



# DESIGN CRITERIA MANUAL

APRIL 1, 2020

## RECORD OF REVISIONS

<u>Number</u>	<u>Date of Adoption</u>	<u>Comments</u>
19-054	10/15/2019	Effective November 1, 2019. <b>Design Criteria Manual</b> was repealed and replaced in its entirety concurrently with revisions to the <b>Unified Development Code</b> .
20-011	03/24/2020	Effective April 1, 2020. Amend <b>Subsection 4.5.6. Fire Lanes, Paragraph F</b> relative to maximum grade applicability and <b>Paragraph H</b> relative to turn around area requirements applicability; <b>Section 4.7. Paving Design Requirements</b> relative to full width concrete panel replacement; <b>Subsection 4.11.5. Lane Widths Pavement Marking Design Requirements</b> relative to lane width standards; <b>Subsection 4.14.1. Conduit and Pull Box Installation</b> relative to standard conduits installation under major streets; and <b>Subsection 4.15.1 General Requirements, Paragraph H</b> relative to pull boxes.

# **CITY OF ARLINGTON**

## **DESIGN CRITERIA MANUAL**

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# CHAPTER 1 - ADMINISTRATION

The Director of Public Works and Transportation (D-PWT), the Director of Water Utilities Department (D-WU), the Director of Planning and Development Services (D-PDS), the Director of Parks and Recreation (D-PR), and the Fire Chief, are hereby authorized to enforce the provisions of this Manual in their respective areas of management.

## 1.1. Overview

This Design Criteria Manual was written by and includes criteria from the following departments:

- Department of Public Works and Transportation (PWT)
- Water Utilities Department (WU)
- Planning and Development Services (PDS)
- Parks and Recreation Department (PR)
- Fire Department

This manual is intended to provide criteria for the most commonly encountered infrastructure designs in the City of Arlington, hereinafter referred to as “City”. This manual was developed for users with knowledge and experience in the applications of standard engineering principles and practices of design. Close coordination with City staff is recommended and encouraged during the planning, design, and construction of all projects. Planning, design, and construction of all land disturbing activities within the city limits or its Extra-territorial Jurisdiction (ETJ) shall adhere to this Manual, applicable City Ordinances, and City Standard Details and Specifications.

The purpose of these guidelines is to provide information required to prepare civil construction plans for:

- Residential Developments,
- Commercial Developments, and
- Capital Improvements

Specific information required for plan submittal can be found in the following chapters and on the City website. Several departments have guidelines and other additional resources that shall be used as references during design and plan preparation. These resources can be found on the City website. It is the responsibility of the Owner and the Owner’s Engineer to ensure compliance with the latest version of the additional resources. Additional design requirements may be specified in the Professional or Engineering Services Contracts for Capital Improvement Projects.

For all development, the Owner and the Owner’s Engineer shall be responsible for the applicability of the information contained in this manual. The Owner and the Owner’s Engineer shall also be responsible for the accuracy of the information furnished in the design of all facilities for both the development and other affected properties. Acceptance by the City shall not be construed to relieve the Owner or the Owner’s

Engineer of any responsibility with the design. The Engineer sealing the design plans shall accept the responsibility of the design.

If there is a conflict between this Design Criteria Manual and the Standard Specifications and Details, the latest Standard Specifications and Details, including the Special Provisions, at time of plan approval shall govern.

## **1.2. Development Requirements**

### **1.2.1. Construction Responsibilities**

The Owner shall be responsible for all necessary improvements, including but not limited to design and construction of any onsite or offsite facilities, easements, and construction staking. When construction of certain public facilities is not immediately feasible and not necessary to protect the health, safety and welfare of the public, the Owner may request to escrow the costs with the City. The escrow amount shall be all costs associated with the construction of the infrastructure, including but not limited to, engineering design, utility relocation, and right-of-way/easement acquisition. The Director of the impacted department shall determine whether escrow will be accepted in lieu of construction. The escrow funds will be reimbursed to the entity that designs and constructs the improvements. The City will not be responsible for any cost difference between the escrow amount and the actual cost of the improvements. The escrow shall be paid prior to filing the plat or issuing a building permit, whichever comes first. Escrow is not allowed as a cost avoidance or convenience measure and will only be allowed with adequate documentation of the reasons for the request.

### **1.2.2. Special Provisions and Standard Specifications**

All public improvements shall be in accordance with the City Standard Specifications which includes the latest Special Provisions, the latest Standard Specifications for Public Works Construction as issued by the North Central Texas Council of Governments (NCTCOG), and the latest City of Arlington Standard Specifications for Water & Sanitary Sewer Construction. Where any discrepancies occur between documents, City Special Provisions shall take priority over drawings, and drawings shall govern over other applicable Specifications. The City Standard Specifications are available on the City website.

### **1.2.3. Standard Details**

All public improvements shall be constructed in accordance with the City Standard Details. Details are subject to change and it is the responsibility of the Engineer to use the most current details from the City website. Any revisions or editing of the City Standard Details will require prior approval from the City. If a City detail is not available, it is the responsibility of the design Engineer to provide necessary details in the plans. All detail sheets must be sealed, signed, and dated by an Engineer.



## **1.2.4. Horizontal and Vertical Control**

### **A. Horizontal Control**

All plans submitted to the City shall be prepared using the NAD83 "Surface" coordinates or as published in the City Survey Design Manual located on the City website. The City has established horizontal control monumentation that is tied to this coordinate system. Monumentation data is available in the map room or on the City website.

### **B. Vertical Control**

Vertical control shall be tied to NAVD88. The City has established vertical control throughout the City. This information is available in the map room or on the City website.

## **1.2.5. Brass Disks**

Brass disks shall be set on new inlets in accordance with plans or at locations as determined by the City when minimum finished floor elevations or flood protection elevations are required. Multiple brass disks may be required for subdivisions. City Inspectors will provide the disks to the contractor. A letter signed, sealed, and dated by a Surveyor (RPLS) shall be submitted at the completion of construction establishing the location and elevation of all brass disks set during the project. The letter shall be accepted by the City prior to initial acceptance of the public improvements.

## **1.2.6. Permits**

Building permits will not be issued until all public improvements are accepted.

Permits necessary for the overall site grading, walls, or electrical components for streetlights on private streets may be issued prior to acceptance of public improvements.

## **1.2.7. Release for Early Grading**

Upon written request from the Owner, the City may allow early grading prior to the construction plans being accepted or plat being filed under the following conditions:

- The Owner must demonstrate that an inability to file the plat within a reasonable timeframe is the result of filing requirements that do not have a substantive impact on the development of the land.
- An approved Stormwater Pollution Prevention Plan (SWPPP) shall be implemented prior to any soil disturbance, including grading, clearing, fill, or removal of concrete in the case of demolition.
- The site plan shall be accepted, and an early grading permit shall be obtained.
- Work is limited to grading activity only.



- Work is limited to areas located outside of the regulatory floodplain.
- Owner accepts any responsibilities for subsequent revisions prior to final grading plans acceptance.

### **1.2.8. As-Built Plans for Public/Private Improvements**

For private improvements in residential or commercial development, the City's standard as-built letter and checklist shall be completed and submitted by an Engineer or Architect prior to issuance of a building permit or a certificate of occupancy. The notarized letter shall attest that the site grading, paving, drainage improvements, and water and sanitary sewer improvements are constructed in accordance with the plans. If field changes occurred, revised signed and sealed plans, together with a revised as-built letter and checklist shall be submitted.

For public improvements completed through Three-Party Contracts, the contractor shall coordinate as-built plans with the Public Works Inspector, the City Project Manager or Engineer, and the Owner's Engineer. If the improvements were not constructed in accordance with the plans, appropriate documentation shall be provided to substantiate any changes. The City shall require the Engineer to document any field changes by submitting signed and sealed as-built plans.

For Capital Improvements, as-built plans shall be coordinated with the City Inspector and City Project Manager or Engineer to document changes to public facilities.

## **1.3. City Participation**

### **1.3.1. Water and Sanitary Sewer Facilities**

Subject to available funding and City Council approval, the City may participate in the construction cost of water or sanitary sewer mains. The Water and Sewer Chapter of the City Ordinance addresses facilities eligible for participation. The Owner shall submit a written request for participation to the City prior to executing Developer Participation Contracts and Three-Party Contracts. The request shall include:

- A plan drawing showing the water and sanitary sewer mains eligible for participation.
- An estimate of quantities and construction costs for the work involved in the participation request. For oversized mains, the City shall pay only the difference in cost between the size main required for the development and the size main required by the City. The size main required for the development shall be the City of Arlington minimum standard size or the minimum size main necessary to serve the development, whichever is greater.

Once WU concurs with the participation amount, a Developer Participation Contract signed by the Owner will be submitted to City Council for authorization. The Owner will be notified once the contract is approved by City Council.

After construction is complete and the facility has been inspected and accepted by the City, the Owner shall submit the following items to the City for processing the participation reimbursement:

- Letter requesting payment for eligible facilities,
- Notarized affidavit from contractor,
- Notarized affidavit from Owner,
- Notarized "Certification of Costs" from Owner, and
- Itemized statement of final construction quantities and costs for eligible facilities.

### **1.3.2. Streets**

Subject to available funding, and City Council approval, the City may participate in the cost of designing and constructing a street or roadway facility included on the Thoroughfare Development Plan (TDP) in excess of the Owner's responsibility to provide adequate roadway facilities as defined in the Unified Development Code (UDC). The City will not participate in any costs that exceed City standards as specified in the TDP and City Standard Specification and Details.

The Owner shall submit a written request for participation to the City prior to executing Three-Party Contracts. The request shall include:

- A plan drawing showing all facilities included in the request, and
- An estimate of quantities and costs for work involved in the participation request.

Once PWT concurs with the participation amount, a reimbursement contract signed by the Owner will be submitted to City Council for authorization. The Owner will be notified once the reimbursement contract is approved by City Council.

After construction is complete and the facility has been inspected and accepted by the City, the Owner shall submit the following items to the City for processing the participation reimbursement:

- Letter requesting payment for eligible facilities,
- Notarized Affidavit from contractor,
- Notarized Affidavit from Owner,
- Notarized "Certification of Costs" from Owner, and
- Itemized statement of final construction quantities and costs of eligible facilities.

### **1.3.3. Drainage**

The Owner shall pay for the cost of all on-site and off-site drainage improvements.

## **1.4. Contractor Requirements**

### **1.4.1. Pre-Qualification**

Contractors must be pre-qualified by the City to construct all public improvements, including but not limited to paving, drainage, water and sanitary sewer improvements. Pre-qualification shall be determined by the City. The contractor shall complete the pre-qualification application indicating the type of work for which the contractor desires to be pre-qualified and submit to PWT for evaluation. Contractors must be pre-qualified prior to the execution of Three-Party Contracts or prior to bid opening for capital projects. Applications for prequalification will not be accepted after execution of Three-Party Contracts or after bid opening. The pre-qualification evaluation may take up to three weeks. Pre-qualification forms are available on the City website.

### **1.4.2. Three-Party Contract**

For residential and commercial developments, standard Three-Party Contracts executed by the Owner, contractor, and the City are required for construction or modification of all public infrastructure. The Three-Party Contract execution process will not commence until construction plans have been accepted by the City. The contract shall provide 100 percent performance, payment, and maintenance bonds, except when the contract is less than \$25,000. When the contract is less than \$25,000, only the maintenance bond is required. The following documents shall accompany the submittal of Three-Party Contracts:

- Bonds: Bonds shall not be executed prior to the date of execution of the contract
- Certificate of Liability Insurance: Coverages as approved by the City. The expiration date of the insurance policy shall not be prior to the completion of the project.
- Trench Safety Plan: signed and sealed by an Engineer
- Traffic Control Plan

### **1.4.3. Traffic Control Plan**

When construction impacts existing roadways or sidewalks, a location specific traffic control plan (TCP) together with the Temporary Traffic Control Permit shall be submitted to the City. A TCP must be included with Three-party Contracts. All traffic control plans shall be in accordance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD). The TCP shall be submitted to the City for approval no later than two weeks prior to closing any streets or causing any obstruction to traffic on any street. For Capital Improvement Projects, TCP submittal shall be in accordance with the construction contract.

#### **1.4.4. Inspection of Public/Private Improvements**

For residential and commercial developments with public improvements, the contractor shall notify the City Construction Services Division 48 hours prior to the start of any construction of public improvements. The contractor shall also ensure that, when applicable, proper authorities with the Texas Department of Transportation (TxDOT), franchise utility companies, railroads, or any other affected entities are notified. For Capital Improvement Projects, the contractor shall abide by the construction contract. Inspections of private street and drainage improvements may be performed by the City at the Owner's request and expense.

#### **1.4.5. Stormwater Pollution Prevention Plan**

All land disturbances shall comply with Texas Pollutant Discharge Elimination System (TPDES) requirements. A SWPPP shall be provided to the City and approved prior to the start of any construction. The contractor is responsible for implementing and maintaining the SWPPP, as well as the posting and submittal of construction site notifications, the Notice of Intent, and the Notice of Termination. Refer to Chapter 5, Stormwater, in this manual for additional information on the SWPPP. For Capital Improvement Projects, the SWPPP shall be prepared and submitted in accordance with the construction contract.

### **1.5. Development Fees**

The following are descriptions of fees related to development. Fee amounts may be found on the City website or by contacting the City. This list is informational and additional fees may be required.

#### **1.5.1. Impact Fees**

##### **A. Roadway Impact Fee**

The roadway impact fee is based on the number of development units and the collection rates as provided in the Impact Fees Chapter of the City Code of Ordinances. The fee must be paid prior to the issuance of a building permit.

##### **B. Water and Sanitary Sewer Impact Fees**

Water and sanitary sewer impact fees are based on the size of the water meter serving the property. A 5/8-inch meter is considered the base (one) service unit. Water and sanitary sewer impact fees must be paid prior to the issuance of a building permit.

#### **1.5.2. Park Development Fees**

All applications for new Residential Developments shall be subject to the collection of park development fees, pursuant to Article IX of the Parks and Recreation Chapter of the City Code of

Ordinances, Arlington Park Development Fee. This document is also available at the Parks and Recreation Administration Office.

Park Development Fees are assessed to assure that park and recreation facilities are available to the residents of Arlington. Current and proposed park standards for development have been established in the Parks, Recreation and Open Space Master Plan. Refer to the City website for the most recent version of the Parks Master Plan.

Fees are collected from all residential developments and shall be used solely and exclusively for the purpose of acquisition and development of park and recreation facilities necessitated to serve proposed development. Types of facilities include neighborhood and linear parks. Fees must be paid prior to issuance of a building permit.

### **1.5.3. Administration and Inspection Fee**

#### **A. Street and Drainage**

This fee is to recover a portion of the cost for reviewing plans, inspection and materials testing for the construction of public streets, their appurtenances (including but not limited to streetlights, street signs, signals, and pavement markings), and drainage improvements. The fee is based on a percentage of the construction contract amount for the public improvements and must be paid prior to the execution of Three-Party Contracts.

#### **B. Water and Sanitary Sewer**

This fee is to recover a portion of the cost for reviewing plans, inspection and materials testing for the construction of public water and sanitary sewer improvements. The fee is based on a percentage of the construction contract amount for the public improvements and must be paid prior to execution of Three-Party Contracts.

### **1.5.4. Water and Sanitary Sewer Subsequent Connector Fee**

The water and/or sanitary sewer subsequent connector fees may be applicable if the City funded construction of water and/or sanitary sewer mains. These fees are intended to recoup the cost for infrastructure previously installed adjacent to the property for the purpose of providing future service.

### **1.5.5. Water and Sanitary Sewer Tap and Meter Fees**

The water and sanitary sewer tap fees are the cost for WU to make the physical connection from the main to the property line or to the meter. The tap fees are not applicable if installed by an approved utility contractor as part of a Three-Party Contract.

The meter fees cover the cost of the meter and installation. All fees must be paid prior to the issuance of a building permit.

A construction (fire hydrant) meter must be obtained for water use during construction and additional fees will be required.

#### **1.5.6. Abandonment Processing and Fair Market Value Component Fees**

A non-refundable fee is charged for processing the application when abandoning right-of-way or easements by separate instrument or by plat. The applicant will be responsible for all costs associated with the abandonment, including the processing fee, relocation of utilities, and fair market value component. The processing fee must be paid with submittal of the abandonment application, if processing by separate instrument. If processing by plat, the fee must be paid prior to filing the plat. Fair market value component fee must be paid prior to final approval of the abandonment.

#### **1.5.7. Stormwater/Flood Study Review Fee**

This fee is to recover the cost associated with the technical review of flood studies and detention facilities. The fee varies based on the number of reviews performed of reports and computer models. The fee must be paid prior to final acceptance of the study.

#### **1.5.8. Floodplain Development Permit Fee**

This fee is to recover the cost of reviewing plans for development within the floodplain. The fee is based on the type and complexity of the work being performed in the floodplain. The fee must be paid prior to acceptance of constructions plans.

#### **1.5.9. Corridor Development Certificate (CDC) Recovery Fee**

This fee is to recover the costs associated with the technical review of the CDC permit by the U.S. Army Corps of Engineers (USACE). This fee applies to projects that are developed in the Regulatory Zone of the West Fork Trinity River and associated major tributaries to the river. A portion of the fee is also used to fund the North Central Texas Council of Governments (NCTCOG) corridor-wide CDC administration. The fee, established by USACE and NCTCOG, must be paid with the submittal of the CDC permit. Please refer to the most current CDC Permit Guidelines for the technical review fees.

#### **1.5.10. Fire Department Permit Fees**

The following Fire Department Permit Fees must be paid at the time of the permit application.

- All blasting/explosive permits

- Authorized outdoor burning
- Installation or testing of underground flammable liquid storage tank systems
- Monitoring wells
- Installation of above ground waste oil tank
- Installation of above ground protected tank
- Removal of underground flammable liquid storage tanks
- Abandonment of underground tanks/lines
- Installation and testing of automatic halon, dry chemical, wet agent, carbon dioxide or other fire extinguishing systems including standpipe systems
- Installation of fire alarm systems—fee varies based on number of devices
- Special locking system
- Installation of any LPG container, except for portable containers of less than 120 gallons water capacity installed at properties where natural gas service is not available
- Installation and testing of automatic sprinkler systems – fee varies based on number of heads
- Installation of underground piping and private fire hydrants
- Residential automatic fire sprinkler system
- Installation of smoke control system

Permit fees shall be tripled if a contractor has begun work without a permit. The fees shall be quadrupled for the second and subsequent occurrences by the same contractor within two years.

#### **1.5.11. Electronic Scanning Fee**

This fee is to recover the cost for scanning the accepted commercial site plans and public improvement plans if printed copies are submitted. Fee is not applicable if plans are submitted electronically. The fee must be paid prior to acceptance of constructions plans.

#### **1.5.12. Easement Filing Fee**

This fee is to recover costs related to preparing and filing easements by separate instrument with the County. Upon submission of the easement documents as described in Chapter 2, the fee will be calculated. The fee must be paid prior to acceptance of constructions plans.

### **1.6. Submittals**

The purpose of these submittal guidelines is to provide information required to prepare construction plans for residential and commercial developments. Specific information required for plan submittal can be found in the following sections or in the guidelines located on the City website.



These submittal guidelines are not applicable to Capital Improvements Projects. Submittal guidelines for Capital Improvements Projects will be in accordance with the Professional or Engineering Services Contract.

### **1.6.1. Residential and Commercial Development Submittals**

The following is a list of the type of plan sheets and studies that may be required as part of development submittals.

- Cover Sheet
- Final Plat
- Dimension Control Plan
- Landscape/Tree Preservation Plan
- Water and Sanitary Sewer Plan, Profile and Details
- Site Grading Plan and Drainage Area Maps
- Street and Drainage Plan, Profile and Details
- Stormwater Management Site Plan
- Gated Entries
- Deceleration Lanes
- Signal Design
- Median Openings
- Streetlights, Street Signs and Pavement Markings
- Drainage Impact Analysis
- Flood Study
- Floodplain Development Permit
- Conditional Letter of Map Change
- US Army Corps of Engineers Permit
- Trinity River Corridor Development Certificate
- Stormwater Pollution Prevention Plan (SWPPP)
- Stormwater Facility Operation and Maintenance Agreement

Where applicable, submittals shall conform to the submittal guidance available on the City website.

After the submittals are accepted, the Applicant will be notified regarding the number of printed plan sets needed. Applications that are not accepted for construction within 12 months after the date of application may be voided unless an extension is requested in writing prior to the application's expiration. One extension will be allowed for a period not to exceed 6 months.

Public Improvement construction plans will expire if no construction has begun within 24 months from the date of public improvement plan approval. A new public improvement application must be submitted along with the construction plans. Plans must comply with design standards in effect at the time of resubmittal.

In cases where a development is phased, the public improvement construction plans will expire 24 months from the date of approval if construction of the undeveloped phases has not begun after City acceptance of the public improvements of the previous phase. Construction plans for the undeveloped phases shall be resubmitted for review, along with a new Public Improvement application, and must comply with design standards in effect at the time of resubmittal.

### **1.6.2. Utility Companies**

The Owner shall submit construction plans to the utility companies when improvements are proposed along existing adjacent streets to determine any conflicts. A list of utility companies and contact names may be obtained from the City at the time of application.

### **1.6.3. TxDOT Submittal**

A permit from TxDOT is required when constructing improvements within the state right-of-way. For development, the completed TxDOT permit application, including the required number of printed plan sets shall be submitted to the City. The City will forward the permit application and the plan sets to TxDOT for review. A permit from TxDOT shall be obtained prior to beginning work.

## **1.7. Alternative Design, Exceptions, and Variance Requests**

The Director of the impacted department shall have authority to approve an alternative material, design, or method of construction for individual cases, when the Director or designee finds that the proposed material, design, or method is satisfactory and complies with the intent of the provisions of this Manual, and that the alternative is at least the equivalent of that prescribed by this Manual in quality, strength, effectiveness, durability, and safety. The applicant shall show, with appropriate engineering evidence, sufficient to the Director or designee that the proposed alternative as offered for the intended purpose, is at least the equivalent of the requirements of this Manual in quality, strength, effectiveness, durability, and safety.

All exceptions or variance requests shall be presented in writing to the City at the time of the original plat application and/or construction plan submittal and must, at a minimum contain the following information:

- Identification of Applicant and project for which the variance will be applied.
- Recitation of criteria or standards from which the Applicant seeks a variance.
- Justification for not complying with the criteria in this Manual.
- Alternate criterion or standard that is proposed to comply with the intent of the criteria in this Manual and other applicable guidance documents.
- Supporting documentation, including necessary calculations, reference materials, software, specifications, etc., adequate to evaluate how the proposed variance satisfies the intent of this Manual.

Variance requests for criteria in Right-of-Way & Easements, Water Utilities, Transportation, and Stormwater chapters must be signed and sealed by a Professional Engineer licensed in the State of Texas. Variance requests for criteria in the Parks chapter must be signed and sealed by a Registered Landscape Architect or Professional Irrigator in the State of Texas.

Incomplete variance request applications will not be processed until the applicant adequately addresses all outstanding items. It is the applicant's sole responsibility to adequately support all requested variances. Construction work related to any specific approval item or variance that has not been approved in writing shall not begin until the Director or designee of the impacted department has granted written approval. Any work that proceeds without specific approval will be subject to removal and replacement in accordance to these standards.

Variance requests for plat applications and construction plan submittals for development projects shall be submitted with the appropriate documentation and justification to the Planning and Development Services Department for initial review and completeness check. The variance request and supporting documentation will be forwarded to the Director or designee of the impacted department for a final decision. A formal response to the variance request will be provided to the requestor by the impacted department.

Variance requests for capital improvement projects shall be submitted with the appropriate documentation and justification to the project manager in the managing department. The variance request and supporting documentation will be forwarded to the Director or designee of the impacted department for a final decision. A formal response to the variance request will be provided to the requestor by the project manager.

As a condition of the alternative approval, other stipulations, including but not limited to the execution of a Maintenance Agreement may be imposed. An approval of an alternative material, design, or method of construction shall not affect nor relieve the Owner, Owner's Representative, or the Owner's Engineer of an ongoing obligation and responsibility for adequacy of such material, design, or method of construction for intended purposes.

# CHAPTER 2 - RIGHT-OF-WAY & EASEMENTS

## 2.1. Easements or Right-of-Way Requirements

This chapter provides guidance on issues involving right-of-way and easements that occur in the City of Arlington (City). Specific requirements, including needs and widths, for roadway, water, sanitary sewer, access, and drainage easements or right-of-way are provided in the applicable chapters of this manual.

Generally, right-of-way is dedicated or acquired for streets and roadways where multiple public uses will occur. Right-of-way may contain paving, water and sanitary sewer, drainage, traffic, and streetlight improvements and other public or private utility improvements as allowed by the City. Right-of-way shall be dedicated in accordance with the TDP by plat or separate instrument.

Easements are dedicated or acquired for a specific purpose and are sized according to the specific use indicated in this Chapter. Easements shall be dedicated by plat or separate instrument.

### 2.1.1. Public Improvements

Public easements are required for infrastructure that needs to be accessed or maintained by the City outside of the right-of-way. The City will only maintain the public infrastructure within the public easement and will not be responsible for other general maintenance, such as mowing or weeding.

#### A. Public Drainage Easements

Public drainage easements are generally required when flow is conveyed across property lines and collected by an engineered or natural drainage system.

Constructed public drainage features within public drainage easements, such as pipes, flumes, or concrete-lined channels are maintained by the City. Specific maintenance responsibilities are described in the UDC. The City does not maintain natural streams.

Public drainage easements may be allowed for privately maintained improvements with approval from the City. The requirements for approval include the execution of a Maintenance Agreement recorded with Tarrant County as a covenant running with the land and a Maintenance Statement included on the plat or on the separate instrument. See Agreements for Private Improvements section in this Chapter for more information.

Drainage features that require specialized or arduous maintenance may be allowed in a public drainage easement but shall be privately maintained.

Specific easement widths are as follows:

1. Culverts and Storm Drain Systems: The minimum width of a drainage easement is 15 feet. When combined with other utilities, the minimum width is 20 feet. The City may require wider easements to accommodate systems with pipe sizes larger than 60 inches or deep systems.
2. Natural Streams: The minimum easement is the width of the 100-year fully developed floodplain. The Owner shall acknowledge maintenance responsibility by means of a Maintenance Statement or by an agreement approved by the City to provide for any maintenance of the natural creek and its associated drainage easement. Refer to Chapter 5 for criteria establishing the Erosion Clear Zone.
3. Constructed/Modified Open Channels: The minimum easement is the width of the channel, including the limits of any structural components, which shall convey the 100-year fully developed floodplain plus an additional 10 feet on each side of the channel for access and maintenance. Easements must also encompass access ramps.

#### B. Public Water and Sanitary Sewer Easements

Public water and sanitary sewer easements are required when public water or sanitary sewer facilities are installed outside the right-of-way. Water and sanitary sewer easements shall be specifically designated for their use (i.e., “water main easement” or “sanitary sewer main easement”) and shall be a minimum of 15 feet wide. Water and sanitary sewer mains shall be centered within the easement.

When both water and sanitary sewer mains are located in the same easement, the easement shall be specifically designated as a “water and sanitary sewer main easement” and shall have a minimum width of 20 feet. Water and sanitary sewer mains shall be a minimum of 5 feet from the edge of the easement.

When water or sanitary sewer mains are constructed deeper than 10 feet, the easement width shall be a minimum of 20 feet. For deep and/or large diameter mains, the width of the easement shall encompass the trench width and side slopes which are based on geotechnical recommendation unless otherwise approved by WU.

Water and sanitary sewer facilities are generally not desirable in the state right-of-way. All water and sanitary sewer facilities adjacent to state right-of-way shall be placed in a separate easement outside the right-of-way.

#### C. Public Utility Easement

Public Utility Easements are required to accommodate public services, such as electric, gas, or telecommunication and shall be a minimum of 15 feet wide. When more than one service is located within the same easement, the easement shall be a minimum of 20 feet

wide. The Owner shall coordinate with the public service providers or other entities for required easements to serve the development or project.

D. Specialty Easements

Easements (other than above mentioned easements) designated for a specific use, such as sidewalks, landscaping, parking, etc. will require approval from the City.

## **2.1.2. Private Improvements**

Easements for private improvements shall be acquired by separate instrument or shown on a plat. The instrument or plat shall describe the properties to be benefited and include a Maintenance Statement for the improvement. In addition to the statement, a separate Maintenance Agreement may be required for certain types of private improvements. See Maintenance Agreement section in this Chapter.

Private improvements that require easements include, but are not limited to, the following:

- A. Detention/Retention Ponds must be contained within a public drainage easement.
- B. Stormwater BMPs must be contained in a public drainage easement.
- C. Private drainage systems
  - 1. A private drainage easement is only required if the improvements cross property lines within a development.
  - 2. If the drainage system receives flow from property outside the development, then a public drainage easement is required.
- D. Water or sanitary sewer service lines that only serve one property, but must cross other properties, must be contained within a private water easement or a private sanitary sewer easement.
- E. Shared driveways or access, private streets, and alleys must be contained within a private access easement.

## **2.1.3. Agreements for Private Improvements**

City Code of Ordinances allows permitting of certain private improvements within public easements or right-of-way with the execution of an Easement Use Agreement or a Maintenance Agreement. These agreements state that the City is not responsible for the maintenance or reconstruction of any improvements located in the easement or right-of-way. Forms and instructions are available from the City.

#### A. Easement Use Agreements

The following items may be allowed within an easement or right-of-way with an approved Easement Use Agreement.

- Driveways
- Brick or stone fences
- Retaining Walls
- Private storm drains or area drains
- Swimming pool decks
- Wood decks
- Rectangular Rapid Flashing Beacons (RRFB)

Other improvements including those listed below may be allowed without the execution of an Easement Use Agreement at the appropriate Director's discretion.

- Concrete flatwork
- Wooden or chain-link fences that do not impeded the conveyance of stormwater
- Retaining walls less than 3 feet in height that do not support a structure nor infringe on the required visibility triangles

A site plan shall be submitted to the City and accepted prior to the issuance of a permit for the construction of the improvements.

Any grading changes, land disturbance, or riparian encroachments within easements or the right-of-way will be subject to the City's stormwater requirements as well any state and federal requirements.

#### B. Maintenance Agreements

In addition to a Maintenance Statement on the plat or on the dedicated separate instrument, a Maintenance Agreement may be required for certain private improvements. The City will provide the Maintenance Agreement. The Maintenance Agreement shall describe the private improvements and identify maintenance responsibilities, which may include specific operation, maintenance, schedules, reports, and corrective actions. The Maintenance Agreement shall be executed and recorded with Tarrant County concurrently with the recording of a plat or separate instrument and be a covenant running with the land.

Maintenance Agreements will be required for private improvements, including but not limited to the following:



- Detention/Retention Ponds
- Stormwater BMPs, if applicable\*
- Drainage features that require specialized or arduous maintenance as determined by the City
- Natural earthen channels

\*Maintenance Agreements for Stormwater BMPs may be executed and recorded with acceptance of site or construction plans rather than with the Plat or separate instrument.

## **2.2. Acquisition of Easements or Right-of-Way**

Easements or right-of-way not shown on a plat shall be procured by separate instrument. The Owner is responsible for obtaining onsite and offsite easements or right-of-way. The Owner may request assistance from the City if the offsite easement or right-of-way is for public use and requires condemnation. If the offsite easement is private in nature, the City cannot provide assistance.

Prior to requesting assistance, the Owner shall provide a written offer to the property owner based on fair market value which shall be based on an appraisal. The City's assistance does not relieve the Owner of the cost of purchasing the easement or right-of-way. In addition, the Owner shall reimburse the City for all costs associated with the acquisition.

Prior to requesting City assistance, the Owner shall exhaust all avenues of negotiation and provide documentation of efforts to the City. City assistance for condemnation of offsite easements or right-of-way is the last resort and requires Council action.

## **2.3. Filing Easements or Right-of-Way**

The following explains the process for filing an easements or right-of-way by separate instrument:

- The Owner shall submit the written metes and bounds description and a drawing of the easement or right-of-way sealed, signed, and dated by a Surveyor. This information along with the ownership information shall be submitted to the City.
- The description and drawing will be forwarded to the Land Bank Division and prepared on City forms. The Easement Filing Fee will be determined for preparing and filing the documents.
- Upon payment of the fee, the instrument will be returned to the Owner for signatures. The signed documents are then returned to the City.
- The City will file the instrument with Tarrant County.
- A copy of the filed instrument will be forwarded to the Owner.

## 2.4. Abandonment of Easements or Right-of-Way

Abandonment of easements or right-of-way is processed by separate instrument or plat, in accordance with the Administration Chapter of the City Code of Ordinances, Article VII – Rights of Way (Street and Alley) and Easement Abandonment. Abandonments may be processed through the platting process if the property is being re-platted for other purposes, or if the plat is a Plat Vacation that reverts back to a previous plat. The right-of-way or easement being vacated with recording of the Plat Vacation must not contain any existing infrastructure. Appropriate City Department approval or consent will be required for all abandonments.

The required approval or consent, as determined by the City is based on the right-of-way or type of easement proposed for abandonment. Generally, the approval or consent is from the City, registered public service providers, and impacted property owners. Except for City and registered public service providers approval/consent, it is the Owner's responsibility to secure all other required approval/consent. If unanimous approval/consent is obtained, and all stipulations and requirements have been satisfied, the application will be processed administratively. If unanimous approval/consent cannot be obtained or if the abandonment involves the closing of public access or a street, the application will be forwarded to City Council for approval. Easements or right-of-way granted to entities other than the City shall be abandoned by that entity via their process.

A request for the abandonment of easements or right-of-way by separate instrument can be initiated by submitting the following to the City:

- An application form (available from PWT or on the City website),
- Parcel drawing and written metes and bounds description prepared by a Surveyor,
- Non-refundable application fee, and
- Impacted property owners' signatures, if applicable.

A request for the abandonment of easements or right-of-way by plat can be initiated by:

- Identifying the area proposed for abandonment by shading and label "Abandoned by this Plat" with its recording information of the existing easements or rights-of-way,
- Non-refundable application fee, and
- Impacted property owner's signatures, if applicable.

As condition of approval, the Owner will be responsible for the following (if applicable) at the Owner's expense:

- Remuneration Fee based on fair market value of area being abandoned,
- Relocation of utilities,
- Drainage Report/Drainage Impact Analysis,

- Flood Study,
- Traffic Study,
- Retaining easements with the right-of-way abandonment, and
- Re-platting.

If relocation of utilities or public improvements are a stipulation of the easement or right-of-way abandonment, then the abandonment will not be approved until the relocation is completed.

Compliance with all stipulations and requirements and the recording of the abandonment with Tarrant County must occur within 12 months from the date of application, otherwise the application shall be considered expired and a new application will be required. If delays occur complying with the stipulations and requirements due to unforeseen circumstances, the applicant may submit a request to extend the time for approval and D-PWT may allow an extension up to six months. For abandonment by plat, the plat submittal requirements regulate the expiration.

## **2.5. Monitoring Wells**

The installation of monitoring wells within City right-of-way shall only occur when there is no other alternative location. For approval of monitoring wells in right-of-way, the following shall be submitted to the Land Bank division through the right-of-way permit process:

- Justification letter,
- Water gradient profile,
- Map showing the proposed location of the monitoring well, and
- Right-of-Way Permit.

The request will be evaluated, and a written response provided within ten working days. Upon approval of a request, the following additional criteria shall be required prior to installation:

- Right-of-Way Use Agreement,
- Waiver of Liability, Indemnification, Release and Hold Harmless Agreement,
- Certificate of Insurance naming the City as additional insured,
- Traffic Control Plan, and
- Approved Right-of-Way Permit.

A permit from the Fire Department is required for the installation of monitoring wells on private property.

## **2.6. Easements Owned by Other Entities**

Requirements for existing or new public service providers' easements specifically for their use shall be coordinated with that entity.

# CHAPTER 3 - WATER UTILITIES

## 3.1. Water Design

This section presents the minimum technical criteria for the analysis, design, and installation of City of Arlington (City) water systems, including distribution mains, transmission mains, water services, and the applicable appurtenances associated with these installations. Additional requirements for specific projects may be established where the conditions of service and related system operations or maintenance needs warrant. Analysis and design of water systems shall be prepared by or under the supervision of an Engineer. It will be the responsibility of the engineer to ensure the design of newly developed or re-developed properties complies with the latest version of all applicable federal, state, and local ordinances, rules, and regulations. These include, but are not limited to, the following:

- Texas Administrative Code (TAC) Title 30 Part 1 Chapter 290
- Water and Sanitary Sewer Chapter of the City Ordinance
- Standard Specifications for Water and Sanitary Sewer Construction for the City
- Standard Details for Water and Sanitary Sewer Construction for the City
- Approved Products Listing for Water and Sanitary Sewer Construction for the City
- Water Utilities Plan Submittal Guidelines

### 3.1.1. Main Extension

- A. The Owner is responsible for all on-site and off-site water infrastructure and associated easements to serve the proposed development.
- B. The Owner is responsible for extending water infrastructure to the development and across the frontage(s) of the development to allow for future extensions for the development of adjacent parcels and to facilitate looping opportunities.
- C. WU shall retain the authority to reject any extension not deemed to be in the best interest of the City.

### 3.1.2. Main Sizing

- A. Distribution mains shall be a minimum of 8 inches in diameter. Fire hydrant leads, blow off leads, and dead-end mains within a cul-de-sac as described in Section 3.1.3.A.6 shall be 6 inches in diameter.
- B. The City may elect to require a larger main diameter size beyond the capacity required to support the development(s). Larger main sizes are identified in the Water Distribution System Master Plan or by WU. Cost for capacity exceeding the minimum size main shall be the responsibility of the City as defined in the Water and Sewer Ordinance.

- C. The Owner's Engineer shall provide calculations showing maximum day usage, peak hour usage, and fire flow demands for the proposed development. WU will use the provided calculations to confirm the existing mains are adequate to support the development or determine the size(s) required to furnish adequate water service for the proposed development. Parameters for calculating water system demands based on typical land use types are shown in Table 3-1, Water System Average Daily Demand (ADD).
- D. Maximum flow velocity during normal operating conditions shall not exceed 7 feet per second.

Table 3-1 Water System Average Daily Demand (ADD)

Land Use	Density		Demand		
	(People per Acre)	(Person per Unit)	Average Day Demand	Max. Day/ Avg Day Ratio	Peak Hour/ Max Day Ratio
Single Family Residential & Duplex	12.0	3.5	130 gal/person	1.9	1.75
Estate Sized Single Family	7.0	3.5	130 gal/person	1.9	1.75
Multi-Family Residential (Includes Townhomes and Condos)	52.0	3.5	110 gal/person	1.9	1.75
Industrial, Commercial or Mixed Use	Industry-specific – contact WU for information				

### 3.1.3. Main Placement

A. Horizontal

1. Mains shall be located a minimum of 2 feet behind the back of curb.
2. Mains shall be located a minimum of 2 feet behind storm drain inlets (use of bends may be necessary).
3. Changes in horizontal alignment for water mains shall be achieved by use of fitting or deflection of joints. If fittings are used, they shall be labeled accordingly on the construction plans. If pipe joint deflection is used, the construction plans shall include the design radius, beginning and ending of curvature, and a detail of the proposed typical deflection. The maximum joint deflection shall be as follows:
  - i. The maximum joint deflection to be used for PVC water mains 12 inches in diameter or smaller is 1 degree which equates to a minimum radius of 1,150 feet.

- ii. The maximum joint deflection to be used for DIP water mains 12 inches in diameter or smaller is 4 degrees which equates to a minimum radius of 290 feet.
  - iii. The maximum joint deflection to be used for other water main sizes and materials shall require approval of WU.
- 4. All bends shall be 45 degrees or less. Two 45-degree bends in a series should be used in lieu of 90-degree bends.
- 5. Mains shall be constructed in a looped configuration for increased reliability of service, reduced head loss, and maintaining disinfectant residual concentrations. A main is considered looped if it remains in service in the event that a connecting main at either end is shut down or isolated from the rest of the system. Proposed mains that approach pressure plane boundaries should be designed to loop within their designated pressure plane.
- 6. Mains located within a cul-de-sac are not required to be looped if all the following conditions are met.
  - i. Connects to a looped main 6 inches in diameter or larger.
  - ii. Has at least one service connection within 5 feet of the terminating end.
  - iii. Has at least a minimum of 2 service connections per 100 feet of main.
  - iv. The maximum dead-end length allowed is 800 feet.
- 7. While looped systems are required, the WU may allow installation of a temporary dead-end main where the main will be extended with future development. If a temporary dead-end main is allowed, the following are required.
  - i. A gate valve shall be installed near the end of the main followed by two joints of pipe and a plug. Thrust blocking shall not be used as a restraint at the end of the main. The Engineer shall determine the necessary length of the restraint on each side of the valve that will keep the main in place for future extension when the plug is removed.
  - ii. No services may be installed between the valve and the plug.
  - iii. A fire hydrant assembly shall be installed on the live side of the gate valve for flushing and maintenance.
- 8. A minimum clearance of 3 feet horizontally and 2 feet vertically shall be maintained from all public service providers such as gas, electric, and telecommunications within City right-of-way. Proposed public service providers shall cross beneath water mains. Coordination with each public service provider is required to confirm clearance requirements. The more stringent clearance requirements will be enforced.

## B. Vertical

1. The required minimum cover shall be 42 inches over the water main as measured from the top of the pipe to the existing ground or the proposed finished grade, whichever is lower. A note stating this requirement shall be included in the construction plans.
2. A profile drawing shall be provided for all mains which meet any of the following conditions:
  - i. 12 inches in diameter and larger,
  - ii. Crossing beneath a storm drainpipe, box culvert, or channel,
  - iii. Installed within a steel casing pipe,
  - iv. Crossing congested corridors, or
  - v. Mains installed greater than 6 feet in depth
3. Changes in vertical alignment for water mains shall be achieved by use of fittings or deflection of joints. If fittings are used, they shall be labeled accordingly on the construction plans. If pipe joint deflections are used, the construction plans shall include the design radius, beginning and ending of curvature, and a detail of the proposed typical deflection. The maximum joint deflection shall be as described in Section 3.1.3.A.3.
4. All bends shall be 45 degrees or less. Two 45-degree bends in a series should be used in lieu of 90-degree bends.
5. Mains shall not be placed below curb inlets.
6. Mains along unimproved (county type) streets shall have a minimum depth of 5 feet below the lowest ditch elevation to the top of pipe to provide grade for future street improvements.
7. Steel casing pipe shall be installed where mains are to be constructed by method other than open cut. Alternate methods and materials may be used upon approval by WU.
8. Mains with less than 2 feet clearance below a 30 inch or smaller storm drainpipe shall be one of the following:
  - i. Ductile iron pipe on center with storm drain crossing, or
  - ii. Installed within a steel casing pipe.
9. Mains installed below a 33 inch or larger diameter storm drainpipe, box culvert, or channel shall be installed within a steel casing pipe. Alternate encasement methods and materials may be used upon approval by WU.



10. Where casing pipe is required, the casing pipe shall extend a minimum of 5 feet beyond the outside edge of the drainage pipe or box culvert, a minimum of 10 feet beyond the outside edge of a drainage channel, or as required for construction and future maintenance practices.
11. Mains installed within a casing pipe with more than two joints require restrained joint pipe.

#### **3.1.4. Connections to Existing Water Mains**

- A. All proposed connections to existing mains that are not an extension, shall be accomplished using a tapping sleeve and gate valve with no water outage associated with the connection to the existing system. If not allowable by manufacturer's recommendations, a tee may be installed at a time determined by WU to limit customer disruption.
- B. Cut-in tee connections may require an additional valve(s) on the existing main to reduce the number of service disruptions.
- C. If a shut-down is required for a connection to an existing transmission main, the Engineer shall make provisions within the construction contract documents (including plans) to notify the contractor that connections to a transmission main will only be allowed on a date and time approved by the WU. Prior to submittal of final plans, the Engineer shall coordinate with WU to discuss the shut-down procedure and to determine if any additional requirements need to be incorporated into the contract documents. Plans shall also contain the following notices for the contractor to adhere to during construction:
  1. Contractor shall coordinate with WU at least four weeks before the approved shut-down date to discuss the plan.
  2. Contractor shall coordinate with WU at least one week in advance of planned connection to discuss details and sequencing procedure of the connection.
  3. No shut-down will occur unless all required material and equipment are on site.
- D. If a facility is required to have two domestic and/or fire services to provide for redundant operation of the entire facility, each service shall be located on separate water mains.

#### **3.1.5. Services - Domestic, Irrigation, and Fire**

- A. Minimum sizes for domestic and irrigation services from the main to the meter are shown in Table 3-2.

Table 3-2 Minimum Size Service Line Based on Meter Size

Service Line Size	Meter Size
1-inch	5/8-inch, 1-inch
2-inch	1 ½-inch, 2-inch
4-inch	3-inch, 4-inch
Greater than 4 inches	Match meter size

- B. A private domestic and irrigation service begins after the meter and shall be labeled “Private Domestic Service” and “Private Irrigation Service” on the construction plan sheet.
- C. A private fire service begins after the public isolation valve located at the public main and shall be labeled “Private Fire Service” on the construction plan sheet.
- D. Multiple domestic and irrigation meters may branch off one service line; however, the service line must be large enough to convey the total maximum flow of all meters being served by the one service. This can be accomplished by ensuring the cross-sectional area of the service line is greater than the total cross-sectional area of all meters.
- E. Service lines shall be connected to the public main located on the side of the lot where the premise is addressed.
- F. Residential service lines shall be located at the center of the lot and stationed on the construction plan sheet.
- G. Services lines shall be installed perpendicular to the main.
- H. Service connections are prohibited on mains designated by WU as transmission mains. In lieu of connecting to a transmission main, a parallel distribution main shall be installed in accordance with the main extension criteria. Consult WU when connecting to a main 16 inches and larger to determine if it is designated as a transmission main.
- I. Domestic and irrigation service connections are prohibited on private fire services and public fire hydrant leads. Private fire services and public fire hydrant leads shall have a sole purpose dedicated to fire protection.
- J. Service taps on public mains will be made by either the City or through a Three-Party Contract.
- K. Service taps that are determined to be obsolete shall be abandoned by disconnecting the service line at the corporation stop.

- L. Backflow prevention assemblies are required for premise isolation on all non-residential domestic services. See Backflow Prevention Ordinance.
- M. Backflow prevention assemblies are required on all irrigation services. See Backflow Prevention Ordinance and Irrigation Ordinance.
- N. Backflow prevention assemblies are required on all fire services, whether new or retrofitting existing connections. See Backflow Prevention Ordinance

### **3.1.6. Meters**

- A. All Meters shall be sized per the latest version of the AWWA M6 – “Water Meters– Selection, Installation, Testing and Maintenance”. A flow data worksheet for meters larger than 2 inches shall be provided to the City for approval by WU.
- B. Meters shall be located in accordance with the Water Utilities Standard Details for meters and services.
- C. Meters shall be located in accessible protected areas outside of vehicular or pedestrian traffic but within right-of-way or an easement.
- D. Where water meter banks are installed, the meters shall be installed in a sequence corresponding with the premise addresses.
- E. A meter shall be required for each building, regardless of development type. Multi-unit buildings will require a separate meter be installed for each unit, unless WU determines that a different configuration is more efficient for operation and maintenance. These requirements may necessitate the installation of a public main within the development.
- F. All meters shall be remote read meters.

### **3.1.7. Valves**

- A. Gate Valves
  - 1. Gate valves shall be installed at water main intersections to allow for the isolation of mains for maintenance.
  - 2. Gate valves shall be placed such that no more than 32 residential lots will be out of service during system maintenance and main repair.
  - 3. Gate valves on mains 12 inches in diameter and smaller shall be spaced at intervals not to exceed 600 feet.
  - 4. Gate valves on mains 16 inches in diameter and larger shall be spaced at intervals not to exceed 1,200 feet.

5. Gate valves installed at water main intersections shall be restrained to the nearest fitting, however certain circumstances approved by WU may require alternate placement.
6. Gate valves are not allowed to be placed within sidewalks, access ramps, driveways, or drainage features.
7. Gate valves installed between intersections shall align with common lot lines.
8. Gate valves shall be installed outside the normal tire path in a lane on a paved roadway.
9. Gate valves located outside of the right-of-way shall be accessible by 2-wheel drive vehicles 24 hours a day and shall be approachable by a dedicated 15-foot minimum easement.
10. Gate valves are required for all fire hydrant leads, fire services, and water services that are 4 inches in diameter or larger. Each valve shall be restrained to the tee.
11. All gate valves shall be installed in the vertical direction. No horizontal orientations will be allowed. Gate valves must be placed perpendicular to the existing/proposed ground elevation.

B. Combination Air Valves

1. Combination air valves shall be installed on mains 16 inches in diameter or larger where topography or other factors may create air locks in mains.
2. Combination air valve locations shall be approved by WU. Air valves are to be sized per the latest edition of AWWA M51: Air Release, Air/Vacuum, and Combination Air Valves.

### **3.1.8. Fire Hydrants**

This section presents the general design requirements for fire hydrants to be placed within public right-of-way and/or easements. It will be the responsibility of the Engineer to ensure the design, placement, and construction of public and private fire protection systems conform to the latest City adopted edition of the International Fire Code and the Fire Prevention Chapter of the City Code of Ordinances.

- A. For all one and two family residences, excluding townhouses and apartments, fire hydrants shall be installed when any exterior portion of the building protected is in excess of 600 feet, as measured by the laying distance for fire apparatus hose lines along public streets and rights-of-way, from the nearest fire hydrant on a public street.
- B. For all other land uses, except one and two family residences, including townhouses and apartments, fire hydrants shall be installed when any exterior portion of the building protected is in excess of 500 feet, as measured by the laying distance for fire apparatus

hose lines along public streets and right-of-way, from the nearest fire hydrant on a public street.

- C. A fire hydrant shall be installed no more than 200 feet from the Fire Department connections for a standpipe or automatic sprinkler system. For high-rise buildings, the Fire Department connection shall be within 25 feet of the street.
- D. Where new mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at a spacing not to exceed 1,000 feet to provide for system maintenance and operation.
- E. Fire hydrants shall be installed at the end of mains in cul-de-sacs and other locations where mains terminate. A fire hydrant shall be placed at all intersecting streets to cul-de-sacs 200 feet and greater in length.
- F. Fire hydrants required between intersections shall align with common lot lines.
- G. Fire hydrants shall be located outside curb returns and at least 5 feet from the edge of the driveway.
- H. Fire hydrants are not allowed within sidewalks. If the sidewalk is adjacent to the curb in the right-of-way, the fire hydrant shall be installed behind the sidewalk. If a parkway exists between the curb and sidewalk, the fire hydrant shall be installed in the parkway. Additional fittings may be required and shall be shown on the construction plans to achieve fire hydrant placement requirements.
- I. In all cases, fire hydrants shall be located such that the location does not conflict with the Americans with Disabilities Act requirements.
- J. Fire hydrants shall be located in accessible and visible locations.
- K. Fire hydrants shall be located at a minimum of 3 feet and no more than 8 feet behind the back of curb.
- L. Fire hydrants shall be located with a minimum 3-foot radius clear space.
- M. Blow-offs per City details are required on mains 16 inches in diameter or larger located at low points for de-watering purposes

### **3.1.9. Sampling Stations**

Water sampling stations are required to meet compliance with regulatory requirements. These stations may be required to be installed at the request of the City.

## **3.2. Sanitary Sewer Design**

This section presents the minimum technical criteria for the analysis, design, and installation of City sanitary sewer systems, including sanitary sewer mains, sanitary sewer services, manholes, and the applicable appurtenances associated with these installations. Additional requirements for specific projects may be established where the conditions of service and related system operation or maintenance needs warrant. Analysis and design of sanitary sewer systems shall be prepared by or under the supervision of an Engineer. It will be the responsibility of the Engineer to ensure the design of newly developed or re-developed properties complies with the latest version of all applicable federal, state, and local ordinances, rules, and regulations. These include, but are not limited to, the following:

- Texas Administrative Code (TAC) Title 30 Part 1 Chapter 217
- Water and Sanitary Sewer Chapter of the City Code of Ordinance
- Standard Specifications and Details for Water and Sanitary Sewer Construction for the City
- Standard Details for Water and Sanitary Sewer Construction for the City
- Approved Products Listing for Water and Sanitary Sewer Construction for the City
- Water Utilities Plan Submittal Guidelines

### **3.2.1. Main Extension**

- A. The Owner is responsible for constructing on-site and off-site sanitary sewer infrastructure and providing associated easements to serve the proposed development.
- B. The Owner is responsible for extending sanitary sewer infrastructure to the development and through the development to serve abutting properties as required.
- C. WU shall retain the authority to reject any extension not deemed to be in the best interest of the City.

### **3.2.2. Main Sizing**

- A. Sanitary sewer mains shall be 8 inches, 10 inches, 12 inches, or 15 inches in diameter. Larger main diameter sizes shall be as identified in the Sanitary Sewer Collection System Master Plan or approved by WU.
- B. Mains shall be sized for fully developed conditions based on the latest version of the Sanitary Sewer System Master Plan or as determined by WU utilizing the latest system hydraulic model.
- C. Mains shall be adequately sized to serve the development and upstream sanitary sewer drainage basin.

- D. Mains shall be designed to produce a minimum velocity of 3.0 feet per second or greater when flowing half full based on Manning's equation using an "n" value of 0.013. Allowable main diameters with associated minimum and maximum slopes are shown in Table 3-3, Allowable Sanitary Sewer Main Diameters & Slopes. Exceptions will require approval by WU.
- E. The diameter of the main shall not be increased in order to provide a minimal slope.
- F. An engineering analysis performed by an Engineer may be required by WU to confirm existing or proposed mains are adequate to support the proposed development. The average daily flow, daily peaking factor, and infiltration/inflow rate for the existing development can be made available upon request.

Table 3-3 Allowable Sanitary Sewer Pipe Diameters & Slopes

Diameter (Inches)	Minimum Slope (%)	Maximum Slope (%)
8	0.61	8.40
10	0.47	6.20
12	0.37	4.88
15	0.29	3.62
18	0.23	2.83
21	0.20	2.30
24	0.17	1.93
27	0.15	1.65
30	0.14	1.43
36	0.11	1.12
Notes: For mains larger than 36-inches in diameter, the minimum and maximum slope shall be determined using Manning's equation to achieve a minimum velocity of 3.0 ft/s under half full conditions with a maximum velocity of 10.0 ft/s under full flow conditions.		

- G. Parameters for calculating sanitary sewer system demands for proposed development based on typical land use types are shown in Table 3-4, Design Sanitary Sewer Loading for Proposed Development.
- H. The Peak/Design Loading Rate for a proposed development shall be calculated based on Equation 3-1.

**Equation 3-1**

$$\text{Design Flow Rate (gpm)} = \left[ \left( \frac{\text{Density} \times \text{ADF}}{1440} \right) * PF \right] + (\text{I\&I Rate} * \text{Area})$$



Table 3-4 Design Sanitary Sewer Loading for Proposed Development

Land Use	Density		Demand		
	(People per Acre)	(Person per Unit)	Average Day Flow (ADF)	Daily Peaking Factor (PF)	Infiltration & Inflow Rate (I&I) (gpm/ac)
Single Family Residential & Duplex	12.0	3.5	100 gal/person	1.85	2.72
Estate Sized Single Family	7.0	4.5	100 gal/person	1.85	2.72
Multi-Family Residential	52.0	3.5	100 gal/person	1.85	2.72
Industrial, Commercial or Mixed Use	Contact WU			1.85	2.72
1. Average Daily Flow represents the “dry weather” flow with no allowance for infiltration and inflow. 2. Daily Peaking Factor and Infiltration/Inflow Rate are from a recent sanitary sewer flow study performed by WU and represent the highest and system-wide averages for each, respectively.					

### 3.2.3. Main Placement

#### A. Horizontal

1. Mains in local streets shall be placed along the centerline of a street.
2. Mains in non-local streets shall be placed along the center of a traffic lane.
3. Mains should be constructed on a straight alignment unless a curved alignment is required. Curvature in a horizontal alignment for sanitary sewer mains shall be achieved by deflection of joints. If the Engineer intends for the contractor to use pipe joint deflection, the construction plans shall include the design radius, beginning and ending of curvature, and a detail of the proposed typical deflection. The maximum joint deflection shall be as follows:
  - i. The maximum joint deflection to be used for PVC sanitary sewer mains 12 inches in diameter or smaller is 0.8 degrees which equates to a radius of 1,440 feet.
  - ii. Sanitary sewer mains larger than 12 inches in diameter shall be constructed on a straight alignment.
4. A minimum clearance of 3 feet horizontally and 2 feet vertically shall be maintained from all public service providers such as gas, electric, and telecommunication within City right-of-way. Proposed public service providers shall cross beneath sanitary

mains. Coordination with each public service providers is required to confirm clearance requirements. The more stringent clearance requirements will be enforced.

**B. Vertical**

1. Mains shall be placed at an elevation low enough to accommodate future development in the sanitary sewer drainage basin.
2. Mains shall have a minimum cover of 42 inches as measured from the top of the pipe to the existing ground or the proposed finished grade, whichever is lower.
3. Mains constructed along unimproved (county type) streets shall be a minimum of 8 feet below the lowest part of the existing street or bar ditch to provide grade for future street improvements.
4. Mains shall be installed on a uniform grade between manholes.
5. Consecutive mains upstream and downstream of a manhole shall maintain a similar grade to avoid flow conditions that can create a hydraulic jump. Table 3-5, Sanitary Sewer Main Grade Change Restrictions lists specific grade change restrictions for specific sizes.

Table 3-5 Sanitary Sewer Main Grade Change Restrictions

<b>Diameter (in)</b>	<b>If Slope of Upstream Main Exceeds (%)</b>	<b>Slope of Downstream Main Must Equal or Exceed (%):</b>
8	3.1	1.8
10	2.9	1.7
12	2.7	1.6
15	2.5	1.4
18	2.4	1.3
21	2.2	1.3

6. When a smaller upstream main joins a larger downstream main, the crown elevation on both sides of the manhole shall match.
7. New downstream mains shall be equal to or larger than mains located upstream.
8. A profile drawing shall be provided for all mains.
9. Steel casing pipe shall be installed where mains are to be constructed by method other than open cut. Alternate methods and materials may be used upon approval by WU.
10. Mains with less than 2 feet clearance below a 30 inch or smaller storm drainpipe shall be one of the following:
  - i. Installed within a steel casing pipe; or
  - ii. Concrete encased with approval of WU.

11. Mains installed below a 33 inch or larger diameter storm drainpipe, box culvert, or channel shall be installed within a steel casing pipe. Alternate encasements methods and materials may be used upon approval by WU.
12. Where casing pipe is required, the casing pipe shall extend a minimum of 5 feet beyond the outside edge of the drainage structure, 10 feet beyond the outside edge of a drainage channel, or as required for construction and future maintenance practices.

### **3.2.4. Services**

- A. Services shall be a minimum of 4 inches in diameter. Larger diameters may be required based on calculated peak effluent.
- B. A private sanitary sewer service begins at the connection to the public main and shall be labeled "Private Sanitary Sewer Service" on the construction plan sheet.
- C. Services shall be installed perpendicular to the main.
- D. Services at the end of a cul-de-sac street shall be straight from the manhole to the property line.
- E. Services shall be located 10 feet offset from the lot centerline toward the downstream end of the sanitary sewer main.
- F. Concrete driveways shall not be placed over a service.
- G. New services shall be shown and stationed on the plan sheet.
- H. The service shall be provided at an adequate depth to allow gravity service to the future development.
- I. Where lot grades are lower than the street or a storm drain crosses the service, the flow line elevation of the service at the property line shall be shown on the plan sheet.
- J. Services on mains larger than 18 inches are prohibited.
- K. Service taps on existing public mains will be made by either the City or through a Three-Party Contract.
- L. Services shall be a minimum of 6 inches from storm drain facilities.
- M. Cleanouts are prohibited on services within the right-of-way.

- N. Service taps that are determined to be obsolete shall be abandoned by disconnecting from the main line. A cap or plug shall be installed in the tee wye and it shall be encased in concrete.

### **3.2.5. Manholes**

- A. A manhole is required at the following locations:
  - 1. Change in horizontal and vertical alignment,
  - 2. Beginning and termination of a curve,
  - 3. Connection of two or more mains,
  - 4. Change in main diameter,
  - 5. Service connections 8 inches in diameter and larger, and
  - 6. End of each main.
- B. The maximum spacing for manholes on a straight alignment shall be:
  - 1. 500 feet (6-inch to 15-inch diameter mains)
  - 2. 800 feet (18-inch to 30-inch diameter mains)
  - 3. 1,000 feet (36-inch and larger diameter mains)
- C. The maximum spacing for manholes on a curved alignment shall be 300 feet.
- D. A standard manhole is 48 inches in diameter.
- E. A 60-inch diameter manhole is required when:
  - 1. Deeper than 10 feet (measured from rim to flow line), or
  - 2. Main is 15 inches in diameter and larger.
- F. Drop manholes shall be required when an influent flow line is greater than 2 feet above the effluent flow line.
- G. A manhole installed at the end of a cul-de-sac shall have a maximum of three service connections.
- H. Watertight rings and bolt-down lids shall be used on manholes when:
  - 1. Mains are 18 inches in diameter and larger,
  - 2. Located within the 100-year floodplain,
  - 3. Located at pavement low points, or
  - 4. Located in areas prone to flooding or running water.

- I. Manholes located outside of the right-of-way shall be accessible by 2-wheel drive vehicles 24 hours a day and shall be approachable by a dedicated 15-foot minimum easement.
- J. Connections to an existing manhole shall be cored, and the invert shall be re-worked.
- K. Manholes shall be installed outside the normal tire path in a lane of a paved roadway.
- L. Manhole venting shall be required per TCEQ requirements.
- M. Manholes will be required to be corrosion resistant in accordance with the Standard Specifications and Details for Water and Sanitary Sewer Construction when any of the following conditions exist:
  - 1. Manholes on sanitary sewer mains 24 inches and larger in diameter;
  - 2. Manholes transitioning from force mains to gravity mains;
  - 3. Drop Manholes; or
  - 4. Manholes constructed with a hydraulic slide.

### **3.2.6. Aerial Crossing, Siphons, Lift Stations and Force Mains**

- A. Aerial crossings, siphons, lift stations, and force mains are prohibited for public sanitary sewer mains. Exceptions will require approval by WU.
- B. If a structure is constructed in such a manner that does not allow the plumbing to be connected to the city sanitary sewer system without the installation of a private on-site lift station, such lift station and necessary force main will be the individual responsibility of the owner. This shall include initial installation costs as well as operation and maintenance.

# CHAPTER 4 - TRANSPORTATION

## 4.1. Objectives

This chapter is intended to provide guidelines for the most commonly encountered transportation-related designs in the City of Arlington (City). This manual was developed for users with knowledge and experience in the applications of standard engineering principles and practices of roadway design. Close coordination with city staff is recommended and encouraged during the planning, design, and construction of all roadway facilities.

The purpose of these guidelines is to provide information required to prepare construction plans for public and private streets. Private streets shall be constructed in accordance with City Standard Specifications and Details.

Specific information required for plan submittal can be found in the following sections and in the guidance located on the City website. Additional requirements may be specified in the Professional Services Contract for Capital Improvement Projects.

## 4.2. Thoroughfare Development Plan (TDP)

The City Thoroughfare Development Plan (TDP) located on the City website includes information relating to current and future street alignments, classification, and number of lanes. The TDP also provides guidelines for context-sensitive designs when the typical right-of-way cross sections are modified by a proposed development. All developments shall comply with the TDP.

## 4.3. Hike and Bike System Master Plan

The Hike and Bike System Master Plan (HBSMP) defines bike path, bike lane, and shared lane locations throughout the City. It also provides details pertaining to the bike lane widths along certain collector and arterial streets. All development and capital improvement projects shall include improvements identified in the HBSMP.

## 4.4. Traffic Impact Analysis (TIA)

### 4.4.1. Purpose

The purpose of a Traffic Impact Analysis (TIA) is to assess the effects of specific development activity on the existing and planned roadway system. It is the intent of these requirements to make traffic access and circulation planning an integral part of the development process. Development activity may include but is not limited to zoning, platting, TDP amendments, site plans, and right-of-way abandonment. Improvements typically analyzed by a TIA may include but are not limited to driveway

locations, number of driveways, vehicle queuing both on roadway and on site, median openings, auxiliary lanes, parking analysis, traffic signals, signs, pavement markings, or any other improvement that impacts traffic circulation or level of service.

#### **4.4.2. Determination of Need**

The City will determine the necessity of a TIA after receiving the following information:

- Existing or proposed zoning categories
- Tract location map
- Tract size in acres
- Existing and proposed land use
- Proposed types and locations of new roadways
- Location of proposed access points and signalization, if applicable
- Right-of-way abandonment application

A TIA will be required for any development expected to generate traffic volumes that will significantly impact the capacity or safety of the street system. If required, a TIA shall be submitted and accepted prior to issuance of permit.

A TIA is a comprehensive study of all aspects of a development's probable impacts on the City's transportation system. This study will analyze how traffic generated by a development relates to traffic on internal and adjacent roadways. The following provides specific situations for a TIA:

- A. A TIA is required for a zoning proposal when the expected vehicle trip generation is 5,000 trips per day (tpd) or greater and the current zoning trip generation is exceeded by 1,000 tpd or more. A TIA may be required for zoning cases generating less than 5,000 tpd but will not be required for zoning cases generating less than 500 tpd.
- B. A TIA is required for a development when the expected traffic generation is greater than 5,000 tpd. Developments expected to generate less than 5,000 tpd may be required to submit a TIA. A TIA will not be required for developments generating less than 500 tpd unless special circumstances exist as outlined in Section E below.
- C. A TIA may be required to support a request for an amendment to the Thoroughfare Development Plan. If the City initiates a Thoroughfare Development Plan amendment, the City will be responsible for the necessary TIA.

- D. A TIA may be required to support the request for abandonment of Right-of-Way. If required, a TIA shall be submitted and accepted prior to the approval of the abandonment.
- E. Special Circumstances: A TIA may be required for a development if the City determines that one or more of the following conditions exist:
  - 1. Traffic generated from a non-residential development will significantly impact adjacent residential neighborhoods.
  - 2. Traffic operational impacts such as problems with driveways, left or right turns, signal timing, median openings or sight distance issues are anticipated. In such cases, the study will only be required to answer questions related to the specific impacts.
  - 3. Existing traffic problems on adjacent streets are expected to worsen due to traffic generated from the new development.
  - 4. Implementation of the TDP in the area will not occur prior to development of the property.
  - 5. The proposed land use differs significantly from that contemplated in the adopted Comprehensive Plan.
  - 6. The internal street or access system is not anticipated to accommodate the expected traffic generation.
  - 7. Required by the City Traffic Engineer or D-PWT.
- F. TIA Update: Any previous TIA or traffic study relating to a development that is more than two years old shall be updated unless the City determines that conditions have not changed significantly. If an updated study is necessary, additional information will be required to:
  - 1. Update changes in the proposed development.
  - 2. Update or refine assumptions made in a prior submittal.
  - 3. Provide specific information not available at the time of previous submittal.

#### **4.4.3. TIA Requirements**

- A. Preliminary Meeting: A meeting shall be held between the owner's Engineer and the City to discuss the development project prior to beginning the TIA. Topics for discussion at the meeting typically include, but are not limited to the following:
  - 1. Trip generation,
  - 2. Directional distribution of traffic,
  - 3. Trip assignment,
  - 4. Definition of the study area,
  - 5. Intersections requiring critical lane analysis,



6. Methods for projecting future volumes and conditions to be analyzed,
7. Special site related issues, and
8. TIA submittal and approval

For development proposals not involved in a formal hearing process, the City will review the TIA to correspond with the review process of the associated activity.

Development adjacent to TxDOT facilities may require a TIA to be submitted to TxDOT for approval. The City will forward the TIA to TxDOT and coordinate the review.

- B. TIA Contents: All TIAs shall be prepared under the direction of an Engineer with experience in transportation engineering. In order to provide consistency and to facilitate staff review, the following information shall be included:

1. Introduction
2. Land Use, Site, and Study Area Boundaries: A brief description of the size of the land parcel, general terrain features and the location within the City and the region shall be included in this section. In addition, roadways that provide site access and are in the study area shall be identified.
3. The limits of the study area shall be based on existing and future traffic conditions surrounding the site and will be determined at the preliminary meeting. A vicinity map that shows the site and the study area boundaries, in relation to the surrounding transportation system, shall be included.
4. Existing and Proposed Site Uses: The existing and proposed zoning of the site shall be identified. In addition, the specific use for the site shall be identified if known, since a variety of uses may be permitted under a zoning category. The study shall address traffic impacts for the land use with the greatest traffic impact allowed by existing zoning or proposed by the comprehensive plan. A proposed site plan shall be included.
5. Existing and Proposed Uses in Study Area: A complete description and map of the existing land uses and zoning in the study area shall be included. In addition, a complete description and map of the assumed future land use shall be provided.
6. Existing and Proposed Roadways and Intersections in Study Area: A complete description and map of the existing roadways and intersections including geometrics, traffic signal control, and volumes shall be included. It shall also identify improvements contemplated by government agencies and provide the following details:
  - i. Proposed roadway and intersection improvements,
  - ii. Implementation schedule, and
  - iii. The agency or funding source responsible.

7. Trip Generation and Design Hour Volumes: A summary table shall be provided listing each type of existing and proposed land use, building size, average trip generation rates (total daily traffic and A.M./P.M. peaks), and the resultant total trips.

The Institute of Transportation Engineers (ITE) Trip Generation Manual provides estimates of the number of trips generated according to land use. Trip generation shall be calculated for the maximum uses allowed under the existing and proposed zoning based on the latest edition of the ITE Trip Generation Manual. If data is not available for the proposed land use, the City shall approve estimated rates. All sources must be cited in the report.

The calculation of design hour volumes used to determine study area impacts shall be based on the most current releases of the following:

- i. Peak hour trip generation rates as published in the ITE Trip Generation Guidelines and explained in the ITE publication, "Using the ITE Trip Generation Report."
- ii. "Site Impact Traffic Evaluation Handbook," FHWA Report PL/85/004, U.S. DOT.
- iii. Traffic volume counts for similar existing uses, if no published rates are available.
- iv. "Designing Walkable Urban Thoroughfares, A Context Sensitive Approach," as published by ITE.

Passerby factors are to be used to reduce the estimated additional total daily traffic to the street serving a proposed development. They are not to be applied directly to reduce trip generation and turning movement volumes at driveways serving the proposed development. The percentage rates for passerby traffic may be obtained from the latest ITE Trip Generation Manual but must be approved by the City prior to use in the TIA.

Internal trip reductions and modal split assumptions will require analytical support to demonstrate how the figures were derived. Other documented rates to account for passerby traffic may be used upon approval by the City.

Daily trip generation from office/commercial mixed-use developments can be accurately predicted by the application of ITE rates to each individual use. The City may allow reduction of the P.M. peak trip generation to eight to ten percent of the total daily generation.

8. Trip Distribution: The estimates of percentage distribution of trips from the proposed development to destinations in the metro region shall be clearly stated in the report using a compass rose. Market studies and information concerning origin of trips to the proposed development may be used to support these assumptions. A map showing the percentage of trips on each street shall be provided.
9. Trip Assignment: The direction of approach for site-generated traffic via the area's street system shall be presented in this section. The technical analysis, basic methods, and assumptions used in this work shall be clearly stated. The assumed trip distribution and assignment shall represent the most logically traveled routes for drivers accessing the proposed development. These routes can be determined by observation of travel patterns to existing land uses in the study area.
10. Existing and Projected Traffic Volumes: The specific time frames to be studied will depend on the individual development. Build-out analysis shall be based on the anticipated earliest completion of the development. The analysis must account for traffic growth from existing volumes and roadway system changes during development of the site. The build-out impacts are intended to reveal expected impacts of the development when it is ready for occupancy. Timing of the build-out or phasing of the project must be included with the existing traffic grown to the build-out or phasing.

The horizon year impacts shall be analyzed when the area is fully developed or 5 years from build-out, depending on the development location and available information.

An interim condition may also be requested in areas where the roadway system is not fully developed, or ultimate improvements are not scheduled. These time frames will be determined at the preliminary meeting.

Graphics shall be provided showing the following traffic impacts for private access points, intersections, and streets:

- i. A.M. and P.M. peak hour site traffic (in and out) including turning movements.
- ii. A.M. and P.M. peak hour total traffic including site generated traffic (in and out). These volumes should include through and turning movement volumes for existing, build-out, and horizon year conditions.
- iii. Any other peak hour which is critical to site traffic and the street system in the study area shall be included in the graphics and with the same information provided for the A.M./P.M. peak hours.
- iv. Actual counts of existing total daily traffic for the street system in the study area at the time the study is prepared.
- v. Build-out and horizon year total daily traffic for the street system in the study area based on traffic generated by the proposed development and

counts of existing daily traffic. The component of the existing daily traffic attributable to the existing uses shall be identified as well as the increase in total daily traffic from the proposed development.

All raw traffic count data (including average daily volumes and peak hour turning movements) and analysis worksheets shall be provided in the appendices of the report.

Volume projections for background traffic growth will be provided by the City, or a method for determining these volumes will be recommended by the City.

All total daily traffic counts shall be actual machine counts and not based on factored peak hour sampling. Latest available machine counts from TxDOT, the City, and other agencies may be acceptable if less than two years old.

11. Capacity Analysis: A capacity analysis for appropriate peak periods shall be conducted for all public street intersections impacted by the proposed development and for all private property access points to streets within the study area. Capacity calculations shall include existing, build-out, and horizon year scenarios. At each location studied, storage requirements shall be calculated for each vehicular movement.

Capacity calculations for build-out conditions must be based on the operational analysis techniques contained in the most current edition of the Highway Capacity Manual (HCM). Horizon year capacity calculations may be based on the planning analysis techniques in the latest edition of the HCM or the planning and operations procedures included in Transportation Research Circular No. 212. The technique used to calculate capacity will be discussed at the preliminary meeting.

All capacity analysis work sheets or computer print outs shall be included in the appendices of the report.

12. Queueing Analysis and Site Access and Circulation Evaluation: A queueing analysis may be required. Depending on the site plan, development location, and available information, a site access and circulation evaluation may be required. These items will be discussed at the preliminary meeting.
13. Traffic Accident Analysis: A traffic accident analysis may be required for affected street corridors. The study period is typically three years. Accident data summaries may be obtained from the City. Estimates of increased or decreased accident potential shall be evaluated for the proposed development.

14. Level of Service Determination: A table indicating the Level of Service for existing, build-out and horizon year traffic scenarios for all streets within the study area shall be included. Level of Service “C” is the design objective for all movements. The Level of Service shall not be less than “D” unless deemed acceptable for site and non-site traffic by the City.
15. Mitigation Analysis: A mitigation analysis shall be performed to determine if any improvements are needed to meet the Level of Service requirements. The Level of Service resulting from the proposed mitigation improvements shall also be provided. Mitigation improvements may include but are not limited to:
  - i. Capacity Improvements: Additional Thru Lanes, Turn Lanes, or Deceleration Lanes: See Section 4.5 (Roadway Design) and Section 4.8 (Median Openings).
  - ii. Roundabouts: See Section 4.6 (Roundabout Design Requirements).
  - iii. New Traffic Signals: The need for new traffic signals shall be based on warrants contained in the TMUTCD. A minimum spacing of one-half mile for all signalized intersections shall be maintained, except as allowed by the City. This spacing is desirable to achieve optimum speed, capacity, and signal progression. The City may require proposed signalized intersections to remain unsignalized and have turning movements limited by access design or median islands if the optimum bandwidth is reduced. See Section 4.13 (Traffic Signal Design Requirements).
  - iv. Modification of Existing Signal Configuration and Timing: Existing traffic signal configuration and timing may need to be modified to accommodate additional traffic volume generated by the development to maintain the desired level of service. Modification of existing traffic signal configuration may trigger upgrading pedestrian facilities to meet current ADA/TAS standards for all crossings of that signal. Modification of signal timing of an existing coordinated signal shall be carefully evaluated to determine the impact on adjacent signals of that roadway. Unless all signals of the coordination group are being evaluated, cycle length adjustment shall not be proposed.
16. Final Conclusions: This chapter of the report must include a summary of the study findings regarding impacts of the proposed development on the existing and proposed street system.
17. Final Recommendations: If the analysis indicates unsatisfactory levels of service or safety problems, a detailed description of proposed improvements to remedy deficiencies shall be included. Assumptions regarding future capacity recommendations shall be approved by the City. The recommendation section shall include a sketch of each improvement showing pertinent geometric features.

## 4.5. Roadway Design

### 4.5.1. Design Speed

All streets should be designed and constructed based on the design speeds shown in Table 4.1, Design Speed.

Table 4-1 Design Speed

Street Type	Design Speed (mph)
Arterial	45
Major Collector	40
Minor Collector	35
Local	30

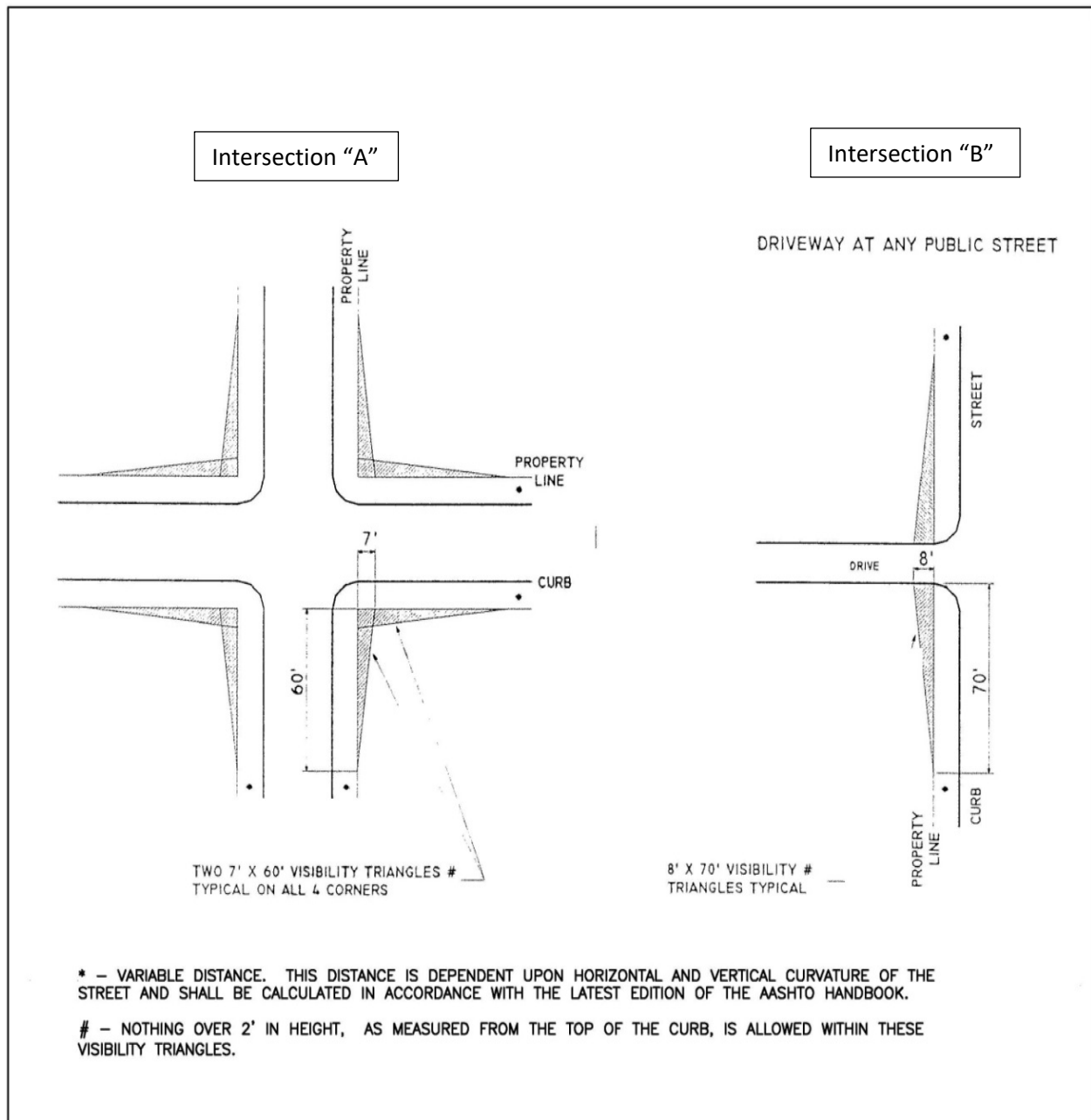
### 4.5.2. Sight Distance

At any intersection, the minimum intersection sight distance (visibility triangles) shall have the dimensions as illustrated in “Intersection A” in Figure 4-1. Where a driveway intersects a public street, the minimum intersection sight distance shall have the dimensions as illustrated in “Intersection B” in Figure 4-1, Minimum Intersection Sight Distance.

**Additional sight distance or visibility easement may be required based on topography, roadway curvature, vegetation, or other sight hindrance.**

Deviations from the minimum intersection sight distance requirements may be allowed provided that the Owner has demonstrated that the area proposed will provide adequate sight distance based on AASHTO standards.

Figure 4-1 Minimum Intersection Sight Distance



### 4.5.3. Access Control Design

No street intersecting an arterial or major collector street shall vary from a 90-degree angle of intersection by more than 10 degrees.

The number of minor collector or local street offsets shall be minimized but, when approved, a minimum centerline offset distance of 125 feet shall be used.

There shall be a minimum of 600 feet between intersections along arterials or major collector streets.

Arterial streets shall be intersected only by collector streets or other arterial streets, unless the only means of ingress and egress to a subdivision is from such arterial street. In this event, the local street shall be widened to a collector street width at the intersection.

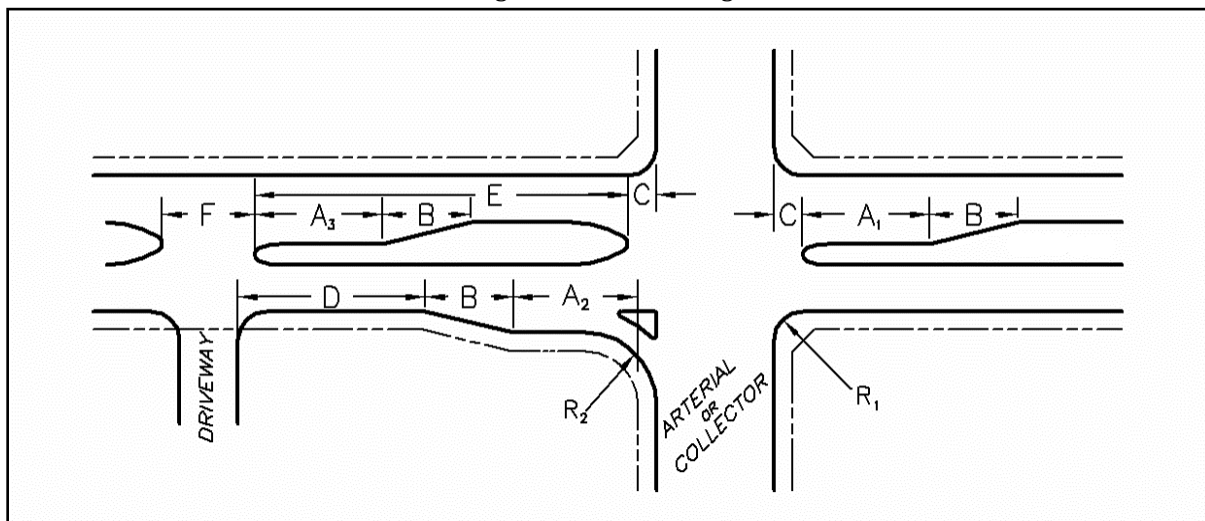
Table 4-2 Street Design Standards, in conjunction with Figure 4-2 Street Design, contains the minimum values for all TDP street designs. Recommended designs for intersection approaches are available on the City website. A TIA may propose modification to the recommended values.

Table 4-2 Street Design Standards

	A <sub>1</sub> *	A <sub>1</sub> +	A <sub>1</sub> #	A <sub>2</sub> *	A <sub>3</sub>	B	C	D	E	F	R <sub>1</sub>	R <sub>2</sub>	Corner Clip
Major Arterial	250'	150'	100'	150'	150'	150'	10'		600'	60'	80'	80'	25 X25
Minor Arterial	200'	150'	100'	150'	150'	150'	10'		450'	60'	80'	80'	25 X25
Major Collector	150'	150'	100'	150'	150'	150'	10'		150'	60'	30'	30'	25X25
Minor Collector											30'	30'	15X15
Local											20'	20'	15X15

\* When intersecting street is a major or minor arterial.  
 + When intersecting street is a collector  
 # When intersecting street is a local street.  
 \*\* For dual left-turn standards, see Intersection Approach Layouts on the City website.  
 A<sub>1</sub> and A<sub>2</sub> may be increased to allow for stacking truck traffic.  
 Corner clip based on 90-degree intersection, may be adjusted for angled intersection.  
 Radius and corner clip are based on highest classification street at intersection.

Figure 4-2 Street Design





## 4.5.4. Vertical Alignment

### A. Minimum Grade Requirements

All streets shall be designed and constructed with a minimum grade of 1 percent. A geotechnical report shall be submitted with the first plan submittal for all proposed roadway improvements. If a 1 percent grade cannot be achieved, a variance shall be required.

For redevelopment, in-fill, and capital improvement projects, minimum grades less than 1 percent will be considered if existing grades are less than 1 percent, and it is impractical to add drainage infrastructure to accommodate the minimum grade requirements.

In order to maintain adequate sight distance, all vertical curves shall be designed and constructed to comply with the minimum values in Table 4-3 Minimum Vertical Curve Length. A vertical curve is not required for changes in grade with an algebraic difference of 1 percent or less. K-value mentioned is the length of curve per percent grade change and is calculated as  $K = L/A$ , where L is length of vertical curve (ft) and A is algebraic difference in grade (%).

Table 4-3 Minimum Vertical Curve Length

Street Type	Crest		Sag	
	K-value	Length (ft)	K-value	Length (ft)
Arterial	61	65	79	80
Major Collector	44	45	64	65
Minor Collector	29	30	49	50
Local Street	19	20	37	40

### B. Maximum Grade Requirements

All streets shall have a maximum grade as shown in Table 4-4, Maximum Roadway Grade.

Table 4-4 Maximum Roadway Grade

Street Type	Grade (%)
Major or Minor Arterial	6.0
Major or Minor Collector	8.0
Local Street	8.0

The maximum intersection grades involving arterial and collector roadways shown in Table 4-5, Maximum Intersection Grades, shall be used at controlled intersections.

Table 4-5 Maximum Intersection Grades

Design Street Type	Intersecting With	Design Street Maximum Grade (%)	Approach Distance (ft)
All Arterials	All Arterials	2	300
All Arterials	Major Collector	3*	300
Major Collector	All Arterials	3*	200
Major Collector	Major Collector	3*	200
Minor Collector/ Local	All Arterials/ Major Collector	4*	150
*Maximum grade should be altered to include a sidewalk section which meets ADA standards.			

### 4.5.5. Horizontal Alignment

The minimum radius for the back of curb on a local street cul-de-sac shall be 39 feet.

The minimum centerline radii shown in Table 4-6, Minimum Centerline Radius, shall be used in the design of all street construction.

Table 4-6 Minimum Centerline Radius

Street Type	Minimum Centerline Radius (ft)
Major Arterial	1000
Minor Arterial	800
Major Collector	500
Minor Collector	350
Local Street	350

Reverse curves shall be separated by a tangent section in accordance with Table 4-7, Minimum Reverse Curve Tangent Length.

Table 4-7 Minimum Reverse Curve Tangent Length

Street Type	Minimum Tangent Length (ft)
All Arterials	200
Major Collector	100
Minor Collector	50
Local	N/A

Collector or arterial roadways intersecting other collector/arterial roadways shall have the minimum horizontal centerline approach tangent section length as measured from the nearest right-of-way line of the intersecting street as shown in Table 4-8, Minimum Centerline Approach Tangent Length.

Table 4-8 Minimum Centerline Approach Tangent Length

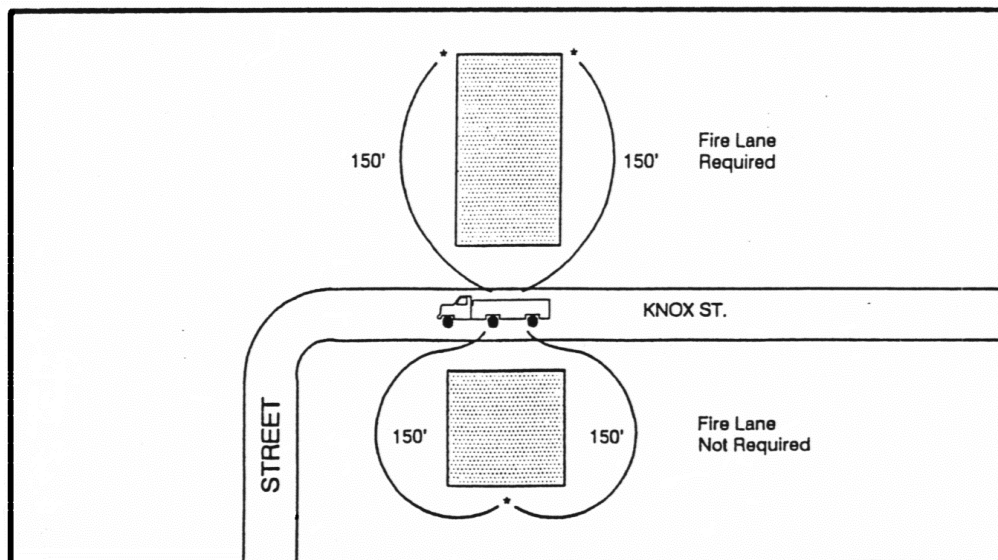
Street Type	Intersecting With	Minimum Approach Tangent Length (ft)
All Arterials	All Arterials	200
Collector	All Arterials	150
Collector	Collector	100

#### 4.5.6. Fire Lanes

##### A. Fire Lane Determination of Need

All buildings or structures shall be constructed such that all ground level, exterior sides of the building are within 150 feet of a dedicated street or fire lane, as shown in Figure 4-3, Hose Lay. The 150 feet is measured along the route necessary to extend fire hose lines around the building (as measured 10 feet off the building). If the 150 feet cannot be reached from a public street, a fire lane will be required on site.

Figure 4-3 Hose Lay



##### B. Construction Requirements

All fire lanes and public streets shall be installed and accepted before any vertical construction occurs to ensure adequate emergency vehicle access.

##### C. Vertical Clearance

All fire lanes shall have a minimum vertical clearance of 14 feet.

D. Width

The minimum unobstructed width of a fire lane shall be 24 feet (measured from face of curb) to allow two fire trucks to pass in case of an emergency. For one single-family dwelling, this width may be reduced with approval of the Fire Department.

E. Turning Radius

All 24 feet wide fire lanes shall have a minimum inside turning radius of 30 feet. 30 feet wide fire lanes shall have a minimum inside turning radius of 20 feet.

F. Grade

The maximum grade for a fire lane when serving a building not protected throughout by an automatic sprinkler system is 8 percent.

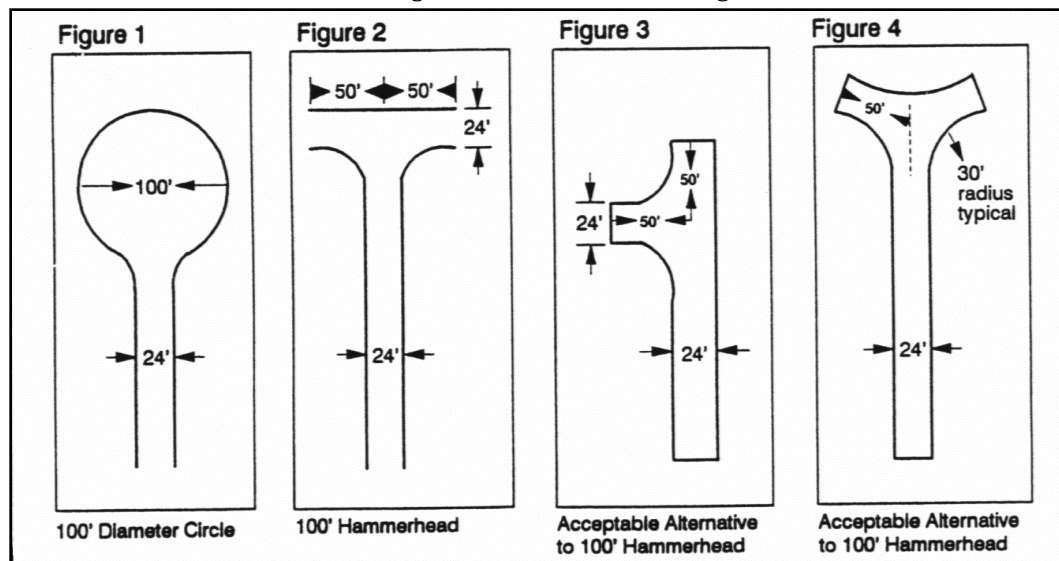
G. Bridges

When a bridge is required to be used as access, it shall be constructed and maintained to carry a minimum load of 80,000 pounds.

H. Turn Around Areas

Dead-end fire lanes shall not exceed 150 feet in length without an approved turn around. Illustrations of approved turn-around arrangements are provided in Figure 4-4, Turn Around Design.

Figure 4-4 Turn Around Design



The required fire lane width shall not be obstructed by parked vehicles or other obstructions. Speed bumps or similar obstacles that have the effect of slowing or impeding the response of fire apparatus shall be approved by the Fire Department prior to installation.

I. Maintenance

All designated fire lanes shall always be maintained by the property owner.

J. Unusual Conditions

When fire lanes cannot be installed due to topography, waterways, non-negotiable grades or other similar conditions, the Fire Department may require an additional fire protection system

## **4.6. Roundabout Design Requirements**

At all intersections, the Engineer shall consider the feasibility of a modern roundabout, mini roundabout, traffic circle, or any other type of traffic calming technique prior to final design. Intersections where roundabouts are deemed feasible shall be designed and constructed as such. All elements of roundabout design shall be designed per FHWA's Roundabouts: An Informational Guide (FHWA-RD-00-067, or most current version). Roundabout designs must be approved by the City. The reason(s) for not choosing a roundabout must be clearly documented.

## **4.7. Paving Design Requirements**

Both public and private streets shall be designed in accordance with the requirements outlined below and constructed in accordance with City Standard Specifications and Details.

- A. The street classification shall be as shown in the TDP.
- B. Streets shall include all appurtenances, including but not limited to sidewalks, streetlights, signs, and pavement markings.
- C. Pavement widths, thickness, and subgrade shall be designed and constructed in accordance with standard pavement sections provided in the City Standard Specifications and Details.
- D. Pavement widths shall be measured from back of curb except for local HMAC rural roadways where the width is measured from outside edge of concrete ribbon. A 30-inch concrete ribbon shall be placed on either side, for a total pavement width of 28 feet.

- E. In small areas, such as the addition of a median opening or auxiliary lanes to existing facilities, Owner may submit a request to allow alternate pavement sections to match existing and alternate subgrade treatment of 8-inch cement treated base.
- F. Alternative street designs may be allowed with approval of the City if an adequate level of service is provided. It is the responsibility of the Owner's Engineer to develop details for constructing alternative roadways. The request shall include the submittal of a geotechnical report and alternate design for a 50-year life prepared by an Engineer. The requirements shall be in accordance with the UDC and this manual. There shall be no waiver from construction specifications.
- G. Pavement for driveways and private alleys shall be 5-inch concrete over 10-inch lime/8-inch cement subgrade.
- H. Fire lanes shall be constructed of a concrete or asphalt surface to provide all-weather driving capabilities. Paving and subgrade shall be designed to local road standards at a minimum.
- I. Full panel replacement is required for concrete pavement; and full width repair is required for asphalt pavement where the pavement is cut for installation of a utility or utility service. 'Zipper patches' will not be allowed for pavement repair. See standard details for further direction and requirements.

## **4.8. Median Opening Design Requirements**

### **4.8.1. General Requirements**

The following shall be submitted for a median opening request:

- A. A drawing showing the location of the proposed median opening and the distance to the next median opening in both directions from the proposed median opening. The drawing shall also include any driveways, public or private streets, and property lines within 600 feet either direction of the requested opening.
- B. A letter from affected property owners on both sides of the street within 600 feet stating their concurrence with the proposed location of the median opening.

Typically, median openings shall be spaced 600 feet apart (measured nose to nose) on major arterials and 450 feet, (600 feet from major intersections), on minor arterials. Median openings may require the construction of left turn lanes. The typical storage length is 150 feet with 150 feet transition. These lengths may be altered based on projected traffic volumes. Median opening requests will not be considered until an engineering services contract is initiated for the design of the street.

### **4.8.2. Existing Improved Streets**

Construction plans shall be submitted to the City and shall be in accordance with the latest City Standard Specifications and Details. Upon acceptance of the plans, Three-Party Contracts will be required for construction of the opening. All costs associated with the median opening shall be paid by the Owner including construction and relocation of utilities and irrigation that may conflict with opening.

### **4.8.3. Unimproved (County Type) Streets – Construction Plans Available**

The Owner's Engineer shall modify the existing plans to include the median opening and prepare a construction cost estimate for approval. The plans shall be in accordance with the latest City Standard Specifications and Details. The Owner shall escrow the approved construction cost of the median opening to the City.

## **4.9. Driveway Design Requirements**

### **4.9.1. General Submittal Requirements**

A site plan showing the following shall be submitted for review:

- A. All existing and future right of way and easements.
- B. All existing utilities and features including, but not limited to curbs, storm drains, inlets, flumes, utilities, trees, sidewalks, meters, fire hydrants, etc.
- C. Proposed driveway grade profile including a minimum of 15 feet beyond the right-of-way.
- D. Existing driveways on both sides of the street and median openings within 150 feet

### **4.9.2. Standards**

Driveway curb returns shall not begin within 4 feet of a fire hydrant, utility pole, or other above ground utility; or within the gutter transition for an inlet. The Owner may have the above ground utility moved at his/her own expense. Driveway curb returns shall not extend beyond the property line, except as provided for in shared driveway agreements.

The values in Table 4-9, Driveway Design Criteria, represent minimum and/or maximum standards and shall be used for the design and construction of driveways. For each driveway, a specific combination of dimensions within these ranges based on the anticipated traffic flow and safety characteristics of the driveway and public street may be required.

Table 4-9 Driveway Design Criteria

Requirements	Street Type	Residential Driveway	Apartment/ Commercial Driveway	Industrial Driveway
<b>Driveway Throat Width</b>	Local	10-28 ft	24-36 ft	24-45 ft
	Minor Collector	10-28 ft	24-36 ft	30-45 ft
	Major Collector	12-28 ft	24-36 ft	30-45 ft
	Arterial (Major/Minor)	12-28 ft	30-36 ft	30-45 ft
<b>Driveway Curb Radius</b>	Local	5-10 ft	10-20 ft	15-30 ft
	Minor Collector	5-10 ft	15-20 ft	15-30 ft
	Major Collector	10-20 ft	20-30 ft	20-30 ft
	Arterial (Major/Minor)	15-30 ft	20-30 ft	20-30 ft
<b>Minimum Driveway Centerline Spacing</b>	Local	15 ft	100 ft	100 ft
	Minor Collector	15 ft	150 ft	150 ft
	Major Collector	100 ft <sup>1</sup>	200 ft	200 ft
	Arterial (Major/Minor)	100 ft <sup>1</sup>	250 ft <sup>6</sup>	250 ft <sup>6</sup>
<b>Driveway Angle</b>	ALL	70-90 degrees	90 degrees	90 degrees
<b>Minimum Distance <sup>2</sup> from Driveway to Intersection</b>	Local	30 ft	75 ft	75 ft
	Minor Collector	50 ft	100 ft	100 ft
	Major Collector	100 ft	150 ft	150 ft
	Arterial (Major/Minor)	100 ft	180 ft	180 ft
<b>Max Approach Grade<sup>3, 5</sup></b>	ALL	+6%	+3%	+3%
<b>Min Approach Length<sup>4, 5</sup></b>	Local/Minor Collector	6 ft	9 ft	9 ft
	All Others	9 ft	20 ft	20 ft

<sup>1</sup> 100 feet spacing applies to infill single family lots. New development requires 240 feet centerline spacing with shared driveways as approved by City. Head out egress shall be provided.

<sup>2</sup> Distance measured from the intersection of the extended right-of-way lines to the centerline of the driveway. The driveway centerline shall not be closer than 100 feet from the curb return departure of the major street facility.

<sup>3</sup> The percent slope measured along the centerline of the driveway.

<sup>4</sup> The minimum distance over which the maximum approach grade must be maintained.

<sup>5</sup> The approach grade and length shall be altered to include a sidewalk section which meets ADA design standards through the drive approach as applicable. See typical details for drive approaches.

<sup>6</sup> Driveways on arterials served by deceleration lanes may be spaced at 200 feet intervals.



### **4.9.3. Residential Driveways**

#### **A. General Requirements**

Driveway access to a residential lot from any major collector or arterial will not be allowed if the proposed access would create a traffic flow or safety problem. Residential driveway access from a major collector or arterial may be allowed if head-out egress is provided and:

1. The residential lot has no other public access,
2. The lot width is a minimum of 120 feet,
3. The lot has a shared driveway and the separation is a minimum of 240 feet.

#### **B. Design Criteria**

A residential driveway shared by two or more properties shall have a minimum throat width of 12 feet. A joint-use private access easement shall be required. Shared residential driveways may be required for adjoining residential lots on major street facilities (arterials, minor and major collectors) to reduce the number of access points on those roadways.

To provide adequate vehicle storage and maneuvering area, a minimum driveway length of 20 feet from the right-of-way will be required. No obstruction will be allowed within 20 feet from the right-of-way, including but not limited to all garages, gates, or other structures served by the driveway. A maneuvering space of 24 feet (minimum) shall be required for all rear-entry garages that may extend into an adjacent access easement or alley.

A circular residential driveway may be allowed on any street type provided that the centerlines of the driveways are at least 50 feet apart and the other requirements in Table 4-9 are met. A circular residential driveway accessing two streets shall only be permitted for 28 feet wide residential streets. If such a driveway is approved on an arterial or major collector street, an off-street maneuvering area shall be provided to ensure that vehicles will not back into the public street.

### **4.9.4. Commercial Driveways**

#### **A. Design Criteria**

The driveway for any apartment, commercial, or industrial property that connects to a major collector or arterial shall extend onto private property a minimum distance of 20 feet before intersecting any internal driveway.

Driveways having a projected design volume of 5,000 or more vehicles per day shall have a minimum of 100 feet continuous approach length without adjacent parking or vehicular cross flow.

All vehicle maneuvering on apartment, commercial, and industrial properties into parking spaces, up to loading docks, or into any other area shall be accomplished within off-street maneuvering areas and internal driveways. No back-in or back-out vehicle maneuvering from a driveway shall be allowed to occur on any public street or right-of-way.

Shared driveways shall require the dedication of a private access easement on each affected property. The combined size of the access easement must be a minimum of 24 feet wide and 48 feet deep. The easement width shall encompass the entire width of the driveway and shall extend at least one foot onto each property.

#### B. Auxiliary Lanes

The City may require the applicant to provide a deceleration lane for any driveway located on an arterial, major collector, or interstate frontage road where the right-turn ingress volume exceeds 40 right turns in the peak hour or if the use of driveway is determined to cause excessive delay on the roadway (i.e., heavy truck traffic) as determined by a TIA.

When a driveway is approved within a right-turn lane or deceleration lane, the lane shall be extended a minimum of 50 feet in advance of the driveway. No driveway shall be permitted within the transition area of a right-turn or deceleration lane. If the driveway requiring a deceleration lane is within 180 feet of an intersection, the deceleration lane shall be extended to the intersection.

A continuous deceleration lane may be required when two or more deceleration lanes are planned, and their proximity necessitates that they be combined for proper traffic flow and safety. The transition taper for a continuous deceleration lane shall not extend into or beyond a public street intersection.

On undivided arterial and collector roadways, a left-turn lane may be required when the projected product of the left-turn ingress volume (50 minimum) and the opposing volume per lane exceeds 420 trips in any design hour. In such cases, the City will require an analysis of the present and future traffic volumes to verify that the left-turn lane is necessary to maintain minimum levels of traffic flow and safety.

The design of a deceleration lane shall conform to the dimensions shown in Figure 4-5, Deceleration Lane.

A maximum of three driveways can be constructed with a continuous deceleration lane unless the lane is an extension of a right turn lane at an intersection. The maximum length

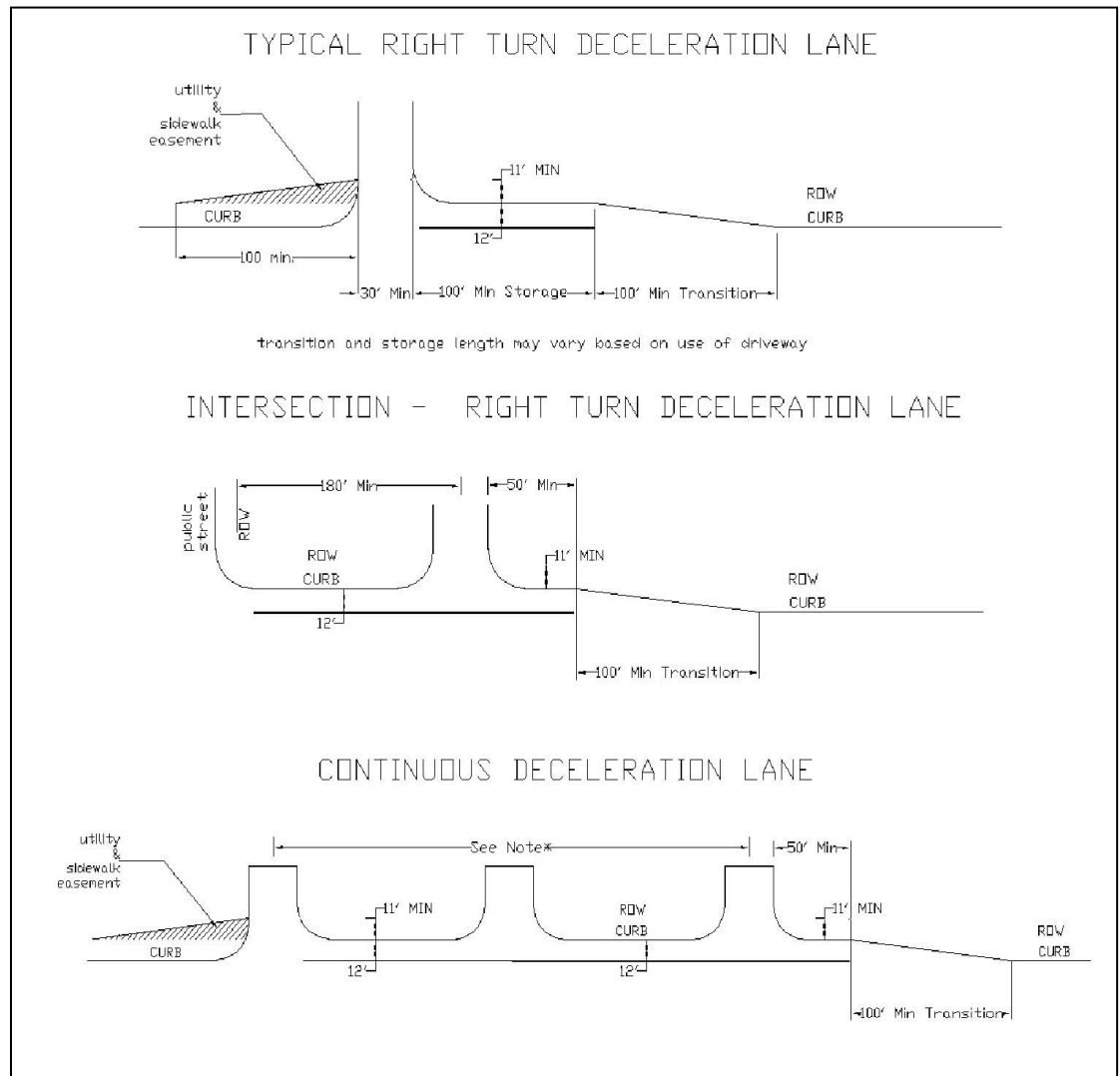
of a combination deceleration-right turn lane is 1,300 feet. Driveway spacing shall be as shown in Table 4 -9 Driveway Design Criteria.

A left turn lane shall be constructed to serve the driveway if it aligns with an existing median opening. An existing left turn lane may require lengthening to provide adequate storage.

Auxiliary lanes may be required on existing county-type roadways proposed as arterials if capacity issues exist.

The Owner shall be responsible for the design, right-of-way acquisition, adjustment of utilities, and construction costs of any auxiliary lane required.

Figure 4-5 Deceleration Lane



### C. Signalized Driveways

On major collectors or arterials, if a TIA indicates a traffic signal is needed, the Owner shall be responsible for the total cost of the traffic signal and installation. The Owner may also be required to construct on-site and off-site improvements necessary to provide proper alignment, adequate signal capacity, smooth traffic flow and safety for the public street/driveway intersection.

An adequate traffic signal easement or adequate right-of-way must be provided along the driveway to allow the City to maintain the signal. The Owner will be responsible for acquiring any onsite or offsite easement or right-of-way.

If a driveway is allowed at an existing signalized intersection, the applicant shall pay any costs and dedicate or acquire easements necessary to modify the existing signal and intersection to accommodate the new driveway.

### D. Special Driveway Designs

The City may require internal driveway improvements, turning movement prohibitions, auxiliary lanes, and traffic control devices to address safety or capacity problems that will have a detrimental effect on the adjacent public street system.

All driveways on undivided arterial roadways having a projected exiting left-turn volume that will operate at a level of service "D" or worse may be required to be constructed with a left-turn egress control median. In addition, any driveway having a projected ingress left-turn volume that will have a level of service "D" or worse may be required to have a left-turn ingress control median. If both conditions exist, a right-in/right-out driveway design may be required.

Driveways may be prohibited where adequate sight distance is not available for the established speed limit or the design speed of a future street improvement. Sight distances shall be calculated in accordance with the latest edition of the AASHTO Handbook. If an inspection indicates that driveway sight distance may be insufficient, the applicant will be required to submit vertical and horizontal information to the City that verifies adequate sight distance is available for the proposed driveway location. The City may deny access or a specific driveway location to any abutting public street if said access cannot be provided in a reasonable and safe manner.

### **4.9.5. Gates**

All gates across streets or fire lanes must be approved by the City. Design plans shall be submitted to the City and approved prior to filing the plat or a permit being issued, whichever comes first. All gated entries must include turn around facilities to accommodate an AASHTO type “SU” design vehicle and provide ingress for a design fire truck as outlined in Section 4.5.6, Fire Lanes. Placement of gate location and call box may vary based on trip generation for the development. All gated entries must be equipped with a Knox System Gate Access Key Switch and a pre-emptive gate opening system as approved by the Fire Department. Gated entries for apartment complexes must remain open during the hours of 7 to 9 a.m. and 4 to 6 p.m. See Gated Entry Layouts located on the City website for design layouts.

## **4.10. Sidewalks and Access Ramps Design Requirements**

### **4.10.1. General Requirements**

All sidewalk and access ramp installations shall conform to the latest American with Disabilities Act (ADA) regulations and Texas Accessibility Standards (TAS). Special zoning districts may have additional sidewalk requirements. Refer to the UDC for these additional requirements.

Sidewalks shall be shown on construction plans. In a residential development, they shall be constructed by the homebuilder except where the sidewalks do not abut a residential lot or when the residential lot backs up to a street. In these cases, the sidewalks shall be constructed with the subdivision public street improvements. The construction drawings shall clearly identify which sidewalks are to be constructed with the public street improvements. The Owner is responsible for submitting all required pertinent information regarding sidewalks and access ramps to the Texas Department of Licensing and Regulation (TDLR) prior to construction.

### **4.10.2. Sidewalk Placement**

Sidewalks shall be placed on both sides of the street within the right-of-way, shall be a minimum of 5 feet wide, and be placed 1 foot off the right-of-way line. If necessary, sidewalks may be placed closer to the curb, but no closer than 2 feet except where site restrictions require the sidewalk to be placed closer to the curb. In these cases, the sidewalk shall be adjacent to the curb and shall be a minimum of 6 feet in width.

### **4.10.3. Sidewalk Obstructions**

If obstructions within the path of a proposed sidewalk cannot be relocated, the sidewalk width and placement may be adjusted to allow the obstruction to remain. In these cases, a minimum sidewalk width of 3 feet shall be maintained adjacent to the obstruction.

#### **4.10.4. Access Ramps**

Access ramps shall be designed and constructed at all street intersections concurrent with the street or signal construction. Ramps may be required at other locations where significant pedestrian traffic is anticipated. If any part of an existing intersection is improved, then all access ramps shall be reconstructed to meet current ADA and TAS requirements.

#### **4.10.5. TxDOT Sidewalk Requirements**

Sidewalks along TxDOT facilities shall be in accordance with TxDOT standards.

### **4.11. Pavement Marking Design Requirements**

The Owner shall be responsible for the design and installation of all pavement markings. The following design requirements shall be used.

#### **4.11.1. Standardization of Application**

All pavement marking design shall conform to the fundamental use and design requirements set forth in the TMUTCD and the City Standard Specifications and Details. Markings shall be visible during hours of darkness and be retroreflective.

#### **4.11.2. Color/Pattern/Width**

Pavement markings shall be yellow, red, or white and shall conform to fundamental use and design requirements listed in the TMUTCD. All markings shall be thermoplastic, visible during hours of darkness, and retroreflective.

#### **4.11.3. General Design Criteria**

Pavement markings, including both longitudinal and transverse, shall be installed on all major collectors and streets of a higher classification. High-speed (Speed Limit 40 or higher) rural roadways shall also have center lines and edge line markings.

Longitudinal pavement markings on residential streets and most minor collector streets are typically not needed. Table 4-10, Pavement Marking Requirements, can be used as a reference to determine when pavement markings are required.

Table 4-10 Pavement Marking Requirements

<b>Volume (trips per day)</b> <b>A=No Markings, B= Centerline, C= Centerline &amp; Lane Line</b>					
Street Width (ft)	0-1000	1000-2000	2000-5000	5000-1000	> 10000
< 30	A	A	B	B	B
30-39	A	A	B	B	B
40-49	C	C	C	C	C
49-60	C	C	C	C	C
> 60	C	C	C	C	C
Note: Non-curb and gutter streets serving as collectors or arterials shall have centerline and edge line markings.					

#### 4.11.4. Typical Applications of Pavement Markings

The following describe specific applications of various pavement marking types (typical pavement marking designs are available in on the City's Standard Details located on the City website):

##### A. Lane Line Extensions

Lane line extensions (puppy tracks) shall be installed when conditions make it desirable to provide control or guide vehicles through an intersection. Such cases may include offset intersections, skewed intersections, or dual turning movements. All extensions shall be 2 feet lines with 3 feet skips. They shall be the same color of the line that is to be extended.

##### B. Left Turn Channelization

Except for continuous two-way left turn lanes and trapped lanes, most left turn lanes on undivided roadways will require a transition before left turn storage is provided. This transition or taper can be of a variety of designs and lengths. Refer to the Left Turn Channelization detail in the City Standard Details located on the City website and Table 4-11, Typical Taper Ratio Per Foot of Lateral Shift. Taper markings are always 4-inch double yellow solid lines.

##### C. Storage Length

Storage length is the distance from the end of the bay taper to the intersection nose or stop bar. This distance should be determined based upon left turn demand and the type of control at the intersection. The desirable distance is the length of the vehicle queue plus 100 feet for the deceleration that must take place before vehicles stop in queue. The

desirable minimum storage length is 150 feet. Turn lane storage areas are delineated by an 8-inch solid white line. This line extends from the stop bar the entire length of the storage area.

Table 4-11 Typical Taper Ratio Per Foot of Lateral Shift

Speed Limit (mph)	Approach Taper	Bay Taper
30	1:15	1:10
35	1:20	1:12
40	1:30	1:14
45	1:45	1:15
50	1:50	1:17
NOTE: Where the street has been flared to provide a left turn lane, the storage length should be maximized, and the taper length should be reduced. The typical taper length in this case is 150 feet for streets with a speed limit of 40 or higher.		

#### D. Non-Longitudinal Markings

Non-longitudinal (or transverse) markings shall be white except transverse median markings applied at the median nose, which shall be yellow. Typical dimensions and patterns of transverse markings are discussed below. Typical sketches are available in the City Standard Details located on the City website.

1. Stop Bars: Stop Bars shall be 24 inches in width. The typical placement is 15 feet from the cross-street face of curb line and shall be 4 feet in advance of any marked crosswalk. In some cases, that distance can be increased to account for potential conflicts with left turning vehicles turning from the cross street and for the proper design of crosswalks to accommodate pedestrian movements. However, in no case shall the stop bar be less than 4 feet nor more than 30 feet from the cross-street face of curb line.

Stop Bars shall be installed across one or more approaches when any of the following conditions exists:

- i. When high pedestrian movements (greater than 50 in one hour) cross a stopped approach.
- ii. When a multi-way stop exists involving a major collector street or arterial.
- iii. At all signalized intersections.
- iv. For stopped approaches at designated school crossings.



- v. At any location where a STOP sign cannot be placed where vehicles should come to a stop for safety purposes and field observations show a significant amount of traffic needs the extra delineation to enter the intersection safely. In these cases, the stop bar may be placed closer than 15 feet from the cross street if there are no significant pedestrian movements.
- 2. Crosswalks: Crosswalks shall be installed if any of the following conditions exists:
  - i. For each approach at a signalized intersection unless pedestrians are prohibited from crossing a specific approach.
  - ii. For controlled approaches at a designated school crossing.
  - iii. At controlled approaches where pedestrian movements exceed 100 in any one hour.
- 3. Mid-block crosswalks should be avoided; however, they can be allowed under the following circumstances:
  - i. At an established school crossing controlled by a school crossing guard.
  - ii. At a warranted signalized pedestrian crossing.
  - iii. If a mid-block crosswalk is deemed necessary, special attention must be given to signage, sight distance, TMUTCD, ADA, and TAS requirements. Appropriate traffic control measures must be provided.
- 4. Word and Symbol Markings: Pavement words and symbols shall be limited to no more than three lines of information. Pavement words and arrows shall be used in conjunction with lane use control signs, railroad crossings, continuous left turn lanes, and where needed to provide proper guidance. The font size shall be a minimum of 8 feet in height. All symbols shall be pre-formed, white, and retroreflective. "SCHOOL" word markings are not normally used in the City but can be installed where special emphasis is needed.
- 5. Bike Lane and Symbol Markers: Bike lanes, shared lanes, and symbol markers shall be in accordance with the classification requirements as indicated in the HBSMP and shall conform to the requirements of the TMUTCD.
- E. Fire Lane Striping: Fire lanes shall be maintained with fire lane striping that consists of 6-inch wide, red background stripe, with 4-inch-high white letters stating "No Parking, Fire Lane" painted on the red stripe every 15 feet. Where a curb defines the fire lane, the markings shall be painted on the vertical surface of the curb. When repainting, additions to the existing fire lanes are not allowed without prior approval of the Fire Department. Only designated fire lanes shall be marked.

Alternative fire lane striping or markings are not allowed without prior approval of the Fire Department. All designated fire lane markings shall always be maintained by the property owner.

#### 4.11.5. Lane Widths

The fundamental considerations involved in establishing lane widths include the width of the design vehicles and clearance between vehicles and roadside objects. The desirable lane width is 12 feet. Substantial traffic volumes can be accommodated in reduced widths; however, increased driver tension, wider speed and headway distributions, and poorer vehicle placement may result. The following table represents the standard in the City of Arlington.

Table 4-12 Lane Widths (feet)

Lane Type	Speed Limit Under 40 mph <sup>1</sup>		Speed Limit 40 mph and Over <sup>1</sup>	
	Minimum	Desirable	Minimum <sup>2,3</sup>	Desirable
Curb Parking Lane Only <sup>4</sup>	11	12	11	13
Curb Travel Lane <sup>4</sup>	11	12	11	13
Inside Lane	10 <sup>2,3</sup>	12	11	12
Turn Lane <sup>5</sup>	10 <sup>2,3</sup>	12	11	12

<sup>1</sup> The design speed for new facilities. For existing streets, use 85th percentile speed plus 5 mph, but not less than the posted speed limit plus 5 mph.

<sup>2</sup> If medium or large trucks or buses exceed 15% of ADT, use 11-foot width.

<sup>3</sup> On horizontal curves with radii of 500 feet and under, use 11-foot minimum for inside lanes and 12-foot minimum for curb lanes.

<sup>4</sup> If moderate to heavy bicycle traffic is expected in the street, a width of 15-feet is desirable.

<sup>5</sup> May be reduced by one foot under severely restricted conditions, if not adjacent to curb on the right and if few commercial vehicles are present. This does not apply to 2-way left-turn lanes.

## 4.12. Sign Design Requirements

The Owner will be responsible for the design and installation of all signs associated with the street improvements. The signs shall be fabricated and installed in accordance with the City Standard Specifications and Details, the TMUTCD, and the State Highway Sign Design Manual (SHSD). The location and design of all street signs shall be included with the construction plans. Refer to the UDC for a full list of special districts and requirements.

### **4.12.1. Fire Lane Signs**

Signs may be substituted for fire lane striping in residential areas with approval of the Fire Department. If the Fire Department determines that striping is ineffective to designate a fire lane, signs shall be required, and a written notice shall be provided to all affected property owners. All designated fire lane signs shall always be maintained by the property owner.

## **4.13. Traffic Signal Design Requirements**

### **4.13.1. General Requirements**

#### **A. Capital Improvement Projects**

Location of proposed signals shall be based on an approved TIA or as directed by the City Traffic Engineer. The consultant shall include signal design at all signalized intersections where new signals or signal modifications are needed as part of the project with the street and paving plans.

#### **B. Development Projects**

The Owner will be responsible for the design and installation of any traffic signal necessitated by the development. Location of proposed signals shall be based on an approved TIA or as directed by the City Traffic Engineer.

### **4.13.2. Signal Design Requirements**

This section provides the basic elements to design a traffic signal for the City. All signal designs shall conform to the latest City Traffic Signal Application Manual, City Uniform Traffic Control Manual (UTCD), or TxDOT signal standards where applicable. All signal designs shall conform to all ADA/TAS requirements. Signal design shall require City specified traffic signal cabinet, controller, and detection equipment.

#### **A. Site Survey**

A site survey shall be conducted, and the construction plans should include the following items within 300 feet of the intersection.

1. Existing conditions, including the roadway, sidewalks, inlets, right-of-way.
2. Dimension the locations of all poles, pedestals, push-button signposts, and the controller from the back of curb. Locate all other utilities to ensure no conflict with the foundations. Revise the design as needed to avoid utility conflicts.
3. All existing signs.

4. All existing pavement markings.
5. All existing signal features including signal shafts/poles, mast arms, pedestals, push-button signposts, signal symbols, pull boxes, conduit, controller, and other physical features.
6. Overhead and underground utilities. If overhead lines appear to conflict with a new signal installation, measure the height of the lines above the ground at the points of conflict.

## B. Design Layout

The design layout shall include the following information.

1. Lay out crosswalks to match ramp locations as designed per 4.10.4.
2. Locate signal poles/pedestals so that vehicle and pedestrian signals are properly oriented and pedestrian pushbuttons meet ADA and TAS requirements. When possible, mount pedestrian signals on signal poles. If signal poles are too far from crosswalks for proper push-button placement, use push-button pedestals. Minimize the use of signal pedestals. A signal pole/pedestal summary table shall be provided including all foundation information.
3. Placement of signal heads shall meet TMUTCD requirements and shall be in clear view of approach vehicles. The signal heads should be located in the center of the traveled lane. A summary table of signal head position on the mast arm shall be provided.
4. Locate necessary unique features, such as flashing beacons, streetlights, or any aesthetic components.
5. Locate existing and proposed right-of-way and/or easements.
6. Proposed power source and new controller locations. They should be located on the same corner, if possible, with adequate corner clearance for traffic turning right. Provide power service identification table.
7. Pull Boxes
  - i. Pull boxes shall be placed at the back of curb and be constructed with 10-inch concrete aprons.
  - ii. One pull box shall be located on every corner, including medians and islands.
  - iii. Where conduit will be bored, a pull box shall be provided on each end of the conduit section. Every conduit run shall terminate in a pull box.
  - iv. Poles and pedestal bases shall not be used in place of pull boxes.
  - v. A pull box shall be used for changes in conduit size or type.
  - vi. Supplemental pull boxes shall be used when a feature is more than 20 feet from one of the pull boxes required above.
  - vii. All pull boxes shall be Type C, quartzite material.

## 8. Conduit

- i. Conduit for the power service shall be 2-inch Schedule 40 PVC conduit. It shall run from the disconnect enclosure on the service pole into a pull box and then into the controller foundation. For power runs to the cabinet, no splices shall be permitted in the pull box. Power service shall not share conduits with other conductors.
- ii. Except as otherwise noted, underground conduit shall be PVC. Conduit on poles may be either rigid metal conduit or electrical metal tubing (EMT).
- iii. Signal conduit under streets shall be 4-inch PVC schedule 40. All signal conduits shall be terminated using 90-degree elbows.
- iv. Conduit under existing streets shall be installed using the horizontal directional boring process, at a minimum depth of 54 inches.
- v. If the power service is across the street from the controller and there is no convenient utility pole to receive overhead service, conduit shall be installed under the pavement. No new service pole shall be set that has no other function.
- vi. Two 4-inch PVC, one 1 ½-inch HDPE and one 2-inch PVC conduit shall be used between the cabinet and its pull box.
- vii. When the signal is a span wire installation, a 4-inch PVC conduit shall be used from the cabinet's pull box to the nearest signal pole and for the riser on the pole.
- viii. Provide minimum 2-inch PVC Schedule 40 conduit for streetlight circuits (luminaires on top of signal pole) as necessary.
- ix. Provide conduit run summary table.

## 9. Signal Phasing Design

- i. Signal phasing diagram with NEMA phase numbers including flashing yellow arrow.
- ii. Definitions of signal face control by NEMA phases and overlaps and a definition of the overlaps, if any.
- iii. Identify all signal heads with a unique number.
- iv. For unusual phasing or sequences and for preemptions, provide a detailed explanation.

## 10. Show all proposed signs

## 11. Provide detector connection chart for all Video/Radar/Preemption Detection

## 12. Provide a wire termination chart

## 13. Provide an APS design including a summary table of voice messages for each pedestrian phase

14. Provide a Legend defining all elements including but not limited to signal displays, signs, and all equipment

### **4.13.3. Location of Signal Conduits**

A request for locates of existing City signal conduits can be made online through the City website or the “Ask Arlington” App.

## **4.14. Fiber Optic Cable Design Requirements**

Fiber optic cables are typically installed along major roadways and at signalized intersections. When a development is required to construct the major roadway or signalized intersection, the Owner will be responsible for installing conduits for the fiber optic cables along the public street and/or at the signalized intersection of the development.

### **4.14.1. Conduit and Pull Box Installation**

Conduit for fiber optic cables shall be installed along the length of the major roadway connecting signals and other City infrastructure for communication, in accordance with the City's network fiber plan. 1 ½-inch HDPE conduit shall be utilized and may be placed in a trench with streetlight conduit at a depth of 36 inches. In addition to the 1 ½-inch purple HDPE conduit for the City fiber optic network; a 4-inch black HDPE for future use shall be installed in the same trench and have separate pull boxes.

Pull boxes for the fiber optic cables shall be at the median noses at all signalized intersections and placed every 1000 feet in between. Pull boxes on median noses will be for juncture of both signal conduit and fiber conduit at signalized intersections. Dedicated pull boxes shall be provided for fiber optic cables and shall be Type C quazite material.

### **4.14.2. Location of Fiber**

A request for locates of existing City Fiber Optic lines can be made online through the City website or the “Ask Arlington” App.

## **4.15. Street Light Design Requirements**

The Owner will be responsible for the design and construction of the streetlights on all public streets. For development projects, the Owner shall also be responsible for the design and construction of streetlights along existing public streets adjacent to the development where streetlights do not exist nor meet the City's minimum requirements as stated in this section. Streetlight design shall be in accordance with the City Standard Specifications and Details. Street classifications for streetlight design shall be in accordance with the current TDP

## 4.15.1. General Requirements

### A. Streetlight Plan Layout

At a minimum, the streetlight design plans shall:

1. Have a title block located at the lower right-hand corner of the drawing, and the north representation shall be displayed in an up or right direction.
2. Show all service poles or transformer pads utilized for streetlight energy source. Include the electric delivery provider's electrical design. Connection to the power source shall be coordinated with the electric delivery service provider.
3. Be drawn using standard symbols and abbreviations.
4. Show all existing and proposed utilities and storm drain facilities, including their easements.

### B. Pole Contacts

Other agencies' facilities may not be utilized for installation of streetlights.

### C. Utility Easements

Additional easements may be required depending on the location of the power source. A minimum width of 10 feet located along common lot lines is required for streetlights. It is the Owner's responsibility to acquire any necessary off-site easements and/or right-of-way.

### D. Service Standards

All conductors and connections shall be in accordance with the latest NEC and NESC guidelines. All underground streetlight services shall be placed in 2-inch PVC Schedule 40 conduit in a trench with a minimum depth of 30 inches.

When the underground conductors are located between properties, the location of the trench shall not run along the property lot lines or fence lines and shall be located approximately 2-1/2 feet from the edge of the easement.

### E. Conductors/Insulation

Conductors for residential installations shall be at a minimum AWG #6. Conductors for major collectors and arterials shall be at a minimum AWG #2. Cable and insulation shall be installed in accordance with the Table 4-13.

Table 4-13 Cable and Insulation for Conductors

	<b>Local and Minor Collector</b>		<b>Major Collector and Arterials</b>	
	Overhead	Underground	Overhead	Underground
Standard Practice	No	Yes	No	Yes
Stranded Aluminum	Duplex (XLP)	Triplex (XLP)	Duplex (XLP)	Triplex (XLP)
240 Volt	N/A	N/A	Standard	Standard
120 Volt	Standard	Standard	N/A	N/A

#### F. Special District Standards

All streetlights in the Entertainment District shall conform to the Entertainment District Design Standards. All streetlights in the Downtown District shall conform to the Downtown Neighborhood and Downtown Business Design Standards. Refer to the UDC for a full list of special districts.

#### G. Pole Type

Pole types shall be in accordance with City Standard Specifications and Details available on City website. Unless otherwise approved by the City, the standard pole design shall be utilized. Decorative poles will only be allowed in the Downtown District and the Entertainment District. Examples of Manufacturer's specifications for the decorative poles are available on the City website. Spacing of decorative poles will at a minimum be the same as standard streetlights. Streetlights that do not conform to the standard or decorative light details and specifications shall only be allowed on private roadways.

#### H. Pull Boxes

Streetlight conduit runs shall be designed to eliminate the use of pull boxes. If pull boxes are necessary, the following requirements shall be met:

1. Located at the bottom of the relay.
2. Located anywhere the streetlight conduit changes/splits directions.
3. Type A quazite boxes.
4. Each pull box shall have a ten-inch concrete apron.
5. The streetlight conduit runs daisy chain from foundation to foundation.

### 4.15.2. Local and Minor Collector Streets

- A. Streetlights shall be installed on local or minor collectors typically at 4 feet from the back of curb.



- B. Streetlights shall be installed at mid-block locations not less than 250 feet nor greater than 500 feet from any adjacent streetlight and on the inside of each horizontal curve with a 200 feet centerline radius or less.
- C. Streetlights shall be installed at all intersections.
- D. Streetlights shall be installed at the end of each cul-de-sac which is 175 feet or greater from the centerline of the intersecting street to the end of the cul-de-sac.
- E. Additional streetlights may be required whenever geometric conditions may create a traffic safety hazard that can be reduced by the installation of a streetlight.
- F. Placement of streetlights along existing roadway shall be coordinated with any existing streetlights along the roadway.

### **4.15.3. Major Collector and Arterial Streets**

#### **A. Fixtures**

Fixtures shall be in accordance with the City's current LED standard for Type II roadway distributions.

#### **B. Lighting Configurations**

1. Median Lighting: Light poles with twin arms and luminaries shall be installed at the center of the median of 4-lane and 6-lane boulevards. Lighting poles within the median of an initial four-lane boulevard planned for expansion to a six-lane boulevard shall be designed such that the poles will not need to be relocated when the roadway is expanded (i.e., at left turn lanes, and transitions for left turn lanes).
2. Staggered Lighting: Light poles shall be installed in an alternating pattern within parkways along both sides of the roadway on undivided roadways.
3. One-side Lighting: Light poles may be installed within the parkway on one side of the roadway along 4-lane undivided roadways only if staggered lighting is not feasible.

#### **C. Spacing Requirements**

The standard spacing distance between all poles in non-intersection areas shall be as shown in Table 4-14, Standard Pole Spacing. Spacing less than standard can be used to clear obstructions and may be increased no more than 15 feet where necessary to avoid conflicts. Any spacing that deviates more than 15 feet shall require submittal of photometrics that meet all three of the following criteria (where  $E_h$  is the luminance on a horizontal plane as described in the AASHTO Roadway Lighting Guides):

1.  $E_h$  (avg.) - The average maintained horizontal illumination in ft. candles shall be a minimum of 0.90.
2.  $E_h$  (avg.)/Min. - The average maintained horizontal illumination value divided by the lowest illumination point encountered within the area of roadway being lighted shall be 3.0 or less.
3. Max./Min. - The highest illumination point divided by the lowest illumination point encountered within the area of roadway being lighted shall be 9.0 or less.

Placement of streetlights along existing roadway shall be coordinated with any existing streetlights along the roadway.

Table 4-14 Standard Pole Spacing

	One-Side Lighting (ft)	Median Lighting (ft)	Staggered Lighting (ft)
Major Collector	160	210	160
Minor Arterial	N/A	210	130
Major Arterial	N/A	190	100

#### D. Major Intersection Placement

Type II optics are required at all four corners of all major intersections. At major intersections, the intersection lighting configurations and reduced spacing shall govern instead of the standard non-intersection spacings. All intersections shall require submittal of photometrics that meet the criteria in Table 4-15, where  $E_h$  is the luminance on a horizontal plane as described in the AASHTO Roadway Lighting Guides.

#### E. Adjustment for Topographic Height Variations

Where the base of the lighting standard is 5 feet higher or lower than the adjacent top of curb, a non-standard spacing between adjacent poles shall be specifically calculated to meet the required illumination values as specified.

#### F. Lateral Clearances

Poles shall be installed 4 to 8 feet from the back of the curb for one-side or staggered lighting. If this conflicts with existing or proposed facilities, an alternative location shall be determined. Streetlight poles shall not be installed within the sidewalk or accessible ramp. Streetlight poles shall not be installed within 4 feet of any street, fire hydrant, drainage flume, inlet, driveway, or within the drip line of any established tree. Streetlights shall not be installed within 10 feet of any overhead utilities.

Table 4-15 Intersection Illumination Requirements

Design Roadway	Intersecting Roadway	$E_h$ (Ave.) <sup>1</sup> (fc)	$E_h$ (Max.) <sup>2</sup> (fc)	$E_h$ (Min.) <sup>3</sup> (fc)	Ave./ Min. <sup>4</sup>	Max./ Min. <sup>5</sup>	Intersection Approach Spacing Reduction (ft)
Major Collector	Major Collector/ All Arterials	1.74	2.54	.77	2.3	3.32	140
Minor Arterial	Major Collector	1.34	2.31	.68	2.0	3.4	110
	Minor Arterial	1.81	2.80	.70	2.6	4.0	110
	Major Arterial	1.35	2.51	.54	2.5	4.65	110
Major Arterial	Major Collector	1.15	2.40	.58	2.0	4.11	90
	Minor Arterial	1.35	2.51	.54	2.5	4.65	90
	Major Arterial	1.12	2.50	.48	2.3	5.2	90

1.  $E_h$  (Avg.) – The average maintained horizontal illumination within the area of roadway being lighted in foot candles (fc) shall not be less than the listed values.

2.  $E_h$  (Max.) – The highest illumination point encountered within the area of roadway being lighted shall not exceed the listed values.

3.  $E_h$  (Min.) – The lowest illumination point encountered within the area of roadway being lighted shall not be less than the listed value.

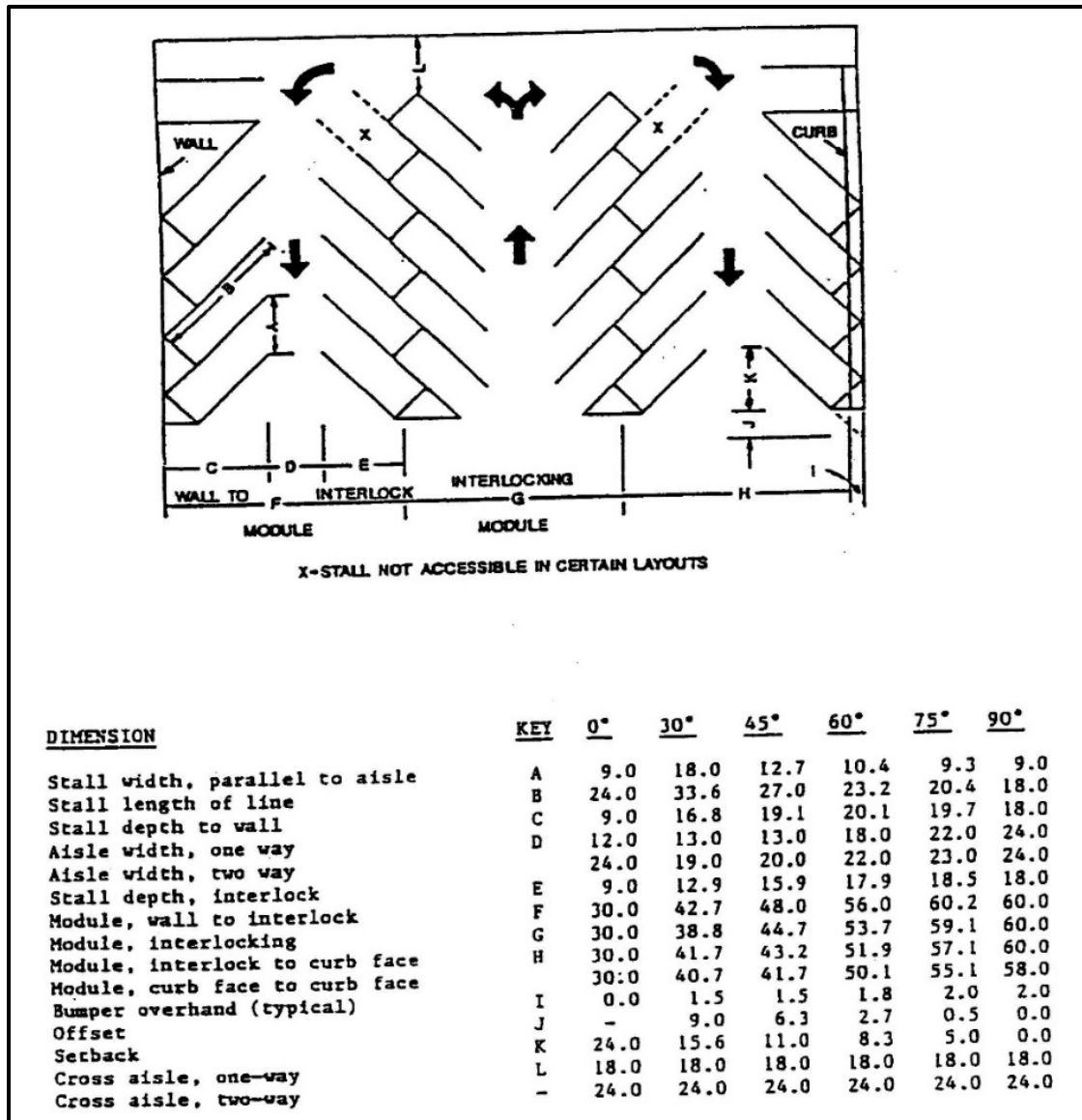
4. Ave./Min. – The average maintained horizontal illumination value divided by the lowest illumination point encountered within the area of roadway being lighted shall not exceed the listed values.

5. Max./Min. – The highest illumination point divided by the lowest illumination point encountered within the area of roadway being lighted shall not exceed the listed values.

## 4.16. Parking Lot Design Requirements

Parking lots shall be designed in accordance with the standards as shown in Figure 4-6, Parking Lot Layout Requirements. The site shall be designed such that all vehicle maneuvers are accomplished on site.

Figure 4-6 Parking Lot Layout Requirements



# CHAPTER 5 - STORMWATER

## 5.1. Objectives and General Guidelines

This chapter is intended to provide guidelines for the most commonly encountered stormwater or flood control-related designs in the City of Arlington (City). It shall also be used as a guide for studies, watershed master plans, preparation of Stormwater Management Site Plans, preparation of Stormwater Pollution Prevention Plans (SWPPPs), and for design of remedial measures for existing stormwater facilities. This manual was developed for users with knowledge and experience in the applications of standard engineering principles and practices of stormwater and flood control design and management. Close coordination with City staff is recommended and encouraged during the planning, design and construction of all stormwater and flood control facilities.

This chapter of the Design Criteria Manual is intended to supplement the City Code of Ordinances with procedures and technical criteria to meet the City's adopted policies. The following paragraphs outline the City's goals, objectives, and guidelines that will provide an understanding of the need and rationale for the drainage and stormwater design criteria.

### 5.1.1. Stormwater Goals and Objectives

- A. Minimize stormwater damage caused by flooding and erosion to public health, safety, life, property, and the environment.
- B. Protect and improve stormwater quality in streams, rivers, and other water bodies to the maximum extent practical, in conformance with the Texas Pollutant Discharge Elimination System (TPDES) permit requirements.
- C. Create comprehensive watershed plans that facilitate sustainable development resulting in an integrated system of public and private stormwater infrastructure.
- D. Ensure that new land disturbance does not increase flooding problems, cause erosion, or pollute downstream water bodies.
- E. Preserve and enhance existing aquatic and riparian environments and encourage restoration of degraded areas.
- F. Promote equitable, acceptable, and legal measures for stormwater management.

### **5.1.2. Stormwater Design Guidelines**

- A. All drainage related plans, studies, and permits shall be prepared and sealed by an Engineer.
- B. All drainage studies and design plans shall be based upon fully developed watershed or drainage area runoff conditions.
- C. Stormwater runoff from new development shall not cause new or increased flooding of existing insurable, habitable structures as defined by FEMA.
- D. Stormwater must be carried to an "adequate and acceptable outfall".
  - 1. An adequate outfall is generally a stream, channel or improved system that does not create or increase flooding or erosive conditions downstream.
  - 2. Water bodies that are not connected to a natural or improved stormwater conveyance system such as a stream, channel, or underground system shall not be considered an acceptable outfall.
  - 3. Off-site conveyance to reach an adequate and acceptable outfall shall be contained within a drainage easement or the public right of way.
  - 4. Outfalls to privately maintained stormwater facilities such as constructed ponds, channels or underground systems may require separate agreements with private property owners in accordance with the City Code of Ordinances.
- E. Proposed stormwater discharge rates and velocities from a new land disturbance or redevelopment shall not alter drainage patterns, concentrate flow, connect to existing stormwater infrastructure, or exceed the runoff from existing (pre-project) conditions, unless no adverse impacts will be created.
- F. Stream velocities shall not exceed the applicable maximum permissible velocity shown in Table 5-7, unless a certified geotechnical/geomorphologic study is prepared that demonstrates that the higher velocities will not create additional erosion. If existing channel velocities exceed the maximum permissible velocities, no additional increase in velocity shall be allowed.
- G. Stormwater storage facilities shall be designed and constructed when proposed stormwater discharge from a new land disturbance or redevelopment outfalls to a downstream system with existing flooding affecting public safety, insurable structures, or habitable structures, or a downstream system without capacity to convey the design storm.

- H. Where provisions of the Flood Damage Prevention and Stormwater Pollution Prevention Chapters of the City Code of Ordinances or the UDC may be more restrictive, the provisions of those chapters shall have authority over all provisions listed above.

## **5.2. Stormwater Submittal Requirements**

### **5.2.1. Stormwater Submittals**

- A. Submittals that may be required with a development include the following items. Additional guidance can be found on the City website.

- 1. Submittals with Preliminary Plat:

- i. Preliminary Grading Plan
- ii. Preliminary Drainage Area Maps
- iii. Preliminary Drainage Plan
- iv. Preliminary Stormwater Management Site Plan
- v. Flood Study

- 2. Submittals with Plats, Site Plans, Construction Plans, or Capital Improvement Plans:

- i. Grading Plan
- ii. Drainage Area Maps
- iii. Drainage Plan and Profile
- iv. Stormwater Management Site Plan
- v. Flood Study
- vi. Floodplain Development Permit
- vii. Conditional Letter of Map Change
- viii. U.S. Army Corps of Engineers (USACE) Permit
- ix. Trinity River Corridor Development Certificate
- x. Stormwater Pollution Prevention Plan (SWPPP)
- xi. Private Stormwater Facility Operation and Maintenance Agreement

- 3. Submittals required before final inspection:

- i. Record Drawings and an as-built letter
- ii. Elevation Certificates for Buildings constructed in or near floodplain
- iii. Documentation of submission of Letter of Map Change to FEMA (with community acknowledgement form)

- B. Table 5-1 Acceptable Hydrologic and Hydraulic Modeling Programs lists several widely used hydrologic and hydraulic modeling packages which are acceptable to the City. Some

of the dynamic models that are listed include both the hydrologic and hydraulic components of watershed and stream/storm drainage systems. The use of a program that is not on this list must be approved by the D-PWT. Only FEMA approved software can be used for design within the Regulatory Floodplain. Refer to Section 5.8.1 for further guidance on flood study software requirements.

Table 5-1 Acceptable Hydrologic and Hydraulic Modeling Programs

Software	Hydrologic Features	Hydraulic Features	FEMA Approved	Water Quality Features
HEC-HMS <sup>1</sup>	X		X	
HEC-RAS <sup>2</sup>		X	X	
PondPack	X	X	X	
StormCAD	X	X	X	
CulvertMaster	X	X	X	
GEOPAK	X	X		
Innovyze <sup>3</sup>	X	X		X
XPSWMM <sup>4</sup>	X	X	X	X
SWMM <sup>4</sup>	X	X		X
<sup>1</sup> HEC-HMS must be 3.5 or later <sup>2</sup> HEC-RAS must be 4.1 or later <sup>3</sup> Dynamic Hydrologic-Hydraulic Models, including InfoWorks and ICM packages <sup>4</sup> Dynamic Hydrologic-Hydraulic Models				

### 5.3. Site Grading

Grading plans shall be submitted for any land disturbance activities. Grading plans shall be consistent with the drainage area map and shall include flow arrows. Existing (pre-project) and proposed contours shall be shown. The natural flow of surface waters shall not be diverted or impounded in a manner that damages adjacent property.

Residential development shall be type A, B, or C drainage for each lot within the subdivision as described in HUD (FHA) Data Sheet 72, as amended. Type 1 or 2 block grading as shown in the HUD information is preferred. Type 3 and 4 block grading are allowed only if:

- A flume or channel is constructed at the rear of the lot to intercept runoff, or
- Runoff from no more than 3 lots is accumulated prior to constructing a drainage system to intercept the runoff.

The Engineer may utilize swales to redirect flows. The Engineer shall provide more detailed information in addition to the lot grading type (A, B, or C) by indicating spot elevations on each lot. If the site is complex and an overall site grading plan cannot be developed in accordance with the HUD standards, an individual grading plan for each lot shall be submitted by an Engineer prior to issuing the building permit. The



individual grading plans shall be coordinated with surrounding lots. For these complex plans, an “as-built” letter shall be submitted by an Engineer prior to final inspection. Copies of the HUD figures are located on the City website.

The City reserves the right to require a minimum finished floor or Flood Protection Elevation (FPE) on any lot. FPEs are required for all lots located in or adjacent to the floodplain, flood-prone areas, or near open drainage features, and shall be set 2 feet above the 100-year fully developed water surface elevation. FPEs may also be required at t-intersections, low points, or as required by the subdivision design. These elevations are typically set at least 1 foot above the top of curb on the high side of the lot.

## **5.4. Drainage Areas and Impacts**

The design of a storm drainage system must account for offsite flows; flows generated by the development/project; and the impacts on the downstream drainage system. The stormwater discharge from the development /project shall not cause adverse impacts to adjacent or downstream properties or facilities.

### **5.4.1. Drainage Areas**

- A. Drainage area maps and runoff calculations shall include all drainage areas contributing to the site.
- B. Separate drainage area maps and runoff calculations shall be prepared for both the existing (pre-project) drainage area and the fully developed (post-project) drainage area.
- C. Drainage areas shall follow natural drainage features if future land disturbance is unknown or existing areas will not be changing under fully developed conditions.

### **5.4.2. Drainage Impacts**

Drainage plans and studies shall demonstrate the development/project will produce no adverse impacts. No adverse impacts include:

- A. No new or increased flooding of existing insurable, habitable structures as defined by FEMA.
- B. No significant increases (0.04 ft) in water surface elevations for the 2-, 25-, and 100-year storm events unless contained in existing channel (with freeboard), roadway, drainage easement and/or right-of-way. Dry lane and gutter capacity requirements shall also be met.

- C. Post-development/project channel velocities shall not be increased by more than 5% above pre-development/project velocities for the 2-, 25-, and 100-year storm events. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion. If existing channel velocities exceed the maximum permissible velocities, no additional increases in velocity will be allowed.
- D. No increases in downstream discharges caused by the proposed development/project that, in combination with existing discharges, exceeds the existing capacity of the downstream storm drainage system.

The drainage analysis shall extend to a point downstream where the proposed development/project creates no adverse impacts. The Engineer shall determine how far downstream the analysis shall extend. For channels, the minimum downstream limit shall extend to the next hydraulically significant structure located at least 1,000 feet downstream of project area (i.e. bridges, culverts, or dams).

If a portion of a larger property is being developed, the limit of drainage analysis shall be determined based on the entire property.

### **5.4.3. Concentrated Runoff from Development**

Site runoff due to development shall not cause adverse impacts. When offsite grading is required or when the development discharges concentrated flow on an adjacent property, off-site conveyance to reach an adequate and acceptable outfall shall be contained within a drainage easement obtained from the affected property owner(s).

## **5.5. Storm Frequency for Drainage Design**

### **5.5.1. General Design Frequency for Drainage Features**

Table 5-2 shows the minimum design frequency to be used when designing drainage facilities in the City.

Table 5-2 Minimum Design Frequency

Type of Facility	Minimum Design Frequency <sup>1</sup>
Curb Inlets <sup>2</sup>	25-year
Drop Inlets <sup>2</sup>	25-year
Storm Drains	25-year
Street right-of-way	100-year <sup>3</sup>
Channels and streams	100-year
Stream culverts and bridges	25-year
Roadside ditch and associated culverts	25-year
Stormwater Storage Facilities	2-, 25-, and 100-year
<sup>1</sup> All design discharges will be based on fully developed watershed conditions. <sup>2</sup> Inlets in low points will require positive overflow within a street right-of-way or drainage easement for the 100-year event. <sup>3</sup> Depending on the amount of flow in the right-of-way, additional drainage infrastructure may be required to reduce the flow in order to protect the health, safety and welfare of the general public.	

### 5.5.2. Street and Storm Drainage System

The 25-year storm must be contained within the permissible spread of water in the gutter as detailed in the hydraulic section of this chapter. Adequate inlet capacity shall be provided to intercept surface flows before the right-of-way capacity is exceeded. The capacity of the underground system may be required to exceed the 25-year storm in order to satisfy the street right-of-way criteria.

The cumulative flows from existing intersections, driveways and flumes shall be considered and inlets provided as necessary where the flow exceeds the existing capacity of the street. For new driveways and flumes, discharges to the street shall not cause flow within the right-of-way to exceed the design capacity. Additional street and inlet design criteria are included in the Hydraulic section.

## 5.6. Hydrology

When a land disturbance requires the design of stormwater facilities, the following criteria for stormwater runoff and drainage plan requirements shall be used. In addition, these criteria shall be used for master drainage studies, FEMA-related studies, capital improvement projects, and other drainage-related studies and designs. Refer to Table 5-1 for acceptable hydrologic and hydraulic modeling programs.

### 5.6.1. Peak Design Discharges Prepared by City

The City may have hydrologic models or design storm flow rates available in City Council adopted watershed studies or development master plans. If available, these shall be used in the drainage calculations. Where no flow rates are available, a unit hydrograph shall be determined by an Engineer.

### 5.6.2. Allowable Hydrologic Methods

Hydrologic methods that are allowable for analysis and design are listed in Table 5-3. The table includes the applications for which these methods can be used. Following paragraphs will describe the application of the Rational Method, the Modified Rational Method and the NRCS hydrograph method for runoff calculations. Other hydrologic methods will need approval of the D-PWT. Stormwater runoff, for all hydrologic methods, shall be based on a fully developed watershed.

Table 5-3 Allowable Hydrologic Methods

Method	Size Limitations <sup>1</sup>	Comments
Unit Hydrograph (NRCS Method)	Any Size	For estimating peak flows and hydrographs for all design applications.
Rational <sup>2</sup>	0 – 20 acres	For estimating peak flows for the design of small roadside ditches, median ditches, storm drain inlets, lateral storm drains, and driveway pipes.
Modified Rational Method <sup>3</sup>	0-20 acres	For detention pond planning and conceptual design.
<sup>1</sup> Size limitation refers to the drainage basin for the drainage facility (e.g., culvert, inlet). <sup>2</sup> For design of stormwater storage facilities, a hydrograph method will be required. <sup>3</sup> Where the Modified Rational Method is used for conceptualizing, the Engineer is cautioned that the method could underestimate the storage volume.		

### 5.6.3. Rainfall Intensity

Rainfall depths for the City shall be in accordance with the rainfall table for Tarrant County in Section 5.0 of the iSWM Hydrology Technical Manual for all hydrologic analysis. Projects requiring TxDOT approval shall use TxDOT rainfall data as described in the TxDOT Hydraulic Design Manual.

### 5.6.4. Time of Concentration

The time of concentration shall be based on fully developed conditions for the watershed. Utilize TR-55 methodologies to calculate the time of concentration. The total time of concentration shall include sheet flow and channelized flow. The maximum length allowed for the sheet flow portion of the calculation is 50 feet. Typical Manning's n values for sheet flow are 0.011 for smooth surfaces or 0.024 for grassed areas. Gutter flow will typically be considered shallow concentrated flow. Additional

guidance on the calculation of the time of concentration can be found in Section 1.2.4 of the iSWM Hydrology Technical Manual.

### 5.6.5. Rational Method

The Rational Method is acceptable for small, highly impervious drainage areas, such as parking lots and roadways draining into inlets and gutters. Table 5-4 provides the Frequency Factors to be used with Rational Method. The product of the frequency factor and the runoff coefficient shall not exceed 1.0.

Table 5-4 Frequency Factors for Rational Formula

Recurrence Interval (years)	Frequency Factor "C <sub>f</sub> "
10 or less	1.0
25	1.1
50	1.2
100	1.25

The most intense land use or zoning shall be used to determine the runoff coefficient for the fully developed watershed. The following table gives values for runoff coefficients that shall be used in the determination of stormwater runoff for the Rational Method. It is often desirable to develop a composite runoff coefficient based in part on the percentage of different types of surfaces in the drainage area.

The typical inlet time in Table 5-5 is provided for guidance only and shall not be used in lieu of time of concentration calculations.

Table 5-5 Runoff Coefficients and Inlet Times for Rational Method

Zoning or Land Use	RUNOFF COEFFICIENT "C"	TYPICAL INLET TIME (Minutes)
Parks and Permanent Open Space	0.35	15
"RS-15", "RS-20", and RE	0.58	10
"RS-7.2", "RS-5", RM-12	0.70	10
"RM-12" Residential Medium Density	0.80	10
"RMF-22" Multi-family Zoning	0.90	5
Commercial, Schools & Churches	0.95	5
Central Business District/Industrial	1.00	5
Streets	0.95	5

### 5.6.6. Modified Rational Method

The Modified Rational Method uses peak flow calculating capability of the Rational Method paired with assumptions about the inflow and outflow hydrographs to compute an approximation of storage

volumes for simple detention calculations. The Modified Rational Method can only be used for conceptual design of detention ponds. Where the Modified Rational Method is used for conceptualizing, the Engineer is cautioned that the method could underestimate the storage volume. The Unit Hydrograph Method shall be used for final design of stormwater storage facilities.

The “C” coefficients presented in Table 5-5 shall be used in the Modified Rational Method. Further guidance on the Modified Rational Method can be found in Section 1.5 of the iSWM Hydrology Technical Manual.

### **5.6.7. Natural Resource Conservation Service Hydrograph Method**

If design flood peak discharges or hydrographs have not been developed for the watershed of interest, the City requires the use of the Natural Resource Conservation Service (NRCS) hydrograph method for drainage areas larger than 20 acres.

The NRCS hydrograph method requires drainage area, a runoff factor, time of concentration, and rainfall. The NRCS method also considers the time distribution of the rainfall, the initial rainfall losses to interception and depression storage, and an infiltration rate that decreases during the course of a storm. Details of the methodology can be found in the SCS National Engineering Handbook, Section 4, Hydrology (USDA, 1985).

#### **A. Design Storm Rainfall**

Rainfall distribution for the NRCS Unit Hydrograph shall be based on the frequency rainfall data, centered at the midpoint of the rainstorm (12th hour of a 24-hour storm) unless otherwise approved by the D-PWT.

#### **B. Curve Numbers**

The NRCS Method uses an index called the runoff curve number (CN) to represent the combined hydrologic effect of the soil type, land use, hydrologic condition of the soil cover, and the antecedent soil moisture. The CN indicates the runoff potential of soil. Higher CNs reflect a higher runoff potential. The runoff CN values for urban areas shown in Table 2-2a of NRCS Technical Release 55 (TR-55) may be used. When open space is used as the cover type, fair condition shall be assumed. The NRCS Soil Survey for Tarrant County may be used to identify the soil group within a project area or watershed. For computation of design events, an assumption of Antecedent Moisture Condition II is required.

Table 5-6 shows the land use categories and corresponding impervious percentages. When the future zoning or development type is unknown, an impervious percentage of

75 shall be used. These values do not supersede the existing conditions. For instance, if an industrial area is currently 90% paved, then 90% is the impervious condition that shall be used.

Table 5-6 Land Use and Percent Impervious

Land Use Description	Impervious Condition (%)
Extremely Low-Density Res (2+ac lots)	15
Very Low-Density Res (1 ac lots)	25
Low Density Res (1/2 ac lots)	40
Medium Density Res (1/3 ac lots)	45
High Density Res (1/4 ac lots)	50
Major Transportation	50
Industrial	72
Institutional	50
Group Quarters	40
Hotel/Motel	85
Mobile Home	35
Multi Family	65
Office	85
Parks/Recreation	6
Retail	85
Unknown Future Land use	75
Under Construction	50
Utilities	60
Vacant	3
Water	100

#### C. Hydrologic Stream Routing.

Routing may be needed within the hydrologic model. These include detention ponds or significant channel reaches that are not within a hydraulic model. Storage and ponding areas shall use Modified Puls Routing with explicit depth area curves determined from topographic contours. Channel segments should be modeled using either Modified Puls or Muskingum Cunge methods using cross sections taken from available topography. For unsteady flow modeling, the routing is included in the hydraulic software being used.

## 5.7. Hydraulics

Hydraulic design is the process of determining the appropriate capture and transport (or storage) of stormwater that has been generated from a rainfall event to an adequate outfall. Stormwater facilities include, but are not limited to, ditches, streets, inlets, storm drain systems, swales, channels, culverts, and ponds or reservoirs. Green and Sustainable Infrastructure and Low Impact Development (LID) also offer



numerous alternative drainage design features to consider that can supplement conventional drainage infrastructure. Refer to Table 5-1 for acceptable hydrologic and hydraulic modeling programs.

### **5.7.1. Roughness Coefficients and Permissible Velocities**

Table 5-7 provides hydraulic roughness coefficients and permissible velocities for design of various drainage facilities in the City. Roughness coefficient ranges are to be used for flood studies. For all other design calculations, normal values for roughness coefficients shall be used.

### **5.7.2. Street and Gutter Flow**

Surface drainage along streets is a function of transverse and longitudinal pavement slope, pavement roughness, inlet spacing, and inlet capacity. The design of these elements is dependent on storm frequency and the allowable spread of stormwater on the pavement surface.

#### **A. Streets with Curb and Gutter**

Local and minor collector streets shall be designed to flow less than curb deep during a 25-year storm. For major collectors and minor arterials,  $\frac{1}{2}$  of a lane in each direction shall remain dry during the design storm. For major arterials, 1 full lane in each direction shall remain dry during the design storm.

The drainage capacities of streets with triangular, composite, and parabolic sections as well as streets with curb splits shall be determined using the procedures in the iSWM Technical Manual for Hydraulics. N-values for new concrete streets built in accordance with City Standard Specifications and Details shall be for rough concrete.

#### **B. Valley Gutters**

Transverse valley gutters are not allowed in lieu of an underground drainage system without approval from the D-PWT. Valley gutters shall be constructed in accordance with City Standard Details. They shall be a minimum of 8 feet wide for the full width of the street (or 4 feet at intersections) and constructed of reinforced concrete. The street crown transition shall be a minimum of 25 feet in both directions.

At any intersection, only one street shall be crossed with a valley gutter and this street shall be the lower classified street. Valley gutters shall not cross arterial or collector streets.

#### **C. County Type Roadways**

County Type roadways may be constructed with roadside ditches in lieu of curb and gutter. Refer to roadside ditch and culvert requirements in this Chapter.

Table 5-7 Roughness Coefficients and Permissible Velocities

Type of Section/Feature	Coefficient of Roughness "n"			Maximum Permissible Velocity, fps
	Minimum	Normal	Maximum	
<b>I. Natural Streams</b>				
A. Stream Section				
1. Some grass and weeds; little or no brush	0.027	0.045	0.048	6
2. Dense growth of grass or brush	0.050	0.055	0.055	6
3. Dense brush and trees	0.060	0.065	0.080	6
B. Floodplain/Overbank Areas				
1. Grass, Weeds, Some Brush and Trees	0.027	0.045	0.048	6
2. Dense Grass, Weeds or Brush	0.050	0.055	0.065	6
3. Dense Brush and Trees	0.070	0.080	0.150	6
4. Buildings		0.500		
<b>II. Constructed/Modified Open Channels</b>				
A. Articulated Block <sup>1</sup>	0.015	0.035	0.050	15
B. Gabion Channels (blankets and baskets)	0.015	0.035	0.050	15
C. Pre-Cast Concrete Block Channels	0.015	0.035	0.050	15
D. Grass Vegetated Channels (maintained) <sup>2</sup>	0.027	0.035	0.040	5.0 for sandy soils 6.0 for clay soils
E. Concrete Channels	0.014	0.016	0.030	15
F. Stone Rip-Rap Channels	0.033	0.035	0.036	Determined by Analysis
<b>III. Streets (curb gutters and valley gutters)</b>				
A. Concrete Section				
1. Smooth	0.014	0.015	0.017	N/A
2. Rough	0.017	0.018	0.019	N/A
B. Asphalt	0.014	0.015	0.019	N/A
<b>IV. Pipes</b>				
A. Reinforced Concrete Pipe	0.012	0.013	0.017	15
B. Corrugated Metal Pipe	0.015	0.022	0.033	15
C. High Density Polyethylene Pipe <sup>3</sup>	0.009	0.011	0.025	15
D. Concrete Boxes (smooth to rough)	0.012	0.013	0.020	15
<sup>1</sup> Manufacturer's specifications for maximum velocities should not be exceeded. Areas of turbulent flow or hydraulic jumps will require additional stabilization, regardless of velocity.				
<sup>2</sup> For non-clay grass lined channels, a shear stress calculation is required to determine velocity				

### 5.7.3. Stormwater Inlets

Refer to the City Standard Details for inlet construction and material requirements. Curb inlets shall be used on public roadways. Drop inlets may be utilized to intercept multiple lot-to-lot drainage or intercept offsite drainage. Grate inlets and combination inlets are not allowed in public storm drain systems. For design of stormwater inlets, use the procedures in the iSWM Technical Manual for Hydraulics.

#### A. Curb Inlets:

Curb inlets shall be a minimum of 10 feet in length. Recessed curb inlets are required on all streets except local streets. The hydraulic efficiency of stormwater inlets varies with gutter flow, street grade, street crown, and with the geometry of the inlet depression. The efficiency of on grade curb inlets can be greatly increased if a small amount (5% to 10%) of gutter flow is allowed to flow past the inlet. The City Standard Details for both recessed and standard curb inlets include a depressed gutter line.

Where an alley or street intersects a street, inlets shall be placed in the intersecting alley or street whenever the combination of flow down the alley or intersecting street would cause the capacity of the downstream street to be exceeded. Inlets shall be placed upstream from an intersection whenever possible.

Curb inlets in low points shall be designed in accordance with additional standards for low point inlets.

#### B. Drop Inlets (Area Drains)

If used, grading plans to direct flow into drop inlets shall be included in the construction plans. Where earthen swales or other means of collecting and directing runoff into drop inlets are needed, they should be contained in appropriately sized drainage easements. Drop inlets shall be located where they can be easily accessed for inspection and maintenance by the City.

Drop inlets in low points shall be designed in accordance with additional standards for low point inlets.

#### C. Low Point Inlets and Overflow Flumes

Requirements in this section apply to both curb and drop inlets. Curb inlets in sumps are addressed in Section 1.2.7 of the iSWM Hydraulics Technical Manual. Drop inlets in sumps are addressed in Section 1.2.9 of the iSWM Hydraulics Technical Manual.

In low points, sag, or sump conditions, the storm drain, and inlets should be sized to intercept and convey a minimum of the 25-year storm. A positive structural overflow is required to provide for the remainder of the 100-year storm. If no positive structural overflow is feasible, low point inlets shall be designed with a 50% clogging factor and the pipe shall be designed for a 100-year flood event. In areas where no structural overflow is feasible, consider additional on-grade inlets upstream of the low point to reduce the required capacity at the low point. Guidance on positive overflow structures can be found in the Flume and Vegetated Swale section of this manual.

Flow into low point inlets shall be calculated using either the weir flow formula for an unsubmerged inlet or the orifice flow formula for a submerged inlet. When the depth of flow above the inlet invert, rises to 1.4 times the opening height or higher, the inlet opening becomes submerged, causing orifice flow to govern the head-discharge relationship. For intermediate depths between the opening height of the inlet and 1.4 times the opening height, a transition between weir and orifice behavior occurs. The capacity shall be calculated assuming both weir and orifice behavior. The smaller of the two capacities, or the larger of the two required inlet sizes shall be used. The depth of flow for low point inlet capacity calculations shall be contained within the surrounding right-of-way/easement.

#### **5.7.4. Storm Drain (Closed Systems)**

Closed systems shall be extended to an adequate and acceptable outfall.

##### **A. Full or Partial Flow in Storm Drains**

All storm drains shall be designed by the application of the Continuity Equation and Manning's Equation either through the appropriate charts and nomographs or by direct solutions of the equations as follows:

##### ***Equation 5-1: Continuity Equation***

$$Q = A * V$$

##### ***Equation 5-2: Mannings Equation***

$$Q = (1.486/n) * A * R^{2/3} * S_F^{1/2}$$

Where:

Q = Runoff in cubic feet per second.

A = Cross-sectional area of pipe or channel.

V = Velocity of flow.

n = Coefficient of roughness of pipe or channel.

R = Hydraulic radius = A/P.

S<sub>f</sub> = friction slope in feet per foot in pipe or channel.

P = Wetted perimeter.

The pipe flow charts and nomographs for circular conduits flowing full and partially full are shown in the iSWM Hydraulics Technical Manual. Equations for flow in conduits with other cross-sections are available in TxDOT Hydraulic Design Manual.

#### B. Hydraulic Gradient and Storm Drain Profile

The hydraulic gradient shall be established for all storm drain systems. Both the fully developed 25-year and 100-year hydraulic gradient lines (HGLs) shall be shown throughout the system. They shall be labeled in the construction plans both in the hydraulic calculations and on the storm drain profile. The design storm HGL shall be below the bottom of the subgrade for systems under pavement. For systems outside of the pavement, the HGL shall be lower than all inlet throats. Allowance of additional head may be required for planned future extensions of the storm drainage system.

The HGL shall start at the: the tailwater elevation or HGL of a connecting feature; the inside top of pipe; or at the HGL determined for a coincident confluence flow condition, whichever is higher. For outlet-controlled systems, the hydraulic gradient is calculated from the downstream end, taking into account all of the head losses that may occur along the line.

The iSWM Hydraulics Technical Manual Table 1.10 provides a table of coincident design frequencies to assist with tailwater determination. A detailed hydrologic and hydraulic study to determine coincident tailwater can be used as an alternative to Table 1.10 in the iSWM Hydraulics Technical Manual.

Refer to the Section 1.2.10 in the iSWM Hydraulics Technical Manual for the equations to calculate energy losses at pipe junctions, bends, manholes, inlets, and other situations. Minimum head loss used at any structure shall be one-tenth (0.10) foot. All HGL calculations shall be carried upstream to the inlet.

#### C. Entrance/Outfall Structures

Headwalls or sloped end treatments shall be constructed at the pipe ends of all storm drain systems. Sloped end treatments are required along streets when the drainage feature is adjacent and parallel to traffic flow. The sloped end treatment shall be a minimum six horizontal to one vertical (6:1) end section. Storm drain systems that outfall to a stream, natural channel, or pond shall conform to the existing side slope of the channel, outfall to the stream flowline, and be connected to a headwall. Hard armor protection and energy dissipation shall be installed at the outfall structure to address potential erosion issues associated with the new storm drainage system. Refer to the iSWM Technical Manual Hydraulics Section for design of channel transitions and energy

dissipation. Follow requirements for open channel transition materials when out-falling to a channel.

#### D. Pipe Material

Underground systems shall be constructed with Class III reinforced concrete pipe. The pipe size shall be a minimum of 18 inches for all public systems. A higher class of pipe may be required when underground storm drainage systems are constructed at shallow or deep elevations. Refer to the pipe manufacturer specifications for cover requirements. HDPE is not allowed for public facilities unless approved by the D-PWT and shall never be allowed under street paving.

All pipe bends and fittings shall be prefabricated. Collar connections shall be in accordance with the City typical detail. Radius pipe shall be placed in accordance with the manufacturer's lay schedule.

Field connections may be allowed when the main pipe is twice the diameter of the lateral pipe; however, field connections are not allowed when the lateral pipe slope is greater than 10 percent.

#### E. Access Points

A manhole or access lateral shall be constructed every 500 feet to provide access into the closed system. A lateral used as an access point shall be at least 36 inches in diameter, an RCP, and no more than 50 feet long to an open-air access point. Open air access is considered a designed entrance point or outfall without obstructions.

#### F. Grades and Velocities

Storm drains should operate with velocities of flow sufficient to prevent excessive deposits of solid materials. A minimum full flow velocity of 2.5 fps in the design storm and a minimum slope of 0.5% shall be maintained in the pipe unless otherwise approved by the D-PWT. Velocities shall not exceed 15 fps and supercritical flow is not allowed in main lines.

#### G. Roughness Coefficients

A roughness coefficient will be selected which will represent the average condition. The recommended coefficients of roughness are listed in Table 5-7

### 5.7.5. Open Channels

This section includes the drainage design criteria for ditches, channels, and dams. Land disturbances that include or are adjacent to a stream and result in impacts to the FEMA 100-year floodplain (Special Flood Hazard Area), City Regulatory Floodplain, or flood-prone areas shall meet the requirements in the Floodplain Impacts Section. Land disturbances affecting the FEMA designated floodplain shall be sent to FEMA for an appropriate map change.

If modifications to a stream or channel are determined to impact the Jurisdictional Waters of the United States (WUS), then the plans shall be submitted to the USACE for review and any required permitting shall be performed and approved prior to construction.

#### A. Hydraulic Design

1. The City requires a tailwater/headwater analysis on any proposed open channels, upstream and downstream channel transitions, energy dissipation structures, obstructions, or small dams (less than 6 feet).
2. The tailwater/headwater analysis shall be used to determine the actual headwater and tailwater elevations, headlosses, capacity, freeboard, and floodplain impacts. The iSWM Hydraulics Technical Manual Table 1.10 provides a table of coincident design frequencies to assist with tailwater determination. A detailed hydrologic and hydraulic study to determine coincident tailwater can be used as an alternative to Table 1.10 in the iSWM Hydraulics Technical Manual.
3. For channels and larger dams that require a flood study, a hydrologic routing model and hydraulic analysis in an acceptable program as detailed in Table 5-1 Acceptable Hydrologic and Hydraulic Modeling Programs will be required to determine impacts on existing floodplains and/or adjacent properties.
4. If a stream or channel has an effective FEMA model and/or a City Council adopted watershed model, the Engineer will be required to use those models for the analysis. If the current effective model for the stream is a HEC-2 model, the Engineer must convert to HEC-RAS for analysis of proposed conditions.
5. For Normal Depth (uniform flow) calculations, the Manning's equation and slope-area method is to be used only for initial sizing. Exceptions will be for small outfall channels with the following options:
  - i. Completely contained on the project site for on-site drainage.
  - ii. Where no off-site drainage easement or grading is required (i.e. not crossing or adjacent to another property that could be flooded if design storm occurs).
  - iii. No nearby downstream restrictions or reductions in channel capacity.

6. Supercritical flow will not be allowed for designed channels. However, for lined channels, the HEC-RAS analysis should include a mixed-flow regime analysis, to make sure no supercritical flow occurs for the designed channel. Mixed or supercritical flow may be allowed for analysis of existing conditions when required. For example, mixed flow analysis may be allowed if there are consecutive cross sections that are defaulting to critical depth in the subcritical analysis and the model cannot be stabilized by adding new cross sections.

The City requires that the computed flow depths in designed channels be outside of the range of instability and shall meet the following requirements:

- i. Depth of flow should be consistently 1.1 times critical depth.
- ii. No more than two consecutive cross section defaulting to critical depth.

Design should evaluate any existing or potential future locations of hydraulic jumps and ensure proper concrete-lining and protection of the channel in these areas.

## 7. Channel Transitions and Energy Dissipation

Upstream or downstream transitions from natural to modified channels along with channel outfalls will require a design based on a hydraulic study and will provide a non-erosive environment. Refer to the NCTCOG iSWM Technical Manual for Hydraulics Section 4.0 Energy Dissipation for design of channel transitions and energy dissipation.

## 8. Material Standards for Channel Transitions and Stream Stabilization

Stone riprap and gabions are typical materials used for channel transitions and stream stabilization. Alternative materials including, but not limited to articulated concrete blocks and turf reinforced matting, must include supporting documentation that the particular product to be used is appropriate for the proposed use. Where stone riprap and gabions are used, the following criteria applies.

### i. Stone Riprap Design

Stone riprap sizing shall be per the Isbash Method described in the NRCS Technical Supplement 14C: Stone Sizing Criteria. Guidance for the riprap gradation is in FWHA HEC-23 Section 5.2.8 Riprap Size, Shape, and Gradation. A properly designed geotextile material is required between the underlying soil and the stone riprap.

For bank slope protection, the maximum face slope is two horizontal to one vertical (2:1).



Regardless of computed stone size, the minimum allowable stone riprap size in channels and streams is eighteen (18) inches (FHWA Class V). The minimum allowable riprap thicknesses at least 1.5 times D50.

ii. Grouted Stone Riprap Design

Stone riprap designed in accordance with City standards can be grouted. However, the design thickness of the stone lining will not be reduced by the use of grout. The edges of grouted stone riprap require special treatment to prevent undermining. The toe should extend to a depth below anticipated scour depth.

Geotextile material is required under all grouted stone riprap to provide a zone of high permeability to carry off seepage water and prevent damage to the overlying structure from uplift pressure.

For bank slope protection, a gravel underdrain and weep holes shall be constructed to relieve hydrostatic pressure buildup behind the grout surface. Weeps should extend through the grout surface to the interface with the gravel underdrain layer.

See the USACE design manual ETL 1110-2-334 on design and construction of grouted stone riprap.

iii. Gabion Design

Gabion mattresses and baskets can be used for bank slope protection that is steeper than three horizontal to one vertical (3:1). Slopes steeper than two horizontal to one vertical (2:1) should be analyzed for slope stability. Gabions are strongly discouraged in areas subject to direct impact from debris or falling water. Gabions subject to falling water must be designed to include a concrete cap six inches thick.

Where gabions are designed as a structural unit, the effects of uplift, overturning and sliding must be analyzed by a geotechnical or structural Engineer.

Geotextile material is required between the gabions and the foundation or backfill to prevent soil movement through the gabions.

Tiebacks into the bank and bed should be provided to protect the gabions from undermining and scour at the toe and the upstream and downstream ends of the gabions.

## B. Unimproved Channels/Natural Streams

For a stream in its natural state, a flood study shall be submitted to determine the easement limits and the FPE for the property.

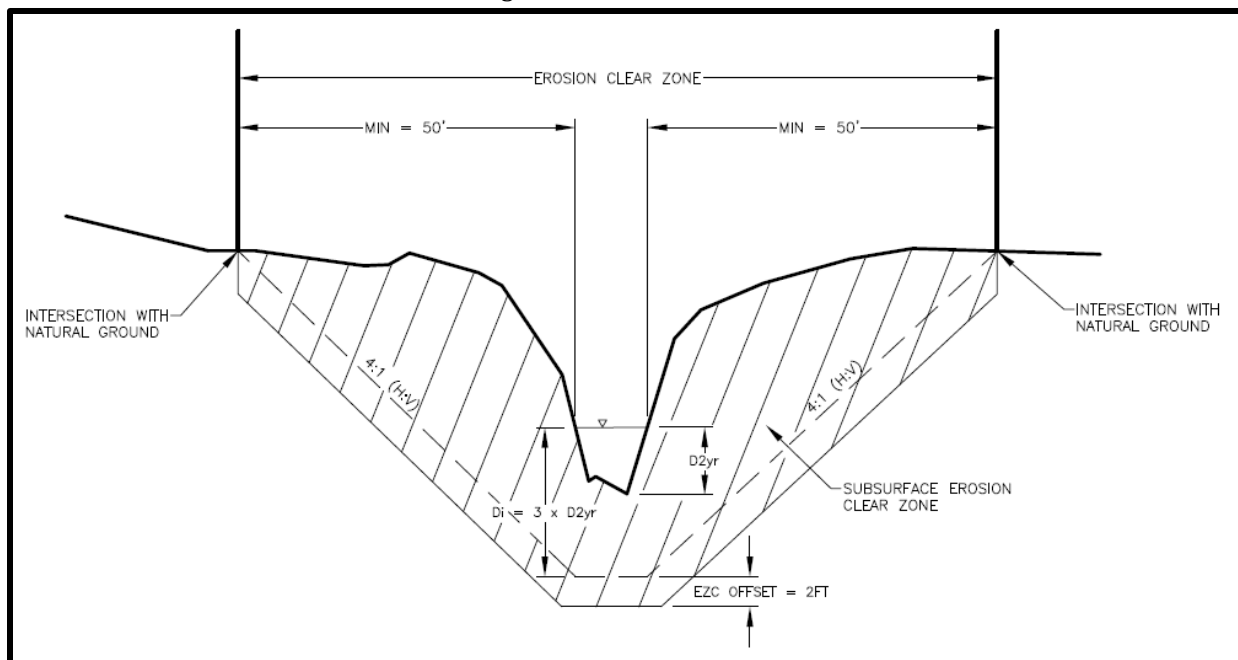
Where natural streams connect to improved closed systems and/or improved channels, permanent transitional materials and energy dissipation are required.

In areas along natural streams where potentially excessive erosion or head cutting may occur or worsen, grade control structures, drop structures, or other structures may be required to stabilize the stream in order to protect structures or infrastructure (especially if existing structures or infrastructure is located within the Erosion Clear Zone).

## C. Erosion Clear Zone

The purpose of the Erosion Clear Zone (ECZ) is to minimize erosion hazards and provide a creek buffer area. The ECZ identifies an area inside of which erosion may potentially result in damage to a resource. Buildings and infrastructure shall be placed outside of the ECZ to ensure that they are not placed in harm's way. The ECZ shall apply to all development activity. No portion of any building, pavement surface, fence, wall, swimming pool, utility or other structure or improvement shall be located or constructed within the ECZ. The ECZ shall be shown, labeled, and described by metes and bounds on the plat or site plan when the ECZ lies outside the drainage easement. Delineation of the ECZ includes both a subsurface and surface representation as shown in Figure 5-1.

Figure 5-1 Erosion Clear Zone



### 1. Surface ECZ Determination

The ECZ is defined by the potential incised bankfull depth ( $D_i$ ). The 2-year fully developed depth ( $D_{2yr}$ ) shall be considered the existing bankfull depth for the purposes of this analysis. The  $D_i$  will be calculated as 3 times the existing bankfull depth ( $D_i = D_{2yr} * 3$ ).

To delineate the elevation and location of the  $D_i$ , measure down from the  $D_{2yr}$  a distance equal to the  $D_i$  and delineate a horizontal line equal to the  $D_{2yr}$  top width.

Beginning at the  $D_i$ , project a line upward and away from the channel at a slope of four horizontal to one vertical (4:1) until it intersects with the natural ground surface. The points at which this line intersects with the natural ground surface on the left and right is the ECZ. The minimum setback from the existing  $D_{2yr}$  shall be 50 feet.

The ECZ may be extended further at stream meanders and bends or when it is determined by the City that the potential for stream erosion exceeds the limits of the ECZ.

### 2. Subsurface ECZ Determination

For projects with subsurface resources and infrastructure, the subsurface limits of the ECZ are determined by vertically offsetting the trapezoidal geometry created using the  $D_i$  and 4:1 slope by two (2) feet. The intent of this offset is to retain an appropriate depth of cover over subsurface resources and infrastructure after erosion has occurred. This offset does not affect the horizontal limits of the ECZ.

### 3. Variances to the ECZ

Where sufficient grade control structures to eliminate future incision exist in the stream reach designated for the project, or where channel incision may have already occurred in response to land use changes, the incision factor can be discounted. For these conditions, a more precise incision factor may be proposed based on geomorphological analysis provided to the City.

The Engineer may also submit a plan to feasibly stabilize and protect the banks of the creek in order to reduce the width of the ECZ. Bank improvements must extend to stable creek sections in accordance with NRCS Stream Stabilization Guidance. Structural design of proposed creek improvements within the ECZ must be adequate to withstand loadings for eroded conditions during the 100-year flood event and not create a public health and safety hazard if exposed.

Stream stabilization and protected features within the ECZ must comply with all other City requirements and shall not create adverse impact by redirecting flow, reducing conveyance, collecting debris, degrading water quality, or damaging ecological health in the riparian zone.

#### D. Constructed/Modified Open Channels

For constructed/modified open channels, a flood study shall be submitted to determine the easement limits and FPEs assuming fully developed watershed conditions.

Where constructed or modified open channels connect to a closed system, natural streams, or a channel of a different material, permanent transitional materials and energy dissipation are required.

Modified channels shall be designed with the following minimum criteria:

- Side Slopes shall be 4:1 for vegetated channels or as specified by manufacturer for other channel materials
- Bottom width shall be at least 6 feet
- Minimum channel slope is 1% for vegetated channels and 0.5% for hard armor channels or pilot channels.
- New channels shall be designed for the 100-year storm fully developed watershed conditions at all locations along the channel.
- Modification or improvement of existing constructed/modified channels shall at a minimum maintain the existing capacity.
- Earthen channels that will be mowed shall be vegetated with Buffalo Grass or an approved alternative. See Section 6.1, Protection and Restoration of Linear Park Land, for recommended plant and vegetation species if channel is to be natural and un-maintained. Soil Retention Blankets will be required on all earthen or grass-lined side slopes and bottoms for slope protection until acceptable vegetation densities are achieved. Soil retention blankets must be appropriately designed for the project's soil, velocity, slope, and length of use and must be from TxDOT's most current approved products list.
- Channels shall be designed with multiple stages (e.g., a "low-flow" or "trickle" channel section for common recurring flows, and a high flow section that contains the design discharge)
- The maximum design velocity for vegetated channels shall be 6-feet per second during the design storm. Higher velocities and/or channel armoring require a sealed geotechnical study for design.
- Each reach of a channel that will require City maintenance must have a ramp for maintenance access. Ramps shall be at least 10-feet wide and have 15%

maximum grade. 12-foot width is required if the ramp is bound by vertical walls. Ramps shall be built in accordance with City Standard Specifications and Details for driveways.

- A fence shall be constructed on each side of the channel. Fences are not allowed to cross public channels.
- New concrete channels are not allowed unless it is required as part of the repair or replacement of an existing concrete channel.
- Armored channels shall generally be trapezoidal in shape and lined with modular block or gabions in accordance with City Standard Specifications and Details.
- The design of the channel armoring shall take into account the superelevation of the water surface around curves and other changes in direction.

#### E. Roadside Ditches

- Ditches shall be set back from the roadway in accordance with the City Standard Detail.
- No median ditches are allowed unless they meet the design requirements of a Stormwater BMP.
- Side Slopes shall be 4:1 for vegetated ditches or as specified by manufacturer for other channel materials.
- Minimum channel slope is 1% for vegetated channels and 0.5% for hard armor channels or pilot channels.
- The maximum design velocity for vegetated ditches shall be 6-feet per second during the design storm. Higher velocities and/or ditch armoring requires a sealed geotechnical study for design.
- Maximum depth will not exceed 5 feet from center-line of pavement.
- If the ditch extends beyond the right-of-way line, an additional drainage easement shall be dedicated extending at least 5 feet beyond the top of the ditch.

#### F. Flumes and Vegetated Swales

- When positive overflow is conveyed between lots, it shall be contained within a concrete flume at least 4 feet wide (face to face) sized to carry the overflow and constructed in a drainage easement. The positive overflow structure must be a concrete flume or other acceptable non earthen structure (such as articulated concrete blocks) extending from the inlet to the storm drainage system outfall.
- Flumes and vegetated swales must be designed with one (1) foot of freeboard from the top of the curb to the adjacent finish floor elevations (minimum finished floor elevations for all lots adjacent to said structures must be shown on the plat).

- Minimum flume slope is 0.5% and the minimum vegetated swale slope is 2%.
- Flumes walls shall be constructed with City approved form liner. Other alternative materials or finishes may be submitted with the construction plans and will be evaluated for acceptance.
- All flumes that pass through sidewalks shall be built per City Detail.
- Where flumes and swales are located in backyards or fenced in areas, fences shall be constructed on each side of the flume or swale and kept behind the curb line of all flumes. Fences shall not obstruct flow within flumes or vegetated swales.

### **5.7.6. Culverts**

#### **A. General Design Criteria**

- Culverts shall be placed at all driveways, intersections, and other locations as appropriate to carry ditch or surface flow safely under roadways and driveways in order to meet conveyance standards for the design storm.
- Concrete sloped end treatments are required when culverts are adjacent and parallel to traffic flow. Erosion protection will be provided at the upstream and downstream ends of the sloped end treatment for all culverts.
- Stabilization and/or energy dissipation shall be provided where allowable channel velocities are exceeded upstream and downstream of the culvert.
- Culverts shall be constructed with Class III reinforced concrete pipe. The pipe size shall be a minimum of 24 inches for roadway crossings and 18 inches for driveway culverts. A higher class of pipe may be required when underground storm drainage systems are constructed at shallow or deep elevations. Refer to the pipe manufacturer specifications for cover requirements.
- The driveway or roadway shall have an invert above the pipe for positive overflow.
- If a culvert is not feasible for a driveway then the driveway shall be constructed with an invert.
- When practical for multiple barrel culverts (3 or more), one of the barrels should be placed at the flowline of the stream with the other barrels at a higher elevation to create a single flow path for lower flows and reduced sediment and debris accumulation.

#### **B. Length and Slope**

- The maximum slope using concrete pipe is 10% before pipe-restraining methods must be taken. The minimum slope is 0.5%.

- Maximum vertical distance from throat of intake to flowline in a drainage structure is 10 feet.
- Drops greater than 4 feet will require additional structural design.

#### C. Headwater Limitations

The allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design storm. The headwater shall not cause damages to upstream property. Culvert headwater shall not exceed the top of curb or pavement in the low point over or around the culvert. The section of roadway over the culvert may not be the lowest point so care should be taken to ensure that headwater does not overtop the roadway around the culvert. In general, the constraint that gives the lowest allowable headwater elevation establishes the criteria for the hydraulic calculations.

The headwater shall be checked for the 100-year storm event elevation to ensure compliance with floodplain management criteria and to ensure it is contained within the right-of-way or easement. The culvert may be required to exceed the 25-year storm in order to satisfy floodplain, channel and street right-of-way criteria.

#### D. Tailwater Considerations

If the culvert outlet is operating with a free outfall, the critical depth and equivalent hydraulic grade line shall be determined.

For culverts that discharge to an open channel, the stage-discharge curve for the channel must be determined.

If an upstream culvert outlet is located near a downstream culvert inlet, the headwater elevation of the downstream culvert will establish the design tailwater depth for the upstream culvert.

If the culvert discharges to a lake, pond, or other major water body, the expected flood pool elevation of the particular water body will establish the culvert tailwater.

#### E. Temporary Flood Storage

If significant storage is anticipated behind a culvert, the design should be checked by routing the design hydrographs through the culvert to determine the discharge and stage behind the culvert.

Comprehensive design discussions and guidance may be found in the Hydraulic Design of Highway Culverts, Chapter 5 - Storage Routing, HDS No. 5, September 1985, Federal Highway Administration, Storage may be taken into consideration only if the storage area

will remain available for the life of the culvert as a result of purchase of right-of-way or an easement.

### **5.7.7. Bridges**

#### **A. General Design Criteria**

Bridges are cross drainage structures with a span of 20 feet or larger. Bridges shall be designed to pass the 25-year storm for fully developed watershed conditions, or the design storm in accordance with TxDOT requirements, whichever is more stringent. Bridges on designated emergency access routes shall be designed to pass the 100-year storm for fully developed watershed conditions. Bridges may be required to exceed the 25-year storm in order to satisfy floodplain, channel, and street right-of-way criteria

For a good overview of bridge design issues see the current Texas Department of Transportation (TxDOT) Hydraulic Design Manual.

#### **B. Hydraulic Design**

A hydrologic and hydraulic analysis is required for designing all new bridges, bridge widening, bridge replacement, and roadway profile modifications that may adversely affect the floodplain, even if no structural modifications are necessary. Typically, this should include the following:

1. Peak discharges for fully developed watershed conditions,
2. Proposed conditions water surface profiles for design flood and other frequency flood impacts.
3. Consideration of the potential for stream stability problems and scour potential.

For final bridge design, a hydraulic analysis will be required, using HEC-RAS, to determine accurate tailwater elevations, velocities, head losses, headwater elevations, profiles and floodplains affected by the proposed structure. This analysis should include the 2-, 25-, and 100-year storm events.

#### **C. Loss Coefficients for Hydraulic Models**

The contraction and expansion of water through the bridge opening creates hydraulic losses. These losses are accounted for through the use of loss coefficients. Contraction ( $K_c$ ) and Expansion ( $K_e$ ) Coefficients shall be used at the bridge location in accordance with current FEMA guidelines.



## **5.8. Floodplain Impacts**

The City regulates all development in flood-prone areas. Flood-prone areas include areas located within the Special Flood Hazard Area (SFHA), flood hazards identified in a City Council adopted watershed study, or reported flood-prone areas located in Zone X. Reported flood-prone areas are subject to the requirements of this manual even if a flood zone has not been identified for the area.

A land disturbance that includes impacts to the SFHA, City identified flood hazard, flood-prone area, or could have impacts on floodplain limits for the associated stream shall require a hydraulic analysis (flood study) to determine drainage easements, minimum finished floors for insurable structures, erosion clear zones, and to evaluate proposed modifications to existing floodplains or floodways.

Depending upon the proposed project, location, and type of stream in the City, the stormwater submittals may include a Flood Study, No Rise Certification, Floodplain Development Permit, FEMA Letter of Concurrence/Approval, USACE Section 10 and Section 404 Permit, and/or a Trinity River Corridor Development Certificate.

### **5.8.1. City Watershed Models and FEMA Effective Models**

The City maintains hydrologic and hydraulic models for several watersheds within the city limits that have been adopted for use by City Council. When available, these models are required to be utilized to establish pre-project or existing conditions and evaluate proposed project impacts to the watershed. When City adopted models are utilized, any submitted models shall be consistent with the base modeling platform. For instance, if the City adopted model is in HEC-RAS Version 4.1, flood studies utilizing the City model will also need to be in HEC-RAS Version 4.1. Proposed or post-project conditions shall be incorporated into the City's watershed models and submitted to the City for review. Truncated models will not be accepted.

The hydrology and hydraulics modeling needed for sites involving land disturbance in floodplain or flood prone areas and/or FEMA Submittals shall conform to the requirements and criteria included in this section and in the Flood Damage Prevention Chapter of the City Code of Ordinances.

All flood-prone areas shall be required to submit a drainage report and flood study to the City and will be subject to the regulations for land disturbing activities within a Regulatory Floodplain. The final approved model and mapping will be incorporated into the adopted City watershed models upon completion of construction and certification of as-built conditions.

### **5.8.2. Flood Study Matrix**

Various hydraulic model analyses are required to satisfy criteria set by the City and FEMA. For FEMA submittals, the hydrology for "existing" watershed conditions will be needed, supplemented by hydrology for "fully developed" conditions for City approval and updates to the City's watershed

models. The Engineer will need to state in the flood study the source of the modeling data being utilized in the submittal. Table 5-8 Flood Study Matrix indicates the types of hydraulic analyses that are required with the flood study submittal. The flood study requirements are designed by the level of mapping for the SFHA. Additional hydraulic analyses may be required depending on the project or action, as determined by the D-PWT.

Table 5-8 Flood Study Matrix

FEMA Flood Zone	City			FEMA			
	Duplicate Effective City model	Corrected Effective City model (Existing or Pre-Project model)	Post-Project & Fully Developed Conditions Model	Duplicate effective FEMA model	Corrected effective FEMA model	Existing Conditions Model	Post-project conditions model
Zone A	x	x	x			x	x
Zone AE	x	x	x	x	x		x
Zone X (unmapped)	x	x	x				

### 5.8.3. Compensatory Storage

Compensatory storage is required for all storage lost or displaced in a Regulatory Floodplain due to land disturbance. Hydraulically equivalent compensatory storage requirements for fill or structures placed in the SFHA and/or within a riverine flood hazard area identified in a City watershed study shall be at least equal to the volume of the storage lost or displaced. Such compensation areas shall be designed to drain freely and openly to the channel and shall be located opposite or adjacent to fill areas. The Regulatory Floodplain storage volume lost below the existing 10-year frequency flood elevation must be replaced below the proposed 10-year frequency flood elevation. The Regulatory Floodplain storage volume lost above the 10-year existing frequency flood elevation must be replaced above the proposed 10-year frequency flood elevation.

### 5.8.4. FEMA Letters of Map Change

The City has the authority to review all Letters of Map Change prior to submittal to FEMA as allowed by the federally adopted standards of 44 Code of Federal Regulations 60 (44 CFR 60).

In order to remove all or portions of a property from the floodplain, or to improve a stream and construct a channel (concrete, earthen or other approved material), the applicant shall submit a Request for a FEMA Letter of Map Change, and a supporting flood study to the City for acceptance.

There are several types of map changes available through FEMA. Refer to the FEMA website for the most current descriptions.

All proposed projects located in the SFHA shall be evaluated for the need of a Conditional Letter of Map Revision (CLOMR). A CLOMR shall be submitted to FEMA in the event that the proposed modifications to the SFHA result in a rise greater than 0.0 feet to the effective base flood elevation. The City reserves the right to require a CLOMR for any proposed project located within the SFHA. Upon completion of construction within the SFHA, all applicants shall verify that the site was constructed according to the proposed conditions and a Letter of Map Revision (LOMR) shall be submitted to the City for review. Upon City acceptance, the applicant shall submit the LOMR with the appropriate review fees to FEMA for approval.

### **5.8.5. Additional Permitting Requirements**

#### **A. Floodplain Development Permit**

A Floodplain Development Permit includes an authorization by the City for any work to be performed within areas of the SFHA as required by the Flood Damage Prevention Chapter of the City Code of Ordinances. Variances will not be issued for proposed projects in the regulatory floodway. Applications for a Floodplain Development permit shall be submitted to the City with the flood study that evaluates existing conditions and proposed project impacts

#### **B. U.S. Army Corps of Engineers Permits**

All federal requirements shall be met prior to site development approval; this includes the USACE Regulatory Permits. The USACE Regulatory Permits Program is authorized to protect the Nation's aquatic resources. The USACE evaluates permit applications for essentially all construction activities that occur in the Nation's waters, including wetlands. Two primary authorities granted to the USACE by Congress fall under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Applicants are required to provide the City with copies of the USACE authorization for a project prior to the issuance of a Floodplain Development Permit.

#### **C. Trinity River Corridor Development Certificate Permits**

The Corridor Development Certificate (CDC) process is a regional permitting program, used to stabilize flood risks along the West Fork Trinity River. The CDC process does not necessarily prohibit floodplain development but ensures that any land disturbance that occurs in the floodplain will not significantly raise flood water levels or reduce valley storage capacity.

The CDC permit is required for any land disturbance activities proposed within the Trinity River floodplain. A technical review of the application is conducted by the USACE. A fee must be paid by the Owner prior to the technical review. The technical requirements for the CDC permit may be obtained from NCTCOG.

For a proposed land disturbance within the CDC jurisdiction, a submittal with hydrologic and hydraulic information, forms, maps, and models must be submitted to the City for review before sending to the USACE, the NCTCOG, and all CDC communities and agencies. After approval of the technical report by the USACE, the City will then issue the CDC permit. Authorization of a CDC Permit is required prior to the issuance of a Floodplain Development Permit.

## **5.9. Stormwater Storage Facilities**

Stormwater storage facilities shall be designed and constructed for any land disturbance when it outfalls to a downstream system with existing flooding affecting public safety, insurable structures, habitable structures or when the downstream capacity is exceeded based upon the current City criteria for hydraulic capacity. Refer to the Hydrology Section. requirements to determine the stormwater runoff requirements.

In lieu of a stormwater storage facility, an Engineer may document that the excess flow will not create adverse impacts as defined in this Chapter.

### **5.9.1. Design Criteria**

- A. For a stormwater storage facility, including detention ponds, retention ponds and amenity ponds, the following general design criteria shall apply.
  - 1. The storage and release rates from a post-construction land use shall be evaluated for the 2-, 25-, and 100-year storm events for the critical duration of the 3-, 6- and 24-hour durations that results in the maximum or near maximum peak flow. The release velocities shall be designed to minimize erosion downstream of the facility. Analysis should consider the existing watershed; the existing watershed plus developed site conditions; and fully developed watershed conditions. Design shall consider all phases of a planned development.
  - 2. Maintenance Agreements shall be filed by separate instrument with Tarrant County for all storage facilities. Maintenance Agreements shall comply with Chapter 2 of this manual and shall include all operation, maintenance, and general costs.
  - 3. TCEQ rules and regulations regarding impoundments shall be followed.
  - 4. In accordance with Texas Water Code §11.142, permanent surface impoundments may be required to obtain a water rights permit from the TCEQ. A completed permit for the proposed use, or written documentation stating that a permit is not required, must be obtained.

5. Above ground facilities are required to meet all state and federal requirements. Facilities that store more than a total depth of 4 feet are subject to additional state and federal criteria for small dams. All storage facilities shall be stabilized against erosion. Grassed side slopes shall be 4:1 or flatter and less than twenty (20) feet in height. Slopes protected with slope pavement shall be no steeper than 2:1. Concrete lined or structural embankments can be steeper with D-PWT approval. Structural plans and a geotechnical analysis will be required for any structural embankments or embankments over 4 feet tall.
  6. An emergency spillway shall be provided at the 100-year maximum storage elevation with sufficient capacity to convey the fully developed 100-year storm assuming blockage of the closed conduit portion outlet works with 6 inches of freeboard. Spillway requirements must also meet all appropriate state and federal criteria. Design calculations shall be provided for all spillways.
  7. Spillways shall not discharge through a conveyance path where an insurable structure is inundated by the base flood or where existing velocities are already erosive. Spillways shall not discharge to a drop inlet.
  8. Storage facilities outlet structures shall be designed to minimize the likeliness of clogging and shall include features to prevent activation of the emergency spillway if such activation would create an uncontrolled discharge. The use of orifice plates or non-standard structures is subject to the approval of D-PWT.
  9. Storage facilities shall be designed with a 10-foot wide access path for maintenance around the entire pond.
- B. For detention ponds the following design criteria shall apply:
1. The release rate of the stormwater storage facility shall not exceed downstream capacity.
  2. When detaining to pre-development conditions, the Engineer shall confirm that any release from the stormwater facility does not exacerbate peak flows in downstream reaches due to the timing of flows.
  3. Calculated proposed stormwater discharge from a site shall not exceed the calculated discharges from existing conditions, unless sufficient downstream capacity above existing discharge conditions is available.
  4. In cases of structural flooding located downstream of the proposed project, the stormwater storage facility must detain the difference between the pre- and post-project flows.
  5. The Modified Rational Method is allowed for planning and conceptual design for watersheds of 20 acres and less.
  6. Final design of storage facilities shall use the NRCS unit hydrograph method.
  7. A calculation summary shall be provided on construction plans. For detailed calculations of unit hydrograph studies, a separate report shall be provided to the City

for review and referenced on the construction plans. Stage-storage-discharge values shall be tabulated and flow calculations for discharge structures shall be shown on the construction plans. Digital hydrologic and hydraulic models shall be included with the submittal of the plans for review.

8. A minimum of 1-foot of freeboard shall be provided for the storage facility.
9. Dry storage facilities must be designed to release their full capacity over at least 24 hours but not more than 48 hours.
10. To receive credit for stormwater quality benefits, storage facilities shall be designed with a forebay and detain the first 1-inch of runoff from the drainage area to be released over at least 24 hours but not more than 48 hours. The forebay must be reasonably maintainable.
11. Dry storage facilities design should consider multiple uses such as recreation.
12. Pilot channels shall be required for dry detention facilities for maintenance purposes if the bottom slope is less than 1% to convey low flows and prevent standing water conditions. As such, pilot channels should follow the edges of the basin to the extent practical. The bottom of the basin shall be graded to drain to the basin low point. Concrete flumes may have slopes as shallow as 0.5% and shall be 4 feet wide.

C. For retention ponds and amenity ponds, the following design criteria shall apply:

1. Engineer must show that daily flows, groundwater, or other water sources are available to maintain a permanent pool with a healthy aquatic community. A water balance shall be submitted with the plan.
2. The pond shall be a minimum of 4 feet deep, have a 10:1 slope for areas that are 1 foot or less deep, and be designed to prevent short-circuiting.
3. Fountains, cascades, other means of aeration shall be provided to prevent the pond from becoming stagnant.

## **5.10. Post Construction Stormwater Quality**

Information provided in this section should be used to help prepare the Stormwater Management Site Plan.

### **5.10.1. Post Construction Stormwater Quality Objectives**

The City has experienced increased stormwater runoff over time due to new development. The increased runoff has had detrimental impacts on the City's streams and rivers, leading to increased flooding potential, stream channel erosion, and reduced stormwater quality. As the remaining open areas of the City are developed and older areas are redeveloped, it is imperative that a properly designed stormwater quality program be implemented to protect the City's natural resources and improve the benefits to human health, fish and wildlife habitat, and recreational opportunities. This

section will establish criteria for the design, operation, and maintenance of the post construction Stormwater Management Site Plan (SWMSP). Construction Stormwater Quality requirements are addressed in the Stormwater Pollution Prevention Plan (SWPPP) section.

Specific objectives of Post Construction Stormwater Controls include:

- A. Protect the integrity of watersheds and preserve the health of water resources;
- B. Minimize changes to the site hydrology for land disturbance and redevelopment to reduce flooding, streambank erosion, and pollution;
- C. Implement beneficial site design practices, such as the preservation of green space and other conservation areas;
- D. Establish provisions for the long-term responsibility for and maintenance of structural and nonstructural stormwater management to ensure that they continue to function as designed, are maintained appropriately, and pose minimum risk to public safety; and
- E. Establish administrative procedures for the submission, review, approval, and disapproval of stormwater best management practices, for the inspection of approved projects, and to assure appropriate long-term maintenance.

## **5.10.2. Stormwater Management Site Plan Requirements**

- A. General Requirements
  - 1. A Stormwater Management Site Plan (SWMSP) shall be prepared for all land disturbance activities of 5,000 SF or more. For land disturbance activities between 5,000 SF and 12,000 SF, the Site Plan can be considered the SWMSP. The grading or drainage plans may also be used as the SWMSP for capital improvement projects.
  - 2. The SWMSP shall identify permanent site features and controls that will be included in the design and constructed with the project to minimize and mitigate the project's long-term effects on stormwater quality and quantity.
  - 3. All new development designs shall evaluate site layout to minimize impervious area and impacts to existing natural resources to promote sustainable development.
  - 4. A Preliminary SWMSP shall be prepared with the preliminary plat.
  - 5. The final SWMSP shall be submitted with the site plan or construction plans. This plan must be accepted by the City prior to any site activity.

6. The SWMSP shall be developed and coordinated with all portions of the plans, but specifically, the grading plan, the drainage plans, and the landscape plan, and shall meet all criteria in the SWMSP Guidance located on the City website. It is the responsibility of the Engineer to design BMPs that address site specific conditions using appropriate design guidance for the North Central Texas region. The source of the design criteria shall be referenced in the SWMSP. It shall be sealed by an Engineer.

**B. Design Criteria**

1. The following minimum number of BMPs shall be provided based on acre(s) of post project impervious area:

Table 5-9 Minimum Number of Permanent BMPs Required

<b>Impervious Area</b>	<b>Minimum Number of Permanent BMPs</b>
<5 acres	1
5 acres < Impervious Area < 20 acres	2
> 20 acres	3

2. Subdivisions with paved alleys in addition to streets shall provide one BMP above the minimum
3. The goal of the BMPs shall be to treat the first flush of runoff from all impervious areas onsite.

### **5.10.3. Stormwater Quality Measures**

**A. Site Layout**

While site layout will not give a specific reduction credit, conscientious site layout will reduce the impervious area, thus reducing the post-construction BMP requirements. When the predevelopment grade is steeper than five horizontal to one vertical (5:1) or the site contains natural creeks or wetlands, the site layout shall be designed to require the least modification to the existing topography and drainage. Factors to be considered are lots oriented and designed to minimize change in grade, drainage systems designed to minimize change in time of concentration, and street layouts designed to minimize extents of pavement.

**B. Potential Pollutants**

Potential pollutants to be treated with post construction BMPs may consist of, but are not limited to the following:



- Total suspended solids
- Increased temperature
- Oil and grease
- Floatables (trash)
- Nutrients (fertilizers)
- Bacteria
- Metals
- Pesticides
- Sediment (soils due to erosion)

#### C. BMP Selection

Examples of factors that shall be considered when evaluating and selecting BMPs area as follows:

- Effect of the development on runoff volumes and rates
- Potential pollutants from the development
- Drainage area to be treated by the BMP
- Effectiveness of the BMP on potential pollutants from the development
- Natural resources on the site (pre and post construction)
- Configuration of site, including changes to existing waterways.

#### D. Allowable Post-Construction BMPs:

The following post-construction BMPs may be used. Refer to the NCTCOG iSWM Technical Manual for Site Development Controls or other acceptable North Texas design criteria for detailed design guidance not contained in this manual.

- Bioretention Pond;
- Rain Garden;
- Enhanced Swale;
- Vegetated swale - maximum grade is 2%;
- Filter Strip - at least 20 ft wide with flow spreaders to ensure sheet flow;
- Dry Detention with Forebay (see Stormwater Storage Facility design guidance);
- Retention Pond (see Stormwater Storage Facility design guidance);
- Permeable pavers - designed with an underdrain system and engineered. Design shall address life expectancy, load bearing capacity, soil condition, and drainage to ensure no standing water;
- Infiltration - discharge of roof drains or impervious area to an infiltration trench, soakage trench or planter box;

- Rainwater Harvesting – holding tank for irrigation. Must show irrigation plan utilizing the holding tank;
- Floatables exclusion system - inlet inserts, trash racks, grates on curb inlets installed on private inlets, and designed to account for clogging. Must demonstrate no adverse impacts as detailed in manual if installed on a public outfall. Credit will not be given for grated surface inlets in parking lots unless installed with an inlet insert;
- Subsurface Treatment Devices - oil/water separators, centrifugal treatment devices, and other commercially available devices that are able to treat the design storm without causing structure flooding;
- Natural Area Preservation – can reduce impervious area and count towards post-construction BMP requirements. This may include preserving, restoring, or creating natural areas and/or riparian areas.

Other post construction BMPs and innovative designs will be considered when submitted with supporting calculations and removal efficiencies in accordance with nationally or regionally recognized design criteria.

#### E. Easement Requirements

Refer to Section 2.2 of this manual.

#### F. Construction and Maintenance

The owner shall construct and maintain all post construction BMPs. Ownership and maintenance responsibility of the BMPs are transferable upon the sale of a property. For subdivisions, maintenance may be performed by an association (including home owners associations), but ownership and maintenance responsibility are transferred to each individual property within the association. The plat or separate instrument dedicating the easement shall include a statement of the owner's responsibility for maintenance; and a Maintenance Agreement shall be filed with detailed information concerning BMP operation, maintenance responsibilities and enforcement actions to be taken if BMPs are not maintained. Standard language for Maintenance Statements and agreements can be obtained from the City.

#### G. Post-Construction BMP Inspection

The City will inspect the installation of Post-Construction BMPs. The Engineer must submit a letter stating that the post-construction BMPs were constructed as designed. This may be incorporated with the as-built letter for private improvements.

Per the maintenance agreement, the Owner may be required to submit an inspection form to the City on an annual basis as detailed in the maintenance agreement. The City may perform periodic inspections for the purpose of confirming the validity of the inspection reports and ensuring that the BMPs are still functioning as designed. The City may require repair or removal and replacement based on its inspection.

#### **5.10.4. Stormwater BMP Construction Sequencing**

Proper construction sequencing can reduce the risk of clogging by excessive accumulation of fine particles in the soil media layers. Engineer shall specify proper construction sequencing to minimize potential disturbance to stormwater BMP structures. During construction, the extent of disturbed, exposed soils should be limited to reduce the risk of erosion by specifying the timing and extent of permanent vegetation establishment. Imported soil media should not be incorporated into stormwater BMPs until the drainage area has been stabilized. Soil media should not be installed until at least the first course of pavement has been set for roads and parking lots, which minimizes the amount of fines washed from the bedding layers into the stormwater BMPs. A geotextile liner might not be sufficient to prevent fines from migrating into and clogging the soil media layer; for that reason, proper construction sequencing is crucial.

### **5.11. Stormwater Pollution Prevention Plan – Temporary Controls for Construction**

#### **5.11.1. Applicable Regulations and Ordinances**

Construction activities shall comply with the SWPPP requirements in the effective TPDES General Permit relating to Storm Water Discharges from Construction Activities, of the Storm Water Pollution Control Ordinance and the appropriate federal (Environmental Protection Agency) and state (Texas Commission on Environmental Quality) regulations. When the ordinance and applicable regulations are in conflict, the most stringent requirements shall apply.

#### **5.11.2. General Requirements**

SWPPP guidance and templates can be found on the City website. Projects that disturb less than 1 acre shall use the SWPPP Template. Projects that disturb more than 1 acre shall comply with the applicable SWPPP guidelines. Residential projects that disturb less than 12,000 SF and are not part of a larger plan of development are exempt from these requirements.

The SWPPP for projects that disturb more than five acres shall be sealed by an Engineer and submitted to the City with the construction plans for review and acceptance.

### **5.11.3. Best Management Practices (BMPs) During Construction**

Structural BMPs shall comply with the City Standard Specifications and Details, this manual, and the latest edition of the NCTCOG BMP Manual titled “Storm Water Quality Best Management Practices for Construction Activities”. When the NCTCOG Manual, City Standard Details, or this manual are in conflict, City Standard Details and then this manual shall govern.

The SWPPP shall provide a series of changing BMPs that are appropriate for each phase of construction. The SWPPP shall also identify which owner/operator is responsible for installing, inspecting, and maintaining each BMP during the different phases of construction. All temporary BMPs must be removed after final stabilization is achieved.

The following items are acceptable temporary BMPs for use during construction:

- A. Preservation of existing vegetation: This is a preferred BMP. When areas of existing vegetation are to be preserved, the areas shall be delineated on the plans, and the plans shall include notes stating that temporary chain-link fencing shall be installed to protect the vegetation.
- B. Vegetated buffer strips: Buffer strips may consist of preserved or planted vegetation. The strip shall be at least 15 feet wide, identified on the SWPPP, and flagged or otherwise designated in the field to prevent disturbance. Wider strips shall be specified when the slope is steeper than ten horizontal to one vertical (10:1). If existing vegetation is used, it may be removed at the end of the project for establishment of permanent landscaping. The following design criteria shall be met when using vegetated buffer strips:
  - 1. The drainage area shall not exceed 0.25 acres per 100 feet length of vegetation.
  - 2. The maximum distance of flow to the vegetated buffer shall be 100 feet or less.
  - 3. The side slope shall not be steeper than five horizontal to one vertical (5:1).
- C. Soil retention blankets: Soil retention blankets shall be anchored per the manufacturer’s recommendations. On lots with slopes of three horizontal to one vertical (3:1) or flatter, the blanketed area shall be at least eight feet wide. Greater widths and additional BMPs shall be specified on steeper slopes. The blankets shall be seeded if used for temporary stabilization. Information about proper soil retention blankets to be used, refer to City Standard Specifications or TxDOT requirements for Type E-H blankets, as appropriate.
- D. Silt fence: Silt fences shall have wire mesh backing and be supported by metal posts. When used as a perimeter control, they shall only be placed down-slope from the construction activity, with the ends turned up-slope, perpendicular to the contours, to form a sediment trap. Silt fences may be used for concentrated flows up to a maximum design flow rate of one cfs. The following design criteria shall be met when using silt fence:

1. The drainage area shall not exceed 0.25 acres per 100 feet of fence length.
  2. For slopes between fifty horizontal to 1 vertical (50:1) and three horizontal to one vertical (3:1), the maximum distance of flow to the silt fence shall be 100 feet or less.
  3. For slopes of three horizontal to one vertical (3:1), and steeper, the maximum distance of flow to the silt fence shall be 20 feet.
  4. The maximum up-slope grade perpendicular to the fence line shall not exceed one horizontal to one vertical (1:1).
- E. Inlet protection: Inlet protection is the least desirable BMP. It will only be accepted for use on private or public streets when no other BMP is viable. Curb and Area Inlet protection shall be installed per City Standard Details. If other measures of protecting the inlet are requested, the Engineer shall evaluate them for possible flooding in low areas and flow diversion on steep slopes and submit a written request to the City requesting the alternative inlet protection. Inlet protection must be configured to pass the inlet's design flows without causing flooding.
- F. Temporary detention structure: If 10 or more disturbed acres drain to a common drainage point, a temporary or permanent sedimentation basin shall be used. Storage volume may be calculated as the volume of runoff from a 2-year, 24-hour storm from each disturbed acre drained. When calculating the volume of runoff from a 2-year, 24-hour storm event, it is not required to include the flows from offsite areas and flow from onsite areas that are either undisturbed or have already undergone permanent stabilization, if these flows are diverted around both the disturbed areas of the site and the sediment basin. Capacity calculations shall be included in the SWPPP. A sedimentation basin providing at least 3,600 cubic feet of storage per acre drained until final stabilization of the site may be used in lieu of calculating the runoff volume. This practice is advisable on smaller drainage areas where practical. If sedimentation basin is to be used as a permanent BMP after construction is complete, provisions must be made to remove excess material from the basin prior to the completion of construction.
- G. Rock check dams: Rock check dams shall be installed per City Standard Details. They are appropriate for areas of concentrated flow such as swales and ditches and at the outfall for a subdivision. Rock shall be contained within wire mesh or shall follow the design guidelines for rock riprap in this Chapter. Check dams shall be placed at a spacing that sets the top elevation of a dam at the toe elevation of the next upstream dam, with the top of the furthest upstream dam set at the invert of the last stabilized portion of the swale or ditch. When check dams are used as an outfall control, the first check dam shall be at least 10 feet from the outfall, but no further than 50 feet from the outfall.
- H. Earthen berms: Earthen berms may be used as a perimeter control to divert runoff from adjacent sites away from the development or to retain runoff within the development.

Earthen berms shall be stabilized within 14 days of their construction. The Engineer shall analyze the impact of these diversion berms on adjacent sites.

- I. Fibrous mulch: Fibrous mulch may be used as an erosion control to limit the runoff from disturbed areas within the development. Mulch shall be at least three inches thick and cover all disturbed areas. When used on slopes of three horizontal to one vertical (3:1), or steeper and in critical areas such as waterways, mulch matting must be anchored with soil retention blankets to hold it in place.
- J. Hydromulch: Hydromulch stabilization may be used as an alternative to seeding for erosion control when all disturbed area is covered by the hydromulch. A strip of hydromulch is not acceptable unless additional structural controls are provided.
- K. Stabilized construction entrance: All construction entrances shall be installed in per City Standard Details. Entrances shall be placed at high points or other areas where runoff from the construction site will not be directed to the entrance. The construction entrance shall not extend into the street or block flow in the gutter.
- L. Other BMPs: It is the responsibility of the Engineer to design appropriate BMPs for each site. If the most appropriate BMP is not in the City Standard Specifications and Details or the NCTCOG BMP Manual, the Engineer shall submit calculations and references for design of the BMP to the City.

#### **5.11.4. Waste and Hazardous Material Controls**

Covered containers shall be provided for construction waste materials and daily trash. Hazardous materials shall be stored in a manner that prevents contact with rainfall and runoff. Onsite fuel tanks and other containers of motor vehicle fluids shall be placed in a bermed area with a liquid-tight liner or be provided with other secondary containment and spill prevention controls.

The SWPPP shall require federal, state, and local reporting of any spills and releases of hazardous materials greater than the regulated Reportable Quantity (RQ) and reporting to the City Storm Water Management Division, Environmental Compliance Section of all spills and releases to the storm drainage system.

#### **5.11.5. Temporary Stabilization**

Portions of a site that have been disturbed but where no work will occur for more than 21 days shall be temporarily stabilized as soon as possible, and no later than 14 days, except when precluded by seasonal arid conditions or prolonged drought.

Temporary stabilization shall consist of providing a protective cover, without large bare areas, that is designed to reduce erosion on disturbed areas. Temporary stabilization may be achieved using the following BMPs: temporary seeding, soil retention blankets, fibrous mulches, hydro-mulches, and other techniques that cover 100 percent of the disturbed areas until either final stabilization can be achieved or until further construction activities take place.

Perimeter BMPs such as silt fence, vegetated buffer strips or other similar perimeter controls are intended to act as controls when stabilization has not occurred. Perimeter BMPs may remain in place during temporary stabilization, however, they are not acceptable as temporary stabilization.

#### **5.11.6. Final Stabilization**

Final stabilization consists of soil cover such as vegetation, geotextiles, mulch, rock, chemical modification of the soil, or placement of pavement. For vegetative stabilization, perennial vegetation must cover all disturbed areas without large bare areas and with a density of 70 percent of the native background vegetative cover. Vegetated buffer strips are not allowed unless designed and credited as a permanent BMP. All non-vegetative stabilization must cover 100 percent of the disturbed area.

For stabilizing vegetated drainage ways, sod or seeded soil retention blankets shall be used. Hydromulch will not be allowed in vegetated swales, channels, or other drainage ways. BMPs may remain in place during stabilization, however, BMPs shall be removed after stabilization is achieved.

The plan for final stabilization shall be coordinated with the permanent BMPs in the SWMSP and with the landscaping plan, if applicable.

#### **5.11.7. Notice of Intent (NOI)**

On projects 5 acres in size or larger, the primary operator(s), including each builder in a residential subdivision, shall submit a copy of the NOI to the City and TCEQ at least 2 days prior to construction.

#### **5.11.8. TCEQ Site Notice**

All primary and secondary operators shall complete the Construction Site Notice provided in the TCEQ Construction General Permit and submit a copy to the City at least two days prior to commencement of construction activities. A signed copy of each Construction Site Notice must be posted at the construction site in a location where it is readily viewed by the general public during all construction activity.

#### **5.11.9. Notice of Termination (NOT)**

All parties that submitted a NOI shall submit a NOT to the City and TCEQ within 30 days after final stabilization is established. When the owner of a residential subdivision transfers ownership of

individual lots to builders before final stabilization is achieved, the SWPPP shall include controls for each individual lot in lieu of final stabilization. These controls shall consist of stabilization of the right-of-way and placement of structural BMPs at the low point of each individual lot or equivalent measures to retain soil on each lot during construction. Additionally, for residential construction within subdivisions, the builder must submit a valid NOI before a NOT can be submitted by the owner.

#### **5.11.10. Inspection and Maintenance during Construction**

The owner shall construct all BMPs and other controls required by the SWPPP. The owner shall have qualified personnel inspect the BMPs in accordance with the TCEQ Construction General Permit and applicable City ordinances. BMPs shall also be cleaned to maintain adequate capacity.

If a discharge of soil or other pollutant occurs, the BMPs shall be evaluated. Changes or additions shall be made to the BMPs within 7 days to prevent future discharges. In addition, the owner shall implement procedures to remove discharged soil from all portions of the Municipal Separate Storm Sewer System (MS4) that received the discharge, including streets, gutters, inlets, storm drains, channels, creeks, and ponds.

Notes requiring the inspection and maintenance shall be placed on SWPPP drawings. The SWPPP shall identify the responsible party for inspecting and maintaining each BMP. If no party is identified, each owner and operator that submitted a NOI for the site shall be fully responsible for implementing all requirements of the SWPPP.

City Inspectors will not allow construction of public improvements to start, nor will they grant final acceptance of public improvements, until the SWPPP is implemented and maintained.

### **5.12. Stormwater Permit Required for Industrial Operations**

The SWMSP shall identify if the planned facility operations, after completion of construction, will be classified by a Standard Industrial Classification (SIC) code that requires an industrial stormwater permit. If the operations will require a permit, the drainage design shall provide for point discharges from the property and access to the discharge points for required stormwater sampling. Stormwater controls shall be included for outside storage areas.

### **5.13. Maintenance of Drainage Facilities**

#### **5.13.1. City Maintenance**

The City will provide for perpetual maintenance, in accordance with City maintenance standards, for all improved public drainage facilities, located within dedicated public easements and constructed in accordance with City Standards.



### **5.13.2. Private Maintenance**

The City will not accept maintenance responsibility for stormwater infrastructure in private drainage easements or for private stormwater infrastructure and BMPs located in public easements.

### **5.13.3. Access**

Access shall be provided to all private and public stormwater facilities to facilitate inspection and maintenance activities.

## CHAPTER 6 - PARKS

Parks, recreation facilities, and open spaces provide a multitude of benefits to both people and the natural environment. Parks include small neighborhood parks, trails, greenways, riparian areas, planned urban parks, and outdoor recreational areas. Proper design and planning are important in ensuring that these spaces are well preserved, constructed, and maintained.

This chapter of the Design Criteria Manual is intended to provide criteria for the design of Linear Parks within the City of Arlington (City). This chapter provides the detailed requirements whereby a site can be designed to conform to the standards of for the UDC and the Linear Park Ordinance.

### 6.1. Protection and Restoration of Linear Park Land

Unstable and disturbed areas shall be secured during the development process through installation of erosion control Best Management Practices (BMPs) as outlined in Stormwater Chapter of this manual.

All areas dedicated as linear park land shall be protected during development of adjacent properties. Protecting linear park land means leaving streams in their natural state whenever possible. This includes:

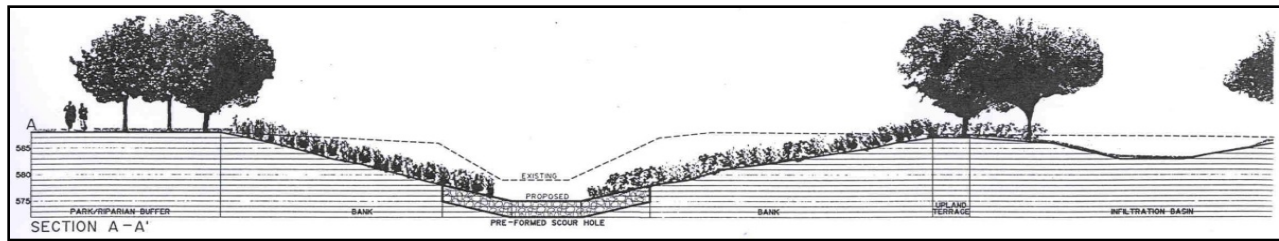
- Not removing or scraping sandbars;
- Whenever possible, limiting use of heavy equipment in sensitive riparian, stream bottom and wetland areas – ideally not entering or mowing or trimming during sensitive times such as breeding, migratory, or nesting seasons (Mid-March to end of June);
- Having a policy of rotational cutting of woody vegetation that avoids leaving long bare reaches along the stream corridor;
- Mowing or cutting back should not occur on both stream banks at the same time;
- An un-mowed strip should be left along both banks of the stream that can serve both as wildlife cover and as a filter zone to help absorb fertilizers and other potential run-off contaminants;
- Only vegetation that absolutely needs to be cut to maintain flood flows should be cut and replanted with flood-compatible indigenous species.

Refer to Figure 6-1 for a typical stream cross section.

### 6.2. Recommended Stream Restoration Plant Species

Restoration of streams and riparian corridors requires specific plant species be utilized. Stream restoration requirements for disturbed native vegetation are listed in the Linear Park Ordinance.

Figure 6-1 Typical Stream Cross Section



Riparian Buffer      Stream Bank      Stream Bed      Stream Bank      Buffer/Detention

### 6.2.1. Woody Plants

#### Canopy Trees

Chinquapin Oak  
Bald Cypress  
Bur Oak  
Red Oak  
American Elm  
Cedar Elm

#### Scientific Name

*Quercus muehlenbergii*  
*Taxodium distichum*  
*Quercus macrocarpa*  
*Quercus sumardii*  
*Ulmus americana*  
*Ulmus crassifolia*

#### Understory Trees

Creek Plum  
Possumhaw  
Yaupon Holly  
Prairie Flameleaf Sumac  
Carolina Buckhorn  
Texas Redbud

#### Scientific Name

*Prunus rivularis*  
*Ilex decidua*  
*Ilex vomitoria*  
*Rhus landeolata*  
*Rhamnus caroliniana*  
*Cercis canadensis*

### 6.2.2. Live Herbaceous Vegetation

#### In Stream Wetland Plants

Smartweed  
Umbrella Sedge  
Bulrush  
Silver Plumegrass  
Prairie Cordgrass  
Bottlebrush Sedge  
Inland Sea Oats  
Sedge  
Canada Wild Rye  
Virginia Wild Rye

#### Scientific Name

*Polygonum spp.*  
*Fuirena simplex*  
*Scirpus validus*  
*Erianthus alopecuroides*  
*Spartina pectinata*  
*Carex comosa*  
*Chasmanthium latifolium (Shade tolerant)*  
*Carex spp. (Shade tolerant)*  
*Elymus canadensis (Shade tolerant)*  
*Elymus virginicus (Shade tolerant)*

**Moist Swale/Point Bar Plants**

Bushy Bluestem

Lowland Switchgrass

Eastern Gamagrass

Lindheimer's Muhly

**Scientific Name***Andropogon glomeratus**Panicum virgatum**Tripsacum dactyloides**Muhlenbergia lindheimeri***Detention Pond Wetland Plants**

Bushy Bluestem

Sedge

Bulrush

**Scientific Name***Andropogon glomeratus**Carex spp.**Scirpus validus***6.2.3. Seeded Vegetation****Riparian Seed Mixture**

Buffalo Grass

Goldenwave Coreopsis

Little Bluestem

Cutleaf Daisy

Sideoats Grama

Green Sprangletop

**Scientific Name***Buchloe dactyloides**Coreopsis lanceolata**Schizachyrium scoparium**Engelmannia pinnatifida**Bouteloua curtipendula, gracilis**Leptochloa dubia***Streambank Seed Mixture**

Canada Wildrye

Virginia Wildrye

Inland Sea Oats

**Scientific Name***Elymus canadensis**Elymus virginicus**Chasmanthium latifolium***Streambed Seed Mixture**

Heath Aster

Carolina Canarygrass

Switchgrass

Eastern Gamagrass

Bushy Bluestem

**Scientific Name***Aster ericoides**Phalaris caroliniana**Panicum virgatum**Tripsacum dactyloides**Andropogon glomeratus***6.2.4. Bio-technical stabilization with Live Woody Plant Stakes****Streambed Stabilization**

Black Willow

Cottonwood (cottonless)

**Scientific Name***Salix nigra**Populus deltoids*

### 6.2.5. Joint Plantings for Articulated Concrete Block

#### Streambed Stabilization

Mexican Feathergrass

#### Scientific Name

*Stipa tenuissima*

## 6.3. Trail Corridor Vegetation Management

The off-street trail corridors should be allowed to remain in a natural state, as much as possible, with minimal disturbance. Any added landscape improvements must allow growth and maintenance that would be compatible with the existing natural landscape setting. Any development that may affect trail corridors through city parks should be reviewed by Park Planning staff for design consistency. Additional improvements and facilities such as trail heads, picnic tables, benches and additional focal points may be added as necessary with approval from the City. Linear parks should feature vegetation that is low maintenance, drought tolerant with native or well-adapted plant species. This might be achieved over time using native grasses, wildflowers, selective weed removal, and, articulated mowing. Articulated mowing means shaping a natural landscape by grooming the trail shoulders and selectively creating mowed meadows and sweeps along the corridor.

Noxious and undesirable weeds should be identified and removed, ideally by cutting rather than chemical application. It is also important to manage vegetation for user security, maintain good lines of sight, user surveillance, and escape routes. Avoid blind thickets close to the trail where a person could hide. These areas may pose, or appear to pose, a threat to users.

It is encouraged to look for opportunities for the introduction of wildflower areas within the natural setting. The City supports the Monarch butterfly initiative. The City's efforts to create an inviting environment for Monarchs includes sowing native milkweed seed in wildflower areas and no mow areas at public parks. The City has also added milkweed to the approved plant list for medians, right-of-way, and landscaping for both public/private buildings as well as collaborated with the University of Texas at Arlington (UTA) to grow milkweed at the Community Garden on campus.

Please review the approved plant materials listing located on the Parks and Recreation website.

## 6.4. Median and Right-of-Way Landscaping

### 6.4.1. Tree Types

The goal of the median and right-of-way landscaping policy is to have stately native trees that line the thoroughfares throughout the City. Trees that provide canopy cover, seasonal color, and food for wildlife were selected based on the species natural range and drought tolerance. To ensure an aesthetically pleasing mix, canopy trees were paired with ornamental trees. Due to this fact, combinations of canopy and ornamental species have been selected to ensure one combination of

trees per median. The following list displays the list of the different type of species that can be used in any combination.

**Canopy Trees**

Bur Oak	<i>Quercus macrocarpa</i>
Chinquapin Oak	<i>Quercus muehlenbergii</i>
Live Oak	<i>Quercus virginiana</i>
Cedar Elm	<i>Ulmus crassifolia</i>
Texas Ash	<i>Fraxinus texensis</i>
Bald Cypress	<i>Taxodium distichum var. distichum</i>
Afghan Pine	<i>Pinus Eldarica</i>
Lacey Oak	<i>Quercus glaucoides</i>

**Scientific Name**

**Ornamental Trees**

Vitex	<i>Vitex angus-castus</i>
Desert Willow	<i>Chilopsis linearis</i>
Chitalpa	<i>Chitalpa tashkentensis</i>
Savannah Holly	<i>Ilex x attenuata</i>
Eve's Necklace	<i>Sophora affinis</i>
Flameleaf Sumac	<i>Rhus lanceolata</i>
Wax Myrtle	<i>Myrica cerifera</i>
Redbud	<i>Cersis texensis</i>
Mexican Buckeye	<i>Ungnadia speciosa</i>

**Scientific Name**

## 6.5. Construction/Design Specifications

A Landscape Architect, currently active and licensed in the State of Texas, shall seal all landscape plans. No land disturbing activity is allowed within any public right-of-way or easements, unless approved by the City.

When the Owner shall raise, lower, or alter the level or existing grade of a site by fill or excavation, they shall, at their expense:

- A. Cut and fill slopes shall be no steeper than is safe for the intended use. Slopes greater than three feet in height shall be no steeper than four foot horizontal to one foot vertical (4:1), except where approved retaining walls or other stabilization methods are engineered and installed.
- B. Protect all adjoining property from encroachment or collapse either by the erection of an engineered retaining wall or by sloping the sides of such fill or excavation entirely within the confines of the site; and

- C. Cuts and fills shall not compromise the intent or use of existing drainage and utility easements or landscaping as originally designed and approved by the City.
- D. Demonstrate that the area is limited by design to the area of construction and the site is left in its natural state otherwise during construction.
- E. Demonstrate that the project will result in preservation of all trees in project areas unless otherwise authorized by the City.
- F. Demonstrate reasonable preservation of trees and understory and that the following criteria is demonstrated in selection of trees to be preserved or removed:
  - 1. Proximity of the trees' critical root zone or drip line to proposed grading activity.
  - 2. Permanent tree protection methods are employed to protect the preserved tree from damage where the trees' critical root zone may be impacted.
  - 3. Other measures have been employed, including site design that improves the chances for tree survival.
  - 4. Temporary tree protection methods are adequately employed.
  - 5. Construction methods for utility service to the site are used that allow protection and preservation of trees, such as, boring under the critical root zone, tree walls, or tree wells.
  - 6. Utility trenching activities are indicated on the plan.
  - 7. Must receive approval in writing from the City Forester prior to starting construction.
- G. Temporary Stabilization must be in accordance with Section 5.11.5 of the Stormwater Chapter.

## **6.6. Tree Spacing and Distribution**

All tree combinations, except for Live Oak, Bur Oak and Shumard Oak, should be distributed with canopy trees 30 feet on center and ornamental trees 20 feet on center from a canopy tree. Due to the size of the Live Oak, Bur and Shumard Oak, spacing should be 40 feet on center for the canopy trees with the ornamental trees spacing 30 feet on center from a canopy tree.

Tree trunks shall be placed a minimum of three to four feet from streetlight conduit, and tree shall be placed 50 feet from streetlights. There must be at least five feet from the tree trunk to the back of curb for the median to sustain tree planting. No trees capable of growing over 20 feet in height will be planted under powerlines or cables. Canopy trees must be placed at least 20 feet from overhead lines.

All trees near intersections must be at least 50 feet from the median nose cone, except in cases where a monument or other structure has been installed. In cases where speed limits are 40 to 54 MPH, trees shall

be 150 feet from median nose cones due to visibility concerns. For roadways where speed limits are 55 MPH or more, trees shall be 250 feet from median nose cones for safety and visibility.

For medians that will be narrowed in future, trees shall be placed such that they will not be disturbed during construction (where practical).

### **6.6.1. Tree Height and Size**

Container grown three-inch caliper trees are required. Balled and burlaped trees are not permitted. No additional soil shall be placed over the root ball, and the first root shall be visible after planting. All canopy trees to be planted on medians shall be a minimum of 10 feet tall.

Additional plants, other than trees, shall be in nursery plant containers with the minimum size noted on the plans. The container dimensions shall be as recommended by the American Standard for Nursery Stock (current edition) published by the American Association of Nurserymen.

### **6.6.2. Irrigation**

All irrigation plans should be sealed by a professional irrigator, currently active and licensed in the State of Texas.

An underground automatic irrigation system approved by the City shall be provided to maintain all landscaped areas. All trees shall be zoned independently of other plantings and shall have two bubblers per tree.

Any irrigation to be installed in the median must be solar powered. No electricity will be provided to power the controller.



# CHAPTER 7 - DEFINITIONS AND ABBREVIATIONS

## 7.1. Definitions

For the purposes of this manual, certain words, terms, and abbreviations shall be defined as follows:

**Acceptance:**

- **Initial:** The acceptance of the public improvements for a development subject to the maintenance bond period during which the City is not responsible for maintenance. For private improvements, initial acceptance shall mean that the infrastructure is complete.
- **Final:** The acceptance of the public improvements for maintenance by the City upon expiration of the maintenance bond.

**Applicant:** Any person, firm or governmental agency who owns property or the duly appointed representative that wishes to develop that property and one who executes the necessary forms to procure a permit to carry out such land disturbance from the City.

**Architect:** A person who is currently licensed by the Texas Board of Architectural Examiners to engage in the practice of architecture in the State of Texas

**Arterial:** Any existing or future roadway classified as a major or minor arterial in the Thoroughfare Development Plan. For purposes of this manual, a freeway frontage road shall be classified as an arterial roadway.

**As-built drawings:** See record drawings.

**Auxiliary Lane:** A separate right turn lane, left turn lane, deceleration lane or acceleration lane.

**Base flood:** The flood having a one percent probability of being equaled or exceeded in any given year. The base flood is also known as the 100-year frequency flood event.

**Base flood elevation (BFE):** The elevation delineating the level of flooding resulting from the one percent chance (100-year flood) frequency storm event.

**Basin:** Sub-watershed areas of the City of Arlington.

**Basin plan:** A study and evaluation of an individual drainage basin's stormwater management, flood control, and restoration / mitigation needs.

**Best Management Practices (BMP):** A physical, chemical, structural, or managerial practice or device that prevents, reduces, or treats pollution of stormwater; prevents or reduces soil erosion; and/or reduces or minimizes stormwater runoff. A BMP may be temporary to protect water during construction or permanent to protect water from the long-term effects of development.

**Building:** A structure that is principally above ground and is enclosed by walls and a roof. The term includes a gas or liquid storage tank, a manufactured home, mobile home, or a prefabricated building. This term also includes recreational vehicles and travel trailers to be installed on a site for more than 180 days.

**Buffer:** An area of predominantly vegetated land to be left open, adjacent to drainageways, wetlands, lakes, ponds, or other surface waters for the purpose of eliminating or minimizing adverse impacts to such areas.

**By-pass:** To route tributary drainage area runoff around and not through a stormwater control structure.

**City:** The City of Arlington, Texas, a municipal corporation, authorized and chartered under the Texas State Statutes, acting by and through its governing body or its City Manager or his/her duly authorized representatives.

**Channel:** Any river, stream, creek, brook, branch, natural or artificial depression, ponded area, lake, flowage, slough, ditch, conduit, culvert, gully, ravine, swale, wash, or natural or man-made drainageway, in or into which surface or groundwater flows, either perennially or intermittently.

**Channel modification:** Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, rip-rapping or other armoring, widening, deepening, straightening, relocating, and lining and significant removal of bottom or woody vegetation of the channel. Channel modification does not include the clearing of dead or dying vegetation, debris, or trash from the channel.

**City Manager or designee:** The Administrator and the designee shall be a person designated by the City Manager for the purpose of permitting land disturbance and administering and enforcing all of the provisions of this Ordinance.

**Compensatory storage:** An excavated, hydraulically equivalent volume of storage used to offset the loss of natural flood storage capacity when artificial fill or structures are placed within a Regulatory Floodplain.

**Conditional Letter of Map Revision (CLOMR):** A letter which indicated that the Federal Emergency Management Agency will revise base flood elevations, flood insurance rate zones, flood boundaries or Regulatory Floodway and/or BFE as shown on an effective Flood Hazard Boundary Map or Flood Insurance Rate Map, once the as-built plans are submitted and approved.

**Continuous Deceleration Lane:** A deceleration lane that serves two or more driveways, public streets, or combination thereof.

**Control structure:** A structure designed to control the rate of flow that passes through the structure, given a specific upstream and downstream water surface elevation.

**Controls:** Measures to prevent erosion, sedimentation, and water material from entering the stormwater system.

**Critical facility:** A facility that is critical to the community's public health and safety, is essential to the orderly functioning of a community, store or produce highly volatile, toxic, or water-reactive materials, or house occupants that may be insufficiently mobile to avoid loss of life or injury. Examples of critical facilities include jails, hospitals, schools, fire stations, nursing homes, wastewater treatment facilities, water plants, and gas/oil/propane storage facilities.

**Dam:** All obstructions, wall embankments or barriers, together with their abutments and appurtenant works, if any, constructed for the purpose of storing or diverting water or creating a pool. Underground water storage tanks are not included.

**Damage:** A measurable rise in flood heights on property currently subject to flooding, flooding of property currently not subject to flooding unless it is contained within the streambanks or a deed or plat restricted area or increases in velocity to the point where the rate of land lost to erosion and scour is significantly increased.

**Deceleration Lane:** A lane, including tapered areas, in advance of a driveway or public street used to allow turning vehicles to exit the through traffic lane and slow before making the turn.

**Design storm:** A selected storm event, described in terms of the probability of occurring once within a given number of years, for which stormwater or flood control improvements are designed and built.

**Detention facility:** A man made structure for the temporary storage of stormwater runoff with controlled release during or immediately following a storm.

**Detention:** The practice of storing stormwater runoff by collection as a temporary pool of water and providing for its gradual (attenuated) release, thereby controlling peak discharge rates and allowing for sedimentation of pollutants. Also referred to as Stormwater Storage Facility.

**Developed multi-residential and nonresidential property:** Developed property which does not serve the primary purpose of providing permanent dwelling units for single-family detached units and duplexes, regardless of the zoning district in which such property is located. Such property shall include but not be limited to triplexes, apartment buildings and complexes, condominiums, boardinghouses, commercial properties, industrial properties, parking lots, recreational, institutional and governmental facilities, hotels, offices, schools and other educational facilities, theaters and other facilities for performances, and churches and other religious institutions.

**Developed property:** Real property which has been altered from its natural state by the addition and attachment of any improvements such as buildings, structures, or other impervious area. For new construction, property shall be considered developed property upon final approval of site improvements by the city.

**Developed residential property:** Developed property which serves the primary purpose of providing a permanent dwelling unit or units, regardless of the zoning district in which such property is located, for single-family detached units and duplexes, and which may or may not have accessory uses related to the purpose of providing permanent dwelling facilities.

**Development:** The submission of a plat or a plan to develop a property, or construction of any structure, or any activity that requires a building permit. Development will also include any land disturbance, including, but not limited to:

- Construction, reconstruction, repair, or placement of a building or any addition to a building;
- Installation of a manufactured home on a site, preparation of a site for a manufactured home, or the placement of a recreational vehicle on a site for more than 180 days;
- Any land disturbance, including but not limited to the following: mining, dredging, filling, grading, paving, excavation, installation of utilities, drilling operations, construction of roads, bridges or similar projects, storage of equipment or materials, or other alternations of the ground surface.
- Clearing of land as an adjunct of construction;
- Construction or erection of levees, walls, fences, dams, or culverts; channel modification.
- Any other activity that might change the direction, height, volume or velocity of flood or surface water, including the drainage of wetlands and removal of vegetation to the extent such that the wetland would no longer meet the criteria of supporting hydrophytic vegetation except that which would be considered appropriate for management purposes.

Development does not include maintenance of existing buildings and facilities such as resurfacing of roadways when the road elevation is not increased, or gardening, plowing, and similar agriculture practices that do not involve filling, grading, or construction of levees. Nor does development include agriculture practices outside of the Regulatory Floodplain involving filling or grading as part of a Natural Resources Conservation Service designed and approved conservation project (i.e., terraces, grass waterways).

**Director:** The director of the department for which the text is applicable, or their authorized representative.

**Disturbed Area:** An area where the land surface has been cleared, grubbed, compacted, or otherwise modified to alter stormwater runoff, volumes, rates, flow direction, or inundation duration.

**Drainage area:** The land area above a given point that contributes stormwater to that point.

**Driveway Throat Width:** The shortest distance between the parallel edges of a driveway.

**Dry detention facility:** A dry detention facility is a detention facility designed to drain completely after temporary storage of stormwater flows and to normally be dry over the majority of its bottom area.

**Elevated building:** For insurance purposes, a non-basement building, which has its lowest elevated floor, raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.

**Elevation certificate:** A form published by the Federal Emergency Management Agency that is used to certify the elevation to which a building has been constructed.

**Emergency overflow:** The structure in a stormwater management system designed to protect the system in the event of a malfunction of the primary flow structure or a storm event greater than the system design. The emergency overflow capacity initiates at the facility design high water level or base flood elevation.

**Engineer:** A person who is currently licensed by the Texas Board of Professional Engineers to engage in the practice of engineering in the State of Texas.

**Equivalent residential unit (ERU):** The total impervious area of a typical single-family residential property, defined as the median impervious area of a representative sample of all developed residential properties in the single-family residential category. The equivalent residential unit is 2,800 square feet.

**Erosion:** The process whereby soil is removed by flowing water or wave action.

**Existing Construction:** For the purposes of determining rates, structures for which the "start of construction" commenced before the effective date of the initial FIRM (March 5, 1976). "Existing construction" may also be referred to as "existing structures."

**Extreme flood protection:** Measures taken to prevent adverse impacts for large low-frequency storm events with a return frequency of 100-years or more.

**Fee:** The monetary amount charged to an applicant or property owner of record of real property for the services provided.

**FEMA:** Federal Emergency Management Agency and its regulations codified as 44 CFR 59-79 effective as of October 1, 1986.

**Floatables:** Litter and other pollutants that float on the surface of water. Examples are plastic bottles, aluminum cans, cigarette butts, and plastic grocery bags.

**Flood:** A general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waves, or the unusual and rapid accumulation of runoff of surface waters from any source.

**Flood frequency:** A period of years, based on a statistical analysis, during which a flood of a stated magnitude may be expected to be equaled or exceeded.

**Flood Insurance Rate Maps (FIRM):** A map prepared by the Federal Emergency Management Agency or HUD that depicts the Special Flood Hazard Area (SFHA) within a community. This map includes insurance rate zones and Regulatory Floodplains and may or may not depict Regulatory Floodways.

**Flood Insurance Study (FIS):** An examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation, and determination of flood-related erosion hazards.

**Floodplain:** Any land area susceptible to being inundated by water from any source.

**Floodplain Alteration:** Any construction of buildings or other structures, mining, dredging, filling, grading or excavation in the floodplain.

**Floodplain (regulatory):** See Regulatory Floodplain.

**Floodplain management:** An overall program of corrective and preventive measures for avoiding or reducing future flood damage.

**Flood-prone area:** Any area inundated by the base flood.

**Flood Protection Elevation (FPE):** The elevation of the base flood elevation plus two feet of freeboard required.

**Flood-proofing:** Any combination of structural and non-structural additions, changes, or adjustments to structures or property which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures, and their contents.

**Flood-proofing certificate:** A form published by the Federal Emergency Management Agency that is used to certify that a building has been designed and constructed to be structurally dry flood-proofed to the Flood Protection Elevation.

**Flood-resistant material:** Any building material capable of withstanding direct and prolonged contact (minimum 72 hours) with floodwaters without sustaining damage that requires more than low-cost cosmetic repair. Any material that is water-soluble or is not resistant to alkali or acid in water, including normal adhesives for above-grade use, is not flood-resistant. Pressure-treated lumber or naturally decay-resistant lumbers are acceptable flooring materials. Sheet-type flooring coverings that restrict evaporation from below and materials that are impervious, but dimensionally unstable are not acceptable. Materials that absorb or retain water excessively after submergence are not flood-resistant. Please refer to Technical Bulletin 2-93, Flood-Resistant Materials for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program, document number FIA-TB-2, dated 4/93, and available from the Federal Emergency Management Agency. Class 4 and 5 materials, referenced therein, are acceptable flood-resistant materials

**Flood Study:** A study performed for a specific land disturbance site that examines, analyzes, evaluates, or determines the hydraulic and hydrologic characteristics of flood hazards for a basin or partial basin area. To be used as a regulatory instrument the study shall, at a minimum, meet the FEMA criteria specified for a Letter of Map Change. The City may have formally adopted flood studies already in place for certain areas.

**Flow Line:** The flow line shall be the lowest conveyance elevation of a particular feature/structure.

**Freeboard:** An increment of height added to the base flood elevation to provide a factor of safety for uncertainties in calculations, unknown local conditions, wave actions and unpredictable effects such as those caused by ice or debris jams.

**General Permit:** An authorization to discharge stormwater issued by the Environmental Protection Agency (EPA) or the Texas Commission on Environmental Quality (TCEQ) and its successor agencies for business sector and classes of activities based on meeting specified operating conditions and submitting a Notice of Intent to operate under the General Permit.

**Guidelines and Specifications for Flood Hazard Mapping Partners:** Most current version.

**Hazardous material:** Any substance or material determined to be hazardous by the Secretary of Transportation according to 49 CFR Part 171.8.

**High piled combustible storage:** Combustible materials in closely packed piles, or combustible materials on pallets or racks more than 12 feet high. For certain special hazard commodities including rubber tires, plastics, some flammable liquids and idle pallets, the maximum height may be as low as 6 feet high.

**High quality aquatic resources (HQAR):** Waters of the United States that are determined to be critical due to their uniqueness, scarcity, function, and/or value.

**High speed:** A speed limit greater than 40 miles per hour.

**Hydraulically equivalent compensatory storage:** Compensatory Storage placed between the proposed normal water elevation and the proposed 100-year flood elevation.

**Hydrologic and hydraulic calculations:** Engineering analysis which determines expected flood flows and flood elevations based on land characteristics and rainfall events.

**Illicit discharge:** Any discharge or dumping of material into the stormwater management system, a flood-prone area, or a Waters of the United States that is not composed entirely of stormwater.

**Impervious surface:** Any material that substantially reduces or prevents the infiltration of stormwater, including, but not limited to, building roofs, parking and driveway areas, graveled areas, sidewalks, and paved recreation areas.

**Indigenous Plants:** Plants native to the Arlington area or adjacent areas of the Blackland Prairie and Eastern Cross Timbers Regions, which are compatible with environmental conditions of a site or portions of a site. The standard reference for this criterion shall be Native Texas Plants by (verify author, publisher, and date) and (second reference).

**In-kind replacement (culvert):** An in-kind culvert replacement has an equivalent cross-sectional area, shape, roughness coefficient, and inlet and outlet elevations; or the replacement may be shown to have an equivalent hydraulic capacity using appropriate engineering calculations.

**Inspect:** To visit, to review plans, or to oversee a site visit or plan review per generally accepted engineering practices.

**Inspector:** A person hired by the City to oversee the construction of public improvements.

**Intersection sight distance:** Adequate sight distance based upon stopping sight distance (SSD) as determined by AASHTO.

**Intersection visibility triangle:** A triangle sight area at an intersection of two streets or driveways.

**Lake:** A natural or artificial body of water encompassing an area of two (2) or more acres which retains water throughout the year.

**Land Disturbance:** Any use of the land by any Person in residential, governmental, industrial, educational, institutional, or commercial development, highway and road construction and maintenance that results in a change in the natural cover or topography and that may cause or contribute to Sedimentation, additional pollutant runoff, increased peak discharges, or stormwater runoff volumes.

**Landscape Architect:** A person who is currently licensed by the Texas Board of Architectural Examiners to engage in the practice of landscape architecture in the State of Texas

**Large Construction Project:** For stormwater purposes only, a construction activity, including clearing, grading, and excavation, that disturbs five acres or more, or a construction activity that disturbs less than five acres and is part of a larger common plan of development or sale with the potential to cumulatively disturb five acres, such as single family home construction in a subdivision of five acres or more.

**Letter of Map Amendment (LOMA):** Official determination by FEMA that a specific structure is not in a Special Flood Hazard Area; amends the effective Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM).

**Letter of Map Revision (LOMR):** Letter issued by FEMA that revises base flood elevation, flood insurance rate zones, flood boundaries or Regulatory Floodways as shown on an effective FHBM or FIRM.

**Level of Service:** Qualitative measures describing operational conditions within a traffic stream and the perception by motorists.

**Local Street:** All streets, primarily residential in nature in which the pavement is less than 38 feet in width. Local Streets are not classified by the Thoroughfare Development Plan.

**Low opening elevation:** The elevation at which water could enter a structure through any non-watertight opening such as a doorway threshold, a windowsill, or a basement window well.

**Lowest adjacent grade:** The lowest finished grade adjacent to a structure, not including the bottom of window wells.



**Lowest floor:** The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; Provided, that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirement of the Code of Federal Regulations 44, Part 60.3.

**Major Arterial:** Any current or future street as identified on the Thoroughfare Development Plan. Typically, within 120 feet of right-of-way. Included in the classification of a major arterial are all freeway frontage roads.

**Major Collector:** Any current or future street as identified on the Thoroughfare Development Plan. Typically, within 70 feet of right-of-way.

**Minor Arterial:** Any current or future street as identified on the Thoroughfare Development Plan. Typically, within 90-100 feet of right-of-way.

**Minor Collector:** Any current or future street as identified on the Thoroughfare Development Plan, typically within 60 feet of right-of-way having a pavement width of 38 feet.

**Mitigation:** Measures taken to eliminate or minimize damage from land disturbance activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.

**Municipal Separate Storm Sewer System (MS4):** The system of conveyances (including but not limited to roads with drainage systems, municipal streets, inlets, curbs, gutters, ditches, man-made channels, or storm drains) owned and operated by the City and designed or used for collecting or conveying stormwater.

**Natural Channel:** An existing channel in its natural state that has not been graded, filled, modified, cleared, or created by equipment. Natural channels also include areas that have been naturalized or restored to mimic an undisturbed state and modified channels which have regained natural characteristics over time.

**NAVD:** North American Vertical Datum of 1988. The datum listed as the reference datum on Flood Insurance Rate Maps should be used for Elevation Certificate and Floodproofing certificate completion.

**New Construction:** For the purposes of determining insurance rates, structures for which the "start of construction" commenced on or after the effective date of an initial FIRM or after December 31, 1974, whichever is later, and included any subsequent improvements to such structures. For flood plain management purposes, new construction means structures for which the start of construction commenced on or after the effective date of the flood plain management regulation adopted by a community and included any subsequent improvements to such structures.

**Non-riverine Regulatory Floodplain:** Regulatory Floodplains not associated with streams, creeks, or rivers, such as isolated Depressional storage area or lakes.

**Notice of Intent (NOI):** The Notice of Intent that is required by the Construction General Permit, the Multi-Sector General Permit, or other General Permit for the discharge of stormwater issued by the Environmental Protection Agency (EPA), or the Texas Commission on Environmental Quality (TCEQ) and its successor agencies.

**Notice of Termination (NOT):** The Notice of Termination that is required by the Construction General Permit, the Multi-Sector General Permit, or other General Permit for the discharge of stormwater issued by the Environmental Protection Agency (EPA), or the Texas Commission on Environmental Quality (TCEQ) and its successor agencies.

**Open Channel:** A stream or area of concentrated drainage modified or constructed as a feature to convey drainage. Includes modified or improved channels.

**Overland flow path:** An area of land which conveys stormwater for all events up to and including the base flood event.

**Owner:** For the purposes of this manual, owner refers to the person responsible for developing a particular site or project.

**Parks Master Plan:** The official adopted Parks, Recreation and Open Space (Master) Plan for the City of Arlington and amendments thereto, including policies or strategies contained in the City's Comprehensive Plan.

**Pedestal Pole:** A pedestal pole is a pole with vehicular signal heads attached atop and may include pedestrian signal heads and push buttons. A pedestrian pedestal pole is a pole with the pedestrian signal heads attached atop and may include push-buttons.

**Pedestal Post:** A pedestal post is a short post with only push buttons attached to it.

**Person:** Any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, interstate body, or other legal entity.

**Pollutant:** Any substance harmful to the environment that is not authorized for discharge from a storm sewer by a TCEQ MS4 or NPDES Permit.

**Pollution:** The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

**Pole Contacts:** Attachment of streetlight arm to an existing utility pole, use of an existing utility pole for anchoring or support of streetlight conductor cable.

**Pond:** A natural or artificial body of water of less than two acres which retains water year-round.

**Positive Overflow:** Positive overflow means conveying the difference between the 100-year flow and the design frequency flow in a secondary drainage feature without flooding structures. The secondary drainage feature may be a street, a concrete flume or other permanent facility.

**Pre-project:** Pre-project conditions for the purpose of this Ordinance assume land use conditions prior to the proposed land disturbance or redevelopment. In such cases where land disturbance is initiated prior to receiving appropriate local, state, and federal permits, the land use condition will be assumed to be the condition prior to European Settlement. In this situation, the vegetative cover is assumed to be native forest.

**Project Manager:** A person hired by the City to oversee the design and construction of public improvements

**Property owner of record:** The person identified as owner by county tax records.

**Public Improvements:** Streets, storm drainage systems, water lines, sanitary sewer lines, sidewalks or other similar improvements constructed within public rights-of-way, drainage easements, or utility easements. Typically, the City maintains public improvements after expiration of any applicable maintenance bonds.

**Qualified Personnel:** Persons who possess the appropriate competence, and ability (as demonstrated by sufficient education, training, experience, and/or, when applicable, any required certification or licensing) to perform a specific activity in a timely and complete manner consistent with the applicable regulatory requirements and generally accepted industry standards for such activity.

**Reportable Quantity:** The amount of a material that may be harmful to human health and the environment if spilled or otherwise released, thus requiring notification of federal officials upon a release per the Clean Water Act (40 CFR 110 and 117) and the Emergency Planning and Community Right-to-Know Act (40 CFR 302).

**Retention:** The practice of storing stormwater runoff by collection as a permanent pool of water without release except by means of evaporation, infiltration, or attenuated release when runoff volume exceeds storage capacity of the permanent pool.

**Reconstruction:** The act of rebuilding a structure.

**Record drawings:** Upon completion of the land disturbance a registered professional engineer or land surveyor shall certify Construction drawings of what was built and that the project is built in accordance with the submitted plans and previous pre-project certifications.

**Redevelopment:** Any land-disturbing activity that does not result in a net increase in impervious area and that provides greater or equal stormwater control than the previous project.

**Registered Professional Engineer:** See Definition for Engineer.

**Regulatory Floodplain:** Regulatory Floodplains may be either riverine or non-riverine depressional areas. Floodplain boundaries shall be delineated by projecting the base flood elevation onto the best available topography. A flood-prone area is a Regulatory Floodplain if it meets any of the following descriptions:

- Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
- Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map and located with the best available topography to be inundated by the base flood.

**Regulatory Floodway:** The channel, including on-stream lakes, and that portion of the Regulatory Floodplain adjacent to a stream or channel which is needed to store and convey the existing and anticipated future 100-year frequency flood discharge with no more than a 1-foot increase in stage due to the loss of flood conveyance or storage. Where interpretation is needed to determine the exact location of the Regulatory Floodway boundary, the City should be contacted for the interpretation.

**Repair, remodeling, or maintenance:** Activities which do not result in any increases in the outside dimensions of a building or any changes to the dimensions of a structure. In the case of roadways and public facilities, these are activities that do not change roadway width or elevation.

**Retention facilities:** A facility designed to completely retain a specified amount of stormwater runoff without release except by means of evaporation, infiltration, or pumping.

**Revenues:** All fees, assessments or other income received by the stormwater utility, including but not limited to amounts received from the investment or deposit of monies in any fund or account, and all amounts received as gifts or donations, and the proceeds from the sale of bonds to finance the stormwater management program, or any other type of funds derived from grants, charges or loans which by purpose or effect relate to stormwater management activities.

**Riparian:** Vegetated areas within the limits of the regulatory floodplain or flood prone area conveyance path, bordering a waterway that provides habitat or amenities dependent on the proximity to water.

**Riverine:** Relating to, formed by, or resembling a stream (including creeks and rivers).

**Roadside Ditches:** Drainage ditches within 25 feet from the edge of the outside travel lane.

**Sedimentation:** The process that deposits soils, debris, and other materials either on other ground surfaces or in bodies of water or watercourses.

**Shared Driveway:** A driveway constructed on or near a common property line between two or more properties and providing access to all such properties.

**Small Construction Project:** For stormwater purposes only, a construction activity, including clearing, grading, and excavation that disturbs less than five acres and is not part of a larger common plan of development or sale with the potential to cumulatively disturb five acres.

**Special Flood Hazard Area (SFHA):** Any area subject to inundation by the base flood from a river, creek, stream, or any other identified channel or ponding and shown on the Regulatory Floodplain map.

**Stabilization:** Covering of disturbed soil with vegetation, geotextile products, mulch, rock, soil modifiers, or pavement to prevent erosion and soil loss.

**Standard Industrial Classification (SIC) Code:** The four-digit number representing the type of service or product a business provides as published by the Office of Management and Budget in 1987 for the purpose of statistical tracking.

**Start of Construction:** The date the permit was issued provided the actual start of construction, repair, reconstruction, rehabilitation, addition placement or other improvement was within 180 days of the permit date. The actual start date includes the first day of any land preparation, including clearing, grading, filling, or excavation. For substantial improvements, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building whether or not that alteration affects the external dimensions of the building.

**Storm event - 100-year:** A storm having a one percent chance of being equaled or exceeded in any given year.

**Stormwater Facility:** Stormwater Facility encompasses all stormwater BMPs and stormwater storage facilities. All ditches, channels, conduits, bridges, culverts, levees, ponds, natural and man-made impoundments, wetlands, wetland buffers, riparian environment, tile, swales, sewers, BMPs (structural and non-structural) or other natural or artificial structures or measures which serve as a means of draining, treating, detaining, or retaining surface and subsurface water from land.

**Stormwater Management:** A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control, and pollutant reduction in runoff.

**Stormwater Storage Facility:** Ponds, depressions, wetlands, swales, and impoundments intended to reduce runoff peaks or volumes through storage and attenuation of hydrographs.

**Stream:** A course of running water flowing in a channel (includes streams, creeks, and rivers).

**Street:** For the purpose of this manual, street or street improvements shall include all its appurtenances, including, but not limited to streetlights, street signs, signals, and pavement markings.

**Structure:** The results of a man-made change to the land constructed on or below the ground, including the construction, reconstruction, or placement of a building or any addition to a building; installing a manufactured home on a site; preparing a site for a manufactured home; or installing a recreational vehicle on a site for more than 180 days.

**Surveyor:** A person who is currently licensed by the Texas Board of Professional Land Surveying as a Registered Professional Land Surveyor.

**Swale:** A vegetated channel, ditch, or low-lying or depressional tract of land that is periodically inundated by conveying stormwater from one point to another.

**Transition Section:** Reaches of the stream or Regulatory Floodway where water flows from a narrow cross-section to a wide cross-section or vice-versa.

**Trapped Lane:** A lane that forces a driver into a turning movement at an intersection.

**Tree Canopy:** The geographic area covered by the horizontal projection of the drip line, or outer branches of a tree or group of trees, in a woodland tract.

**Thoroughfare Development Plan (TDP):** A comprehensive plan of current and future roadway locations and classifications. This plan offers the framework for orderly development and is responsive to present and future traffic needs within the community.

**Trinity River Corridor:** The portion of the bed and banks of the Trinity River and all of the adjacent land area and all watercourses contained within the boundaries of the river floodplain within the Arlington city limits.

**Violation:** Failure of a structure or other land disturbance to be fully compliant with the regulations identified by Ordinance.

**Watershed:** The land area above a given point on a channel that contributes stormwater to that point.

**Watershed Benefit:** A decrease in flood damages to structures or an improvement in water quality upstream or downstream of the project site created by installation of the stormwater management system. The benefit must be beyond the benefit provided by meeting the minimum Stormwater Ordinance standards and Design Criteria Manual guidance.

**Waters of the United States:** Those water bodies and wetland areas that are under the U.S. Army Corps of Engineers jurisdiction.

**Wet Detention Facility:** A wet detention facility designed to maintain a permanent pool of water after the temporary storage of stormwater runoff.

**Wetland:** Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) soils, and 3) vegetation as mandated by the current Federal wetland determination methodology.

**Wetland Impact:** Waters of the United States that are hydrologically disturbed or otherwise adversely affected by flooding, filling, excavation, or drainage which results from implementation of a land disturbance activity.

## 7.2. Abbreviations

AASHTO	American Association of State Highway Transportation Officials
ADA	Americans with Disabilities Act
AWG	American Wire Gauge
AWWA	American Water Works Association
BMP	Best Management Practice
CDC	Corridor Development Certificate
CLOMR	Conditional Letter of Map Revision
CLP	Cold laid plastic
CY	Cubic Yard(s)
D-PDS	Director of Planning & Development Services Department
D-PR	Director of Parks and Recreation Department
D-PWT	Director of Public Works and Transportation Department
D-WU	Director of Water Utilities Department
DIP	Ductile Iron Pipe
EPA	Environmental Protection Agency
ETJ	Extra-territorial Jurisdiction
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
ft	Feet
fps	Feet per second
gpm	Gallons per minute
HCM	Highway Capacity Manual
HDPE	High Density Polyethylene
HGL	Hydraulic grade line
HMAC	Hot mix asphalt concrete
HPS	High pressure sodium
HUD	Housing and Urban Development
ITE	Institute of Transportation Engineers
LED	Light Emitting Diode
LOMR	Letter of Map Revision
MEP	Mechanical, Electrical and Plumbing
MFF	Minimum Finished Floor
Mils	1/1000 of an inch
mph	Miles per hour
MS4	Municipal Separate Storm Sewer System
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NCTCOG	North Central Texas Council of Governments

NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
OPRTCT	Official Public Records, Tarrant County, Texas
PDS	Planning & Development Services Department
PI	Plasticity Index
ppm	Parts per million
PR	Parks and Recreation Department
psi	Pounds per square inch
PVC	Polyvinyl Chloride
PWT	Public Works and Transportation Department
RCP	Reinforced concrete pipe
ROW	Right-of-Way
RPLS	Registered Professional Land Surveyor
SIC	Standard Industrial Classification
sf	Square feet
SWMSP	Stormwater Management Site Plan
SWPPP	Stormwater Pollution Prevention Plan
sy	Square yard
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
TDP	Thoroughfare Development Plan
TIA	Traffic Impact Analysis
TMUTCD	Texas Manual on Uniform Traffic Control Devices
tpd	Trips per day
TPDES	Texas Pollutant Discharge Elimination System
TxDOT	Texas Department of Transportation
WU	Water Utilities Department