequence of construction, street lighting plans, and traffic signals, signs, and pavement marking plans. If bridge, box culvert, or other structures are involved, preliminary plans shall include structure plan-profile sheets and typical section/detail sheets for the structure(s).

7.3.4 Horizontal and Vertical Control Drawing

The Horizontal and Vertical Control drawing shall provide control as specified in Appendix A.3. Survey control depicted on the Horizontal and Vertical Control drawing shall be shown on all engineering design sheets and shall control all design and construction. Survey control shall be referenced to the Right-of-Way / Boundary sufficient to allow staking of the boundary of the street or alley. See Appendix A.3 and the Plan Production Workflow procedures shown on the City of Dallas Public Works website for details on horizontal and vertical control requirements.

7.3.5 Paving Plan and Profile Sheets

All paving plan and profile sheets shall be based on the approved Horizontal and Vertical Control drawing. Paving plan and profile sheets shall be prepared with a horizontal scale of one-inch equals forty feet (1" = 40') and a vertical scale of one-inch equals ten feet (1" = 10'). In the plan view, the centerline of the street shall be drawn and stationed at one hundred feet intervals, and each sheet shall begin and end with even or fifty feet stations. The centerline length on each sheet shall not exceed 500 feet.

Also shown on the plan view shall be the horizontal geometrics and dimensions of the proposed paving improvements including curb and gutter, median, pavement edges, driveways, sidewalks, alley approaches, street approaches, street headers, temporary pavement, etc. Where the cut or fill exceeds 0.5 foot vertically from existing ground at the property line, the top of the cut slope or the toe of the fill slope shall be shown on the plan.

Right-of-way information shall include dimensions of existing and proposed property lines and easements and shall be shown on the proposed street and intersecting streets. All lots fronting on the proposed street shall be dimensioned and shall be identified by the lot and block number, house number, and ownership.

The proposed paving improvements shall be cross-hatched/shaded as necessary to clarify the intent of the plans. Pavement dimensions, unless otherwise noted, shall be to the face of the curb. City of Dallas CAD standards, shall be used in preparing the plans. Download the latest drafting standards from the City of Dallas ftp site at <ftp://ftp.dallascityhall.com/PBW/CAD Standard>. All plans prepared for the City shall be prepared using Computer Aided Drafting and Design Methods (CADD) unless authorized in writing by the City.

The design engineer shall, through the City Project Manager, coordinate with the Transportation Engineering Section for planned locations of traffic control facilities, median lighting,

and other appurtenances which should be included with the construction plans. The design engineer shall be responsible for the design, layout, and inclusion into the plans of said appurtenances when they are required for the project.

Proposed storm drainage systems and inlets shall be shown on the paving plan indicating the paving station at the centerline of the inlet, inlet size, inlet type, top of curb elevation, and inlet flow line. The throat elevation shall be given for all proposed "Y" type inlets. Existing storm drainage systems and utilities shall be properly shown and identified.

Other data to be shown on each plan sheet shall include two City of Dallas benchmarks, which will not be disturbed by the proposed work and will remain after construction of the improvements, flow arrows indicating direction of storm water flow, street names, match lines, scale, north arrow, item numbers, etc. The item numbers shall identify items of work to be completed and shall be taken from the City item list.

The profile section shall show the existing ground profile at each right-of-way line and the proposed top of curb profile on each side of the street. The existing ground profiles shall agree with the ground line shown on the cross sections. If the street has a median, the profiles of the median curbs shall also be shown with the existing ground profile, at the pavement centerline. On the profile section street intersections, the top of curb elevations at the horizontal curb P.I.'s together with the paving stations shall be shown along with the name of the intersecting street.

Street grades should be determined according to the procedure in Appendix A.2. Of utmost importance in determining street grades is the safety of all persons and vehicles using the street. The convenience and comfort of through traffic must be balanced against the necessity to serve the abutting property.

Road construction plans shall show transitions across intersections, even if the intersection is beyond the project limits unless the nearest intersection curb return is 150 feet or greater away from the tie-in point.

The proposed street grade shall be indicated to the nearest one hundredth percent. Vertical curve data shall be shown including length of vertical curve, mid-ordinate distance (M), station and elevation at point of vertical intersection (PVI), point of vertical curvature (PVC), point of vertical tangency (PVT), and high point or sag point station and elevations.

Elevations of the proposed top of curb shall be shown at fifty-foot stations including elevations on vertical curves at the fifty-foot stations as well as at the starting and ending stations of the vertical curves. Station and elevations of low points on sag vertical curves and high points on crest vertical curves shall also be shown.

7.3.6 Cross Sections

Cross sections shall be taken at the locations and in the manner described in Appendix A.3. Cross sections must be adequate for use in engineering design, calculation of excavation and fill quantities, and showing the effect the proposed construction will have on abutting property.

The usual scale for plotting cross sections will be 1"= 4' vertical and 1"= 10' horizontal. Special conditions may require variations in the scale used. Prior approval from the City of Dallas for variations in scale will be required. Cross sections shall be plotted on standard size 11"x 17" paper sheets.

Each section shall be clearly defined by centerline station and elevation. A clear description shall be added to the section if other than at 100 feet or 50 feet stations. Cut and fill areas shall be recorded for each section, quantities calculated, and quantities summarized corresponding to paving plan sheets.

Each sheet shall have a title block in the same relative position as the paving plan sheets giving the project name and limits, scale, file number and sheet number.

Each paving project shall be defined by one or more typical paving sections. The typical section(s) shall be placed on the quantity summary/general note sheet or on a separate detail sheet. Information which shall be shown on the typical section(s) includes:

- Paving station limits for which typical section(s) applies
- Right-of-way width
- Proposed type and dimension of pavement
- Subgrade stabilization including width and depth of treatment and amount of lime or cement to be added to the existing soil, or depth and type of imported base material. Compaction requirements should also be shown.
- Type, width, depth and treatment of base (if required)
- Curb type and details
- Driveways and driveway grades
- Location and width of sidewalks including minimum and maximum slope which will be allowed. If the sidewalk abuts the curb, a sidewalk lug or doweling shall be included with all necessary details.
- Median width and location
- Pavement crown or cross slope (min. and max.)

- Buffer/furnishing/curb zone dimensions and requirements
- Ties to existing grade (with max and min slopes)
- Existing typical ground line and typical features
- Retaining walls (if required)
- Removal and pay limits with associated item numbers
- Travel lane widths (as applicable)
- Bike lane widths (as applicable)
- Bike lane buffer widths (as applicable)
- Parking lane widths (as applicable)
- Turning lane widths (as applicable)
- Total curb to curb width (as applicable)

7.3.7 Storm Drainage Plans

Storm drainage plans to accompany the paving project shall be prepared in accordance with Section 10 - Submittal Requirements of the City of Dallas Drainage Design Manual. Storm drainage plans accompanying paving plans must have a separate drainage file number, and all sheets shall be numbered separately from the paving plans.

7.3.8 Storm Water Pollution Prevention Plan (SWPPP) and Erosion Control Plan

An erosion control plan showing NCTCOG best management practices (BMP) for construction activities (silt fence, inlet protection, etc.) with the associated items and quantities shall be included in the design of all roadway and private development projects. The erosion control plan shall define site parameters and techniques to be employed to reduce the release of sediment and pollution from the construction site. The design shall provide at least 70% effectiveness for entrapment of project generated sedimentation and pollution.

Projects which have a disturbed area of one acre or more shall require a complete SWPPP meeting the Texas Commission on Environmental Quality (TCEQ) regulations, submittal and reporting requirements. The SWPPP shall be prepared by the contractor as part of the construction contract. Projects which have a disturbed area of less than one acre do not require a complete SWPPP that meets all of TCEQ regulations; however, standard types of erosion and pollution prevention controls and associated locations shall be included in the erosion control plan by the designer.

7.3.9 Review of Preliminary Plans

Prior to submittal of preliminary plans, the engineer responsible for the project shall have walked the project and thoroughly reviewed the preliminary plans with the existing conditions on site to insure accuracy and completeness of the design. Upon submittal of the preliminary plans, a review will be completed and comments provided outlining areas of concern or items which need to be addressed before distribution to other City Departments.

After the preliminary plans have been reviewed and modified as needed, and before preparation of final plans, reproducible drawings shall be submitted to the Public Works Department by the designer. Copies of the preliminary plans may be distributed to other City departments and utility companies for their review and comment. Comments received which may be resolved by redesign shall be addressed in the final design phase.

7.3.10 Deliverables for Preliminary Design Phase

The following are possible deliverables to consider for this phase:

- Plan sheets (per previously stated criteria)
- Preliminary Design Report indicating any revisions from the Concept Design Report
- Geotech Report (sealed by the Project Geotech Engineer)
- Traffic studies (sealed by the Project Traffic Engineer)
- Draft design exceptions
- Right-of-way descriptions for easements or acquisitions (sealed by the Project Land Surveyors)
- Utility plats (from each affected utility)
- Needs for utility potholing
- Environmental certifications
- Preliminary cost estimate
- Specifications outline

7.4 FINAL DESIGN PHASE

7.4.1 General

During the final design phase, the construction plans shall be placed in final form. All sheets shall be set up for 11-inch by 17-inch format and shall be legible. Lettering shall be sized at a minimum 1/8 inches or 11-foot equivalent to be easily read when the plans are reduced and placed on microfilm. Each plan sheet shall show the revision date and print date for that sheet. Special provisions/specifications for nonstandard work or materials shall be submitted to the City for review and approval.

7.4.2 Preparation of Final Plans

7.4.2.1 Final Design and Drafting

Review comments shall be considered, additional data incorporated, and the final design and drafting of the plans completed. All geometrics of paving improvements, pavement removals, storm drains, paving grades, elevations, storm drain sizes and grades, existing signs to remain, signs to be removed and replaced, proposed signs, utility locations, special notes, items, and quantities shall be completed and checked by the design engineer, and each plan-profile sheet shall have two benchmarks shown. General notes (provided by the City) shall be added to the plans. A quantity summary plan sheet providing a sheet by sheet breakdown of item numbers, estimated quantities, and bid quantities shall be prepared. Each drawing shall be sealed and signed in the lower right hand corner by a licensed Professional Engineer of the State of Texas and / or other appropriate professionals as needed.

7.4.2.2 Correlation between Paving Plans, Drainage Plans, Erosion Control Plans, Cross Sections and Structural Plans

In preparing the final plans, the engineer shall insure that paving, storm drain, and inlet stations and elevations are correctly shown on storm drainage plans, structural plans, and paving plans if applicable. Inlet locations on storm drainage plans shall conform to inlet locations as shown on the drainage

area map and paving plans. Proposed pavement location shall agree horizontally and vertically between paving plans, storm drainage plans, structural plans, and cross sections. Existing and proposed walls, pavement, drive approaches, and proposed grading shall be shown on the cross sections and shall coincide with the locations and extent specified on the paving and structural plan. Striping plans shall show pavement markings across intersections, even if the intersection is beyond the project limits. Striping and traffic signal plans shall indicate lane striping, widths and curve data. Street lighting plans shall be prepared and sealed by a licensed professional engineer competent in street lighting design.

7.4.2.3 Standard Construction Details

Standard Construction Details, File 251D-1, have been prepared by the Public Works Department. These standard details shall be used in design as needed.

7.4.2.4 Special Details and Specifications

Any special details required for the project and not shown on the Standard Construction Details, File 251D-1 shall be prepared by the engineer and included in the plans. Structural details for bridges, special retaining walls, headwalls, junction boxes, culverts, special inlets, etc. shall be provided as well as bridge railings, hand railings, special barricades (permanent and temporary), and warning signs.

Material and construction specifications which are not a part of the standard specifications as currently amended by the City of Dallas addendum to the NCTCOG Public Works Construction Standards shall be submitted in writing as a part of the Special Provisions.

A sequence of construction plan shall be prepared if required by the Public Works Department to guide the contractor in preparing the traffic control plan(s) needed for construction. The traffic control plan shall provide for maintenance of traffic as required by the Traffic Safety Division. Access requirements, use of existing paving, cut and fill requirements, traffic requirements, public convenience and safety, and minimizing cost and schedule shall be considered when determining the sequence of construction. The sequence of construction shall be general in nature in addressing the above concerns yet at the same time providing for sound construction practices and flexibility to the contractor. The traffic control plan shall be in compliance with the Texas Manual on Uniform Traffic Control Devices, as currently amended.

Structural analysis computations shall be provided in a legible form for any existing structure which will act as a support or supplement to the designed facility.

Items on the plans requiring special provisions and special construction techniques shall be clearly delineated on the plans and specifically called to the City's attention by letter prior to final plan submission.

7.4.3 Preparation of Field Notes

Field notes shall be prepared in accordance with the Public Works Department Survey Section "Field Note Guidelines", for street right-of-way, drainage easements, slope easements, temporary working area easements, and all other easements required for the construction of the project together with legal descriptions and parcel maps. Upon receipt of approval by the City, the field notes and related paperwork shall be submitted to the City's Project Engineer.

7.4.4 Submission of Final Plans

Before submission of final construction plans, the engineer shall carefully review plans against the check list in Appendix A.4. The completed check list shall be submitted with the final plans.

After completion of final plans for City improvement projects, the engineer shall prepare and submit a final construction cost estimate for the project. The estimate shall include the subtotal costs for paving, storm drainage, traffic control, striping, pavement markings, and bridge or major structure. The Department of Public Works' list of updated average unit prices is available to assist the Project Engineer in preparing the cost estimate. The final documents shall be delivered to the Public Works Department and shall include:

1. Final plans and cross sections including DWU plans on DMIBOP10 "Indoor-Banner-Outdoor Poster Paper" (Nylon Reinforced 10mil/250 Micron)
2. One set of 22-inch by 34-inch prints of final DWU plans on Mylar
3. One set of 11-inch by 17-inch prints of final plans and cross sections including DWU plans
4. Eleven sets of 22-inch by 34-inch prints of final DWU plans (including cover sheet)
5. Computer disk of final design (CADD file) which shall include the alignment/horizontal control drawing
6. Final construction cost estimate
7. Field survey notes
8. Hydraulic calculations used for drainage design
9. Structural design notes and calculations (if required)
10. Approved Special Provisions for non-standard work or materials (if required)
11. Right-of-way and easement field notes, legal descriptions, and parcel maps (if required)
12. Completed check list from Appendix A.4



Appendices

A.1

FIGURES AND TABLES

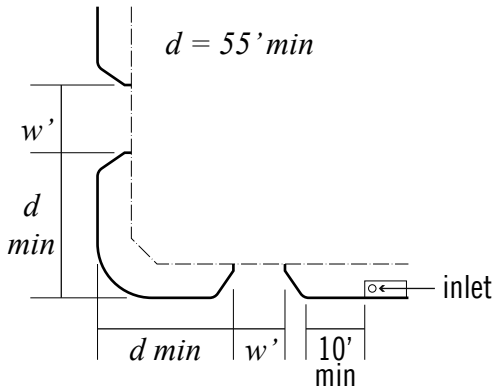
Table 2.1 Typical Characteristics of Functional Classifications

	Designated Frequency			Undesignated Thoroughfares ¹	
	Principal Arterial	Minor Arterial	Community Collector	Residential Collector	Local
Function	Backbone of the street system; Mobility function is primary; Access function is minor; Serves long trip lengths	Provides route and spacing continuity with principal arterials; Mobility function is still primary; Access function is secondary; Serves moderate trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; Serves short trip lengths	Collects/distributes traffic between local streets and arterial system; Mobility and access functions are balanced; through traffic is undesirable; Serves short trip lengths	Remainder of surface streets; Access is primary; Through traffic is undesirable; Serves short trip lengths
System Continuity	Regional Continuity; Connects with freeway system; Crosses several community boundaries	Community continuity; Connects with freeway and arterial systems; Usually does not cross community boundaries	Neighborhood continuity; connects to arterial system; may extend across arterials	Neighborhood continuity; Connects to arterial system; Usually does not extend across arterials	Discontinuous
Roadway Length	>5 miles	2 to 5 miles	1/2 to 2 miles	1/2 to 2 miles	<1 mile
Traffic Volume	>3,500 vld 8 lanes: >28,000 vpd 6 lanes: >21,000 vpd 4 lanes: >14,000 vpd	2,500 to 5,000 vld 5 lanes: 15,000-30,000 vpd 4 lanes: 10,000-20,000 vpd 2 lanes: 5,000-10,000 vpd	1,250 to 3,500 vld 4 lanes: 5,000-14,000 vpd 2 lanes: 2,500-7,000 vpd	1,250 to 2,500 vld 4 lanes: 5,000-10,000 vpd 2 lanes: 2,500-5,000 vpd	<1,250 vld 2 lanes: <2,500 vpd
Spacing	1 to 2 miles	1/2 to 2 miles	1/2 mile from other thoroughfares	1/2 mile from other thoroughfare	300' to 500' from other streets
Neighborhood Relationship	Traverses boundaries	Traverses boundaries	Traverses boundaries	Usually internal to one neighborhood	Internal to one neighborhood
Direct Land Access	Restricted; Some movements may be prohibited; Driveway spacing and number strictly controlled	Restricted; Some movements may be prohibited; Design controls are used to ensure safety	Design controls are used to ensure safety; limited regulation	Design controls are used to ensure safety	Design controls are used to ensure safety
Posted Speed	30-45 mph	30-40 mph	30-35 mph	30 mph	30 mph
Parking	Restricted	Restricted	Permitted	Permitted	Permitted
Through Truck Routes	Permitted	Permitted in Commercial Areas	No	No	No
Bus Routes	Yes	Yes	Yes	Yes	Not Encouraged
Bicycle Routes	Not Recommended	Not Recommended	Limited	Encouraged	Encouraged
Sidewalks	Yes	Yes	Yes	Yes	Yes

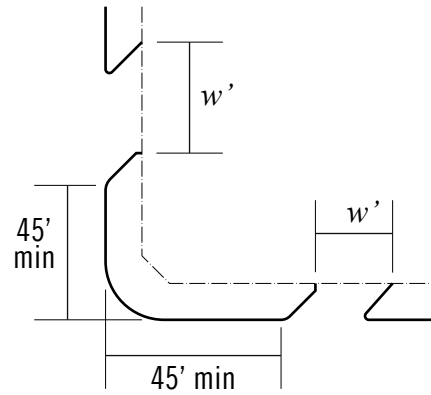
Figure 3.8 Minimum Distance from Intersections for Driveways

1. Intersection- Arterial thoroughfares with arterial & collector thoroughfares or pedestrian or school crossing

(A) 90° driveway approaches

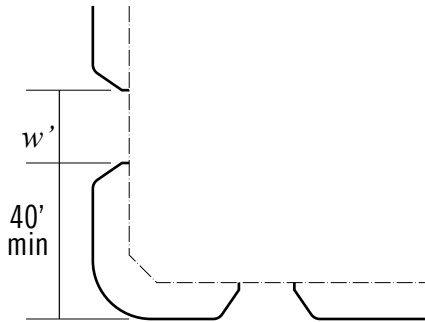


(B) Angle or oneway approaches

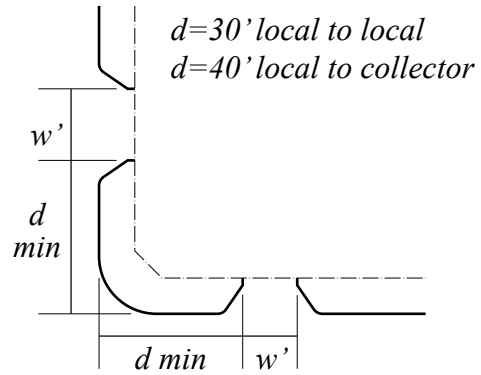


2. Intersection- All other cases (without free right turn lane)

(A) Arterial thoroughfare with local residential collector

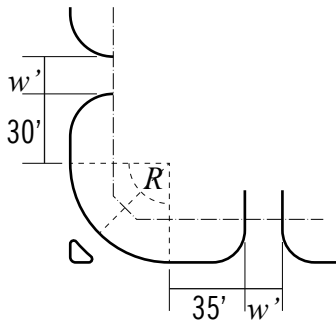


(B) All other cases

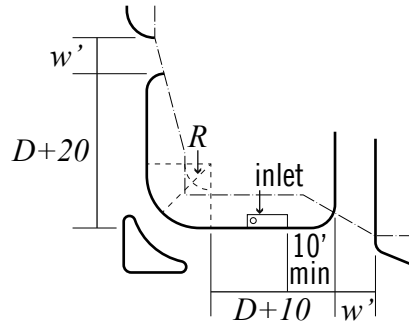


3. Intersection- Free right turns

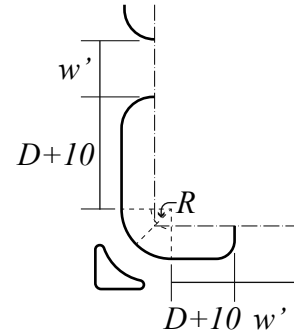
(A) Free right turn lane no acceleration or deceleration lanes



(B) Free right turn lane acceleration or deceleration lanes may exist



(C) Free right turn lane continuous flow



For arterial thoroughfares (standards apply to both 90° and angle approaches) location of driveway is dependent upon speed and free right turn traffic volume return percent.

R = Curb Radius

W = Min Driveway Width

D = D-Value (see Table 3.1)

Figure 3.9 Visibility Triangle Guidelines

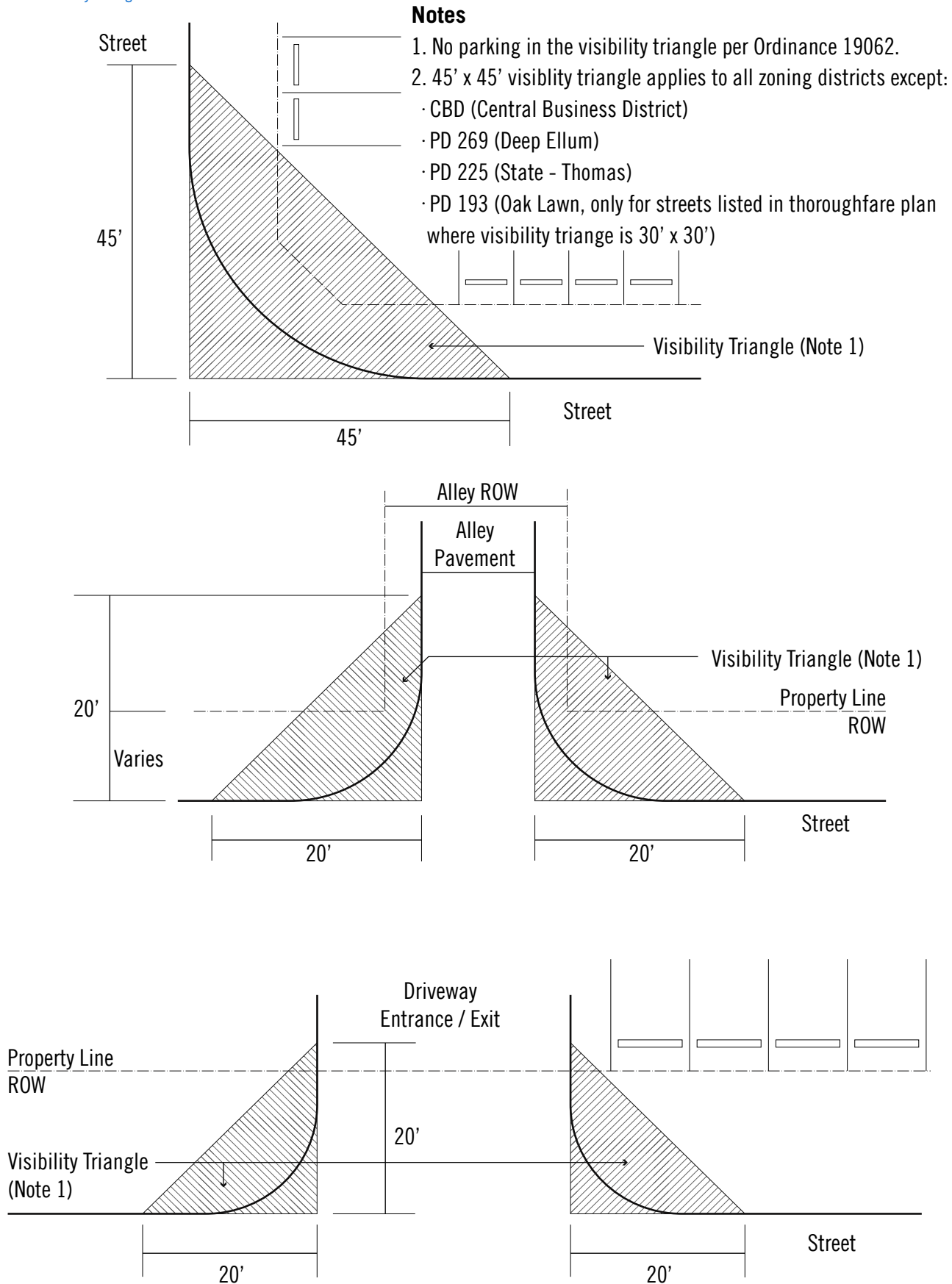


Table 4.5 Minimum Centerline Radius for Thoroughfares

Superelevation Rate		Min Centerline Radius (ft) ¹ Target Speed (mph)						
(in/ft)	(ft/ft)	25	30	35	40	45	50	55
-1/2	-0.0417	210	340	530	780	1,120	1,700	2,260
-3/8	-0.0313	200	320	500	730	1,030	1,540	2,030
-1/4	-0.0208	190	210	470	680	950	1,400	1,830
-1/8	-0.0104	180	290	440	640	890	1,290	1,680
0	0	170	280	420	600	830	1,200	1,540
+1/8	+0.0104	160	260	400	570	780	1,110	1,430
+1/4	+0.0208	160	250	380	540	740	1,040	1,330
+3/8	+0.0313	150 ²	240	360	510	700	980	1,250
+1/2	+0.0417	150 ²	230	350	490	660	920	1,170

¹ Minimum centerline radius for Local L-2-U (B) section streets is 150 feet, for Local L-2-U (A) section streets is 200 feet, and for Local S-2-U and M-2-U section streets is 230 feet for residential zoned districts and 280 feet for all other zoned districts.

² Minimum centerline radius is 150 feet.

Table 4.6 Horizontal Curve Restrictions Due to Intersection Site Distances

Classification Section	Target Speed (mph)	Left Side (ft)				Right Side (ft)			
		Desirable Min		Safety Min		Desirable Min		Safety Min	
		<i>SD</i>	<i>R</i>	<i>SD</i>	<i>R</i>	<i>SD</i>	<i>R</i>	<i>SD</i>	<i>R</i>
Local									
L-2-U (B)	25	235	460	110	150 ²	240	350	150	150 ²
L-2-U (A)	25	235	540	110	200 ³	240	360	150	200 ³
M-2-U	30	315	1,290	145	275	315	745	200	290
S-2-U	30	315	970	145	210	315	605	200	230
Residential Collector									
M-2-U	35	405	2,130	180	425	410	1,280	225	370
S-2-U	35	405	1,600	180	320	410	1,040	225	300
M-4-U ¹	35	405	1,500	180	310	410	985	225	280
Community Collector⁴									
M-2-U	40	485	3,060	225	660	485	1,800	275	565
S-2-U	40	485	2,300	225	495	485	1,470	275	455
M-4-U ¹	40	485	2,220	225	480	485	1,390	275	430
Minor Arterial⁴ (undivided)									
M-4-U	40	485	3,050	225	660	485	2,050	275	645
S-4-U	45	575	5,450	270	1,210	580	4,320	325	1,350
Minor Arterial⁴ (divided)									
M-4-D (B)	40	485	3,050	225	660	500	1,640	275	475
M-4-D (A)	45	575	3,900	270	865	595	2,120	325	610
S-4-D	50	675	6,650	325	1,560	700	3,570	400	1,150
Principal Arterial (couplet⁵)									
M-3-U	45	575	5,030	270	1,110	575	5,030	270	1,110
M-4-U	45	575	4,280	270	950	575	4,280	270	950
S-3-U	45	575	3,980	270	880	575	3,980	270	880
S-4-U	45	575	5,460	270	1,210	575	5,460	270	1,210
Principal Arterial (divided)									
M-6-D (B)	45	575	6,300	270	1,400	610	3,110	325	865
M-6-D (A)	50	675	6,040	325	1,420	710	2,850	400	880
S-6-D	55	780	7,330	375	1,710	825	3,500	450	1,020
S-8-D	55	780	7,770	375	1,810	840	3,290	450	910

¹ Striped for two lanes

² Minimum centerline radius for street set to 150 feet

³ Minimum centerline radius for street set to 200 feet

⁴ Collector thoroughfares which are designated with Minor Arterial sections with 4 lanes of traffic shall be designed to Minor Arterial Standards. Minor Arterial thoroughfares which are designated with Principal Arterial sections with 6 lanes of traffic (3 lanes in each direction) shall be designed to Principal Arterial Standards.

⁵ Applicable for oncoming traffic side on one-way couplet.

SD - Sight Distance

R - Radius

Table 4.7 Sight Easement Requirements Due to Intersection Site Distances

Classification Section	Table 4.7 Radius (ft) (no crossfall)	Min Radius with Sight Easement (ft)				
		0	1	2	3	4
Community Collector						
M-2-U	600	660	595	565	535	565
M-2-U ²	600	660	595	540 ²	495 ²	460 ²
Minor Arterial (undivided)						
M-4-U ²	600	660	590 ²	540 ²	495 ²	455 ²
S-4-U ²	830	1,350	1,040 ²	915 ²	820 ²	750 ²
Minor Arterial (divided)						
M-4-D (B)	600	660	590	540	495	475
M-4-D (A)	830	865	785	715	660	-
S-4-D	1,200	1,560	1,360	1,210	1,150	1,150
S-4-D ²	1,200	1,560	1,360	1,210	1,100 ²	1,010 ²
Principal Arterial (couplet)						
M-3-U	830	1,110	965	860	780	710
M-4-U	830	950	850	770	705	655
S-3-U	830	880	790	720	660	-
S-4-U	830	1,210	1,040	915	820	750
Principal Arterial (divided)						
M-6-D (B)	830	1,400	1,170	1,020	905	865
M-6-D (B) ²	830	1,400	1,170	1,020	905	820 ²
M-6-D (A)	1,200	1,420	1,260	1,140	1,050	965
S-6-D	1,540	1,710	1,540	1,410	1,300	1,200
S-8-D	1,540	1,810	1,620	1,470	1,350	1,250

¹ Sight easements are required along the inside right-of-way curves only to achieve the above minimum centerline radii except for the M-4-U and S-4-U sections and for those cases footnoted below in which cases, sight easements are required along both the inside and outside right-of-way curves.

² This section requires sight easements along both sides of the street right-of-way to achieve reduced minimum centerline radii shown in parenthesis.

A.2

PROCEDURE FOR SETTING STREET GRADE

1. Plot left and right ground line profiles along the property lines on plan sheets. Check for the following:
 - a Show drives, intersections, ditches, etc. Profiles must give realistic picture of conditions grades must meet.
 - b If additional right-of-way is to be acquired, confirm profiles have been plotted along the proposed property line, not existing property line.
 - c If property line falls in a ditch, show a second profile at normal ground elevation also.
 - d Check any sharp breaks in the profile which might identify plotting errors.
 - e Confirm that the profiles plotted agree with the cross-section information.
2. Spot critical points in profile which will control top of curb elevation. Calculate maximum curb elevation permissible at these points.
3. Lay tentative grade for low side of street.
 - Minimum grade = 0.4%
 - Desirable minimum = 0.5%.
4. Lay matching grade on high side of street. Watch the following:
 - a On streets with parabolic crown, avoid all crossfall unless conditions require it, and then crossfall must not exceed 1/2 foot. Remember that a few tenths of a foot crossfall seldom benefits enough to justify the reduced water carrying capacity of the street.
 - b On divided streets the cross slope of traffic lanes should not be less than 6 inches between curbs nor more than 1/2 inch per foot any place in the roadway.
 - c Avoid fill if at all possible. If absolutely necessary to fill, try to limit height so access to abutting property will not be restricted.
 - d In extreme cases the street may cross slope the same direction for the full width of the street. Special permission is required for this.
 - e Occasionally the centerline of the proposed pavement can be offset from the centerline of right-of-way to aid in matching improvements on the high side.
 - f In flat areas try to keep top of curb 1/2 foot below ground at property line. This will assure good drainage from the abutting property.
 - g If street is in the flood plain, the minimum curb elevation must be at least one foot above the design surface elevation (1% AEP storm water surface elevation or elevation of design flood of record, whichever is higher), provided by the Flood Plain Management section of Dallas Water Utilities. Streets crossing creeks require higher minimum curb elevations (see Drainage Design Manual Section 4.2).
5. Use standard design criteria for vertical curves. Safe sight distances must not be compromised.
6. Check safe speed of all curves. Superelevation may be necessary on short radius curves to maintain safe target speed.
7. Avoid changing shape of crown since this requires hand work by the contractor and increases cost.
8. Plot proposed tops of curbs on cross sections. Check for proper slope in parkway at every location. Look for places grade may be improved to serve property better. Numerous breaks in grade to enhance value of abutting property are preferable to long straight grades which may be detrimental to property.
9. Check every intersection carefully. Give special attention to:
 - a Drainage. Make sure ditches and gutters drain.
 - b Riding quality. This is very important at the intersection of two thoroughfares. Severe grade breaks must be avoided in both directions.

- c Approach grades should not be over 4%. Steeper grades require special consideration. Motorists should be able to see approaching traffic clearly in both directions.
10. Check both ends of project as to drainage and riding quality. Avoid such solutions as “Grade to Drain.” If necessary to drain into existing ditches show ditch profiles and proposed grades in profile. Show spot ditch elevations in plan view.
 11. Sags in grade should fall at locations where inlets will cause least inconvenience to abutting property owners.
 12. Outside curb and median curb grades on arterial thoroughfares follow the curb line of the through traffic lane, usually 7.5 feet from centerline for median curbs. Therefore it is necessary to show spot top of curb elevations at critical points on right and left turn lanes. Show these in the plan view. Slope of right and left turn lane should match slope of adjacent through lanes if possible.
 13. In general, street grades must meet the needs and safety requirements of the traveling public, but must also serve the abutting property. Do not neglect the property owner who will be assessed for a portion of the cost of paving.

A.3

PROCEDURES FOR ESTABLISHING HORIZONTAL AND VERTICAL CONTROLS

A.3.1 General Survey Requirements

A.3.1.1 Horizontal and Vertical Control

- A. All Horizontal control shall be identifiable marks; a Mag or 60-D nail with washer or an iron rod with cap stamped “BASELINE”. Horizontal Control shall be as stable as conditions permit. All Vertical Control (bench marks) shall be set on stable, accessible material, in public (City of Dallas) property. Consideration shall be given to establishing bench marks outside the limits of construction, as far as conditions permit.
- B. A digital CAD file with all line work and symbology on the proper level, line style, line weight and color as specified by the City of Dallas shall be submitted to the Project Manager along with an electronic raster (.pdf or approved equivalent) file on Compact Disc (no flash drives will be accepted). Hardcopy for preliminary review may be submitted on standard engineering bond. All final hardcopy submittals must be on the DMIBOP10 media specified in Section 7 herein.
- C. All final submittals of Horizontal and Vertical Control drawings shall bear the seal and signature of the Texas Registered Professional Land Surveyor responsible for the work and shall bear the standard certification statement provided by the Office of the Chief City Surveyor.
- D. Digital drawing files shall be in a format compatible with the City of Dallas CAD software, and shall allow the determination of coordinate values for any point depicted on the file.

- E. The Horizontal and Vertical Control drawing shall have all Survey Baseline and Reference Line stations shown, and a numbering system developed for controlling monuments which are not on the Survey Baseline. Major Horizontal Control elements, Baseline index stations 10+00, 15+00, etc., as well as Controlling Monuments deemed significant by the Project Surveyor, shall have State Plane Coordinate values tagged to the point, as well as the Surface Projection values necessary for construction of the project. NO Surface Projection Coordinate values shall be shown which appear the same as State Plane Coordinate values. The surveyor shall truncate Surface Projection Values in the manner stipulated by the Office of the Chief City Surveyor.
- F. Both the State Plane Coordinate and Surface Projection Coordinate values for major Horizontal Control points shall be shown in a table with the attendant Point Number, Northing, Easting and description of the mark or monument set or found.
- G. The centerline pavement stationing shall be given on the Alignment / Horizontal Control Drawing at the beginning and end of the project.
- H. Curve data shall include the Radius, Central Angle, Arc Length and Chord Length and Bearing.
- I. The Horizontal and Vertical Control drawing shall not contain any topographic survey elements. The centerline of proposed improvements, if other than the Survey Baseline, may be shown and referenced on the Horizontal and Vertical Control drawing.
- J. Topographic survey elements shall be shown on the Plan and Profile sheets, along with all survey control and design alignment data.

A.3.1.2 Engineering Design

Sections are needed at every location which may affect street grades, surface drainage, or structures. See Section A.3.4, Procedure for Cross-Sectioning, for details.

A.3.1.3 Earthwork Calculations

Complete and accurate sections shall be provided which show all grade breaks, both transverse and longitudinal. These sections shall be used not only for estimating but may be used for actual payment to the Contractor. See Section A.3.4 for details.

A.3.2 Procedure for Establishing Horizontal Control

- A. All Horizontal Control shall be ON DATUM. The datum shall be the North American Datum of 1983, Texas North Central Zone 4202, realization of 2011 (or latest realization if applicable). Surface projection scale factor shall be the standard Dallas County scale factor established by the Texas Department of Transportation of 1.000136506. No special consideration shall be given to areas of the City of Dallas which lie outside Dallas County, as the scale difference is negligible. Surface projection coordinates shall be truncated as noted in Section 7.2.1, E, herein. NO surface projection coordinate data which mimic State Plane Coordinates will be allowed.
- B. Reference monumentation shall be set for the centerline points at the beginning and end of the project and at all intersecting streets. A minimum of two reference monuments shall be required for each of these centerline points and shall be located sufficiently away from the construction areas so as not to be disturbed by the contractors or utilities. These reference points shall be set so that the paving and right-of-way centerline may be reestablished during and after construction.
- C. Points shall be set at 100 foot stations along the project pavement centerline. Points shall also be set at all PC's, PT's, and angle points. All monumentation and points set shall be appropriately described, (i.e. PK Nail, 60d, Fnd or Set IR, etc.).

A.3.3 Procedure for Establishing Vertical Control

- A. Vertical Control (Bench Marks) shall be based on the City of Dallas Bench Mark Network. This bench mark network is on the NGVD 1929 Datum and will not be adjusted. All effort shall be made to include one (1) Standard Bench Mark and one (1) system bench mark in the level loop. This requirement may be changed to two (2) system bench marks upon the approval of the Chief City Surveyor. To avoid confusion with existing City of Dallas Bench Marks, all bench marks set for these projects shall be referred to as "PROJECT BENCH MARKS" for the duration of the project. The Office of the Chief City Surveyor will provide an official City of Dallas Bench Mark Number, which shall replace the consultant assigned temporary numbers on the Horizontal and Vertical Control sheet(s) and Plan and Profile drawings.

- B. Vertical control may only be established using differential leveling techniques. Elevations established using Trigonometric Levelling techniques or derived from GPS observations will not be accepted. All levelling loops must be a true loop. One-way runs from one existing bench mark to another will not be accepted. Closure accuracy of all level loops shall second order (0.035 US survey Feet times the square root of the number of miles in the level loop as run) as published by the U.S. National Geodetic Survey.
- C. Bench marks are to be established outside the limits of construction at each end of the project, with intermediate bench marks set at approximately 500-foot intervals, while paying special attention to setting bench marks outside the limits of construction. Greater or lesser spacing will be approved if bench marks can be set outside the limits of construction. A minimum of two bench marks are to be shown on each plan and profile sheet, with a narrative location description and elevation given for each bench mark. The narrative location description for bench marks can only be written in the field. When digital levelling technology is used, the data printout shall be accompanied by the narrative location descriptions and final elevations. Where standard automatic levelling is used, a bench mark recapitulation sheet shall be submitted showing the adjustment made, if any, to each Project Bench Mark. As it is difficult and unproductive to set bench marks in alleys, the requirement for spacing at 500-foot intervals shall be met by setting the project bench marks for an alley project on the adjacent street at the 500-foot interval. This will help expand and densify the City of Dallas Bench Mark Network.
- D. Turning points should be sufficiently stable to maintain desired accuracy. Backsights and foresights should be balanced in distance and shots should not exceed 300 feet. Care should be taken to ensure the level rod is properly extended and lock and rocked slowly and rhythmically directly toward and away from the instrument to ensure the proper reading.
- E. Existing City of Dallas bench marks shall be referred to by their official bench mark number and include a narrative location description as well. Elevations shall be as posted on the Dallas Water Utilities Department website. Project bench marks set shall be numbered and described as noted above.
- F. Bench marks established shall be reasonably permanent and substantial (avoid using R/R spikes, 60d nails, crosses on top of fire hydrants, etc.). They shall be easily identified and afforded reasonable protection against damage or destruction. A

description of the B.M. shall be written in a clear and concise manner so that it can be easily recovered (specify distance to nearest cross street when applicable).

A.3.4 Procedure for Cross-Sectioning

- A. Cross sections and / or elevations taken must be from Bench Marks established in accordance with Section A.3.3, Procedure for Establishing Vertical Control. Bench marks must be read at the beginning and end of each instrument set-up. Two bench marks should be used for each set-up. NO SHOTS SHALL BE TAKEN IN EXCESS OF 400 FEET FROM THE INSTRUMENT.
- B. Stationing for center line shall be from south to north, or west to east, with station 10+00 at the beginning center of intersection on street surveys and at the intersection of street ROW and center line of alley for alley surveys. Cross-sections shall begin 200 feet before the starting limit of the project and extend 200 feet past the limits of the project. The limits of the project are defined as the points where the proposed grading or pavement transitions tie to the existing pavement or ground.
- C. Orientation for cross-sections shall be looking up station.
- D. Cross sections shall be taken at a maximum of 50 feet intervals along the centerline of the proposed pavement, at any intermediate breaks in grade, and at locations outlined below in Subsection E. In the transverse direction, cross sections shall include, but shall not be limited to the following shots both right and left of centerline: existing and proposed pavement centerlines, quarter points, edges of road, edges of pavement, gutters and top of curbs, edges of existing sidewalks, property lines, any intermediate breaks in slope, and shots 25 feet past the street right-of-way lines. Shots shall also be taken at high banks, low banks, center of ditches, toe of banks, flow line of ditches, etc. Shots will be taken no greater than 15 feet apart in the transverse direction.
- E. Sections must also be taken at every location which may affect design. These include:
 1. Driveway centerlines, or each edge of the driveway, depending on width of driveway and grade of street;
 2. Lead walks and steps, edge of parking lots, beginning and end of walls;
 3. Grade breaks between sections, such as low areas, terraces or walls perpendicular to street, drain ditches, roof drains, etc.

4. Alleys. Take shots for at least 200 feet from the street centerline up alleys. Sometimes property line shots will be needed in addition to the usual centerline information if the alley is not paved.
 5. Existing drainage pipes and structures for at least 200 feet from street centerline both upstream and downstream, always including flow lines of the structure.
 6. Beginning and end of existing walls, buildings or other structures close to or on the right-of-way line. Label each special cross section with an exact description so it is clear as to the location of the section. The special cross sections shall also be labeled using centerline paving station, left or right.
- F. Cross sections shall be taken at intersecting streets along property lines, high bank and toe of bank of ditches, edge of pavement, top of curbs, gutters, quarter points and centerline for at least 200 feet past the centerline of the principal street being surveyed. Actual distance shall be dictated by design requirements.
- G. Shots must be taken to locate utility elevations in manholes, inlets, culverts, water valves, etc. Shots in manholes should include elevations, size, and direction of all lines coming in and for the line going out and elevation to the top of the operating nut on water valves.
- H. All cross sections shall extend at least 25 feet behind the proposed street right-of-way lines and shall extend farther as necessary to define the point that the proposed grades tie to the existing grade and to define cross drainage to this point. Deep cut and fill areas also require wider cross sections than are normally required.
- I. All cross sections shall be labeled using the centerline paving station at the section.

A.4

CHECKLIST FOR STREET PLANS

A.4.1 General

A.4.1.1 North Arrow Provided

- A. Each sheet
- B. Clearly Visible
- C. Preferably in upper right corner

A.4.1.2 Bench Marks Provided

- A. Two provided on each paving plan / profile sheet with description and location
- B. Spotted in plan view
- C. Conveniently spaced (about 500 feet +/-)
- D. Located outside construction limits
- E. On permanent structure

A.4.1.3 Private Property Identified

- A. Block Numbers
- B. Lot numbers and lot lines
- C. Dimensions
- D. Owners
- E. Right-of-way, easement, and slope easement lines and temporary work areas (by permission) with dimension shown
- F. Street addresses

A.4.1.4 Title Blocks Completed

- A. Completely filled out according to standard.
- B. Title agrees with cover sheet.
- C. Sheets numbered.
- D. Engineer's seal (adjacent to title block).

A.4.1.5 Street Names Provided

- A. Street under design identified.
- B. Intersecting streets identified.

A.4.1.6 Plan Notes

- A. Provide complete and applicable set of General Notes (Standard General Notes to be obtained from City Project Engineer).
- B. Provide special notes on plan sheets controlling construction (including pertinent ROW considerations, if any).

A.4.1.7 Typical Paving and Grading Sections

- A. Centerline shown and dimensioned to proposed curbs and right-of-way lines.
- B. Existing structures and grade shown including type of material and thickness.
- C. Proposed structures and grade shown, including cut and fill slopes.
- D. Proposed pavement cross slopes or crown specified.
- E. Give type and depth of proposed pavements based on project-specific geotechnical engineering analysis and recommendations using type thoroughfare or street designation for the street as given in the City Thoroughfare Plan, as currently amended, but not less than that shown in Table 5.4, Minimum Street Pavement Design Sections.
- F. Give required base and subgrade stabilization based on project-specific geotechnical engineering analysis and recommendations. Where a project specific geotechnical analysis is unavailable, the information shown in Table 5.4, Minimum Street Pavement Design Sections, shall be considered the minimum requirements for subgrade stabilization.
- G. Show proposed sidewalks.
- H. Cross slope limitations provided for parkway area (maximum and minimum when applicable) or proposed cross slope specified.

- I. Driveway grades specified from gutter to right-of-way line and behind property line, if applicable.
- J. Special driveway cross sections provided showing proposed grades from street gutter to existing grade for driveways in deep cuts, on fill areas or in steep graded adjoining property areas. High point of driveway above gutter shown on cross sections.
- K. Complete dimensions provided.
- L. Construction and pay limits clear.
- M. Pay items given and described clearly.
- N. Adequate number of typical sections provided.

A.4.1.8 Special Sections and Details

- A. Provided for all non-standard work.
- B. Existing and proposed features clearly shown.
- C. Complete dimensions provided.
- D. Removal, construction and pay limits clear.
- E. Pay items given and described clearly.

A.4.2 General

- A. Standard format as currently required by the responsible City department
- B. Project job number(s) provided
- C. Official project title for project and each street paved
- D. Plan revision summary block
- E. Signed and sealed by professional engineer registered in Texas
- F. Plan index block listing file numbers, plan descriptions and sheet numbers for all plans approved for this project
- G. Specify length in feet for each street to be paved
- H. Project location map
- I. Plan sheets keyed on location map or detailed plan description in plan index block
- J. Appropriate signature block
- K. Show CADD file name with complete path at lower right corner of cover.
- L. Submit Auto-Turn analysis for left and right turns at intersections. Design and Control Vehicles shall be shown based on criteria in this Street Design Manual.

- M. Submit design submittals for review as required by the City. These are typically at 20, 65, and 85 percent levels of completion. Final submittals at 100% complete shall be signed and sealed by appropriate licensed design professional.

A.4.3 Survey Information

- A. Provide Alignment / Horizontal Control Drawing as outlined in Appendix A.3, Procedures for Establishing Horizontal and Vertical Control.
- B. Provide notes documenting establishment of horizontal and vertical control as outlined in Appendix A.3.
- C. Plans shall include complete survey data for construction of the project, and all survey control points required to stake the proposed work must be set on the ground. Check for floating dimensions not tied to centerline.
- D. Critical survey control points clearly shown, described, identified and referenced. State whether found or set.
- E. Property lines adequately tied and dimensioned. Both existing and proposed right-of-way lines and all easements and temporary working areas (by permission) and sloping easements must be shown on paving and drainage plan view sheets.
- F. Iron pins or monuments located by station and distance.
- G. Centerline stationing shown and related to profile.
- H. Stationing shall be shown on the centerline, measured distances on transit line. Transit line shall be shown on the Alignment / Horizontal Control Drawing.
- I. Certain topographical features must be tied by centerline station and distance and shown on plans: walls, fence comers and other improvements near property line or construction limits; inlets and headwalls which will stay in place; utility poles, traffic signal poles, and utility appurtenances near proposed curbs; and other features of concern to contractors when bidding and constructing the job.

A.4.4 Topography

- A. Show and describe all existing features clearly in close proximity to the construction including utilities, roadways, railroads, landscaping, creeks, driveways, buildings, signs, etc. using standard drafting symbols.
- B. Show all buildings adjoining project with address numbers.

- C. Existing driveways shown and described including width and type of paving.
- D. Show and describe existing fences including type and height. If encroaching, address removal / relocation and temporary fencing needs.
- E. Show and describe trees. Give caliper, actual location, and kind. If close to property line or otherwise questionable status, can tree be saved? Specify save or remove.
- F. Show and describe signs. If commercial and in ROW, who will remove? State if electrical service is involved.
- G. Show intersecting streets. Give type, thickness and width of pavement and sidewalks.
- H. Show spot elevations in ditches or gutters sufficient distance to clarify drainage and transitions.
- I. Show existing concrete paving clearly using standard symbols and with accurate dimensions. Curbs and gutters must be dimensioned.
- J. Show existing storm drains and inlets using standard symbols.
- K. Show existing travelways and identify as to type, depth, etc.
- L. Show walls. Specify preserve or remove. Address material to be salvaged for property owner.
- M. Show mail boxes, rural type; address relocation (pay item).
- N. Design roof drain connections to storm drain.
- O. Show lawn sprinklers and irrigation systems and address relocation.
- P. Show existing landscaping and address adjustment or relocation.

A.4.5 Utilities

- A. Show all existing and proposed facilities
- B. Existing underground facilities must match visible appurtenances such as manholes, valve covers, etc.
- C. Underground facilities close or in conflict with proposed construction must be located by excavating and obtaining actual ties and elevations.
- D. Clarify status of existing facilities whether to remain in service, abandon or remove and by whom.
- E. Show design location of proposed facilities. Reference file number of plans. Give time table if known.

- F. Add caution notes when construction operations will come close to any facility, giving telephone number of utility company to call for assistance in locating.
- G. Check for adequate clearance for any work wider overhead high voltage wires. Provide caution notes to contractor where appropriate.

A.4.6 Storm Drains

- A. Locate inlets so as to give least inconvenience to property owners.
- B. Check street cross fall at inlet locations. Provide at least 1/4 inch per foot cross fall into inlet. Provide adequate inlet capacity on low side of street.
- C. Proposed storm drains shall be shown by standard symbols. Drainage pattern shall be clear without having to refer to storm drainage plans.
- D. Inlets and pipes shall be drawn to scale.
- E. For each inlet show size, paving station at center, top and flow line elevations and pay item number. Also show throat elevations for “Y” inlets.
- F. Locate manholes for inlets directly above the adjoining lateral pipe entrance.
- G. Verify that inlet data on paving plans matches drainage plans.
- H. Show gutter drainage flow arrows in paving plan view at inlets, crests and sags.
- I. Complete items on the “Checklist for Storm Drainage Plans”, Drainage Design Manual.

A.4.7 Plan

- A. Provide proposed pavement grades low enough to drain adjoining properties and provide adequate access with minimum encroachment on private properties.
- B. Clearly show all proposed features, grading and improvements and provide clear descriptions and dimensions including limits of proposed construction using standard drafting symbols.
- C. All work on private property will require either a letter of permission or an official easement. Show any required conditions affecting the construction on the plans.
- D. All work on Park property will require Park Board approval. Show any required conditions affecting the construction on the plans.

- E. Clearly show all removal items including limits and pay item number for each.
- F. Properly dimension all proposed pavement, sidewalk, driveways, etc. including length and width.
- G. Provide all property frontage dimensions.
- H. Clearly define limits of new paving, adjustments to intersecting streets and driveways by stations and dimensions as necessary.
- I. Provide special detail sections for ties to existing driveways which are nonstandard or which go beyond street right-of-way and for ties to existing streets which go beyond the proposed street turnout.
- J. Provide proper pavement transitions for ties to all intersecting streets, alleys, parking lots and private property, including cross section and structure for all proposed transition pavements. Show transition details, curb radii, stations and offsets.
- K. Provide special details to clarify congested or difficult to read construction problems.
- L. Extend paving improvements through the intersection (begin at curve radius), if one side is touched.
- M. Clarify drainage patterns by flow arrows, spot elevations in ditches and gutters, and other notations. Especially address intersections, ties to adjoining properties and all ends of the project.
- N. Medians shall not extend into crosswalks unless ADA-compliant path is provided for pedestrians.
- O. Provide barrier free ramps on all sidewalks at street and driveway intersections. Provide barrier free ramps and crosswalks on all corners of the intersection even if only one corner is touched.
- P. Show toe of slope and top of cut limit lines where grade differences are 6 inches or more. Provide field notes for all slope easements meeting approval of the Chief City Surveyor.
- Q. Show dimensional temporary work areas provided by property owner permission.
- R. Draw steps to scale and show number of risers. Clearly show on plans what is existing and what is proposed.
- S. Specify proposed wall types, beginning and end paving stations and top of wall elevations. Address drainage behind walls. Show walls in profile. Provide designs for modified or non-standard retaining walls.
- T. Check existing / proposed retaining walls, fences, guard rails, utility poles, trees, etc. for adequate sight distance.

- U. Check all drives, intersections, median openings and other locations involving retaining walls or steep grades and cross traffic for possible hazardous situations. Design for unobstructed sight distances, eliminate hindrances to safe operation at target speed, danger to pedestrians, etc.
- V. Turn lanes and Median Openings
 1. Check median opening for compliance with minimum distance standards from street intersections and other median openings.
 2. Center median openings on streets and driveways.
 3. Provide traffic buttons and striping per standards in 251D-1
 4. Show proposed top of 6-inch median curb at PC's, PRC's, PT's, median nose (6th theoretical curb) and intermediate points for left turn lanes and existing top of median curb elevations for portions to remain.
 5. Check median and street cross fall for compliance with standards.
 6. Provide median pavement and monolithic median nose per standards.
 7. Provide typical paving section for left and right turn lanes.
 8. Show existing driveways and inlets in proximity to turning lanes and on both sides of the street at all proposed median openings.
 9. Show required street lighting and traffic control improvements as required by the Transportation Division.
 10. Provide curve and reverse curve geometry for curbs transitioning to turning lanes in conformance with Public Works and Transportation Standards
- W. Check transitions at ends of project and at intersections for safety, complete design addressing tie to existing features, drainage, etc. Show complete topography and design information adjoining limits of all transition work.
- X. Look beyond the limits of the project and address adverse impacts on traffic flow, safe conditions and use of developed property.
- Y. Provide shading and cooling where needed for clarification.

- Z. Lettering and drafting shall be clear when reduced to half scale.
- AA. Provide pay item numbers for all proposed work unless otherwise clearly noted in the plans. Provide clear, concise definitions and pay limits to eliminate confusion.
- AB. Provide "No Separate Pay" or "Work Incidental to Pay Items Provided" notes for each specified work items not covered under a specific pay item.
- AC. Provide estimated pay items and work quantities on separate quantity summary sheet. Check for obvious errors. Provide space for City to add contingency pay items. Provide column for bid quantities. Confirm quantities reflect all revisions made to the plans during the plan review process.
- AD. Provide plans showing location, signage, and other details for temporary alternate pedestrian circulation paths through or around a construction site.

A.4.8 Profiles and Grades

- A. Show in profile existing ground elevation at proposed property lines and street centerline. Have drives, street intersections, lead walks, walls, etc., been plotted to show realistic ground line?
- B. Design top of curb grades should be below existing ground profiles at right-of-way line to provide at least 1/4 inch per foot of parkway crossfall between ROW line and the top of curb unless embankment section is required or street is in 100-year floodplain. Check fill areas for encroachment or damage to adjoining properties.
- C. Design driveway and intersecting street adjustments and transitions compatible with grades and profiles. Deeper cuts or fills require longer adjustments.
- D. Check street crossfalls with minimum and maximum standards. Check inlet locations in plan in relation to cross fall to insure design drainage interception.
- E. Check gutter capacity, grade and cross fall of all streets and design inlets to insure street capacity is not exceeded and required drainage is intercepted.
- F. Design grades to provide smooth intersections. Provide vertical curves when grade breaks on the proposed street pavement exceed 1%.
- G. Confirm that no abutting property is in danger of being damaged due to poor vehicular access or loss of improvements. Double Check!

- H. Complete vertical curves information. Confirm that proposed vertical curves meet minimum sight distance requirements for street target speed.
- I. Show in profile proposed top of 6-inch curb profiles including median curbs if applicable.
- J. For each profile provide top of curb elevations at 50-foot stations and at beginning and ending match lines, at vertical curve P.V.I.'s, at beginning and ending of approach or structural slabs, at intersecting street point of curb intersection points (outside curb profiles only) and at beginning and ending of street curb points. Provide centerline paving stations for all points of elevation which are not at 50-foot stations.
- K. Provide curb grade slope in percent to nearest one hundredth percent for each profile.
- L. Provide smooth riding grades for pavement transitions. Grade breaks exceeding 1% require vertical curves. Use same grade design standards as for proposed pavement design.
- M. Provide appropriate profiles for pavement transitions showing centerline and edge of pavement grades at 50-foot stations and at beginning and ending match lines or ties to proposed and existing pavement and at vertical curve P.V.I. 's, P.C.'s and P.T.'s. Provide centerline paving stations for all points of elevation which are not at 50-foot stations.
- N. Provide proposed top of wall elevations at beginning, ending and P.V.I.'s with centerline street stations given.
- O. Show existing or proposed drainage, utility or structure facilities which are in close proximity to the construction.
- P. Check paving grades, cross sections and plan view carefully; eliminate any place water might pond by revising design grades and plan view picture as required. Locate inlets at sag points of vertical curves.
- Q. Confirm grades, crossfall, slopes, etc., are consistent with information shown on typical sections.
- R. Check all horizontal curves for safe operation at target speed. Provide superelevation as required to comply with standards. Revise profile grade and plan view as required.
- S. Confirm that proposed paving grades do not pond drainage on adjoining properties.
- T. Check ends of project for drainage. If gutters drain to ditches or field type inlets, provide proposed grades and profiles for required grading. Show required grading and transition to existing features in plan view. Provide grading typical sections.

A.4.9 Traffic Control, Signage and Striping, and Lighting Plans

- A. Drawing notes for this section to include:
 1. All work shall comply with the Texas MUTCD, the City's "Traffic Sign Standards" manual, and applicable regulatory or guidance documents.
 2. All installation and removal of street markings shall be performed by the contractor.
 3. All fabrication, installation, and removal of signs shall be performed by the contractor.
 4. All installations of street lights shall be performed by the contractor.
 5. All temporary markings, signs, barricades, and traffic signal adjustments are the responsibility of the contractor, and shall comply with Texas MUTCD or as directed by the City to provide for the safety and welfare of the public or to accommodate orderly progression of traffic.
- B. Design of all regulatory and warning signage and markings shall comply with Texas MUTCD.
- C. Provide sequence of construction details and traffic control plan as required by the City to protect the public interest and comply with Texas MUTCD.
- D. Design all traffic control work and provide items as required by the Transportation Division. Show all required signal and facility foundation removals.
- E. Provide for street and traffic control signs and markings as required by the Transportation Division.
- F. Design street light structures on thoroughfares as required by Transportation Division, using City provided spacing and standard details.
- G. Show overall existing and proposed signage and striping covering the entire project.
- H. Show signage and striping transition to existing condition beyond project limits.
- I. Show dimensions of lane widths, turn lane storage lengths, taper lengths.
- J. Show all existing signs. It is important to define what will remain, what will be removed, and what will be added so that the final composite condition is clear and without confusion to motorists.

- K. Identify locations of new signs with roadway station numbers or dimensional information.
- L. Pedestrian crosswalks at intersections shall be shown with full continental-style white thermoplastic crosswalk markings. For pavers and stamped concrete, crosswalk shall be outlined by 12-inch white thermoplastic markings on each side.
- M. Where bike lanes do not cross through the intersection, end bike lanes and merge with travel lanes approximately 100 feet upstream of the intersection.
- N. Restrict parking within 50 feet of unsignalized intersections and within 100 feet of signalized intersections.
- O. Superimpose landscape plans onto all signage and street lighting plans. Resolve conflicts between landscaping and required placement of regulatory and warning signage. Adjust landscaping placement and / or material types where conflicts occur with this signage and street lighting. Account for visibility and clear lines of sight as landscaping matures.
- P. Provide at least one extra 2-inch conduit parallel to street lighting conduits as a spare for City use.

G. Related Submittals

1. Review plans shall be submitted to City Survey section for stakeability review; all comments must be addressed.
2. Review plans shall be submitted to the City Construction Inspection section for constructability review; all comments must be addressed.
3. Review Plans shall be submitted to City Transportation Division for street lighting and traffic control review; all comments must be addressed.
4. Approved preliminary plans shall be submitted to City for Utility clearance review; all comments must be addressed.
5. Review plans shall be submitted to other involved governmental agencies for review; all comments must be addressed. Such agencies may include TxDOT, Dallas County, abutting municipalities, USACE, etc.

A.4.10 Additional Requirements

- A. All required landscaping and irrigation designs shall be completed in conformance with City standards with pay items and established quantities provided on the plans and quantity sheet.
- B. Designer shall verify that landscaping will not block traffic control devices or street lights, and that sidewalks are ADA-compliant.
- C. Storm Water Pollution Prevention Plans shall be prepared with pay items and estimated quantities provided on the plans and quantity sheet. Design shall provide 70% sediment trap effectiveness.
- D. All required hydraulic backwater analysis shall be prepared and run as required for streets encroaching in the 100-year (1% AEP) flood plain. Design shall conform with approved City flood plain management plans and/or flood plain ordinance.
- E. Plans shall be consistent with all Dallas Water Utilities joint water and wastewater design plans for this Project.
- F. Provide specifications for all nonstandard materials and designs proposed for this project.

A.5

STREET CENTERLINE AND CORNER CURB RETURN RADII DETERMINATION EXAMPLES

- A. EXAMPLE 1. To determine the minimum centerline radius allowed for a Principal Arterial class thoroughfare with an M-6-D(A) section and a super elevation of 1/4 inch per foot sloping from median curb (high side) down to outside curb (low side) on both sides of the median.
1. What is the minimum centerline radius for the thoroughfare without intersection sight distance requirements? There are intersecting streets and alleys in the curved section.
 2. What is the desirable minimum and safety minimum centerline radii for both sides for intersecting streets and alleys?
 3. Which controls the required min. centerline radius?
 4. Will dedication of sight easements in the curve reduce the required minimum centerline radius?

SOLUTION TO EXAMPLE 1

The minimum centerline radii for thoroughfares for various cases of target speed and superelevation without consideration of sight distance requirements is given in Table 4.5, Minimum Centerline Radius for Thoroughfares.

Step 1 Determine the design speed. Referring to Table 4.2, Target Speed by Street Typology and Functional Classifications. The target speed for a Principal Arterial class thoroughfare with an M-6-D section is a maximum 45 miles per hour (MPH).

Step 2 Determine the minimum centerline radii for both sides of the thoroughfare using the super elevation given. For the half of the street on the inside of the curve. The pavement slopes up from the outside curb line to the median curb line at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table 4.5, the minimum centerline radius for this half of the roadway is 1,040 feet for a target speed of 45 MPH. For the half of the street on the outside of the curve. The pavement slopes down from the median curb line to the outside curb line at a rate of 1/4 inch per foot. This is equal to -1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table 4.5, the minimum centerline radius for this half of the roadway is 1,400 feet for a target speed of 45 MPH.

Step 3 The larger of the two minimum radii governs the street minimum centerline radius.

ANSWER to 1a): 1,400 feet

- B. b) The desirable minimum and safety minimum centerline radii due to sight distance requirements for intersecting streets, alleys and driveways are given in Table 4.6, Horizontal Curve Restrictions Due to Intersection Sight Distances.

Step 1 Determine the target speed as shown in the solution to Example 1 a) Step 1.

Step 2 Using Table 4.6, determine the left side desirable minimum and safety minimum radii using a Principal Arterial class thoroughfare with an M-6-D section and a target speed of 45 MPH. Desirable Minimum Radius is 6,040 feet and the Safety Minimum Radius is 1,420 feet for the left side.

Step 3 Similarly for the right side using Table 4.6, the Desirable Minimum Radius is 2,850 feet and the Safety Minimum Radius is 880 feet.

ANSWER to 1b):

For the Left Side: Desirable Minimum Radius is 6,040 feet;
Safety Minimum Radius is 1,420 feet.

For the Right Side: Desirable Minimum Radius is 2,850 feet;
Safety Minimum Radius is 880 feet.

- C. The larger of the three radii: the Minimum Centerline Radius answer to part a), the left side Safety Minimum Radius answer to part b), and the right side Safety Minimum Radius answer to part b) will control.

Step 1 The Minimum Centerline Radius as given by the answer to Example 1a) is 1,400 feet.

Step 2 The left side Safety Minimum Radius as given by the answer to Example 1b) is 1,420 feet.

Step 3 The right side Safety Minimum Radius as given by the answer to Example 1b) is 880 feet.

Step 4 The larger of the three radii is 1,420 feet.

ANSWER to 1c): 1,420 feet. The left side Safety Minimum Radius for intersection sight distance requirements controls.

D. The effect of dedication of sight easements on the required minimum centerline radius, where intersection sight distance is a factor, is given in Table 4.7, Sight Easement Requirements Due to Intersection Sight Distances.

Step 1 Using a Principal Arterial class thoroughfare with an M-6-D(A) section, read from Table 4.7 the minimum radius with the given sight easement widths:

- No easement allows 1,420 foot radius
- One foot easement along the inside street right-of-way curve allows 1,260 foot radius
- Two foot easement along the inside street right-of-way curve allows 1,140 foot radius
- Three foot easement along the inside street right-of-way curve allows 1,050 foot radius
- Four foot easement along the inside street right-of-way curve allows 965 foot radius

Step 2 Compare the table of radius for the various easement widths with the controlling minimum centerline radius determined in Example 1c) which is 1,420 feet.

Step 3 Find an easement width that allows a smaller minimum centerline radius. For example, an easement width of one foot along the inside street right-of-way curve allows a minimum centerline radius of 1,260 feet.

Step 4 Compare the reduced minimum centerline radius with the minimum centerline radii for thoroughfares given in Table 4.5. Example 1a) determined this radius as 1,400 feet. The reduced required minimum centerline radius must not be less than the Table 4.5 radius.

ANSWER to 1d): Yes, the required minimum centerline radius determined in Example 1c) can be reduced if a one foot wide sight easement is provided along the inside street right-of-way curve but the required radius can only be reduced to 1,400 feet since the radius cannot be lower than the radius determined from Table 4.5.

EXAMPLE 2. In Example 1, a Principal Arterial class thoroughfare, section M-6-D and a Minor Arterial class thoroughfare, section S-4-U intersect the given thoroughfare.

- A. What are the minimum required corner curb return radii and estimated corner clips at the four corners of the M-6-D thoroughfare to M-6-D thoroughfare intersection?
- B. What are the minimum required corner curb return radii and estimated corner clips at the four corners of the M-6-D thoroughfare to S-4-U thoroughfare intersection?

SOLUTION TO EXAMPLE 2

- A. The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of two divided streets are given in Table 4.12, Type II Intersection.

Step 1 Determine the Initial Street and the Destination Street to provide orientation and the possible right turn traffic movements. A plan picture of the intersection should be used to clarify. The Initial Street is the street on which the turning movement begins and the Destination Street is the street onto which the traffic is turning. In this example, the four curb returns can be described by one movement:

- Movement A: Going from the Principal Arterial class thoroughfare M-6-D section to a Principal Arterial class thoroughfare M-6-D section.

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for this right turn movement and use this radius and corner clip at all four corners of the intersection .

Step 2 Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Table 4.12, Type II Intersection. Reading from Table 4.12, the Typical Corner Curb Return Radius "R" is 30 feet and the Typical Corner Clip "CxC" is 11 foot x 11 foot.

ANSWER to 2a): Corner curb return radius of 30 feet and estimated corner clip of 11 foot x 11 foot at all four corners of the intersection.

- B. The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of a divided street and an undivided street are given in Table 4.13, Type III Intersection.

Step 1 As in Example 2a) the possible right turn traffic movements must be determined. For the Principal Arterial class thoroughfare M-6-D section intersection with a Minor Arterial class thoroughfare S-4-U section, there are 2 possible movements with the diagonal corners being symmetrical:

- Movement A: Going from the Principal Arterial M-6-D section to the Minor Arterial S-4-U section
- Movement B: Going from the Minor Arterial S-4-U section to the Principal Arterial M-6-D section.

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each movement and use this radius and corner clip at the diagonal intersection corners also.

Step 2 Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Table 4.13, Type III Intersection. Reading from Table 4.13, the Typical Corner Curb Return Radius “R” and the Typical Corner Clip “CxC” for each movement given in Step 1 is as follows:

- Movement A: (M-6-D to S-4-U)
Max. *R* is 40'
CxC is 25' x 25'
- Movement B: (S-4-U to M-6-D)
R is 35'
CxC is 15' x 15'

ANSWER to 2b): Corner curb return radii of 40 feet is required at the two diagonal corners with traffic turning from the Principal Arterial M-6-D section to the Minor Arterial S-4-U section with estimated corner clips of 19 foot x 19 foot.

Corner curb return radii of 35 feet is required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Principal Arterial M-6-D section with estimated corner clips of 15 foot x 15 foot.

EXAMPLE 3. Determine the minimum centerline radius allowed for a Minor Arterial class thoroughfare with an S-4-U section and a super elevation of 1/4 inch per foot across the full street section from the curb on the outside of the curve (high side) down to the curb on the inside of the curve (low side).

- What is the minimum centerline radius for the thoroughfare without intersection sight distance requirements? There are intersecting driveways and streets in the curved section.
- What is the desirable minimum and safety minimum centerline radii for both sides for intersecting driveways and streets?

- Which controls the required minimum centerline radius?
- How will dedication of sight easements in the curve affect the required minimum centerline radius?

SOLUTION TO EXAMPLE 3

- The minimum centerline radii for thoroughfares for various cases of target speed and super elevation without consideration of sight distance requirements is given in Table 4.5, Minimum Centerline Radius for Thoroughfares.

Step 1 Determine the target speed. Referring to Table 4.2, the target speed for a Minor Arterial class thoroughfare with a S-4-U section is 40 miles per hour (MPH).

Step 2 Determine the minimum centerline radii for both sides of the thoroughfare using the super elevation given. For the half of the street on the inside of the curve, the pavement slopes up from the outside curb line to the street centerline at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table 4.5, the minimum centerline radius for this half of the roadway is 740 feet for a target speed of 40 MPH. For the half of the street on the outside of the curve, the pavement slopes up from the street centerline to the outside curb line at a rate of 1/4 inch per foot. This is equal to +1/4 inch per foot in relation to the center of the horizontal curve of the street. Referring to Table 4.5, the minimum centerline radius for this half of the roadway is 740 feet for a target speed of 40 MPH.

Step 3 The larger of the two minimum radii governs the street minimum centerline radius.

ANSWER to 3a): 740 feet

- The desirable minimum and safety minimum centerline radii due to sight distance requirements for intersecting streets, alleys and driveways are given in Table 4.6, Horizontal Curve Restrictions Due to Intersection Sight Distances.

Step 1 Determine the target speed as shown in the solution to Example 3a) step 1.

Step 2 Using Table 4.6, determine the left side desirable minimum and safety minimum radii using a Minor Arterial class thoroughfare with an S-4-U section and a target speed of 40 MPH. Desirable Minimum Radius is 5,450 feet and the Safety Minimum Radius is 1,210 feet for the left side.

Step 3 Similarly for the right side using Table 4.6, the Desirable Minimum Radius is 4,320 feet and the Safety Minimum Radius is 1,350 feet.

ANSWER to 3b):

For the Left Side: Desirable Minimum Radius is 5,450 feet;
Safety Minimum Radius is 1,210 feet.

For the Right Side: Desirable Min. Radius is 4,320 feet;
Safety Minimum Radius is 1,350 feet.

C. The larger of the three radii: the Minimum Centerline Radius answer to part a), the left side Safety Minimum Radius answer to part b), and the right side Safety Minimum Radius answer to part b) will control.

Step 1 The Minimum Centerline Radius as given by the answer to Example 3a) is 740 feet.

Step 2 The left side Safety Minimum Radius as given by the answer to Example 3b) is 1,210 feet.

Step 3 The right side Safety Minimum Radius as given by the answer to Example 3b) is 1,350 feet.

Step 4 The larger of the three radii is 1,350 feet.

ANSWER to 3c): 1,350 feet. The left side Safety Minimum Radius for intersection sight distance requirements controls.

d) The effect of dedication of sight easements on the required minimum centerline radius, where intersection sight distance is a factor, is given in Table 4.7, Sight Easement Requirements Due to Intersection Sight Distances.

Step 1 Using a Minor Arterial class thoroughfare with an S-4-U section, read from Table 4.7 the minimum radius with the given sight easement widths:

- No easement allows 1.350 foot radius
- 1-foot easements on both sides of the street right-of-way allows 1,040-foot radius
- 2-foot easements on both sides of the street right-of-way allows 915-foot radius
- 3-foot easements on both sides of the street right-of-way allows 820-foot radius
- 4-foot easements on both sides of the street right-of-way allows 750-foot radius

Step 2 Compare the table of radius for the various easement widths with the controlling minimum centerline radius determined in Example 3c) which is 1,350 feet.

Step 3 Find an easement width that allows a smaller minimum centerline radius. For example, an easement width of 4 feet allows a minimum centerline radius of 750 feet.

Step 4 Compare the reduced minimum centerline radius with the minimum centerline radii for thoroughfares given in Table 4.5. Example 3a) determined this radius as 740 feet. The reduced required minimum centerline radius must not be less than the Table 4.5 radius.

ANSWER to 3d): The required minimum centerline radius determined in Example 3c) can be reduced to 750 feet if 4-foot-wide sight easements are provided in the curved section along both sides of the street right-of-way. This radius is not lower than the radius determined from Table 4.5.

EXAMPLE 4. In Example 3, a Community Collector class thoroughfare, section S-2-U and a Local Street, section L-2-U intersect the given thoroughfare.

- A. What are the minimum required corner curb return radii and estimated corner clips at the four corners of the S-4-U thoroughfare to S-2-U Collector thoroughfare intersection?
- B. What are the minimum required corner curb return radii and estimated corner clips at the four corners of the S-4-U thoroughfare to L-2-U Local Street intersection?

SOLUTION TO EXAMPLE 4

- A. The minimum required corner curb return radii and estimated corner clips at the four corners of the intersection of two undivided streets are given in Table 4.4, Intersection Summary Street Without Median Intersecting Street Without Median.

Step 1 Determine the Initial Street and the Destination Street to provide orientation and the possible right turn traffic movements. A plan picture of the intersection should be used to clarify. The Initial Street is the street on which the turning movement begins and the Destination Street is the street onto which the traffic is turning. In this example, the four curb returns can be described by two movements with the diagonal corners being symmetrical:

- Movement A: Going from the Minor Arterial class thoroughfare S-4-U section to a Community Collector class thoroughfare S-2-U section.
- Movement B: Going from the Community Collector class thoroughfare S-2-U section to the Minor Arterial class thoroughfare S-4-U section.

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each right turn movement and use this radius and corner clip at the diagonal intersection corners also.

Step 2 Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Table 4.11, Type I Intersection. Reading from Table 4.11, the Typical Corner Curb Return Radius “R” and the Typical Corner Clip “CxC” for each movement given in Step 1 is as follows:

- Movement A: (5-4-U to 5-2-U)
R is 30'
CxC is 10' x 10'
- Movement B: (5-2-U to 5-4-U)
R is 20'
CxC is 5' x 5'

ANSWER to 4b): Corner curb return radii of 30 feet are required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Community Collector S-2-U section with estimated corner clips of 10 feet x 10 feet. Corner curb return radii of 20 feet are required at the two diagonal corners with traffic turning from the Community Collector S-2-U section to the Minor Arterial S-4-U section with estimated corner clips of 5 feet x 5 feet.

B The minimum required corner curb return radii and estimated corner clips at the four corners of two undivided streets are given in Table 4.11, Type I Intersection.

Step 1 As in Example 4a) the possible right turn traffic movements must be determined.

For the Minor Arterial class thoroughfare S-4-U section intersection with a Local Street L-2-U section, there are two possible movements with the diagonal corners being symmetrical:

- Movement A: Going from the Minor Arterial S-4-U section to the Local Street L-2-U section
- Movement B: Going from the Local Street L-2-U section to the Minor Arterial S-4-U section.

Symmetry allows us to determine the corner curb return radius and estimated corner clip required for each movement and use this radius and corner clip at the diagonal intersection corners also.

Step 2 Determine the required corner curb return radius and estimated corner clip for each right turn traffic movement determined in Step 1 using Table 4.11, Type I Intersection. Reading from Table 4.11, the Typical Corner Curb Return Radius “R” and the Typical Corner Clip “CxC” for each movement given in Step 1 is as follows:

- Movement A: (5-4-U to L-2-U)
R is 30'
CxC is 10' x 10'
- Movement B: (L-2-U to S-4-U)
R is 20'
CxC is 5' x 5'

ANSWER to 4b): Corner curb return radii of 30 feet is required at the two diagonal corners with traffic turning from the Minor Arterial S-4-U section to the Local Street L-2-U section with estimated corner clips of 10 feet x 10 feet. Corner curb return radii of 20 feet is required at the two diagonal corners with traffic turning from the Local Street L-2-U section to the Minor Arterial S-4-U section with estimated corner clips of 5 feet x 5 feet.

A.6

TRAFFIC STUDY GUIDELINES

Designers and Engineers shall use the latest version of the City's traffic study guidelines in conducting traffic models for streets and their intersections with other streets and driveways. Methods and models used shall be those identified herein or as authorized by the City. Work may include preliminary assessments or analysis to support entitlement activities such as zoning change proposal or a change of development density or use.



CITY OF DALLAS

TRAFFIC STUDY GUIDELINES

LAST UPDATED: MARCH 2018
SUSTAINABLE DEVELOPMENT & CONSTRUCTION
IN COORDINATION WITH THE TRANSPORTATION DEPARTMENT



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GENERAL

The City of Dallas traffic study guidelines supplement the requirements established in the Dallas Development Code. These guidelines outline staff's expectations of traffic studies and facilitate a coordination of their scope and analysis contents, parameters and assumptions.

The general objective of these guidelines is to promote and protect the health, safety, and general welfare of the public through the establishment of an administrative procedure for proposed developments considered likely to significantly impact surrounding land uses and public infrastructure.

OBJECTIVES OF A TRAFFIC STUDY

Traffic studies associated with new development should objectively present a basis to quantify impact. More explicitly, a traffic study should, at a minimum:

1. Document anticipated traffic operations and access needs for a subject site.
2. Identify any potential hazard to traffic safety
3. Quantify any significant burden on public infrastructure that can be avoided or substantially mitigated by reasonable modifications of a proposed plan.
4. Identify existing crash patterns emphasizing movements potentially impacted by proposed development.
5. Provide a basis for commensurate impact mitigation on public rights-of-way as well as the funding in conjunction with zoning, permit, subdivision plats or thoroughfare amendment applications.

TRAFFIC STUDY CRITERIA

A traffic study is required before an application is submitted for any permit when the proposed development increases the trip generation of an individual lot by more than 1,000 vehicle trip ends per day or 100 vehicle trip ends per hour. A traffic study may also be required in areas where any amount of additional traffic may adversely impact existing infrastructure at the discretion of the director. Supplemental analysis may be required after a report is submitted based on review by city staff and comments from citizens, affected agencies (e.g., DART, TxDOT, Downtown Dallas Inc., neighborhood committees), City Plan Commission, or City Council.

Trip generation should be based on selected uses from the latest edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual. Base rates for uses not listed in the manual must be determined from surveys of similar existing uses. Applicant must consult with reviewing staff before assuming any adjustment to the published average trip generation rates or equations including pass-by, internal capture, or mode split reductions. City staff reserves the right to review and approve any deviations from base rates.

All traffic studies must be prepared under direct supervision of and signed, stamped and dated by a licensed Professional Engineer registered in the State of Texas with specific expertise in transportation and traffic engineering, preferably certified as a Professional Traffic Operations Engineer.

TRAFFIC STUDY WAIVERS

Waivers of required traffic studies will be considered on a case-by-case basis upon submittal of a traffic impact waiver application and corresponding staff review. The applicant must provide technical justification to waive a traditional traffic impact analysis, should one be required.

TRAFFIC STUDY GUIDELINES

A. Study Scope Proposal

Applicant is responsible for contacting city staff before a traffic study is submitted to determine the scope of a traffic study, should one be needed. The scope should be commensurate to the scale of the development and general impact to local streets, taking into account factors such as adjacent roadway geometry and conditions.

The following modules provide a guideline to facilitate staff's review of a proposed study scope:

1. **Project Description:**

- Include address(es), land use(s), existing/proposed zoning, existing site conditions (e.g. undeveloped), access roadways and any other pertinent information.

2. **Proposed Study Intersections:**

- Controlled intersection, site driveways (existing and proposed), etc.

3. **Proposed Roadway Links:**

- Street X west of Street Y

4. **Proposed Study Hours:**

- Weekday AM Peak (e.g. 7-9 AM), weekday PM Peak (e.g. 4-6 PM), etc.

5. **Development Phase:**

- Single- or multiple-phase scenarios with anticipated buildout in <buildout year>

6. **Proposed Study Scenarios:**

- Existing
- Background (<buildout year>, Phase I)
- Project Buildout (<buildout year>)
- Project 5-year Horizon (or longer if project requires thoroughfare plan amendment)

7. **Preliminary Site Traffic Generation:**

- Calculation of total daily trip ends and peak hour volumes including any adjustments or reductions (e.g. pass-by, internal capture, mode split, etc.)

8. **Proposed Traffic Growth:**

- Calculation of traffic growth on study roadway links (see Item 3) based on historical data

9. **Proposed Trip Distribution:**

- Directional percent or to be ascertained upon review of existing turning movement counts, ZIP Code/license plate analysis, etc.

10. **Preliminary Traffic Study Elements:**

- Intersection level of service analysis using <software> modeling
- Roadway link capacity analysis
- Pedestrian level of service analysis
- Parking Demand Analysis
- Site access: driveway location, spacing, sight distance, median access, auxiliary lanes, etc.
- Historical accident analysis
- Traffic signal and/or stop-control warrant analysis

11. **Site Location Map:**

- Map showing all traffic signals, DART stops and proposed study intersections and roadway segments within a one-mile or ½-mile radius from the subject property.

B. Preliminary Traffic Assessment

A Preliminary Traffic Assessment presents a snapshot of traffic information and potential issues related to a proposed development. The purpose of this document is to provide technical justification to waive a traditional traffic impact analysis. The assessment must be prepared by a Professional Engineer registered in the State of Texas with specific expertise in transportation and traffic engineering, preferably certified as a Professional Traffic Operations Engineer. The assessment should include basic parameters of a traffic study to include (but not limited to):

1. Project Description

Provide a general description of the project including site location, existing and proposed land uses, building areas, zoning, traffic operation strategies, and any other pertinent information.

2. Site Plan

Briefly describe and/or attach a site plan showing existing and proposed curbs, driveways, adjacent travel lanes, median opening, parking facilities, building and open leasable areas.

3. Trip Generation

Trip generation should be calculated based on average or fitted curve equations published on the latest edition of the ITE *Trip Generation* Manual. Any adjustments or reductions for pass-by, mode split based on person-trips or internal capture must be based on guidelines outlined in the 10th edition of the ITE Trip Generation Handbook. Staff reserves the right to refute engineering judgement that contradicts field observations.

4. Parking Generation

Include a table of a preliminary parking analysis including City of Dallas off-street parking requirement and existing and proposed parking supply.

5. Roadway Conditions

Provide a description of all adjacent roadways including name, thoroughfare plan designation, average daily traffic, design hourly volume, number of lanes, and any transit, bicycle and pedestrian facilities.

6. Evaluation of Traffic Operations

Summarize an evaluation of existing and proposed traffic operations, site access, adjacent intersections, crash analysis, anticipated trip distribution, etc. Identify any potential traffic related issues required to address internal constrains.

7. Site Access Evaluation

Summarize a technical justification for a Traffic Impact Analysis wavier including an evaluation of site access evaluation such as driveway geometry, driveway spacing, crash analysis, etc. as needed.

8. Certification Statement

Preliminary Traffic Assessment must include the following statement, signed and sealed by the professional engineer responsible for the contents of the document:

“I, <full name>, hereby certify that the information provided in this report is complete and accurate to the best of my knowledge.”

C. Traffic Impact Analysis Report

1. *Cover Page*

Report must be stamped and sealed by engineer of record. Cover page must be dated, include contact information of engineering firm, zoning case or permit number.

2. *Project Description*

Provide a general description of the project including site location, existing and proposed land uses, building areas, zoning, traffic operations, and any other pertinent information.

3. *Study Area*

Include a site location map showing all traffic signals within ½-mile radius, adjacent DART stops and proposed study intersections and roadway links. Report must list and describe all study intersections and roadways. Description should not be limited to traffic controls, roadway geometries, traffic operations, City of Dallas Thoroughfare Plan designation and any pedestrian and bike lane facilities.

Provide a description of all adjacent roadways including name, thoroughfare plan designation, average daily traffic, design hourly volume, number of lanes, and any transit, bicycle and pedestrian facilities.

4. *Site Plan*

Briefly describe and/or attach a site plan showing existing and proposed curbs, driveways, adjacent travel lanes, median opening, parking facilities, building and open leasable areas.

5. *Study Scenarios*

- Existing
- Background (<buildout year>, Phase I)
- Project Buildout (<buildout year>)
- Project 5-year Horizon (or longer if project requires thoroughfare plan amendment)

NOTE: All study phases must include a no build (background) analysis with and without any recommended improvements to quantify impact.

6. *Trip Generation*

Trip generation should be calculated based on average or fitted curve equations published on the latest edition of the ITE *Trip Generation Manual*. Any adjustments or reductions for pass-by, mode split based on person-trips or internal capture must be based on guidelines outlined in the 10th edition of the ITE Trip Generation Handbook. Staff reserves the right to refute engineering judgement that contradicts field observations.

Table 1—Projected Trip Generation

ITE CODE	ITE LAND USE	QUANTITY	WKD TRIPS	AM PEAK HOUR			AM PEAK HOUR		
				IN	OUT	TOTAL	IN	OUT	TOTAL
710	General Office Building	649,900 SF	6,519	759	103	862	140	640	780
931	Quality Restaurant	20,000 SF	1,677	12	3	15	105	51	156
Development Totals:		669,900 SF	8,196	771	106	877	245	691	936
Internal Capture ⁷ :			469	4	4	8	21	21	42
Total External Trips:			7,700	767	102	869	224	670	894

7. Adjustments

Not all traffic entering or exiting a site driveway is necessarily new added traffic to the existing street network. Trip generation rates may require an evaluation of pass-by or diverted trips, alternative modes of transportation, or internal trip for mixed use developments. The traffic study should acknowledge any adjustment of based trip generation rates should any of these phenomena be estimated to be significant.

In general, the use of person trips and local data are acceptable methods to adjust trip generation in accordance with the ITE Trip Generation Handbook, 3rd Edition. In fact, applicants are encouraged to read and reference the handbook in preparation of any traffic study.

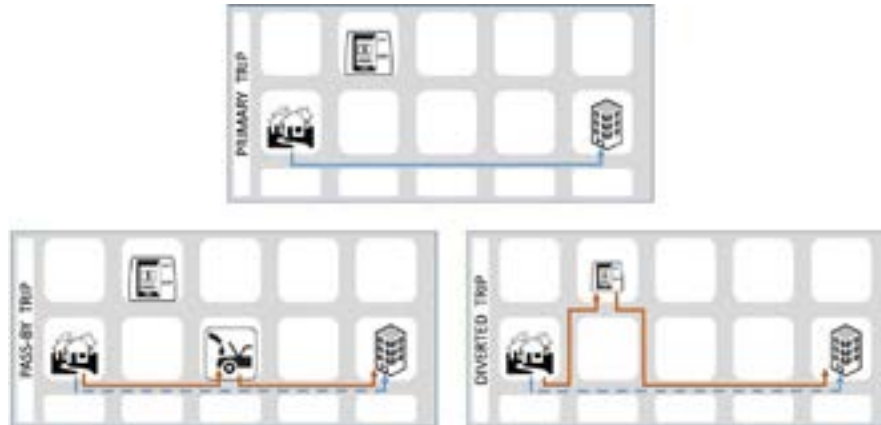


Figure 1. Illustration of accepted primary, pass-by and diverted trips

8. Trip Distribution and Traffic Assignment

Trip distribution and traffic assignment is a subjective exercise based upon professional judgment and understanding of regional demographics, roadway conditions. Analyses of origins and destinations will be assessed on a case-by-case basis. Studies must include exhibits depicting any assumed trip distribution and traffic assignment as a percent of the total trip generation.

9. Traffic Counts

Traffic study must include turning movement counts on two consecutive days noting motor vehicles, trucks, pedestrians, and bicycle counts summarized in 15 minute intervals.

10. Field observations

Report must include a brief description of all study intersections and roadway. When possible, photographs should be included from field visits.

11. Projected background Traffic Volumes

Evaluation of projected, background traffic must be based on a review of historical average daily traffic counts. It is the responsibility of the applicant to request any information relative to other potential developments in the vicinity of the study site.

12. Intersection Analysis

Intersection analysis must be based on either Intersection Capacity Utilization (ICU) or Highway Capacity Manual methodology. A single peak hour factor (PHF) may be applied to all approach movements of an intersection per HCM guidelines. City of Dallas suggests a maximum design value of 0.92. Alternative PHFs should be considered for specific movements with lower values; such conditions may be discussed as part of the scope proposal.

The standard criterion used to define quality of traffic flow is “level of service” (LOS). The Highway Capacity Manual defines LOS as a quality measure describing operational conditions within a traffic stream. This standard provides an assessment of factors such as speed and travel time, traffic interruptions, freedom to maneuver, and comfort and convenience. LOS ranges from “A” (free flow) to “F” (extended delay and queues fail to clear) as shown in Table 2. Results from delay-based methods or simulation from HCM, Synchro, Vissim or SimTraffic must be summarized in tables showing measures of effectiveness including LOS, average delay and 95th percentile queue lengths per approach as shown in Table 3.

Table 2. HCM LOS Criteria based on average control delay (sec/veh)

LOS	SIGNALIZED INTERSECTION	UNSIGNALIZED INTERSECTION
A	≤ 10	≤ 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

Source: Transportation Research Board, Highway Capacity Manual, Special Report 209, Third Edition, National Research Council, Washington, DC, 2000.

Table 3. Peak hour intersection capacity summary

CONDITION	EXISTING 2018			BACKGROUND 2020			BACKGROUND		
GEOMETRY	EXISTING			EXISTING			PROPOSED IMPROVEMENT		
INTERSECTION APPROACH	LOS	DELAY (SEC/VEH)	QUEUE* (FEET)	LOS	DELAY (SEC/VEH)	QUEUE* (FEET)	LOS	DELAY (SEC/VEH)	QUEUE* (FEET)
<u>Cole Ave at Lee St</u>									
EBLTR	D	37	24	D	44	29	D	53	35
EBTR	--	--	--	--	--	--	C	33	48
WBLTR	D	37	24	D	44	29	D	53	35
WBTR	--	--	--	--	--	--	B	17	1
SBTRT	A	3	0.1	A	3	0.1	A	3	0.1

*based on 95th percentile queue lengths.

13. Roadway Link Analysis

Roadway link analysis should examine operating conditions of roadways segments based on hourly roadway capacities within an area as determined by the North Central Texas Council of Governments (NCTCOG)’s Dallas-Fort Worth Regional Travel Model (DFWRTM), 2009. The model defines area type by activity density (per acre) assuming areas remain relatively constant within the study network.

Table 4. Hourly service volume capacity per lane by area type and roadway function

AREA TYPE	Activity Density Range (per acre)	PRINCIPAL ARTERIAL		MINOR ARTERIAL & FRONTAGE ROAD		COLLECTOR & LOCAL STREET	
		Divided or One-Way	Undivided Two-Way	Divided or One-Way	Undivided Two-Way	Divided or One-Way	Undivided Two-Way
CBD	>125	725	650	725	650	475	425
Outer Business	30-125	775	725	775	725	500	450
Urban Residential	7.5-30	850	775	825	750	525	475
Suburban Residential	1.8-7.5	900	875	900	825	575	525
Rural	<1.8	1,025	925	975	875	600	550

Table 5. NCTCOG’s volume to capacity ratio for roadways operating under capacity.

LOS	UPPER THRESHOLD FOR V/C RATIO
A/B/C	0.65
D/E	1.00

14. Site Access Evaluation

Traffic studies should include an evaluation of proposed access driveways included but not limited to:

(i) Auxiliary (deceleration or deceleration) lanes

Evaluation may be based on simplistic volume thresholds as well as access management considerations. No single factor should be a determining justification to appropriately evaluate the need for auxiliary lanes. In general, the following recommendations should be considered based on published literature¹:

- **Functional Classification:** exclusive turn lanes should be incorporated with adequate storage unless it is impractical to provide them. Collectors and arterials should be planned with auxiliary lanes to provide desired mobility and access. Left turn lanes are generally recommended for driveways at median opening and/or on high speed road or curves. Noting, however, that exclusive turn lanes negatively impact pedestrians and bicyclists. Left turns should not be prohibited unless alternative routes are investigated. Design of left turn lanes should avoid unnecessary conflicts; driveways should not be situated within the functional area of a left turn lane. Median openings that allow traffic across left-turn lanes create a safety issue and violate driver expectancy.
- **Operating Speed:** left turn lanes reduce conflict between high speed through traffic (45 mph or higher) and vehicles slowing to turn.
- **Percent of Left Turns:** left turn lanes recognize primary travel routes for high percentages vis-à-vis approaching traffic—an arbitrary decision.
- **Roadway Capacity:** left turn lane increases approach capacity but also increase pedestrian-vehicle conflict points; let's keep pedestrians and bicyclists in mind.
- **Crash History:** evaluation should include evidence of right angle crashes. Safety should be the main reason behind exclusive turns.

(ii) Signage and pavement marking on public rights-of-way

Developer is responsible for the installation of all signage and striping associated with a private development project including portions of public row. The city is responsible for reviewing that work and provide a release should the work meet city standards.

(iii) Historical accident analysis

The analysis must identify crash patterns that may be of concern, emphasizing movements potentially impacted by proposed development.

(iv) Driveway sight distances

Driveways must be located to provide adequate sight distance for motorists to safely operate their vehicles. Turn restrictions may also be assessed provided an analysis illustrated in the City of Dallas *Off-Street Parking & Driveways Handbook* and summarized as shown in Table 6.

Table 6. Roadway link analysis summary (example)

STUDY DRIVEWAY	DESIGN SPEED (MPH)	SIGHT DISTANCE REQUIREMENT			
		DESIRABLE LEFT SIGHT	MEASURED LEFT SIGHT	DESIRABLE RIGHT SIGHT	MEASURED RIGHT SIGHT
Driveway 1 on Mockingbird Lane	40	design criterion*	500 ft	design criterion*	500 ft

*Based on *Off-Street Parking and Driveways Handbook* and AASHTO's *Geometric Design of Highways and Street*.

¹ NCHRP 745: *Left Turn Accommodations at Unsignalized Intersections*, NCHRP 780: *Design Guidance for Auxiliary Lanes*

(v) Pedestrian safety at unsignalized crossing

A technical review of appropriate pedestrian crossing treatment should be based upon recommendations presented in the Transportation Research Board's Improving Pedestrian Safety at Unsignalized Crossings (NCHRP Report 562). The NCHRP report provides guidelines and a nationally accepted methodology to investigate adequate improvements of pedestrian safety.

(vi) Number of access points needed without negatively impacting adjacent roadways

(vii) Driveway spacing

(viii) Corner clearance (adjacent to signalized intersections or channelized right turns lanes)

(ix) Median openings

(x) Shared access

(xi) Stop sight distance

(xii) Traffic signal or STOP control warrant analysis

(xiii) Driveway improvements

(xiv) Curb return radius

15. Summary

Any development impact (i.e. a significant change in MOEs from intersection capacity summary) must be mitigated. Alternatively, the amount of proposed development may be re-evaluated. Summary must include an outline of all findings and recommendations for distribution and discussion with staff, public, City Plan Commission, City Council, etc.

16. Certification Statement

Traffic studies must include the following statement, signed and sealed by the professional engineer responsible for the contents of the document:

"I, <full name>, hereby certify that the information provided in this report is complete and accurate to the best of my knowledge."

17. Appendix

Appendix must include worksheets that provide average delay, LOS, v/c ratios/ and 95th percentile queue lengths.

D. School Traffic Management Plans

A school traffic management plan (TMP) is a site-specific plan providing guidelines to coordinate traffic circulation during school peak hours. TMPs should promote strategies to manage all modes of transportation and maintain student safety paramount at all times. An effective plan requires continual planning, renewed understanding and coordinated efforts by city staff, school administration and staff, neighbors, parents, and students.

The school operator must prepare a traffic study evaluating the sufficiency of any TMP. The study must be based on field observations of both afternoon pick-up and morning drop-off periods. The study must include but is not limited to:

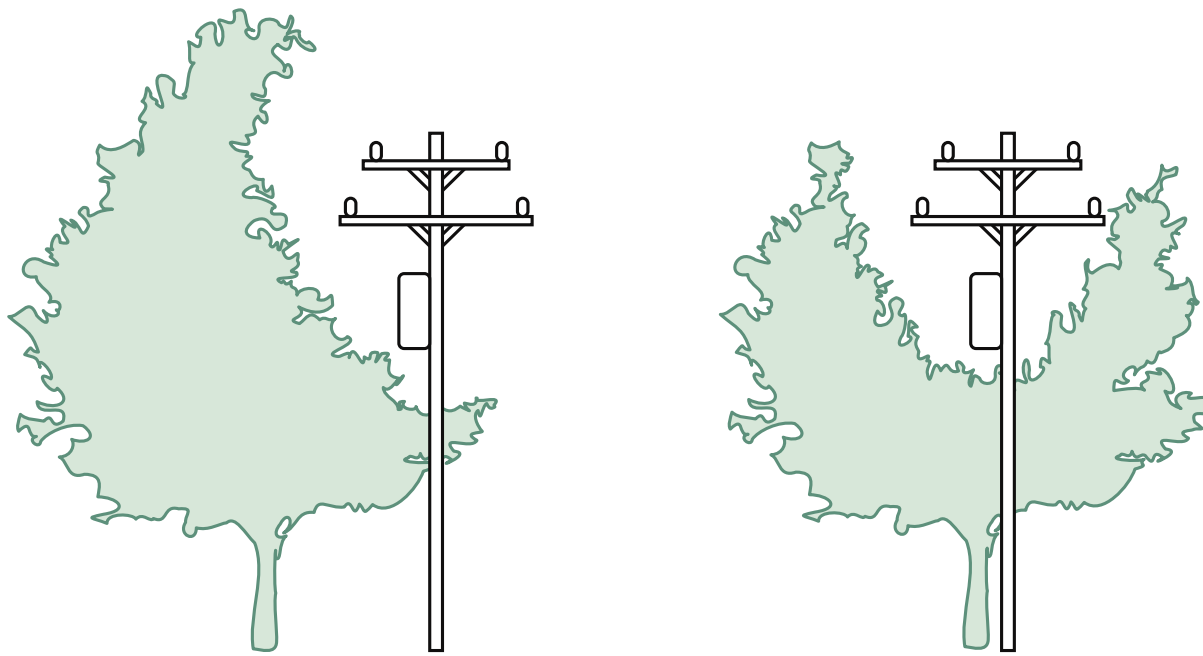
- 1. TMP exhibit to scale showing building footprints, curbs, parking, pavement markings, designated student drop-off and pick-up locations
NOTE: aerial image background are difficult to duplicate and therefore are not acceptable.
- 2. School site location and description of adjacent roadways
- 3. All ingress and egress points of access for motor vehicles or pedestrians
- 4. Pickup queuing summary table indicating school schedule and student enrollment for each grade, maximum vehicular accumulation, storage capacity, and surplus for each dismissal period and/or designated student loading zone
- 5. On-site traffic circulation, including any temporary traffic control devices
- 6. Proposed student drop-off and pick-up coordination system: passenger ID system, separation of modes of transportation, staggering times, etc.
- 7. Number and location of school staff assisting with unloading and loading students, including staff requirements and expectations
- 8. Number and location of adult school crossing guards and/or off-duty deputized officers
- 9. Statement confirming that plan was developed with direct input from individuals familiar with the general characteristics of the traffic needs and contact information of approving school administration official
- 10. Signed, stamped and dated by a licensed Professional Engineer in the State of Texas with specific expertise in transportation and traffic engineering, preferably certified as a Professional Traffic Operations Engineer
- 11. Prepared in a format that is easy to transmit to parents and school staff
- 12. Where applicable,
 - School bus loading operations
 - Methodology for projected maximum vehicular accumulation
 - Identify pedestrian routes up to half a mile away from all pedestrian access points
 - Parking management strategies
 - Recommendations to encourage walking and biking
 - Recommendations to inform and engage parents, students, staff and neighbors
 - Traffic control plan depicting traffic signs on public rights-of-way
 - If school is adjacent to any roadway with posted speed limit of 35 mph or greater, include:
 - Turning movement counts at all adjacent major intersections
 - Stopping and Intersection sight distances at school driveway approach

A.7

TREES AND OVERHEAD UTILITIES

Where overhead electrical and communication wiring remain, those elements will limit the selection and placement of trees. ONCOR provides specific guidelines and tree recommendations for plantings under and beside electrical power lines, within their easements, and these guidelines should be followed. Opportunities and coordination for installation of taller poles and higher strung wiring may allow additional tree species and sizes to be planted, with ONCOR's approval. Trees which are misplaced or inappropriate for the setting near or under a power lines can result in a very misshapen plant. The following represents an example where a large tree is too close to a power line, and the tree must be trimmed by ONCOR to maintain reliable electric power for its customers.

Figure A.7.1 Large Trees and Overhead Lines



A.8

RECOMMENDATIONS FOR MAINTENANCE

Table A.8.1 Tree/Plant Health, Aesthetics, Design Performance and Safety

Activity	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Per Yr.
Tree straightening - first year after installation	•	•	•	•	•	•	•	•	•	•	•	•	•
Tree pruning to provide canopy clearance over sidewalks, roads & structures	•	•	•									•	•
Trees - removal of dead wood & suckers	•	•	•	•	•	•	•	•	•	•	•	•	•
Trees - remove excess mulch, soil & ant beds to maintain exposure of tree root flare	•	•	•	•	•	•	•	•	•	•	•	•	•
Trees - treat damage to trunks by vandalism or natural event	•	•	•	•	•	•	•	•	•	•	•	•	•
Cultivate planting beds		1				1			1				3
Hand weed beds - do not allow weeds or seedling trees to establish & mature	1	1	2	4	4	5	4	4	5	4	2	1	37
Muhly grasses - comb & pull dried seed stalks from crown of plant by hand with rubber gloves, only cut back once every 2 to 3 years only as necessary, remove all trimmings from beds		1											0.5 - 0.3
Trim/cut back warm season ornamental grasses to 1/3rd of the plant height - 1 time every 2 years, remove all trimmings from beds		1											0.5
Trim/cut back cool season sedges to 1/3rd of the plant height - 1 time every 2 years, remove all trimmings from beds									1				0.5
Trim spent yucca & hesperaloe blooms & remove dead lower foliage if it easily pulls away or releases from plant	•	•	•	•	•	•	•	•	•	•	•	•	•
Trim/Dead head perennials – pick prune by hand or use pruning tools, remove all trimmings from beds	•	•	•	•	•	•	•	•	•	•	•	•	•
Trim back dead stalks of perennials after plant becomes dormant to 6 inch height above grade to mark where plant will come up in Spring, removal all trimmings										•	•	•	•
Pick prune shrubs, only if necessary, to maintain natural character – no shearing or topping is allowed	•	•	•	•	•	•	•	•	•	•	•	•	•

Table A.8.1 Tree/Plant Health, Aesthetics, Design Performance and Safety (continued)

Activity	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Per Yr.
Dig out, cut off & remove plant sucker growth that has grown beyond the extents of the defined bed area	•	•	•	•	•	•	•	•	•	•	•	•	•
Remove all debris, trimmings, fallen branches & thatch from planting bed areas	•	•	•	•	•	•	•	•	•	•	•	•	•
Bush hog one time per year in mid to late February		1											1
Organic Insecticide - Ant control	•	•	•	•	•	•	•	•	•	•	•	•	•
Applications & treatment with organic: insecticides, herbicides, fungicides & for brown patch	•	•	•	•	•	•	•	•	•	•	•	•	•
Apply organic biological fertilizer to planting beds, isolated planter areas, trees & turf areas, raingardens, bioretention areas, bioswales, & bioretention swales			1			1				1			3
Apply rustic cut hardwood mulch at planter bed areas to maintain full 3 inch depth topdressing			1							1			2
Remove decomposed mulch and apply fresh single grind/interlocking hardwood mulch at raingardens, bioretention areas, bioswales & bioretention swales to maintain full 3 inch depth for first year until plants are established			1							1			2
Remove decomposed mulch & apply fresh single grind/interlocking hardwood mulch around bases of drain structures at raingardens, bioretention areas, bioswales & bioretention swales			1							1			2
Curb Inlet/Splash Pad/Forebay – sand bag removal at curb opening (end of 9 mo. – 1 yr.) and maintenance to remove all trash and sediment from basin and openings	1	1	1	1	1	1	1	1	1	1	1	1	12
Mowing of turf grasses, and temporary grasses to 1.5 inch to 2 inch height	•	1	2	2	2	•	•	•	•	•	1	1	•
Bagging turf grass clippings adjacent to planters, raingardens, bioretention areas, bioswales & bioretention swales	•	1	2	2	2	•	•	•	•	•	1	1	•
Blow grass cuttings back into turf areas & away from planter beds, raingardens, bioretention areas, bioswales, or bioretention swales	•	•	•	•	•	•	•	•	•	•	•	•	•
Mowing drainage features grasses & forbs area to no less than 5 to 7 inch height	1						1						2
Irrigation check	5	4	4	4	5	4	5	4	5	4	4	4	52
Irrigation inspection & repair				1	1	1	1	1	1			1	7
Clean, repair & restore aggregate surfaces – remove sediments from aggregates with stormwater inflow	5	4	4	4	5	4	5	4	5	4	4	4	52
Remove trash from, repair & restore large aggregate surfaces	•	•	•	•	•	•	•	•	•	•	•	•	•

1 INTRODUCTION
 2 STREET TYPES
 3 NETWORKS / ACCESS
 4 GEOMETRIC DESIGN
 5 PAVEMENT
 6 STREET LIGHTING
 7 CONSTRUCTION PLAN
 APPENDICES

Table A.8.1 Tree/Plant Health, Aesthetics, Design Performance and Safety (continued)

Activity	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Per Yr.
Litter & leaf removal from planters, raingardens, bioretention areas, bioswales & bioretention swales	5	4	4	4	5	4	5	4	5	4	4	4	52
Trash, recycling & dog waste removal, install new liners, & restock dog waste bags	5	4	4	4	5	4	5	4	5	4	4	4	52
Raised Tree Planters – check irrigation & drain inlets	•	•	•	•	•	•	•	•	•	•	•	•	•
Site furniture – maintenance, damages reported to City	•	•	•	•	•	•	•	•	•	•	•	•	•
Site furniture – repair or replace missing components per approval from City	•	•	•	•	•	•	•	•	•	•	•	•	•
Remove graffiti from retaining walls, abutments, seat walls & paving	•	•	•	•	•	•	•	•	•	•	•	•	•
Removal of hazardous materials	•	•	•	•	•	•	•	•	•	•	•	•	•
Repair erosion control features	•	•	•	•	•	•	•	•	•	•	•	•	•
Remove all flood debris (logs, branches, trash, sediments, etc.) from impacted drainage storage areas & channels	•	•	•	•	•	•	•	•	•	•	•	•	•
Remove debris, pull back mulch, cleanout & inspect surface drain grates & area drains	1		1		1		1		1		1		6
Inspect & cleanout subdrain system	1		1		1		1		1		1		6
Inspect & cleanout sedimentation basins	1		1		1		1		1		1		6
Inspect & clean out drain pipe outfall openings to ensure they are free of debris & functioning	1		1		1		1		1		1		6
Remove Snow, Ice and Sand from sidewalks & planter areas after ice storm event – do not put into planters	•	•	•	•							•	•	•
Remove Snow, Ice and Sand from raingarden, bioretention area, bioswale & bioretention swales after ice storm event	•	•	•	•							•	•	•
Inspection & testing surface infiltration rate at different locations & applications (hydraulic conductivity test)	1 time per year												1
Light fixtures - outage reported to City	1	1	1	1	1	1	1	1	1	1	1	1	12
Visit w/ Contracting Officer	1	1	1	1	1	1	1	1	1	1	1	1	12

• = as needed

This table is not comprehensive and is intended as a guideline. Refer to project documents for further information.

Duration of project work and from adjacent construction: Inspect and Repair BMP's until adjacent construction is complete to prevent siltation of Drainage Storage Features; remove BMP's.

Table A.8.2 Permeable Pavers and Pavements

Activity	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Per Yr.
Repair & replace cracked or broken pavers	Once every 20 years upon inspection/determination												0.05
Repair & level pavers if ½" in parking or if ¼" for ADA access	Once every 20 years upon inspection/determination												0.05
Replenish paver jointing aggregate	Once every 20 years upon inspection/determination												0.05
Replace or add to subbase of pavers	Once every 20 years upon inspection/determination												0.05
Remove weeds and moss	Minimally 1 time per year												1
Remove trash & gently clean off with blower	12 times a year minimally												12
Regenerative air machine vacuum cleaning of pavements/pavers in street or sidewalks	Adjust cleaning intervals as based on infiltration test results – possibly one every 2-3 years												0.5
Underdrain system – inspect, remove debris, & cleanout			1		1							1	3
Snow, Ice & Sand removal from paver areas after ice storm	After adjacent street sanding event to remove sands from joints												1
Inspection & testing surface infiltration rate at different locations & applications	1 time per year												1

Duration of project work and from adjacent construction: Inspect and Repair BMP's until adjacent construction is complete to prevent siltation of paver system; remove BMP's.

One initial visit for regenerative air machine vacuum cleaning of pavers/pavements within the first year of service.

CITY OF