# CITY OF CORINTH
# ENGINEERING STANDARDS MANUAL

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CORINTH
ENGINEERING

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# Section 1. General

## Subsection 1.01. Supplement to the Subdivision Regulations in the Unified Development Code

This Article supplements the Subdivision regulations in the Unified Development Code. The following design criteria are primarily intended for use by the Developer's Engineer. There may be special circumstances which would dictate requirements in excess of those outlined; however, in most cases, these exceptions will be apparent to the Developer's Engineer while preparing the Construction Plans and Specifications for the subdivision.

In the interpretation and application of the provisions of these regulations, it is the intention of the City Council that the principles, standards and requirements provided herein shall be minimum requirements for the design of both subdivisions and municipal capital improvement projects for the City, and, where other City ordinances or regulations of the City are more restrictive in their requirements, such other ordinances or regulations shall govern.

The City has adopted various ordinances and master plans, which address various requirements not explicitly included in the Engineering Standards Manual, including, but not limited to the following. The engineer is responsible for understanding and complying with the City's various ordinances and master plans.

- City of Corinth Code of Ordinances
- City of Corinth Unified Development Code
- Master Plans….
    - 2004 Storm Water Master Plan
    - Comprehensive Plan
        - Trails Mater Plan

- Thoroughfare Plan

## Subsection 1.02. NCTCOG Standards

The "Standard Specification for Public Works Construction, North Central Texas" of the North Central Texas Council of Governments, with all amendments thereto, shall govern and shall constitute the technical specifications except as amended by these design criteria and the Corinth Construction Standards.

## Subsection 1.03. Compliance Required for Construction Plan and Final Plat ~~Approval~~Acceptance

No final plat shall be approved by the City Council, and no completed improvements shall be accepted by the City Engineer, unless and until such improvements conform to Corinth's design criteria and all other applicable standards as prescribed by the City of Corinth. All streets, alleys, sidewalks, drainage ways, water and sewer lines and improvements shall be designed, placed and constructed in accordance with the following design criteria and with the Construction Standards and Details.

~~City Manager~~The City's Engineering Standards are issued by the Public Works Department, Planning Department and City Engineer, who are hereby authorized to enforce the provisions of these Engineering Standards. The standards and any updates will be available on the City's website.

The Engineering Standards Manual shall be in full force and effect immediately upon adoption by the City Council. Projects will be required to comply with all requirements. The standards include the various design criteria, technical specifications, and standard construction details which are considered minimum requirements for the design and construction of adequate public facilities within the City**. The Engineer of record shall bear the sole responsibility for meeting the Engineering standard of care for all aspects of the design and providing a design that's required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City's design and construction requirements. Plan acceptance shall not constitute variance to these standards.**

## Subsection 1.04. Amendments

The City Staff may amend the Engineering Standards Manual. In order to ensure that the Design Engineer has the City's latest design standards, they are directed to the City's website to acquire the City's most current design standards. The Engineering Standards Manual will include a Record of Revisions to identify any revisions to the engineering Standards. The current engineering standards shall be applied to any new application for construction within the City.

A formal request to modify the current design criteria or add a new design criteria may be submitted to the City for consideration in writing to the City Engineer or designee.

## ~~Subsection 1.04.~~Subsection 1.05. City Engineer May Authorize a Variance

Where a specific topographic feature or other condition makes a variance necessary to achieve the best interest of the City, then these standards may be modified by the City ~~Manager, upon recommendation from the City Engineer.~~Engineer. All deviations from the requirements included in the Engineering Standards Manual shall be authorized by the City Engineer or designee. A grant of an alternate material, design, or method of construction shall not affect nor relieve the Engineer of the obligation and responsibility of such material, design, or method of construction for the intended purposes.

In the event that specific circumstances dictate requirements not already included in the Engineering Standards Manual, it shall be the responsibility of the Engineer to provide the additional information as deemed necessary by the City Engineer or designee in writing for review.

## ~~Subsection 1.05.~~Subsection 1.06. Definitions

The definitions set forth in the Subdivision regulations and Unified Development Code shall apply to this Engineering Standards Manual.

# Section 2. Minimum Standards

If any required dedication or other exaction exceeds the minimum standards by oversizing or upgrading in any form, the City will determine the impact of the development. A subdivision that requires improvements which meet only the minimum standards will not require a new study but will be based upon prior studies. If the subdivider maintains that he is not responsible for constructing infrastructure at greater than the minimum standard, the subdivider shall submit to the City engineering investigations, studies, and calculations in support of constructing the minimum standard.

# Section 3. Stormwater Discharge Permit

In accordance with the Federal Water Pollution Control Act, 33 U.S.C. Para. 1251-1387 (1990), also known as the Clean Water Act, as amended in 1987 and codified as 40 C.F.R., Part 122, the development shall be required to obtain a storm water discharge permit (E.G. NOI) for construction activity from the Texas Commission on Environmental Quality (TCEQ).

Under current regulations, construction activities including clearing, grading and excavation, must be permitted for storm water discharge unless the operations result in the disturbance of less than five (5) acres total land area and the areas are not part of a larger common plan of development. Copies of documentation of the appropriate permit(s) shall be filed with the City at least two (2) days prior to commencement of construction. During construction a copy of the Storm Water Pollution Prevention Plan (SWPPP) shall be available on site in accordance with TCEQ requirements.

The following ~~hyperlink provided~~hyperlinks provide additional information regarding City storm water planning requirements and regulations.

1. Storm Water Management Plan
2. ~~Erosion Control / Illicit Discharge Ordinance~~~~Storm Water Management Plan~~
3. ~~3.~~2. Code of ordinances Chapter 159 Erosion and Sediment Control

# Section 4. Streets

All roadways shall be designed to their ultimate configuration as concrete streets with a minimum lifespan of thirty (30) years.

A geotechnical report sealed by a Professional Engineer licensed in the State of Texas shall provide recommendations for the total pavement design including subgrade treatment thickness, lime or cement content, base type and thickness, and surface type and thickness. The geotechnical investigation shall be submitted with the construction plans. The minimum pavement design should be for a 30 year life loading.

The design engineer shall provide the City with a pavement design using regionally accepted projected traffic volumes and providing for a stable subgrade for long term durability. Streets shall consist of a minimum six inch (6") concrete pavement with six inch (6") of lime or cement stabilized subgrade, though these are minimums and the pavement design shall outline the entire cross-section of the pavement structure. Considerations shall be made to stabilize the entire ROW width to include stabilization of the sidewalks.

## Subsection 4.01. Concrete Pavement

### 4.01.01. Concrete Strength Requirements

Concrete Curb and Gutter

Concrete shall be constructed of a batch design, providing a twenty-eight (28) day compressive strength of three thousand six hundred (3,600) pounds per square inch (psi).

Reinforced Concrete Pavements and Monolithic Curb

Concrete pavement and monolithic curb properly and continuously reinforced shall be constructed of a concrete batch design, providing the appropriate twenty-eight (28) day compressive strength. The minimum reinforcement shall be No. 4 deformed bars spaced at eighteen (18) inches center to center, both ways.

Subgrade Stabilization

Lime stabilization – Hydrated lime shall be spread uniformly over the soil to be treated and sprinkled to the proper moisture content dictated by a geotechnical engineering report. At a minimum, lime shall be distributed at a rate of 40 lb/cy. The soil, lime, and water shall be mixed until a homogeneous product is obtained that is free of clods and lumps. The Lime shall be mixed initially to a depth of 8" and secondarily mixed at 6". The mixture shall then be immediately rolled to the required compaction. In the event that non-cohesive soils are encountered, then subgrade stabilization will be obtained by cement, applied in the amounts and according to methods suitable for the soil and approved by the City Engineer.

Substitutions of materials other than Lime shall be individually reviewed on a case-by-case basis with supporting geotechnical information provided to the City Engineer.

The recommendation from the geotechnical investigation or the above standard shall be the minimum requirement whichever is greater.

### 4.01.02. Pavement Thickness Requirements

Local Street and Alley Construction

A minimum six inch (6") thickness of three thousand-six hundred (3,600) psi reinforced concrete pavement on a compacted sub-base shall be required. ~~Said six inch (6") thickness will be acceptable without performing additional soils investigation or design calculations.~~

~~1. All steel reinforcing shall be deformed No. 4 bars on twenty four inch (24") centers both ways.~~

~~2. Stabilization of the subgrade, six inches (6") thick with six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization), shall be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.~~

Collector Street

Collector streets shall be designed and constructed with minimum eight inch (8") thickness of three thousand-six hundred (3,~~000~~600) psi reinforced concrete pavement on a compacted sub-base.

~~3. All steel reinforcing shall be deformed No. 4 bars on twenty-four inch (24") centers both ways.~~

~~4. Stabilization of the sub-base with a six inch (6") thickness of six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization) will be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.~~

Arterial Street Construction

Arterial streets shall be designed and constructed with ~~an~~a minimum eight inch (8") thickness of three thousand-six hundred (3,600) psi reinforced concrete pavement on a compacted sub-base.

~~5. All steel reinforcing shall be deformed No. 4 bars at twenty-four inch (24") centers both ways.~~

~~6. Stabilization of the subgrade, six inches (6") thick with six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization), shall be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.~~

# Subsection 4.02. Miscellaneous

### 4.02.01. Reinforcing Steel

Steel for street and alley paving shall meet ASTM designation A 15, A 16, or A 408 and shall be deformed bars. The use of imported steel shall be prohibited.
Steel for street and alley paving shall be a minimum of a #4 bar at 18" on-center each-way.

### 4.02.02. Sawed Dummy Joints

~~B. Sawed Dummy Transverse Joints~~
Sawed dummy transverse joints shall ~~be~~ not be greater than 20'-0" apart or as required by the City Engineer at intersections.

~~C. Longitudinal Sawed Dummy Joints~~
Longitudinal sawed dummy joints shall be required in all pavements where the concrete is poured in a continuous width of 30 feet or more. The longitudinal dummy joints shall be located at one-third point of the width or as directed by the City.

### 4.02.03. Expansion & Construction Joints

Expansion joints shall be placed at distances no greater than 600 feet and shall be constructed in accordance with the City's standard~~.~~ details. Construction joints shall be constructed in accordance with the expansion joint standard. Expansion joints shall have ~~dowels~~ #5 smooth ~~at~~dowels on 18-inch centers. Construction joints shall have the reinforcing bars continuous through the joint.

~~1.01.02. Longitudinal Pavement Slopes~~

### 4.02.04. Roadway Geometrics

The minimum ~~longitudinal standard alley pavement slopes~~horizontal curvature radii for design of street centerlines shall be as follows.

~~A. The maximum longitudinal slopes are as follows:~~

Arterial = 775 feet

Collector = 350 feet

Residential = 250 feet

And

Table~~: Maximum Longitudinal Slopes~~ 4.02.04(A): Horizontal Curves

| ~~Type of Street~~Design Speed V (MPH) | Friction Factor F | ~~Maximum Slop~~Superelevation E (ft/ft) | Radius, R (ft) Rounded for Design |
|---|---|---|---|
| ~~Arterial~~25 | ~~6%~~0.23 | -0.02 | 250 |
| ~~Collector~~30 | ~~8%~~0.20 | -0.02 | 350 |
| ~~Local~~35 | ~~10%~~0.18 | -0.02 | 525 |
| 40 | 0.16 | -0.02 | 775 |
| 45 | 0.15 | -0.02 | 1100 |
| 50 | ~~Maximum grades for alleys shall be 8% within 30 feet of its intersection with a street and~~ | -0.02 | 1400 |

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| | | | |
|---|---|---|---|
| | ~~14% elsewhere.~~0.14 | | |

A tangent of at least one hundred feet (100') long shall be introduced between reverse curves on arterial and collector streets.

The minimum vertical curvature for design of street shall be as follows.

In order to maintain an adequate sight distance use the standard formula L=KA; L is the length of the vertical curve in feet, K is the rate of vertical curvature, and A is the algebraic difference of the street grades in percent (%). The minimum K values based on the design speed of the roadway are listed in the below table:

Table:4.02.04(B): Vertical Curves

| Design Speed MPH | Crest Vertical Curve "K" Value | Sag Vertical Curve "K" Value |
|---|---|---|
| 30 | 28 | 35 |
| 40 | 60 | 60 |
| 50 | 110 | 90 |

* No vertical curves are necessary when A is less than or equal to 1.8%

** Minimum vertical curve length shall be fifty feet (50') for residential streets and one hundred feet (100') for all other streets.

All street intersection geometry:

1. Shall be constructed to form a ninety degree (90˚) angle +/- 10˚ unless approved by the City Engineer.
2. The minimum radius for curb returns at intersections shall be 25 feet (25') to the back of curb.

The minimum and maximum longitudinal slopes are as follows:

Table:4.02.04(D): Maximum Longitudinal Slopes

| Type of Street | Minimum Slope | Maximum Slope |
|---|---|---|
| Arterial | 0.8% | 6% |
| Collector | 0.8% | 8% |
| Local | 0.5% | 10% |
| | Maximum grades for alleys shall be 8% within 30 feet of its intersection with a street and 14% elsewhere. | |

### ~~4.02.04.~~ 4.02.05. Transverse Pavement Slopes

The transverse pavement slope for all non-divided streets shall consist of a parabolic curve from the pavement centerline to the gutter. The crown of the parabolic curve shall be a minimum of five (5) inches above the gutter grade on local streets and six (6) inches on collector streets. For divided streets, the transverse slope shall be ~~as required by the City~~one-quarter of an inch (¼") per one foot (1') .

### ~~1.01.03. Lime Stabilization~~

~~Hydrated lime shall be spread uniformly over the soil to be treated and sprinkled to the proper moisture content dictated by a geotechnical engineering report. The soil, lime, and water shall be mixed until a homogeneous product is obtained that is free of clods and lumps. The mixture shall then be immediately rolled to the required compaction.~~

~~In the event that non-cohesive soils are encountered, then subgraded stabilization will be obtained by cement, applied in the amounts and according to methods suitable for the soil and approved by the City Engineer.~~

### 4.02.06. Pavement Cut and Repair

Utility improvements shall be designed to minimize the impact to existing pavement, where feasible.
No public pavement shall be cut unless approved by the Construction Inspector or the City Engineer. Pavement cut and repair shall be in accordance with the City's standards and, if needed, NCTCOG Item 402 and NCTCOG Standard Drawings 3070A through 3070D.
Full panel concrete pavement replacement shall be required for all public pavement cuts.

# Section 5. Drainage and Storm Sewer

## Subsection 5.01. General

~~**1.01.04. Storm Water Flows ≤ 200 cfs**~~

~~An enclosed storm sewer shall be provided in all areas where the quantity of the accumulated storm runoff does not exceed two hundred (200) cubic feet per second (cfs).~~

~~**1.01.05. Storm Water Flows > 200 cfs and ≤ 500 cfs**~~

~~In drainage courses where the accumulated storm runoff is more than two hundred (200) cfs and less than or equal to five hundred (500) cfs, either an enclosed storm sewer system or an open -lined channel shall be constructed.~~

~~**1.01.06. Storm Water Flows > 500 cfs**~~

~~In drainage courses where the accumulated storm runoff is more than five hundred (500) cfs, the drainage improvements may be either an enclosed storm sewer system, or an open channel. Earthen channels shall be designed according to the criteria as set forth herein for open channel sections. All earthen channels shall be located within an easement outside of the right-of-way or the right-of-way shall be widened to accommodate the open channel.~~

## ~~Subsection 1.02. Runoff Calculations~~

~~**1.02.01. Runoff Calculations**~~

~~A. Selection of Calculation Method~~

~~1. The selection of which method to use for calculating runoff depends upon the size of the contributing drainage area at the most downstream point of the project.~~

~~2. The "Rational Method" is acceptable for designing projects in which the drainage area is less than 160 acres.~~

~~3. A unit hydrograph method is required for projects with larger drainage areas, 160 acres or greater.~~

~~B. One (1) Acre Requirement~~

~~A developer or builder of property greater than one acre in size, or any property that was platted as a part of an overall tract which was greater than one acre in size (including churches and schools), shall match current outfall conditions at the boundary or tract property or other drainage point.~~

~~C. Runoff computations~~

~~Runoff computations shall be based upon fully developed watershed conditions in accordance with the land use projections in the latest Comprehensive Land Use Plan for the City of Corinth.~~

~~1. The design engineer shall size drainage facilities by disregarding the detention effects of upstream property and calculating the runoff as if the off-site property were developed without any detention.~~

~~2. If an approved regional detention/retention facility is in operation, the design engineer may size downstream drainage facilities based on consideration of the detention effects of the regional facility.~~

### 1.02.02. Procedure for drainage area less than 160 acres

Computation of storm water runoff for drainage areas less than 160 acres may be by the "Rational Method" which is based on the principle that the maximum rate of runoff from a given drainage area for an assumed rainfall intensity occurs when all parts of the area are contributing to the flow at the point of discharge. The formula for calculation of runoff by the "Rational Method" is: Q = CIA

A. "Q" Value

Where Q = the maximum rate of discharge or flow rate, at a given point, expressed in cubic feet per second.

B. "C" Value

Where C = Coefficient of Runoff. The runoff coefficient which considers the slope of the terrain, the character of the land use, the length of overland flow, and the imperviousness of the drainage area, shall be determined from the ultimate land development plan of the City. Typical "C" values are listed in the table below:

Table 2: Typical "C" Values

| Land Use | "C" |
|---|---|
| Undeveloped Property | 0.30 |
| Park Areas - No Developed Land | 0.35 |
| Developed Park Sites | 0.40 |
| Single Family Residential | 0.55 |
| Multiple Family (i.e., Townhomes, Apartments, etc.) | 0.70 |
| Schools | 0.70 |
| Churches | 0.70 |
| Neighborhood Commercial | 0.80 |
| Office Commercial | 0.80 |
| Commercial | 0.90 |
| Industrial | 0.85 |

C. "I" Value

Where I = Intensity of Runoff in Inches per Hour. The rainfall intensity - frequency curves, which are shown on , are plotted from data published by the U.S. Department of Commerce Weather Bureau, Technical Paper No. 40. The intensity, I, in the formula Q = CIA, is determined from these curves by arriving at a time of concentration and adapting a storm frequency upon which to base the drainage improvements.

D. "A" Value

Where A = Drainage Area in Acres. The area used in determining flows by the "Rational Method" shall be calculated by subdividing a map into drainage areas within the basin contributing stormwater runoff to the system.

E. Time of Concentration

1. Time of concentration is the longest time, without interruption of flow by detention devices, that a drop of water takes to flow from the farthest point of the drainage area to the point of concentration (i.e., the point of design). The time of concentration is composed of the inlet time and the flow time in a conduit or channel to the point of design. A nomograph shown on is attached for estimating the time of concentration.

2. When designing inlets and laterals, the time of concentration is equal to the inlet time. The design engineer will compare the above specified inlet times to the actual calculated inlet time by computing the flow time overland and along the gutter to the first inlet. Manning's equation shall be used to determine flow time to the inlet. The design engineer may use the actual calculated or specified inlet time. In no case shall a longer inlet time than 10 minutes be used for multiple family, commercial,

~~churches, schools, industrial and business areas and 15 minutes for parks, cemeteries, agricultural, and single-family areas.~~

~~Procedures for~~ Use the **NCTCOG iSWM Technical Manuals** for design of Drainage and Storm Sewers, in conjunction with the local Criteria Manual.

http://iswm.nctcog.org/technical-manual.html

### ~~1.02.03.~~ Drainage ~~Areas greater than 160 acres~~

~~A. Unit Hydrograph Method~~

~~For drainage areas in excess of 160 acres where the use of the "Rational Method" does not provide reliable results, the use of a unit hydrograph method shall be made. The use of a unit hydrograph calculation will be based upon standard and accepted engineering principles subject to the approval of the City Engineer. Acceptable methods include the Soil Conservation Service (SCS) Technical Release Number 55 for drainage areas from 100 acres to 2,000 acres, and SCS's TR20 or the Corps of Engineers HEC-1 models for drainage areas 160 acres or more.~~

~~B. Fully Developed Watershed Conditions~~

~~The unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from the small on-site detention facilities for maintaining the rate of runoff as if the property were developed as single family residential use. The detention effects of large regional detention facilities can be taken into account in unit hydrograph methods.~~

~~C. Circumstances~~

~~Circumstances that may require the use of a unit hydrograph method include sizing open channels, reclaiming floodplains, creating lakes, or building other types of drainage-related facilities on major drainage courses.~~ Design ~~engineers of these types of facilities should be aware that the requirement of designing for fully developed watershed conditions will mean that they will have to calculate these fully developed flows instead of using the flows calculated in the Federal Emergency Management Agency's (FEMA) flood insurance studies for Corinth.~~ Manual (also known as the iSWM Local Criteria Manual) via City Website

## Subsection 1.03. Design Storm Frequencies

### 1.03.01. Drainage Facility and Corresponding Recurrence Interval

Table 3: Drainage Facility and Corresponding Recurrence Interval

| Drainage Facility | Design Recurrence Interval |
|---|---|
| Right-of-way & Drainage Easement Boundaries | The 100-year storm (ultimate conditions) must be contained herein. |
| Curb and Gutter and Borrow Ditches | The 50-year storm must be contained between the curbs or within the borrow ditches. |
| Streets | One lane of traffic must remain unflooded on local streets. Two lanes of traffic (one each direction) must remain unflooded on collector and arterial streets. |
| Closed Storm Sewer Systems | 25-year with 100-year positive overflow for Inlets on Grade in streets such that the depth of flow in the street does not exceed the top of curb. |
| Closed Storm Sewer Systems and Inlets at Street Low Point or Sag | 100-year |
| Culverts and Bridges | 100-year |
| Concrete-lined Channels | 100-year |
| Earthen Channels | 100-year |

### 1.03.02. Approved Drainage System and Positive Overflow

The approved drainage system shall provide for positive overflow at all low points. The term "positive overflow" means that when the inlets do not function properly or when the design capacity of the conduit or inlet is exceeded, the excess flow can be conveyed overland along a grassed or paved course. Normally, this would mean along a street or alley, or shall require the dedication of drainage easements as required to provide for the flows.

### 1.03.03. Recommended Design Storm Frequencies

Recommended design storm frequencies for the storm drainage improvements in the City are shown in a table as follows:

Table 4: Recommended Design Storm Frequencies

| Type of Facility | | Description of Drainage Area | Maximum Time of Concentration (Minutes) | Design Frequency (Years) |
|---|---|---|---|---|
| (1)(3) | Storm Sewers | Residential, Commercial, and Industrial | 30 | 25 |
| (2) | Culverts, Bridges, Channels and Creeks | Any type of area less than 100 acres | 30 | 100 |
| (3) | Culverts, Bridges, Channels and Creeks | Any type of area greater than 100 acres but less than 1,000 acres | 45 | 100 |
| (4) | Culverts, Bridges, Channels and Creeks | Any type of area great than 1,000 acres | 60 | 100 |

| Notes | |
|---|---|
| (1) | If the maximum time of concentration or area to be drained is exceeded, the design shall be based on a fifty (50) year frequency. |
| (2) | If the maximum time of concentration or area to be drained is exceeded, the design shall be based on a one hundred (100) year frequency. |
| (3) | Whenever, in a storm sewer system, an inlet is located at a low point so that flow in excess of the storm sewer capacity would be directed onto private property, the design frequency shall be increased beyond twenty five (25) years. If the inlet location is such that overflow could cause damage or serious inconvenience, it may be desirable to increase the design frequency to as much as one hundred (100) years. |
| (4) | When the maximum time of concentration of sixty (60) minutes is exceeded on any area to be drained, the design shall be based on a one hundred (100) year frequency having a maximum time duration of 60 minutes. |

## Subsection 1.04. Street and Alley Capacity

### 1.04.01. Streets

The 50 year storm shall be contained within the outermost curbs or within the borrow ditches for any street section and the 100 year storm shall be contained within the street right-of-way.

### 1.04.02. Alleys

A. Flows Contained

The flows created by the 100-year storm shall be contained within the limits of all paved alleys.

B. First floor elevations

1. The first floor elevations of all residential and other structures shall be set at a minimum elevation of one foot above the top of the street curb elevation or the alley invert at the lowest point along the property frontage, and with positive drainage provided away from the structure.

2. Positive overflow sections shall provide a minimum of 1 foot of freeboard from the overflow invert adjacent to structures and the corresponding first floor elevation of all residential and other structures.

### 1.04.03. Spread of Water

A. Quantity of Storm Water

During the design storm, the quantity of storm water that is allowed to collect in the streets before being intercepted by a storm drainage system is referred to as the "spread of water". In determining the limitations for carrying the storm water in the street, the ultimate development of the street shall be considered. The use of the street for carrying storm water shall be limited to the following:

Table 5: Quantity of Storm Water

| Street | Quantity Standard |
|---|---|
| Arterial Streets (divided) | One (1) traffic lane each direction to remain clear. |
| Collector Streets | One (1) traffic lane each direction to remain clear. |
| Local Streets | Six inch (6") depth of flow at curb, and one lane completely clear. |
| | |

B. Formulas

Formulas are provided on for determining the flow in parabolic street sections. Also provided are gutter flow curves, and , for determining the capacity of parabolic gutters for various street widths and a curve for determining the curb inlet opening length in slumps ().

C. Length of On Grade Inlet Opening

The length of on grade inlet opening for each cubic foot per second of gutter flow is:

Table 6: Length of On Grade Inlet Opening

| Street Grade | Length of Inlet Opening in Feet per CFS |
|---|---|
| Less than 2% | 1.0 |
| 2% to 3.5% | 1.5 |
| Greater than 3.5% | 2.0 |

## Subsection 1.05. Storm Sewer Design

Storm water runoff in excess of that allowed to collect in the streets shall be intercepted in inlets and carried away in a storm sewer system.

### 1.05.01. Calculating Storm Water Capacity

Storm sewer capacity shall be calculated by Manning's formula.

| Table 7: Manning's Formula |
|---|
| $Q = 1.486\ AR^{2/3}S^{1/2}$, where n |
| Q is the discharge in cubic feet per second; |
| A is the cross-sectional area of flow in square feet; |
| R is the hydraulic radius in feet; |
| S is the slope of the hydraulic gradient in feet per foot; and, |
| n is the coefficient of roughness (n=0.013 for concrete pipe and 0.015 for poured concrete culverts). |

### 1.05.02. Elevation of the Hydraulic Gradient

In the design of the storm sewer system, the elevation of the hydraulic gradient of the storm sewer shall be a minimum of one and one-half feet (1.5') below the elevation of the adjacent street gutter.

### 1.05.03. Storm Sewer Pipe Sizes

Storm sewer pipe sizes shall be so selected that the average velocity in the pipe will not exceed fifteen feet (15') per second and shall not be less than three feet (3') per second.

### 1.05.04. Storm Sewer Pipe Standards

Storm sewer pipe shall be reinforced concrete culvert pipe conforming to ASTM designation C76 Class III and shall be a minimum of eighteen inches (18") in diameter. Other pipe material may be used with the approval from the Director of Public Works and the City Engineer.

## Subsection 1.06. Inlet Placement and Capacity

### 1.06.01. Inlet Design

Storm sewer inlets shall be built along paved streets at such intervals that the depth of flow, based upon the 50-year storm, does not exceed the top of curb. Inlets shall be located as necessary to remove the flow based on a 10-year storm. If in the opinion of the City Engineer the flow in the gutters would be excessive using the above design criteria, the storm sewers or inlet locations could be altered to relieve adverse conditions.

### 1.06.02. Inlet Placement

Inlets shall be placed upstream from an intersection whenever possible. At any intersection, only one street shall be crossed with surface drainage and this street shall be the lower classified street. When an alley intersects a street, inlets shall be placed in the alley whenever flow down that alley would cause the capacity of the intersecting street to be exceeded.

### 1.06.03. Inlet Standards

The minimum inlet size shall be five feet. No more than 20 feet of inlet shall be placed along one gutter at any given location. Minimum sizes of laterals shall be 18 inches for use with 5 foot inlets, and 21 inch laterals with 10 foot to 20 foot drop inlets, and 24 inch laterals for 20 foot inlets. Where laterals tie into storm sewer lines, the laterals shall be connected so that the longitudinal centers intersect.

## ~~Subsection 1.07. Pipe (Closed Conduit) Design Standards~~

### ~~1.07.01. Sized to Flow Full~~

~~Storm sewer conduit shall be sized to flow full. Manning's equation shall be used to determine the conduit size. If flow is less than full flow, then all calculations shall be based on partial flow characteristics.~~

### ~~1.07.02. Minimum and Maximum Velocities in Pipes~~

~~A. Minimum Velocities~~

~~The minimum velocities in conduit shall be 3.0 feet per second.~~

~~B. Maximum~~

~~1. The maximum discharge velocities in the pipe shall not exceed the permitted velocity of the receiving channel, or conduit, at the outfall to prevent erosive conditions.~~

~~2. The maximum outfall velocity of a conduit in partial flow shall be computed for partial depth and shall not exceed the maximum permissible velocity of the receiving channel unless controlled by appropriate energy dissipater (e.g., stilling basins, impact basins, or riprap protection).~~

~~C. Concrete Pipe Conduit~~

~~1. In general, stormwater shall be carried in concrete pipe conduit, but other types of conduit may be used to carry stormwater provided that prior permission to use other conduit materials is obtained from the City Engineer prior to plan approval.~~

~~2. Any conduits located under or crossing existing, proposed or future pavement shall be concrete pipe appropriate for those installations.~~

~~D. Standards~~

~~1. Conduits must be sized, and slopes must be set, such that runoff flows smoothly down the drainage system.~~

~~2. The hydraulic grade line shall be plotted on the profiles for all storm sewer systems (including pipes, laterals and channels).~~

~~3. The hydraulic grade line shall be a minimum of 1.5' below the adjacent street gutter elevation.~~

~~E. Analyses~~

~~1. When performing hydraulic analyses for (storm sewers) channel, or drainage way design, the starting water surface shall be based on the calculated water surface in the receiving channel (50 or 100 year).~~

~~2. The developer shall provide documentation and/or calculations verifying the water surface elevation in the receiving channel.~~

## ~~Subsection 1.08. Culvert Design~~

~~Culverts shall be designed to the 100-year frequency. Culverts shall be designed in accordance with the Texas Department of Transportation Hydraulic Manual, Chapter 4 – Culverts. The calculation of hydraulic grade lines will consider both inlet and outlet control for the culvert.~~

## Subsection 1.09. Open Channels

### 1.09.01. Engineering Design

Open channels may be used instead of enclosed systems when the drainage area contributing flow to the channel is greater than 100 acres. Open channels shall not be permitted when the drainage area is less than 100 acres. All channels shall be designed for the 50-year frequency plus 1-foot of freeboard, or for the 100-year frequency. Both the 50-year and 100-year frequency water surface elevations shall be plotted on the channel construction drawings.

### 1.09.02. Excess Storm Water Runoff

Storm water runoff in excess of that allowed to collect in the streets in developed areas and runoff in undeveloped areas may be carried in open channels (not in the street right-of-way). Open channel capacity shall be calculated by Manning's formula, and roughness coefficients shall be as follows:

Table 8: Open Channel Capacity

| Type of Lining | Roughness Coefficient "n" | Maximum Permissible Mean Velocity |
|---|---|---|
| Earth (Bermuda Grass) | 0.035 | 8 ft. per sec. |
| Earth (Non-Vegetated) | 0.030 | 5 ft. per sec. |
| Concrete-Lined | 0.015 | 15 ft. per sec. |
| Weathered Rock | 0.030 | 15 ft. per sec. |

### 1.09.03. For Channels with a Contributing Drainage Area of 100 Acres or Greater

A. Channel Standards

1. Channels may be left in their natural state provided that the channel velocities are 6.0 feet per second or less.
2. If the natural channel is to be replaced by an improved channel, the flow from the 50-year design flood must be contained within the improved channel while allowing for one foot of freeboard, or the flow from the 100-year design flood must be completely contained in the channel.
3. Improved channels shall include a lined section if the design velocity is greater than eight (8) feet per second. Lining types such as concrete, riprap, rock walls and gabions, may be used upon prior approval of the City Engineer. Lined channels shall be designed to prevent erosion and to reduce the velocity to less than 8 fps before being released into unlined or natural drainage facilities.
4. Concrete lining in channels shall have a minimum thickness of six (6) inches and shall be reinforced with #3 rebar with a nominal diameter of 0.225 inches and a nominal weight of 0.136 lbs./L.F.
5. Concrete-lined channels shall have a reinforced concrete toe wall constructed along the base and side slopes of the lined channel and shall have a minimum vertical depth of two (2) feet. A horizontal concrete section, one (1) foot in width, shall be constructed between the top of the channel lining and the toe wall.
6. For lined channels, all of the channel bottom and at least the first three feet (vertical height) of the side slopes up from the channel bottom shall be lined, unless otherwise approved by the City Engineer.
7. Earthen sides above the lined section or totally earthen channels shall be on at least a four horizontal to one vertical slope (4:1) and shall have approved ground cover established to prevent erosion.
8. Unless shown to be feasible in a soils report prepared by a Licensed Professional Engineer in the State of Texas, and approved by the City Engineer, improved channels shall have side slopes no steeper than below:

    a. 3 feet horizontal to 1 foot vertical for earthen, grassed-lined side slopes.

b. 1.5 feet horizontal to 1 foot vertical for concrete-lined side slopes or side slopes in rock.

9. The developer or owner shall use low maintenance vegetation for vegetative cover, as approved by the City prior to planting. The selection of materials shall comply with the current ground cover listing for North Central Texas furnished through the Texas Agricultural Extension Service.

10. The developer shall dedicate a easement on all earthen and concrete-lined channels of sufficient width to provide for excavation of the open channel to proper width, plus two feet (2') on one side and fifteen feet (15') on the opposite side to permit ingress and egress for maintenance. No channel may exist between opposite flowing lanes of traffic (in medians).

11. Culvert Discharge – Velocity Limitations

Table 9: Culvert Discharge – Velocity Limitations

| Culvert Discharging Onto | Maximum Allowable Velocity (f.p.s.) |
|---|---|
| Earth | 6 |
| Sod Earth | 8 |
| Paved or Riprap Apron | 15 |
| Shale | 10 |
| Rock | 10 |

In no case shall the velocity at culvert discharge or in earthen channel exceed 6 fps.

Generally, all culverts shall be designed with a free outfall, and in accordance with the State Department of Transportation, Bridge Division, Hydraulic Manual.

## ~~Subsection 1.10. Erosion Prevention~~

~~All channel designs must consider and account for channel stabilization. This requirement pertains to all sections whether they are left in their natural conditions or are modified in any manner. Three sets of requirements are provided, depending upon the relationship of the existing channel to the limits of the developer's property. The City Engineer shall have the discretion to require the implementation of the portion of these requirements as deemed necessary, depending on the specifics of the property being developed or improved.~~

### ~~1.10.01. Improved Stabilized Channel Cross-Section~~

~~Provide for an improved stabilized channel cross-section which reduces all velocities to 6.0 fps or below for vegetated channels. The channel improvements must meet all City requirements.~~

### ~~1.10.02. Grade Control Structures~~

~~For vegetated channel sections with overbank velocities ranging from 6 to 8 fps, construct grade control structures within the channel and overbank areas to prevent erosion. Grade control structures shall have a minimum effective depth of 3.0 feet below existing or proposed grades with an adequate number of structures to prevent degradation.~~

### ~~1.10.03. Vegetation Cover~~

~~At least seventy percent (70%) of any disturbed land area shall be cover by vegetation.~~

## ~~Subsection 1.11. Starting Water Surface Condition~~

~~When performing hydraulic analyses for (storm sewers) channel, or drainage way design, the starting water surface shall be based on the calculated water surface in the receiving channel (50 or 100 year). The developer shall provide documentation and/or calculations verifying the water surface elevation in the receiving channel. If the time of concentration for the storm sewer discharge is less than the time of concentration for the receiving waterway, then additional calculations shall be provided to account for the free outfall condition.~~

## ~~Subsection 1.12. Detention~~

~~If it is determined that development will have an adverse effect (increase runoff, raise water surface elevation or flood) on downstream property owners, developments, or other improvements (i.e., streets, etc.), then detention may be required by the City.~~

## ~~Subsection 1.13. Flumes~~

~~The use of flumes is not recommended for widespread use. Flumes shall not be permitted when the purpose of a permanent flume is to carry runoff down the sides of earthen channels. A flume may be used to direct overflow runoff along property lines until the runoff can be intercepted by streets or conduits. Flumes crossing sidewalks shall be covered or bridged such as to minimize danger to pedestrians.~~

It shall be the responsibility of the design engineer to schedule a meeting with the City Engineering staff to review the site regarding drainage prior to construction plan submittal.

## Subsection 5.02. Residential Grading and Drainage

### 5.02.01. Lot to Lot Drainage Standards

~~For standards refer to the Unified Development Code.~~

Drainage discharge from one lot shall not flow through another residential lot before entering a drainage easement, public right of way or storm drainage pipe system.

Any new building construction within a Special Flood Hazard Area shall provide the City Engineer with a Form Board Survey at the time foundation boards are set. An Elevation Certificate shall be provided to the City Engineer at the completion of construction, prior to the issuance of a Certificate of Occupancy.

### 5.02.02. Four General Residential Categories

Four general categories of residential lot grading and drainage plans are anticipated within the City. Specific deviations from these four plans will be considered on an individual basis.

Type 1: Rear Ridge

1. Lot grading resulting in a ridge along the rear property line of the residential lots with the lots flowing from back to front into the street.
2. Single swale, minimum 6-inch depth, between lots along the side lot lines when lots are at the same grade.
3. Single swale, minimum 6-inch depth, along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

Type 2: Gentle Cross Slope

1. Lot grading resulting from a gentle cross slope between parallel streets.
2. An interceptor system may be constructed along the rear lot line within a minimum 20-foot wide drainage easement ~~20 feet in width.~~ .
    i. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.
3. Single swale, minimum 6-inch depth, between lots along the side lot lines when lots are at same grade.
4. Single swale, minimum 6-inch depth, along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or an exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

Type 3: Steep Cross Slope

1. Lot grading resulting from a steep cross slope between parallel streets.
2. An interceptor system may be constructed along the rear lot line of the lower or downstream lot, solely upon the downstream lot, within a minimum 20-foot wide drainage easement ~~a minimum of 20 feet in width.~~ .
    a. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.

b. In cases where swales only are utilized, the minimum easement width may be reduced, with the approval of the ~~Director of Public Works~~City Engineer, if the depth of the swale is shallow enough to maintain a ~~mowable~~mow-able slope within the swale with the reduced easement width.

3. Single swale, minimum 6-inch depth, between lots alongside lot lines when lots are at the same grade.
4. Single swale, minimum 6-inch depth, along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

Type 4: Rear Valley/Swale

1. Lot grading resulting from a natural or planned valley or swale along the rear property line resulting in flows from lots fronting the parallel streets collecting at the rear of the lots.
2. An interceptor system shall be constructed along the rear lot line within a minimum 20-foot wide drainage easement ~~a minimum of 20 feet in width.~~.
   a. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.
   b. In cases where swales only are utilized, the minimum easement width may be reduced, with the approval by the City, if the depth of the swale is shallow enough to maintain a ~~mowable~~mow-able slope within the swale with the reduced easement width.
3. Single swale, minimum 6-inch depth, between lots alongside lot lines when lots are at same grade.
4. Single swale, minimum 6-inch depth, along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

## Subsection 5.03. Nonresidential Grading and Drainage

### 5.03.01. Lot to Lot Grading and Drainage Standards

For standards refer to the Unified Development Code.

### 5.03.02. Universal Considerations

Erosion Control

1. Erosion control is addressed at the time of completion of the development and prior to release for building permits.
2. Specific actions on the part of the individual home builder or building contractor shall be taken as needed to prevent damage to the swale system as well as the enclosed systems resulting from erosion and sediment build up.
3. Refer to Section 3 Stormwater Discharge Permit~~Ordinance 10-08-05-24~~ for ~~erosion control and illicit discharge regulation~~more information.

Inspection

Inspection of all lot grading and drainage shall take place:

1. In conjunction with the final inspection and acceptance (Letter of Final Acceptance) of the development infrastructure; and
2. At the time of final inspection of the structure under permit for Certificate of Occupancy.
3. Refer to Section 3 Stormwater Discharge Permit~~Ordinance 10-08-05-24~~ for ~~erosion control and illicit discharge regulation~~more information .

Enforcement

1. No approval and acceptance of the development infrastructure shall be issued by the City until the lot grading and drainage meets the plans submitted with the development's Construction Plans.
2. No Certificate of Occupancy shall be issued until lot grading and drainage meets the plans submitted with the building permit Application.
3. Any new building construction within or adjacent to a Special Flood Hazard Area shall provide the City Engineer with a Form Board Survey at the time foundation boards are set. An Elevation Certificate shall be provided to the City Engineer at the completion of construction, prior to the issuance of a Certificate of Occupancy.

## Subsection 5.04. Swimming Pool, Fence, Parking Lot, & Other Permit Applications

Unless exempted by the Director of Planning, building permit applications for the construction of swimming pools, fences, storage buildings, and other types of construction shall include a Grading and Drainage Plan reflecting the planned construction's impact upon the existing lot grading and drainage and any modifications to the existing lot grading and drainage that will be necessary to maintain proper drainage on the lot.

~~**1.13.01. Development Projects in Progress**~~

~~A. Buildings~~
~~Buildings under construction shall meet the intent of this policy by whatever means necessary to insure that lots drain appropriately.~~

~~B. Developments~~
~~Developments under construction shall incorporate the necessary additional drainage features and easements to meet the intent of this policy to insure that lots drain appropriately.~~

## Subsection 5.05. Erosion Hazard Setback

### 5.05.01. Erosion Hazard Setback

An erosion hazard setback shall be included within a Drainage Easement for open channels. The purpose of the setback is to reduce the potential for any damage to a private lot or street right-of-way caused by the erosion of the bank. The erosion hazard setback shall be determined as follows:

1. For stream banks composed of material other than rock, locate the toe of the natural stream bank. Project a 4:1 line sloping away from the bank until it intersects finished grade. From this intersection add fifteen feet (15') away from the bank. This shall be the limit of the erosion hazard setback.
2. For stream banks composed of rock or where the initial setback limits are too restrictive, the engineer may perform a detailed analysis of the erodibility of the streambank using industry standards for approval by the City Engineer. This usually requires a detailed geomorphological analysis which would take into account the type of rock present and the state of erosion of the creek.
3. Any modification within the area designated as erosion hazard setback, will require a geotechnical and geomorphological stability analysis, and a grading permit..

No Certificate of Occupancy shall be issued until lot grading and drainage meets the plans submitted with the building permit Application.

# Section 6. Sanitary Sewer

## Subsection 6.01. Basic Requirements

The Sanitary Sewer system shall be designed in conjunction with the City's Master Plan.

Design criteria for all sanitary sewer systems shall comply with TCEQ Chapter 217 (Design Criteria for Domestic Wastewater Systems), latest revision. Chapter 217 is included in Part 1 of Title 30 of the Texas Administrative Code.

Wastewater mains shall be sized and extended through the limits of a development to serve adjacent properties.

### 6.01.01. Minimum Diameter of Sewer Mains

The minimum diameter of sewer mains shall be eight inches (8").

### 6.01.02. Drainage Area Consideration

All sanitary sewers shall be designed with consideration for serving the full drainage area subject to collection by the sewer in question~~.~~, utilizing the City's current Land Use and Zoning information. All developments shall extend sewer to adjacent properties, at the development's cost, as determined based on the City's Master Plan.

### 6.01.03. Manholes

General Standards

1. Manholes shall be placed at points of change in alignment, grade, or size of sewer, the intersection of sewers, and the end of all sanitary sewer mains that will be extended at a later date.
2. Manholes shall be placed on property lines in the vicinity of their designated area.
3. Manholes ten feet (10') or deeper must be five feet (5') in diameter; otherwise a standard four foot (4'~~ wide~~) diameter manhole may be used.
4. Manholes shall be placed ~~in lieu of cleanouts~~ at the end of the line if the sewer line ~~is deeper~~, no cleanouts.
5. Manholes shall be concentric type conforming to ASTM C478 and C76.
6. Only precast manholes are approved for use. Cast in place manholes may be used with approval from the City Engineer.
7. ~~4.~~ Where more than three ~~feet.~~ manholes in sequence are to be bolted and sealed, every third manhole shall be vented two feet (2') above the 1% fully developed floodplain or ten feet (10') above the adjacent ground line, whichever is higher. The design engineer shall provide the elevation of the 1% fully developed floodplain. Vents shall include passive odor
8. False manhole bottoms shall be furnished and installed in all manholes constructed in advance of paving. These false manhole bottoms shall be placed at a time directed by the Construction Inspector, but will usually be constructed after all work is completed on the wastewater system including the air test, but prior to the final inspection. The contractor shall notify the Construction Inspector when they intend to remove a false manhole bottom. The paving contractor and Construction Inspector will coordinate the removal of the false manhole bottoms after the final appurtenance adjustment inspection.
9. Manholes lids shall have pick slots only unless specified otherwise with city approval.
10. Manholes with hinged lids shall not be permitted.
11. Manholes in low points, undeveloped areas or near floodplains shall be bolted down, gasketed, and water tight and/or built up 2' above the fully developed floodplain.

Spacing

1. Maximum manhole spacing for sewers with straight alignment and uniform grades should be determined so as to assure continuous operation based on available cleaning equipment~~.~~, and shall in no case exceed TCEQ spacing requirements.
2. The maximum manhole spacing shall be ~~as follows:~~five hundred feet (500'). Manholes on curved sanitary lines shall be located at the point of curvature (PC) or the point of tangent and have a maximum spacing of three hundred feet (300') along the curve.

~~Table 10: Minimum Manhole Design Standards~~

| ~~Sewer Pipe Size~~ | ~~Manhole Diameters~~ | ~~Maximum Distance Between Manholes~~ |
|---|---|---|
| ~~8"~~ | ~~4'-0"~~ | ~~650 Feet~~ |
| ~~10"~~ | ~~4'-0"~~ | ~~800 Feet~~ |
| ~~12"~~ | ~~5'-0"~~ | ~~900 Feet~~ |
| ~~15"~~ | ~~5'-0"~~ | ~~1,000 Feet~~ |
| ~~18"~~ | ~~5'-0"~~ | ~~1,000 Feet~~ |
| ~~21"~~ | ~~5'-0"~~ | ~~1,000 Feet~~ |
| ~~24"~~ | ~~5'-0"~~ | ~~1,000 Feet~~ |
| ~~30"~~ | ~~6'-0"~~ | ~~1,000 Feet~~ |
| ~~36"~~ | ~~6'-0"~~ | ~~1,000 Feet~~ |

Manhole Abandonment

1. Remove frame, lid and cone
2. Cut and plug all abandoned sewer mains at manhole
3. Fill bottom up to two inches (2") above the top of any prior openings with 2000 psi concrete.
4. Backfill and compact manhole cavity with sand and/or gravel.
5. Repair surface to match existing area.

### 6.01.04. Etching

The face of the curb shall be etched with ~~an~~ "MH" to mark the location of all manholes. The letters shall be a minimum of ~~3~~three inches (3") high. This is to be done by the utility contractor using a marked-up set of plans. The location of the etching shall be along a line that intersects the center of the manhole cover and is perpendicular to the centerline of the street. For manholes located in intersections the curb shall be stamped at the closest location to the manhole.

### 6.01.05. Sanitary Sewer Layout

All sewers shall be laid in straight alignment where possible with a uniform grade between the manholes. In those cases where horizontal curvature must be utilized to serve a particular area, the minimum radius of curvature shall be two hundred feet (200'). ~~Grades and appurtenances of sanitary sewers shall conform to the requirements of the TCEQ, and the following are the minimum slopes which should be provided for a velocity of at least 2 feet per second; however, slopes greater than these are desirable.~~

1. Wastewater mains shall be located at least two feet (2') off the back of curb, outside the pavement.
2. Wastewater mains shall be designed as straight as possible between manholes.

3. Wastewater mains running parallel with the right-of-way shall match change in street direction. When streets have horizontal curvature, curved sewers are acceptable to maintain parallel alignment with a roadway.
4. Minimum cover for a public wastewater main shall be four feet (4').
5. In general, the minimum depth for a wastewater main to serve a given residential property with a four inch (4") lateral shall be three feet (3') plus 2% times the length of the house lateral. This for a house one hundred and thirty five feet (135') from the wastewater main, depth would be 3'+2.7=5.7'. The depth of the flow line of the wastewater main then should be at least 5.7' below the elevation of the ground at the point where the service enters the house. Profiles of the ground line twenty feet (20') past the building line will be required to verify that this criterion is met.
6. No vertical bends or vertical curves shall be allowed between manholes.
7. A parallel wastewater main shall be required for wastewater lateral connections on wastewater mains deeper than twelve feet (12')
8. Wastewater mains shall be placed on such a grade that the velocity is not less than two feet per section (2 fps) or more than ten feet per second (10 fps) at design peak flow. The following table of values may be used. .

Table 6_1: Sanitary Sewer Minimum Slopes

| Sewer - Diameter | Minimum Slope in Feet Per 100 Feet |
|---|---|
| 4-inch in the right-of-way (service only) | 1.000 |
| 6-inch (service only) | 0.500 |
| 8-inch | 0.330 |
| 10-inch | 0.250 |
| 12-inch | 0.200 |
| 15-inch | 0.150 |
| 18-inch | 0.110 |
| 21-inch | 0.090 |
| 24-inch | 0.080 |
| 27-inch | 0.060 |
| 30-inch | 0.055 |
| 36-inch | 0.045 |

*The slopes were calculated using Manning's Equation and a roughness coefficient of 0.013.

### 6.01.06. Flow Line

The flow line into a manhole must ~~not~~ be either greater than 6 inches above the flow line out~~, or the flow line in must be greater~~ and less than 2 foot above the flow line out. Manholes where the flow line in is greater than ~~2~~two feet (2") above the flow line out shall be outside drop manholes.

### 6.01.07. Sewers

Sewers shall be located in the right-of-way as per standard detail and shall be a minimum of ~~five~~four feet (~~5~~'4') deep to the top of pipe.

### 6.01.08. Cleanouts

~~Standard~~If allowed by the City Engineer, cleanouts shall be constructed at the ends of all sanitary sewers where a manhole is not provided. A 2'-0" x 2'-0" x 4" reinforced concrete pad (#3 rebar) shall be placed around all cleanouts. The curb location shall be stamped with "CO" in letters a minimum of three (3) inches high.

### 6.01.09. Specifications

All pipe manholes, cleanouts, ~~embedments~~embedment materials, testing procedures, and other improvements, associated with the installation of the sanitary sewerage system improvements shall be furnished and constructed in conformance with the applicable specifications of A.S.T.M., A.N.S.I., W.E.F. and N.S.F., latest editions.

### 6.01.10. Final Grade

Manholes and cleanouts shall be adjusted to final grade prior to placement of permanent paving.

~~**1.13.02. Rainstopper**~~

### 6.01.11. Infiltration & Inflow

Each manhole shall be furnished with an inflow and infiltration barrier apparatus (see approved material list) between the cone and support frame of the manhole system. The apparatus includes a barrier, a manhole insert, and seal that restricts the inflow and infiltration of water or other debris into the interior of the manhole system. All manholes shall be equipped with a non-collapsible ~~rainstopper~~rain stopper installed between the lid and ring. ~~Rainstopper~~Rain stopper manufacturers shall be approved by the City.

### ~~6.01.11.~~ 6.01.12. Extend to the Borders of the Subdivision

All sewer mains installed within a subdivision must extend to the borders of the subdivision as required for future extensions of the collection system, regardless of whether such extensions are required for service within the subdivision.

### ~~6.01.12.~~ 6.01.13. Service Laterals

All service laterals below proposed areas to be paved shall be installed, tested and properly backfilled prior to the subgrade preparation and pavement construction.

Service laterals for residential subdivisions shall be installed to the right of way and extended to the building pad and extended 3' above grade unless the home construction is happening simultaneously. When the building contractor and plumber connect to the sewer service, a cleanout shall be installed to city standards and inspected by the city prior to acceptance. All repairs shall be made prior to acceptance of the home if there are any service

### ~~6.01.13.~~ 6.01.14. Lateral Locations Stamped

All lateral locations shall be stamped into the curb by the utility contractor with an "S" at the point the lateral crosses the curb. Lettering shall be at least three inches (3") high.

### ~~6.01.14.~~ 6.01.15. Service Lateral used for the Discharge of Industrial Waste

Any service lateral used for the discharge of industrial waste into the City's sanitary sewer collection system shall have a control manhole constructed and maintained by the discharger of the industrial waste. The control manhole shall be constructed downstream from any storage tanks or pretreatment works and shall be used by the City for sampling and monitoring the industrial waste. The control manhole shall be constructed in a location where City personnel are not restricted from access. The control manhole shall be located within the Right-of-way or the industry must provide an easement.

### ~~6.01.15.~~ 6.01.16. All Residential Sewer Services

All residential sewer services shall be ~~4~~four inch (4") SDR-35 pipe located on the lot~~,~~ line between two lots or ten feet ~~down stream~~(10') downstream from the center of the lot when common lot lines won't work with the layout. Services shall be extended into the lot with a plug and green sewer detector tape at the end of the line. For new developments, extend the PVC clean-out thirty-six inches (36") above finished grade with plug. The cleanout shall be installed at the customers side of the property line.

### 6.01.17. All Other Sewer Services

All other sewer services shall be six inch (6") SDR-35 pipe and directly connect to a manhole. If no manhole is present along the main, then a manhole shall be built over the existing main.

### ~~6.01.16.~~ 6.01.18. Depth

Sewer services shall be no deeper than ~~6 to~~ seven (7) feet unless otherwise specified. Services that cross roads must be compacted and densities taken.

### ~~6.01.17.~~ 6.01.19. 150 psi Rated Sewer Line

When a 150 psi rated sewer line is required due to its proximity to a water line (less than 9' horizontally), the 150 psi rated pipe shall terminate at a manhole on each end. All changes in pipe inside diameter shall require a manhole at the junction.

### ~~6.01.18.~~ 6.01.20. Sanitary Sewers Specifications

Standards

Sanitary sewer mains shall be constructed of polyvinyl chloride (PVC) pipe and shall conform to the specifications of ASTM D 3034, SDR 35, or equal. Joints for the PVC pipe and fittings shall be compression rubber gasket joints. The bell shall consist of an integral wall section with factory installed ring securely locked in bell groove to provide positive seal under all installation conditions. Fittings and accessories shall be manufactured and furnished by the pipe supplier, or approved equal, and shall have bell and/or spigot configuration identical to that of the pipe. If the sanitary sewer main is greater than fourteen feet (14') deep, SDR-26 or equal shall be used. Domestic products only.

Connections

Connections shall be made with ~~fabricated~~prefabricated fittings. Field-glued connections are not allowed. When PVC pipe passes through a manhole wall, a positive water-tight connection shall be made.

~~A. Design~~

Embedment

The PVC pipe shall be placed on a six-inch (6") layer of crushed rock, rounded gravel bedding material. The trench shall be backfilled with a minimum of six inches (6") of gravel/rock on the sides and six inches (6") gravel/rock over the top of the pipe and consolidated to a minimum of 95 percent standard proctor density. This is basic Class "B" embedment as defined by ASCE Manual No. 37 and AWWA C900-75 and ASTM C2321, with five percent (5%) maximum ~~Mandrell~~Mandrel Test to be performed. The ~~embedent~~embedment material is further defined as follows:

~~1.~~9. 95% of Material Passing 3/4" Screen

~~2.~~10. 95% of Material Retained on No. 4 Screen

Standard Details and Specifications

The encasement, embedment, and backfill requirements for PVC pipe, and ductile iron pipe shall conform to the standard details and specifications of the City.

### ~~6.01.19.~~ 6.01.21. Tests

Testing

Prior to ~~acceptance,~~placement of paving and prior to final acceptance (depending on potential damages (i.e. franchise, grading, paving etc.), the sanitary sewers shall be subject to T.V. camera, air (in accordance with American Water Works Association [AWWA]), and ~~Mandrell~~Mandrel tests. Force mains shall be tested at 150 psi for four (4) hours. Testing time for gravity lines shall be determined by the City Inspector.

Payment of all Expenses

Any developer or contractor causing infiltration or in-flow into the City's sanitary sewer system, either knowingly or unknowingly, shall be required to pay all expenses incurred by the City due to said infiltration or in-flow as determined by the City.

### 6.01.22. Wastewater Flows

If project specific wastewater flow projections or actual flow measurements are not available for a development, the criteria in the below table shall be used to calculate average daily wastewater flows. This criteria meets or exceeds the minimum requirements as set by TCEQ in Title 30 of the Texas Administrative Code, Part 1, Chapter 217, Subchapter C, Rule 217.32(a)(3).

Table 6-2: Wastewater Flow Projections

| Land Use | Design Factors | Average Daily Wastewater Flows |
|---|---|---|
| Apartment | • 3.0 persons/unit<br>• 102 gallons per person per day | 306 gpd/unit |
| Residential/ Town Home/ Patio Home | • 3.5 persons/unit<br>• 102 gallons per person per day | 357 gpd/unit |
| Hospital (beds) | • 200 gallons per bed per day | 200 gpd/bed |
| Nursing Home or other Institution (beds) | • 100 gallons per day per bed | 100 gpd/bed |
| Commercial / Industrial/ Office | • 1 person per parking space, or<br>• 1 person per 400 s.f. of building<br>• 20 gallons per person per day | 20 gpd/unit |
| School | • 20 gallons per student per day | 20 gpd/unit |

*gpd = gallons per day

Ideally flow monitoring should be used to determine the relationship between the peak flows and the average daily flow for each area of a wastewater system. In the absence of flow monitoring data a standard peaking factor relationship can be utilized. The Dallas Water Utilities (DWU) method will be used unless specified otherwise by the City Engineer. This method applies a peaking factor based on pipe size that varies 3.0 to 4.0. The peaking factor is applied to the average daily flows and considers infiltration and inflow.

Table 6 2: Dallas Water Utilities – Wastewater Peaking Factors

| Pipe Size | Peaking Factor | Depth of Flow |
|---|---|---|
| Less than 18" | 4 | Full |
| 18" through 30" | 3.5 | Full |
| Larger than 30" | 3.0 | Full |

### ~~6.01.20.~~ 6.01.23. Lift Stations

Design

All lift stations shall be designed and constructed with two or more sewage pumps, and the stations shall be capable of pumping the design maximum flow with the largest pump out of service. Detailed design data, plans, and specifications of the pumps shall be submitted to and accepted by the City Engineer prior to the installation of the lift station.

Additional Design

The lift station site design shall also include the following:

1. Auto dialer with active telephone service,
2. SCADA system and all required antennas and electronics to connect to city systems,
3. A metering system,

~~3. A fence of 6' chain link with 3' of barbed wire or 8' chain link,~~

4. A fence of 8' decorative metal with curved bars at the top towards the outside. Substitution of other materials shall be approved by the Director of Public Works.

~~4.~~5. Gates approved by the ~~City~~Director of Public Works, and

~~5.~~6. Paved access.

The City utilizes Xylem for pumps & equipment and Prime Controls for SCADA. For use of other manufacturers obtain approval from the Director of Public Works.

### ~~6.01.21.~~ 6.01.24. Force Mains

Materials

All force mains shall be polyvinyl chloride or ductile iron water pipe. Ductile iron pipe shall be minimum class 50, with rubber gasket joint, and shall have a cement mortar lining, with a seal-coat of bituminous material or may have a polyethylene lining.

Design

At design for average flows, a cleansing velocity of at least two (2) feet per second shall be maintained. Automatic air relief valves shall be placed at high points in the force main.

### 6.01.25. Dumpster Drains

Should a dumpster pad/enclosure require a drain/inlet or should the area need to be washed out, then a drain shall be provided and routed to the wastewater system and not the storm drainage system. Dumpster enclosures shall be designed and constructed to prevent the site drainage from entering the enclosure in order to limit the amount of rainwater that would enter the wastewater system.

# Section 7. Water

## Subsection 7.01. Basic Requirements

### 7.01.01. General

The intent of the water system design requirements is to list minimum requirements for public water distribution and transmission system facilities and appurtenances. Private fire service mains shall also be designed according to these water system design requirements, the City's Fire Code and the National Fire Protection Association (NFPA) 24: Standard for the installation of Private Fire Service Mains and Appurtenances, latest revision.

Design criteria for all water systems shall comply with Texas Commission on Environmental Quality (TCEQ) Chapter 290, Subchapter D (Rules and Regulations for Public Water Systems); latest revision. Chapter 290 is included in Part I of Title 30 of the Texas Administrative Code.

Water mains shall be sized and extended through the limits of a development to serve adjacent properties.

Dead end water mains are not allowed unless approved in writing by the City Engineer or designee; however, if approved, an automatic flushing device shall be provided. Automatic flushing devices shall drain via a pipe system to the storm sewer system..

### ~~7.01.01.~~ 7.01.02. Water Mains Standards

All water mains ~~in residential areas~~ shall be a minimum of ~~six~~eight inches (~~6~~8") in size and looped with ~~six~~eight inch (~~6~~8") minimum diameter mains at intervals not to exceed one thousand feet (1000'). ~~Where intervals between connecting mains must exceed one thousand feet (1000'), or where dead-ends must exist, eight inch (8") diameter or larger mains shall be installed.~~

Water mains in industrial and commercial areas shall be AWWA C900 Class 151 (DR18) PVC pipe, a minimum eight inches (8") in size and be connected to an eight inch (8") or larger main that connects to pump stations or elevated storage reservoirs ~~every six hundred feet (600').~~ . Where dead-ends must exist, eight inch (8") or larger mains shall be installed with a flush valve or fire hydrant installed. The minimum ~~limits set forth in the above~~dead end main of six hundred feet (600') shall not be exceeded except upon the specific approval by the Director of Planning, City Engineer, Director of Public Works ~~Director~~, and the Fire Chief, but in no event shall these requirements be less than the minimum required by the State Board of Insurance or the Fire Prevention and Engineering Bureau of Texas.

Horizontal and Vertical Alignment

1. Water mains shall be installed a minimum of two foot (2') from back of curb, as measured to the centerline of pipe
2. Water main locations can be adjusted based on existing field conditions with approval from the City Engineer.
3. Water mains shall be designed to minimize bends and fittings and follow right-of-way alignments or roadway centerline curves at a uniform distance from the edge of right-of-way or centerline or back of curb.
4. Water mains shall transition around stormwater inlets to provide at least 1' clear between the outside of the pipe and the back of the inlet. The transition shall be made via a series of horizontal curves.

5. A clearance of eighteen inches (18") shall be maintained when crossing storm drain systems. Where a minimum clearance cannot be achieved, water mains shall be encased in six inches (6") of concrete in accordance with the standard detail.
6. Lines less than twelve inches (12") in diameter, within developed areas, shall have a minimum cover of four feet (4'), within undeveloped area six feet (6') shall be required.
7. Lines between twelve inches (12") and twenty inches (20") within developed areas, shall have a minimum cover of five feet (5'), within undeveloped area six feet (6') shall be required.
8. Lines greater than twenty inches (20") within developed areas, shall have a minimum cover of six feet (6'), within undeveloped area seven feet (7') shall be required.
9. Water mains shall be designed as straight as possible following the existing or proposed grade at the minimum depth of cover. Bends shall be provided where vertical slope changes exceed eighty percent (80%) of the manufacturer's joint deflection.
10. Excessive high points that trap air and restrict water flow shall be avoided.

### Separation Distance Between Water and Wastewater

1. The separation distance between water mains and wastewater mains, manholes or other appurtenances is governed by Title 30 of the Texas Administrative Code, Part 1, Chapter 290, Subchapter D, Rule 290.44(e) and Chapter 217, Subchapter C, Rule 217.53(d).
11. Water mains shall have a minimum separation distance of nine feet (9') in all directions from wastewater collection facilities. Separation distances shall be measured from the outside surface of each of the respective facilities.
12. If the minimum separation distances cannot be achieved for parallel water and wastewater mains, the separation distances may be reduced if the material of the wastewater main has a minimum pressure rating of 150 psi. In these cases, the water main shall be placed above the wastewater main with minimum separation distances of four feet (4') horizontally and two feet (2') vertically.
13. If the minimum separation distances cannot be achieved for crossing water and wastewater mains, the separation distances may be reduced under two scenarios:
    a. The wastewater main has a minimum pressure rating of 150 psi.
    b. The water or wastewater main is cased for a minimum of eighteen feet (18') with a casing pipe having a minimum pressure rating of 150 psi.

    Under each scenario, the water main shall be centered on the wastewater main crossing with a minimum separation distance of twelve inches (12").
14. When water mains are designed to be closer than nine feet (9') to wastewater manholes the water main shall be cased as described in section 2.1.3D above.
15. Residential water and sewer service lines shall be ten feet (10') apart.

### Average Daily Water Demands

Apart from project specific water demand and/or actual flow measurements, the following values shall be used when calculating the average daily water Demands:

Table 7 1

| Land Use | Design | Calculation |
|---|---|---|
| Apartment | 3.0 persons/unit<br>230 gallons per person per day | 690 gpd/unit |

| | | |
|---|---|---|
| Residential/ Town Home/ Patio Home | 3.5 persons/unit<br>230 gallons per person per day | 805 gpd/unit |
| Hospital | 720 gallons per day per bed | 720 gpd/bed |
| Nursing Home or other Institution (beds) | 240 gallons per day per bed | 240 gpd/bed |
| Commercial/ Industrial/ Office | 1 person per parking space, or 1 person per 400 SF SF of building | 50 gpd/person |
| School | 30 gallons per day per student | 30 gpd/student |

### ~~7.01.02.~~ 7.01.03. Fire Hydrant Flush Values

Install automatic flush valve ~~where necessary~~at the end of dead end mains.

### ~~7.01.03.~~ 7.01.04. Water Main Testing

The water mains shall be tested at 150 psi for four (4) hours in accordance with AWWA testing standards.

### ~~7.01.04.~~ 7.01.05. Fire Hydrant

Fire hydrants shall conform strictly to the latest edition AWWA C502 *Standard Specifications for Ordinary Water Works Service* dry-barrel fire hydrants with all bronze to bronze moving parts, except for changes or additions specifically outlined as follows:

~~B. Details~~

All fire hydrants shall have one 4 1/2" steamer nozzle and two 3 1/2" NST hose connections with the City's standard threads. The main barrel valve opening shall not be less than five inches (5"), and shall be placed on connecting mains of not less than eight inches (8") in diameter. Six inch (6") gate valves shall be placed on all fire hydrants leads.

~~C. Valves~~

Valves for fire hydrants shall be ~~flanged~~bolted directly to the tees installed on the main, using either a flanged tee and valve or a MJ with spool/retainer gland allowing the valve to be directly bolted to the tee. .

~~D. Paint~~

All fire hydrant bonnets and caps shall be painted by the developer in accordance with the size of the water main in which the fire hydrant lead is attached. The remainder of the hydrant above ground shall be painted aluminum.

~~1.~~16. 8-inch Main - Safety Blue

~~2.~~17. 10-inch main and larger - Standard Yellow

~~E. Operating Nut~~

The operating nut shall be a 1 1/2 inch pentagon nut, designed to prevent seepage of rain or sleet and the accumulation of dust around the revolving nut. The operating nut shall conform to the standards now in use by the City. The hydrant valve shall open by turning to the LEFT.

~~F. Operating Mechanism~~

The hydrant top or bonnet shall be free draining of a type that will maintain the operating mechanism in readiness to use under freezing conditions. It shall be so designed as to make tampering difficult and shall be provided with convenient means to afford lubrication to insure ease of operation and the prevention of wear and corrosion.

~~G. Breakable Flange or Breakable Cast-Iron Flange Bolts~~

The body of the hydrant shall be equipped with a breakable flange, or breakable cast-iron flange bolts, just above the grade-line.

~~H. Extension Design~~

All hydrants shall be of such design as will permit their extension without excavating in case of future grade changes.

~~I. Accident Design~~

The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision, it may be replaced without excavating or breaking the pavement. The barrel and operating mechanism shall be so designed that in case of accident, damage or breaking of the hydrant above or near the grade level, the main valve will remain reasonably tight against leakage or flooding.

~~J. Waterway~~

Changes in shape or size of the waterway shall be accomplished by means of easy curves. The junctions of hose or pumper nozzles with the barrel shall be rounded to ample radii. Exclusive of the main valve opening, the net area of the waterway of the barrel and foot piece of the smallest part shall be not less than 150 percent of that of the net opening of the main valve.

~~K. Drain or Drip Valve~~

Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs or gravity is not acceptable.

~~L. Operating Stems~~

Operating stems whose threads are not located in the barrel or waterway shall be made of genuine wrought iron or steel and shall be bronze bushed where passing through the stuffing box. Operating threads must be sealed against contact with the water at all times regardless of open or closed position of main valve. All operating stems shall be coupled opposite the break flange with a breakable coupling or coupled in such a way as to part without breaking.

~~M. "O" ring seals~~

Unless otherwise specified by the City, hydrants shall be furnished with "O" ring seals.

~~N. Hydrant Adjustment~~

The hydrant head shall be constructed so that it may be rotated to face the nozzles in any desired direction. Fire hydrants shall be adjusted to proper grade after placement of permanent paving and the steamer nozzle shall be placed facing the street frontage.

~~O. Bronze Cap Nut~~

Hydrants closing with the pressure must have a bronze cap nut to seal the bottom end of steam threads against contact with water.

~~P. Placement~~

~~Fire hydrants shall be installed within the area between the back of curb and front of sidewalk with the use of grade lock devices or retainer glands.~~ Thrust blocks shall be placed behind the hydrant so as not to block the weep holes. **"DO NOT"** use plastic around bottoms of hydrants, not allowing the weep holes to drain.

~~Q. Reflector and Stamp~~

A blue ~~Stimsanite Fire Lite~~ reflector ~~or approved equal~~ shall be placed in the center of the street opposite the fire hydrants. "FH" shall be stamped on the curb at the location of the fire hydrant in letters a minimum of 3 inches high.

~~R. Flush Values~~

Automatic Flush valves shall be installed in cul-de-sacs where a fire hydrant is placed more than ~~100~~one hundred feet (100') from the end of the cul-de-sac. Flush valves shall consist of two inch (2~~"~~") copper or Poly SDR9, tapped to the main and run into a jumbo meter box with a female curb stop, pointed up.

**Commented [GM1]:** Need to modify

~~S. Drawings~~

If required by the City, the developer shall furnish drawings with complete detailed dimensions of the hydrant proposed for the subdivision.

Fire Hydrant Locations and Standards

1. Fire hydrants shall be ~~placed~~installed within the area between the back of curb and front of sidewalk with the use of grade lock devices or retainer glands (typically 2-3' off the back of curb).

2. Fire hydrants shall be installed at a minimum of ten (10') away from the curb return for all ~~locations shown in the plans.~~ streets and fire lanes.

~~1.~~3. Each hydrant shall be set upon a slab of stone or concrete not less than four inches (4") thick and not less than one (1) square foot of surface area. Where solid rock exists in the bottom of the trench and same is excavated to the proper depth to form a foundation for the hydrant, the slab of stone or concrete above specified may be omitted.

~~2.~~4. The hydrant shall be set perpendicular, and to the proper depth, and shall be carefully and substantially blocked against firm trench walls using Class 2,000 concrete as herein specified.

~~3.~~5. There shall be placed around the base of the hydrant not less than seven (7) cubic feet of sound broken stone or clean gravel, or other suitable material to provide sufficient reservoir capacity so that the hydrant will completely drain when closed~~.~~

Fire Hydrant Flush Pad

A 6" reinforced concrete pad shall be placed twelve inches (12") around the hydrant (min 30" in width) and extending & tied to the back of curb.

Loop

Fire Hydrant leads exceeding one hundred (100') shall be looped with a minimum eight inch (8") line.

Fire Hydrant Installation Required before Erection of any Building

Fire hydrants shall be installed, tested and operable prior to a building permit being issued.

Easements

The owner of any commercial or industrial tract property contemplated for development on which fire hydrants and water mains are to be installed shall provide easements to the City whereby the Fire, Police and Water Utilities Departments of the City shall have ready ingress and egress to, from, and across such property to any location on such property when necessary to extinguish a fire or to prevent the occurrence of a fire or to maintain, service and inspect such fire hydrants and water mains that may be installed or when such access to and from said property is essential to the preservation of life or property.

### 7.01.02. Gate Valves

Gate valves shall conform to American Water Works Association Specification C 509, or latest edition. Valves shall be designed for a minimum water working pressure 150 pounds per square inch. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning to the left. Each valve shall have the maker's initials, pressure rating, and year in which manufactured cast in the body. Valves installed for future service shall be in the closed position on ~~stubouts.~~ stub outs. At least twenty feet (20') of pipe shall be installed beyond the valve and plugged.

All valves buried in the ground shall be provided with cast-iron valve boxes of proper dimensions to fit over the valve bonnets and to extend to such elevation at or slightly above the finished street grade or ground line. Tops shall be complete with adjustable covers. Valve boxes shall be set vertical and concentric with the valve stem and adjusted to proper line and grade after placement of permanent paving. Any valve box which has so moved from its original position as to prevent the application of the valve key shall be satisfactorily reset by the developer at his own expense. A reinforced concrete pad of the dimensions 2'-0" x 2'-0" x 4" with #3 rebar shall be placed around all valve boxes.

### 7.01.03. Depth of Cover

The depth of cover shall be a minimum of 60 inches from finished grade to top of pipe.

### 7.01.04. Pipeline Markers
Pipeline Markers will be used to locate road crossings and cross country lines in rural areas.

### 7.01.05. Valve Markers
Valve markers shall be provided in rural areas.

### 7.01.06. Adequate Air Relief, Drain, and Flush Valves
Adequate air relief, drain, and flush valves must be provided for flushing, disinfection, daily operation requirements, and repairs.

### 7.01.07. Conformance of Water System Improvements
All pipe, fittings, valves, services, embedment materials, testing procedures, and other facilities related to the water system improvements shall be furnished and installed in conformance with the applicable specifications. A.S.T.M, A.W.W.A., A.N.S.I., latest editions.

### 7.01.08. Minimum ~~Fireflow~~Fire flow
The minimum ~~fireflow~~fire flow shall be as recommended by the State Board of Insurance.

### 7.01.09. Stamping “W”
All service locations shall be marked by stamping a "W" into the face of the curb where the service intersects the curb. All lettering shall be a minimum of 3 inches high.

### 7.01.10. Stamping “V”
All valve locations shall be stamped into the face of the curb with the letter "V". All lettering shall be a minimum of 3 inches high. The stamp shall be located on a line that intersects the curb and valve box cover perpendicular to the center line of the street.

### 7.01.11. Water Mains Twelve-Inch (12") in Diameter and Smaller
All water mains twelve inches (12") in diameter and smaller may be either ductile iron pipe, thickness Class 50 minimum, or polyvinyl chloride pipe as specified below, unless otherwise specified. Water mains larger than twelve inches (12") may be constructed with either, PVC, ductile iron pipe, or other materials approved by the City Engineer.

### 7.01.12. Ductile Iron Pipe
The ductile iron pipe shall have a single rubber gasket joint, shall have a cement mortar lining of the "Enameline" type, or approved equal, and shall have a minimum cover of sixty inches (60"). Water mains ~~fourteen inches (14") and larger may be either~~of ductile iron pipe~~,~~ shall have a thickness Class 50 minimum, with cement mortar lining~~, or~~ and reinforced concrete steel cylinder pipe, Class 150 minimum. Ductile iron pipe or pvc with approved casing shall be required in all bores, in unstable solid conditions (expansive clays, unstable subsoil), in or near creeks or where lines must be installed at shallow depths (less than 36").

The ductile iron pipe shall be centrifugally cast in metal molds in accordance with the latest edition of the applicable specifications of ANSI A21.5 (AWWA C151) and Federal Specification WW-P-421c. The joint details shall be in accordance with the applicable specifications of ANSI A21.11 (AWWA C111), latest edition. All ductile iron pipe shall be ~~polywrapped~~poly wrapped as recommended by the manufacturer .

### 7.01.13. Polyvinyl Chloride (PVC) Pipe
Polyvinyl chloride (PVC) pipe may be installed for water mains in the public water utility system.

PVC Pipe and Fittings

1. PVC pipe shall be new, manufactured in the United States of America, and shall conform to the current specifications of AWWA C900 Class 150 (DR18) PVC pipe with cast iron outside

dimensions and with rubber ring joints. PVC water pipe shall be listed by Underwriters Laboratories and approved for use in cities and towns of Texas by the State Board of Insurance. The rigid PVC pipe shall bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

2. Provision must be made for contraction and expansion at each joint with a rubber ring and an integral thickened bell as part of each joint. Pipe and fittings must be assembled with a non-toxic lubricant. Pipe shall be made from NSF approved class 12454-A or B PVC compound conforming to a minimum ASTM resin specification D 1784. PVC pipe shall be Class 150 (DR 18) and meet the physical dimensions as shown on the following list.

| Table 7.2: PVC Physical Dimensions | | |
|---|---|---|
| Nominal Size (Inches) | Outside Diameter (Inches) | Class 150 (DR-18) Nominal Wall Thickness (Inches) |
| ~~6~~ | ~~6.90~~ | ~~0.406~~ |
| 8 | 9.05 | 0.533 |
| 10 | 11.10 | 0.654 |
| 12 | 12.20 | 0.777 |

3. PVC pipe shall be designed for a minimum 150 p.s.i. water pressure, plus 35 p.s.i. surge allowance. Service connections shall not be made by direct tapping for service lines; a brass tapping saddle shall be used to tap service lines.

PVC Pipe Special Embedment

1. PVC Pipe shall be placed on a six inch (6") layer of cushion sand.
4. The trench shall be backfilled with a minimum of six inches (6") of sand on the sides and twelve inches (12") of loose sand over the top of the pipe and consolidated to a minimum of 95 percent standard proctor density. This is basic - Class "B-3" as defined by ASCE Manual No. 37 and AWWA C900-75. Final backfill is to conform to Section W.4.16.1, or Section W.4.16.2. The Class "B" embedment material is further defined as follows:
   a. 95% of Material Passing 3/4" Screen
   b. 95% of Material Retained on No. 4 Screen
   c. Cushion sand acceptable by the City
5. Tracer tape, blue in color, similar to Terra Tape or an approved equal "D" DETECTABLE, shall be installed in the backfill material twenty four inches (24”) over the top of all water mains in accordance with the manufacturer's recommendations.

### 7.01.14. Fittings

Fittings shall be ductile iron with mechanical joints and shall be cement-lined and coated with a seal-coat of bituminous material, unless the pipe material is reinforced concrete steel cylinder, in which case special fitting shall be furnished. ~~Megalug~~Mega-lug flanges (or equivalent) shall be used. All ductile iron fittings shall conform to the applicable standards and specifications of ANSI, latest edition. The use of imported fittings and appurtenances shall be prohibited.

### 7.01.15. Water Services

~~Water~~Single water services shall be placed on property line opposite from the sanitary service. At a minimum, 3/4” CC thread, 3/4” comp x CC thread corporation stop,, 3/4” copper, 3/4” curb stop compression x female thread, and 3/4” locking angle stop. The top of the angle stop shall be 7-1/2” below the top of the meter box.
Bullhead water services, when absolutely necessary, shall be placed on property lines to serve two lots. It is the preference of the Public Works Department to utilize single services whenever possible. A service consists of a

bronze or brass tap saddle with 1" CC thread, 1" comp x CC thread corporation stop, 1" copper, 1" curb stop compression x female thread, and a bull-head 7-1/2" wide with male thread on all three sides and two 3/4" locking angle stops. The top of the angle stop shall be 7-1/2" below the top of the meter box. The meter box shall be
The City will allow the use of poly pipe for water services as individually approved by the Director of Public Works and/or City Engineer.

### 7.01.16. Where Single Services Exist

Where single services exist they shall be placed on property line with a 1" line and reduced at the angle stop.

### 7.01.17. Where a Dual Service Intersects a Manhole or Hydrant

Where a dual service intersects a manhole, inlet or hydrant, two singles shall be brought up to both sides of the object with the same specifications as single services.

### 7.01.18. Thrust Blocking

Thrust blocking shall be installed behind fire hydrants, elbows, and tees ~~without plastic wrap~~. Poly wrap all fittings prior to thrust blocking installation. (2 layers of

~~**1.13.03. Water Samples**~~

All pressurized water and wastewater mains shall be restrained against thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.
Thrust restraint shall be accomplished by concrete thrust blocks and restrained joints
All valves, fittings and changes in elevation shall have concrete thrust blocks and restrained joints installed.
Thrust blocking shall be Class "B" concrete and sulfate resistant. It shall be able to withstand a minimum 200 psi test pressure with a minimum safety factor of 1.5 without exceeding the soil bearing capacity.
Restrained joints lengths shall be calculated to withstand a minimum 200 psi test pressure with a minimum factor of safety of 2.0.
All calculations are based on internal pressure of 200 psi for ductile iron and P.V.C.
Volumes of thrust blocks are net volumes of concrete to be furnished. The corresponding weight of the concrete is equal to or greater than the vertical components of the thrust on the vertical bend.
Pour concrete for block against undisturbed earth
Dimensions may be varied as required by field conditions where and as directed by the Engineer.
The soil bearing pressure are based on 1000 lbs/s.f in soil and 2000 lbs./s.f in rock.
Use polyethylene wrap or equal between concrete and bend, tee or plug to prevent the concrete from sticking to it.
For standard fittings, concrete shall not extend beyond joints.
The following technical references are available for calculating thrust restraint systems:

1. AWWA Manual M9: Concrete Pressure Pipe by AWWA, Latest Edition.
2. AWWA Manual M11: Steel Pipe – A Guide for Design and Installation by AWWA, Latest Edition.
3. AWWA Manual M23: PVC Pipe – Design and Installation by AWWA, latest Edition.
4. Thrust Restraint for Ductile Iron Pipe by Ductile Iron Pipe Research Association (DIPRA), 2006, or Latest Edition.
5. Thrust Blocking, National Fire Protection Association Standard 24, standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2007 Edition

### 7.01.19. Testing

Water Quality and Testing: Water mains shall be designed to provide adequate circulation by looping water mains to prevent odor, taste and color problems associated with stagnant water. Disinfection must be performed in accordance with American Water Works Association (AWWA) requirements. Water samples shall be collected and submitted to a City approved laboratory by the Contractor. The water main will remain out of service until the water mains have been tested and approved for public consumption. In general, bacteriological tests are performed with

passing results after the lines have been pressure tested. One water sample per each street name or as approved by the City Engineer.
The contractor shall be responsible for the following:

1. Cleaning pipes by purging using the flushing method or the poly-pig method to enter and exit at approved strategic locations if possible and as per NCTCOG item 506.7 specifications, to include all equipment, materials, fittings and labor.
2. Water samples may be taken after the pressure test and chlorine has been injected and sat for a 24 hour period. Water samples can be taken by the City ~~or by the Contractor.~~ Inspector. Test Results shall be sent to City of Corinth, 3300, Corinth Parkway, Corinth, Texas 76208 Attention: Utilities Superintendent~~.~~ and Construction Inspector.
3. Hydrostatic test as per NCTCOG item 506.5 specifications.
4. All temporary test points are to have corporation stops at the main.
5. All temporary testing and chlorination points shall be removed at the corporation prior to final acceptance.

The contractor shall provide backfill, density and concrete testing for all projects unless specified otherwise. All reports shall be turned in to the Inspector within five (5) working days.

# Section 8. Miscellaneous Utility

## Subsection 8.01. Trenchless Construction (water and wastewater)

Launching and receiving pits for trenchless construction shall be a minimum 5' from the edge of pavement.

Location, size, depth of the pit shall be evaluated during the design of the project and prior to City review.

Horizontal Boring – Shall require a steel casing pipe with minimum yield strength of 35,000 psi and minimum wall thickness of a quarter of an inch (1/4"). Actual wall thickness shall be designed based on a highway loading of HS-20, a maximum deflection of 5% and a minimum factor of safety of 2.0.

Pipe Jacking – Pipe shall be designed to withstand all jacking forces with a factor of safety of 2.0 during construction.

## Subsection 8.02. Creek Crossings

1. All water and wastewater mains crossing under a flowing stream or semi-permanent body of water such as a marsh or pond shall be encased with concrete or steel casing pipe in accordance with Horizontal Boring, or approved equal.
2. Wastewater main crossings shall include a manhole on each side of the creek crossing beyond the erosion hazard setback.
3. Water main crossings shall include a valve beyond the erosion hazard setback on each side.
4. Water mains installed under and across creeks or ditches shall be designed according to the following:
    a. Water mains with less than 4' of cover shall be protected by Class PC concrete encasement a minimum of ten feet (10') past the top of the embankment on each side.
    b. Trench backfill under creeks and ditches shall consist of flow-able backfill in accordance with NCTCOG Item 504.2.3.4.
    c. Rock bottom Creeks with ditches shall include a six inch (6") concrete cap at the surface in accordance with NCTCOG Item 504.5.2.14.
5. Bank stabilization shall be required at all crossings and shall consist of a pervious armored surface to resist scour and shear forces on all disturbed areas.

Elevated crossings for water and wastewater mains should be avoided.

## Subsection 8.03. Corrosion Protection

Corrosion protection should be considered on all water and wastewater mains.

# ~~Section 8.~~Section 9. Sidewalks

## ~~Subsection 8.01.~~Subsection 9.01. General

### ~~8.01.01.~~ 9.01.01. Construction

All concrete for sidewalks shall be placed on a two inch (2") sand cushion and shall be reinforced with #3 rebar on-center each-way.
Sidewalks shall be a minimum of five feet (5') wide in all areas. Sidewalks along I-35E shall be a minimum six feet (6') wide and constructed outside of the TxDOT ultimate right of way.

### ~~8.01.02.~~ 9.01.02. Slope

Longitudinal slope of sidewalks shall be that of the curb adjacent to the sidewalk. The transverse slope of the sidewalk shall be no more than 1/4-inch per foot sloping toward the curb. The maximum ground slope from the edge of the sidewalk on the property line side shall not exceed A ~~3~~4:1 slope. If it does exceed a ~~3~~4:1 slope, a retaining wall, that is acceptable to the City, shall be provided on the property line.
All sidewalks shall conform to the requirements of the Americans with Disabilities Act (ADA).

### ~~8.01.03.~~ 9.01.03. Construction Joint

A construction joint shall be placed where the sidewalk connects to the backs of curbs and driveways.

## ~~Subsection 8.02.~~Subsection 9.02. Sidewalk Routing

~~1.13.04. Specification~~

### 9.02.01. ~~The following specifications~~Location

~~A.~~ Sidewalks shall ~~apply:~~

~~1. Ramp to~~ be ~~4' in width.~~

~~2. Ramp to be constructed with Class "A" concrete.~~

~~3. Ramp concrete thickness shall be the same as the street (6" normal residential).~~

~~4. No. 3 bars shall be used for reinforcement (18" on centers).~~

~~5. Curb return shall match existing curb height of the street~~generally designed and ~~taper to the connecting walk with a 1 foot radius.~~

~~6. Street shall be blocked out (max. 12") and dowels~~ installed~~.~~

~~7. Saw joints shall be made 1 1/2" minimum depth and sealed with silicone joint sealant material.~~

~~8. Subgrade shall be prepared to a minimum depth of 6".~~

~~9. At no time shall the walk running parallel to the street be altered, unless.~~ one foot (1') off the right-of-way. Curvilinear sidewalks shall be approved on a case by case basis. Widening the ~~City to avoid obstructions.~~

~~Surface of walk~~sidewalk may be ~~coarse and ribbed to provide extra traction~~required if alignment varies from the one foot (1') off the right of way spacing.

### 9.02.02. Ramps

Ramps shall be designed to meet ADA, TDLR, and TAS standards
The City's minimum standards are as shown on the current version of the TxDOT standards PED-18 Pedestrian Facilities-Curb Ramps (or most recent) Link to TxDOT Standards

# ~~Section 9.~~Section 10. Retaining Wall Construction

## ~~Subsection 9.01.~~Subsection 10.01. Design

### ~~9.01.01.~~ 10.01.01. Construction Standards

A retaining wall shall be designed and constructed using a cantilevered reinforced concrete structure, masonry gravity structure, or stone gravity structure, capable of supporting the live load and dead load forces. Brick may be used as a facing material on a concrete retaining wall, but shall not be used as a structural element of the wall.

### ~~9.01.02.~~ 10.01.02. Development Standards

If a retaining wall is to be constructed in a new subdivision, the design of the retaining wall shall accompany the site development construction plans ~~with the submittal of the final plat. A geotechnical report, sealed and signed by a geotechnical engineer licensed in the State of Texas, shall be provided with the retaining wall design. Design of structural elements of the wall exceeding four (4) feet in height shall be sealed and signed by a structural engineer licensed in the State of Texas.~~

The following items shall be included with the submittal for retaining wall over four (4) feet in height:

1. A site specific geotechnical report, sealed and signed by a licensed geotechnical engineer licensed in the State of Texas. The geotechnical report shall include soil parameters to be used in the design of the retaining wall for sliding and overturning stability. Additionally, global stability analysis shall be included in the geotechnical study for retaining walls with a retained height of over 10 feet or immediately adjacent to a stream or ponded water.
2. Structural calculations, sealed by a licensed professional engineer in the State of Texas, for the proposed retaining wall that utilize the parameters provided in the geotechnical report indicating that the retaining wall is stable in sliding, overturning, and internal failure modes.
3. Retaining wall plans, sealed by a licensed professional engineer in the State of Texas, with dimensions and reinforcing in accordance with the structural calculations.

Tiered retaining wall systems shall be spaced with clear dimension between the farthest structural element of the lower wall (including back of footing, reinforced zone, etc.) and the leading structural element of the upper wall (including wall toe, leveling pad, etc.). The clear dimension shall be a minimum distance equal to the clear height of the lower wall.

Avoid placing retaining walls at the top of slopes of greater than 10 (horizontal) to 1 (vertical). If a retaining wall must be placed at the top of a slope greater than 10 to 1, the wall shall bear below the bottom of the slope and the soil in front of the wall shall be neglected in the calculations for the wall.

## ~~Subsection 9.02.~~Subsection 10.02. Prohibited Material

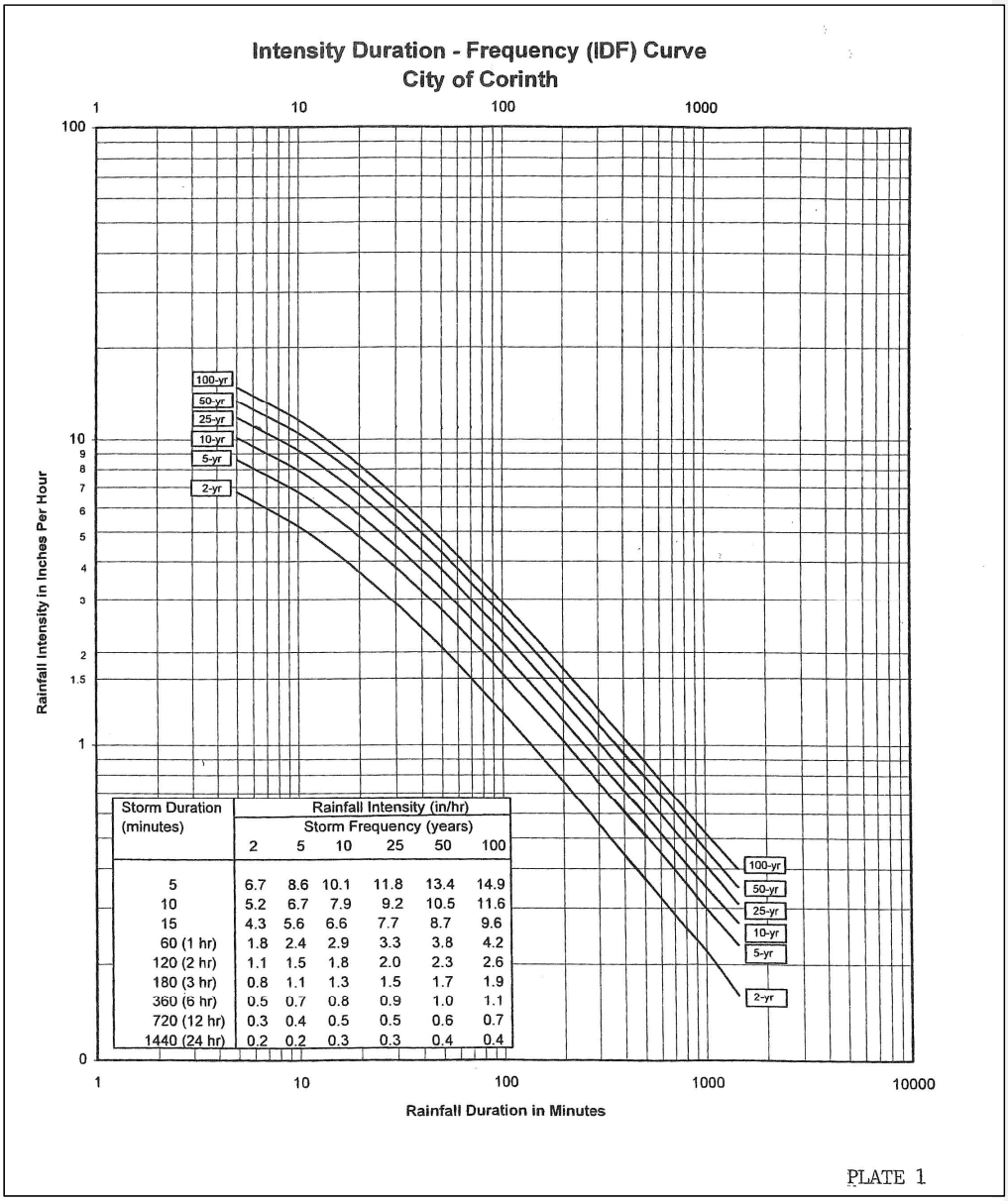
Timber material is prohibited for use as any part of a retaining wall, regardless of height.

# ~~Section 10.~~Section 11. Miscellaneous

## ~~Subsection 10.01.~~Subsection 11.01. Trench Safety

In conformance with House Bills 662 and 665 as passed by the Seventieth Legislature Regular Session of the State of Texas, all construction projects within the City of Corinth or its extraterritorial jurisdiction as provided by the Municipal Annexation Act (Article 970a, Vernon's Texas Civil Statutes) shall contain provisions for trench safety. On construction projects in which trench excavation will exceed a depth of five (5) feet, the uniform set of general conditions must require that the bid documents and the contract include detailed plans and specifications for adequate safety systems that meet Occupational Safety and Health Administration standards and that these plans and specifications include a pay item for these same safety systems.

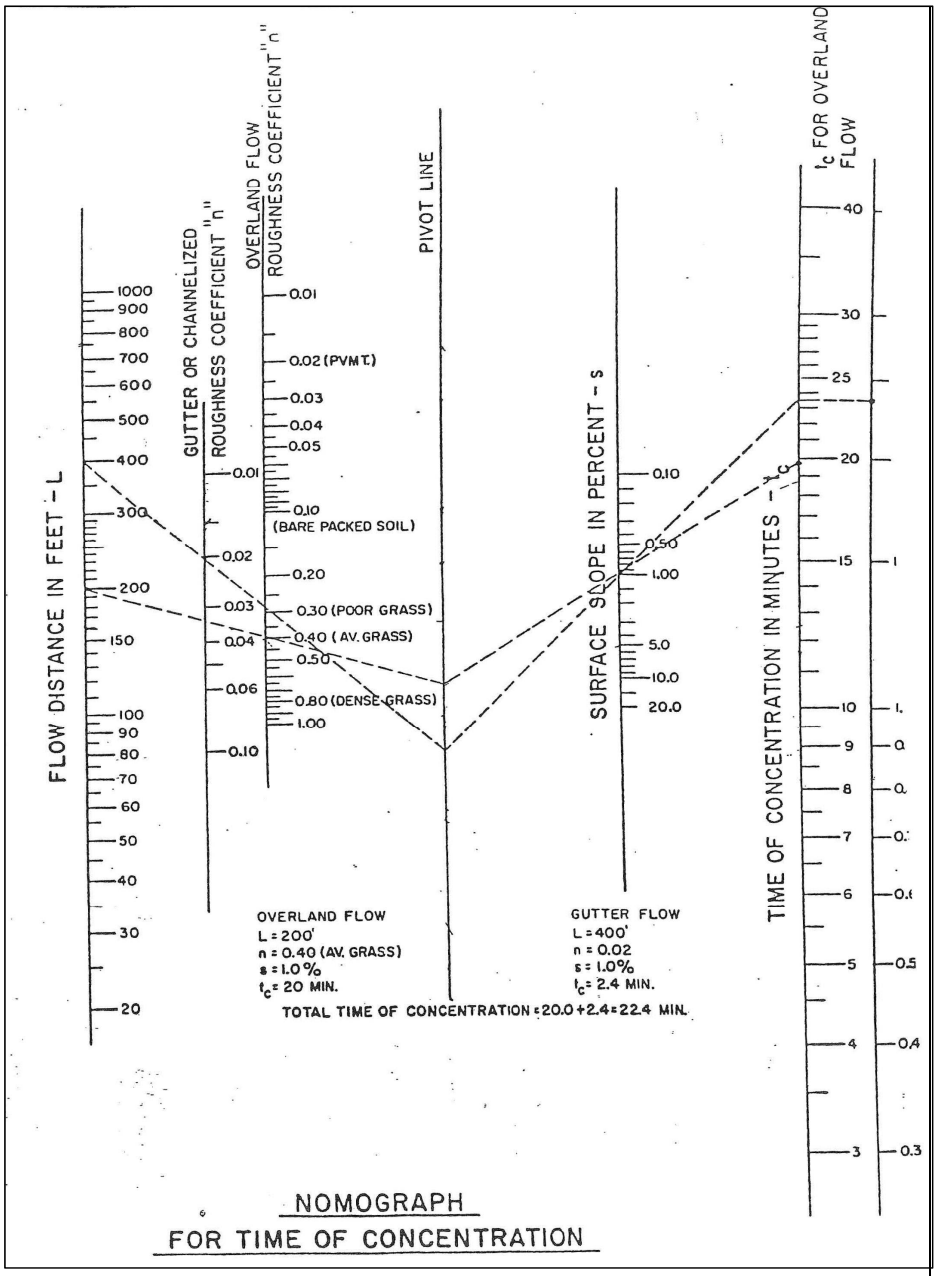
# ~~Section 2. Appendix A: Drainage Formulas and Curves~~




| Storm Duration (minutes) | Rainfall Intensity (in/hr) Storm Frequency (years) | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 100 |
| 5 | 6.7 | 8.6 | 10.1 | 11.8 | 13.4 | 14.9 |
| 10 | 5.2 | 6.7 | 7.9 | 9.2 | 10.5 | 11.6 |
| 15 | 4.3 | 5.6 | 6.6 | 7.7 | 8.7 | 9.6 |
| 60 (1 hr) | 1.8 | 2.4 | 2.9 | 3.3 | 3.8 | 4.2 |
| 120 (2 hr) | 1.1 | 1.5 | 1.8 | 2.0 | 2.3 | 2.6 |
| 180 (3 hr) | 0.8 | 1.1 | 1.3 | 1.5 | 1.7 | 1.9 |
| 360 (6 hr) | 0.5 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 |
| 720 (12 hr) | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 |
| 1440 (24 hr) | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |

PLATE 1

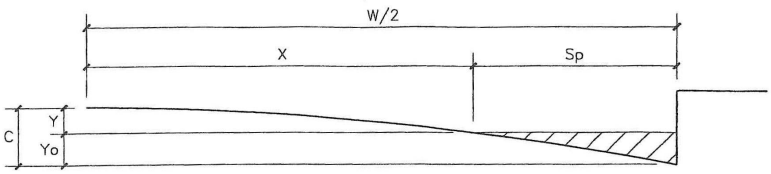
**Plate 1**




NOMOGRAPH
FOR TIME OF CONCENTRATION

**Plate 2**

## FLOW IN PARABOLIC STREETS




Qo = gutter discharge in c.f.s.
C = street crown in feet
W = street width from face of curb in feet
Yo = depth of gutter flow in feet
Y = C − Yo (crown − depth)
n = roughness coefficient
So = street or gutter slope in ft. per ft.
Sp = spread of water in feet

Equation of Parabolic Street Section:

$$X = [\ ((0.5W)^2/A) * Y\ ]^{1/2}$$

Cross-Sectional Flow Area:

$$\text{Area} = \frac{CW}{6} + \frac{2XY}{3} - \frac{WY}{2}$$

Wetted Perimeter:

$$\text{Perimeter} = \frac{W}{2} + \frac{16C^2}{3W} - X - \frac{8Y^2}{3X} + C$$

Flow:

$$Qo = \frac{1.486\ C\ (\text{Area}/\text{Perimeter})^{2/3}\ (\text{Slope})^{1/2}}{n}$$

**Plate 3**

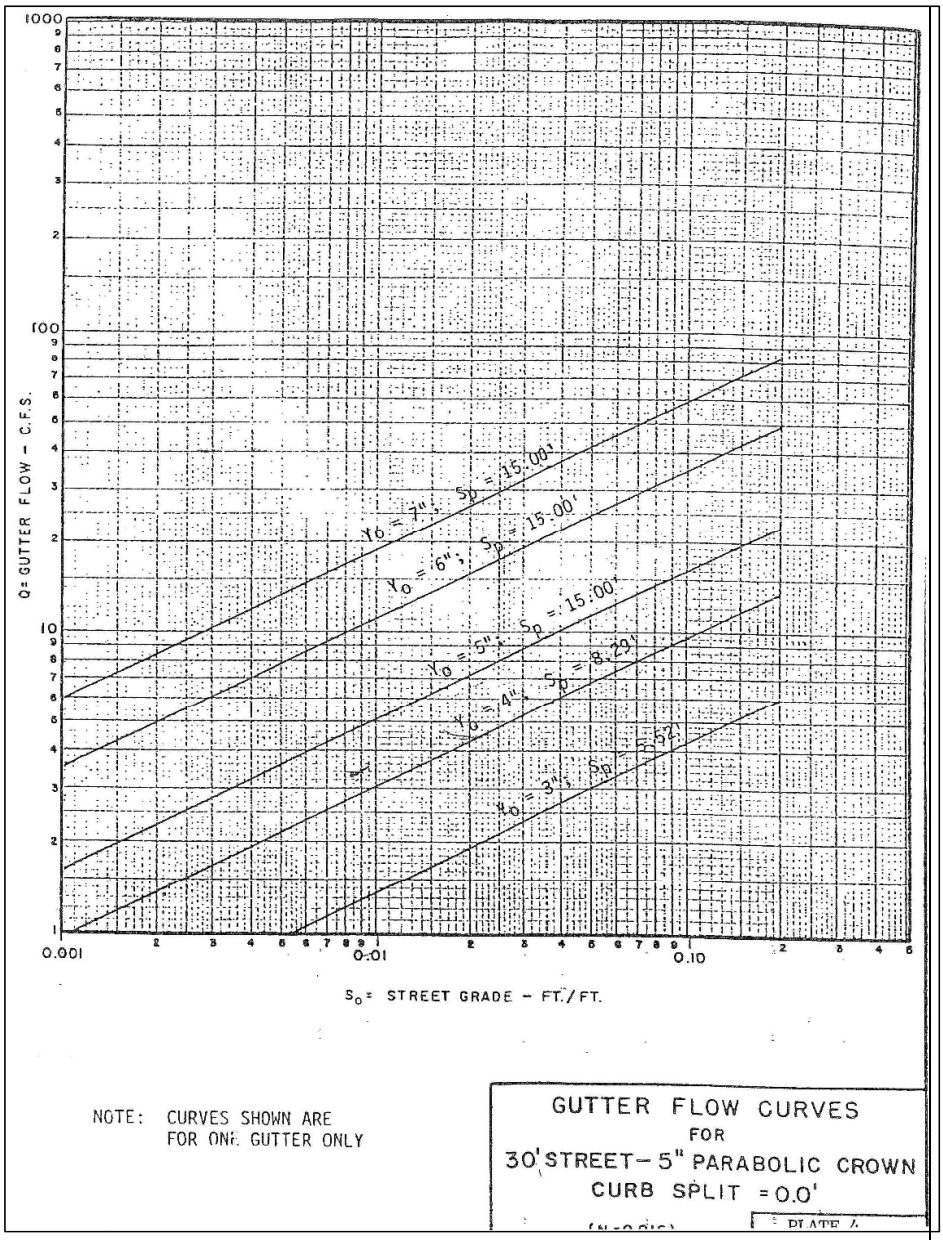

Q= GUTTER FLOW - C.F.S.
1000
100
10
1
0.001
0.01
0.10
$Y_0 = 7"$; $S_p = 15.00'$
$Y_0 = 6"$; $S_p = 15.00'$
$Y_0 = 5"$; $S_p = 15.00'$
$Y_0 = 4"$; $S_p = 8.29'$
$Y_0 = 3"$; $S_p = 5.52'$
$S_0$ = STREET GRADE - FT./FT.
NOTE: CURVES SHOWN ARE FOR ONE GUTTER ONLY
GUTTER FLOW CURVES
FOR
30' STREET - 5" PARABOLIC CROWN
CURB SPLIT = 0.0'
PLATE A

**Plate 4**

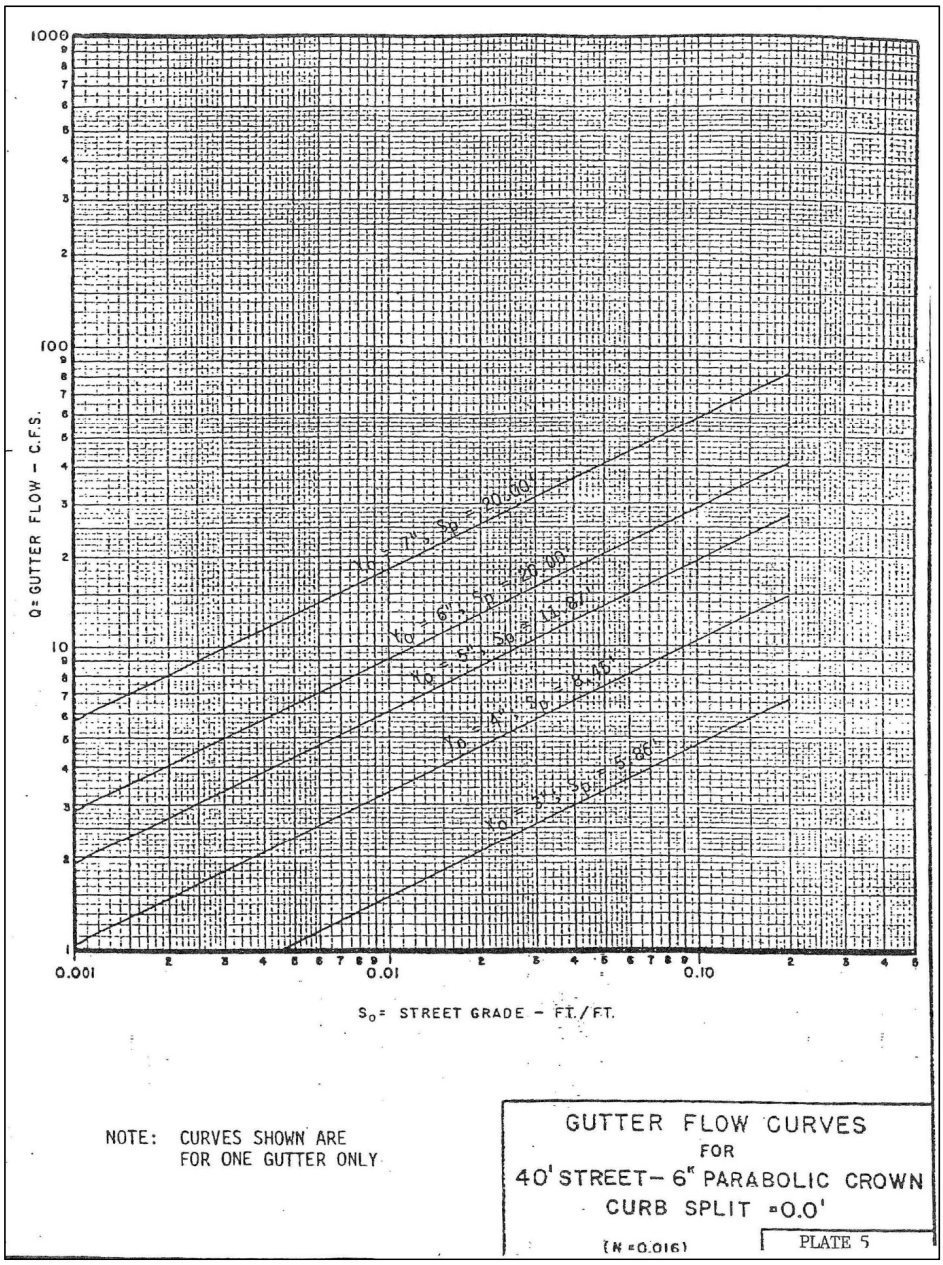

Q= GUTTER FLOW - C.F.S.
1000
100
10
1
0.001
0.01
0.10
$S_o$= STREET GRADE - FT./FT.
NOTE: CURVES SHOWN ARE FOR ONE GUTTER ONLY
GUTTER FLOW CURVES
FOR
40' STREET- 6" PARABOLIC CROWN
CURB SPLIT =0.0'
(N=0.016)
PLATE 5

Plate 5

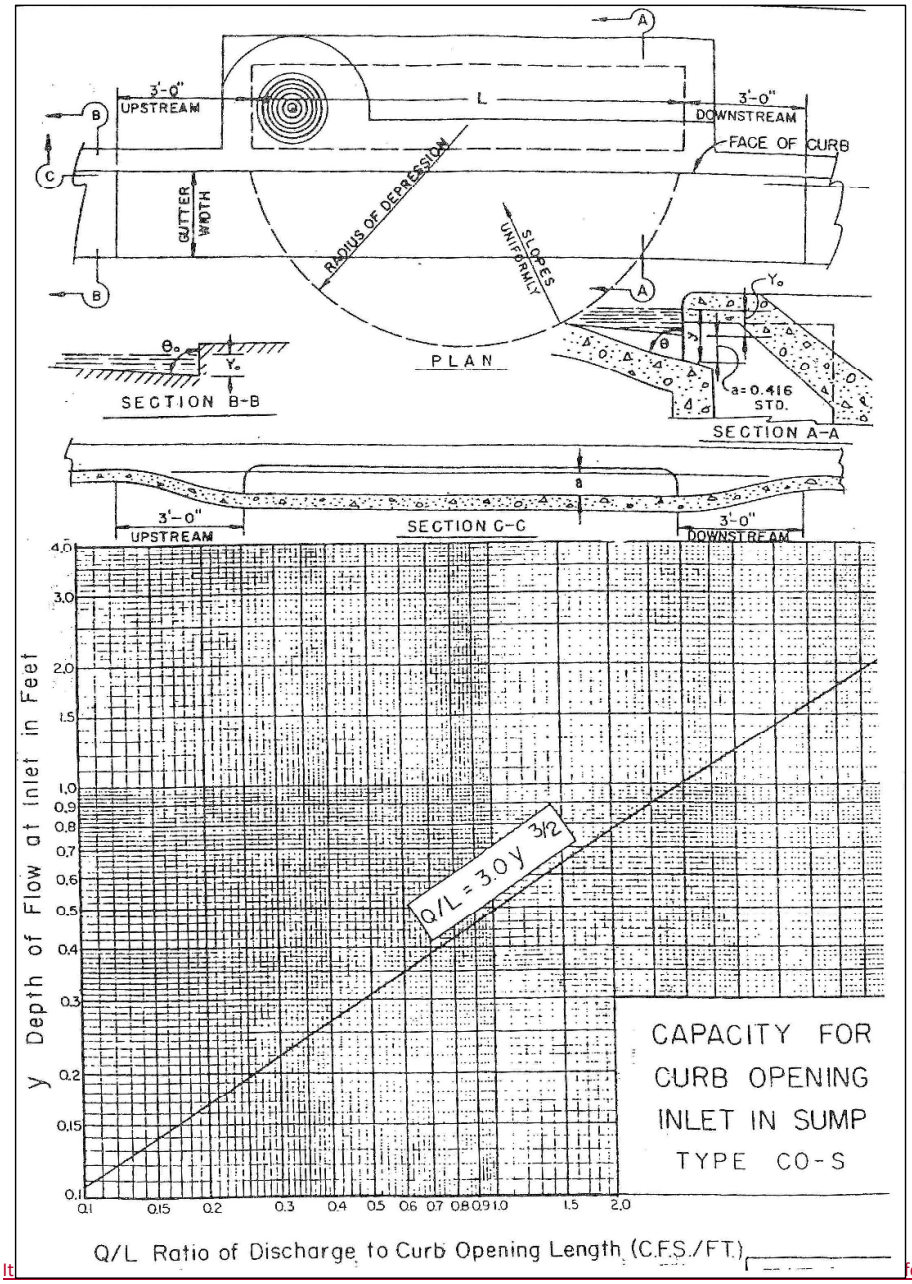

A
B
C
3'-0"
UPSTREAM
L
3'-0"
DOWNSTREAM
FACE OF CURB
GUTTER WIDTH
RADIUS OF DEPRESSION
SLOPES UNIFORMLY
PLAN
$\theta_o$
$Y_o$
SECTION B-B
$\theta$
a= 0.416
STD.
SECTION A-A
SECTION C-C
y Depth of Flow at Inlet in Feet
Q/L = 3.0 y 3/2
CAPACITY FOR
CURB OPENING
INLET IN SUMP
TYPE CO-S
Q/L Ratio of Discharge to Curb Opening Length (C.F.S./FT.)

Plate 6

## Subsection 11.02. Abandonment of underground conduits

The abandonment of utility mains shall be of an approved method per NCTCOG Standard Specifications. All mains shall be filled and grouted in their entirety or removed entirely, unless otherwise approved by the City Engineer. Plugging the ends of the pipe will not be sufficient.