CITY OF TERRELL

TECHNICAL CONSTRUCTION STANDARDS AND SPECIFICATIONS

JANUARY 2005
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CITY OF TERRELL

TECHNICAL CONSTRUCITON STANDARDS AND SPECIFICATIONS

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PART 1 – GENERAL

1.1 PURPOSE

The purpose of the Technical Construction Standards and Specifications is to provide a set of standards for designing streets, thoroughfares, drainage facilities, water lines, sanitary sewer lines and preparing construction plans for such facilities that are to be owned, operated and/or maintained by the City of Terrell, Texas. These standards will be used by the City staff and consulting engineers employed by the City for the above described improvement projects, and engineers for private developments in the City of Terrell. Unusual circumstances or special designs, requiring a variance from the standards in this manual, may be approved by the City Engineer.

1.2 STANDARDS OF DESIGN

The Standards of Design, as adopted by the City of Terrell, are set forth herein. These standards shall be considered as the minimum requirements, and it shall be the responsibility of the developer to determine if more stringent requirements are necessary for a particular development. It is not intended that the Standards of Design cover all aspects of a development. For those elements omitted, the developer will be expected to provide designs and facilities in accordance with good engineering practice and to cause to be constructed facilities utilizing first class workmanship and materials. The recommended procedure for setting street grades is included in Appendix A and typical pavement sections are included in Appendix B.

1.3 STANDARD SPECIFICATIONS FOR CONSTRUCTION

Standard specifications for construction as adopted by the City of Terrell shall be in accordance with the Fourth Edition "Standard Specifications for Public Works Construction" as published by the North Central Texas Council of Governments (NCTCOG) (copies obtained from NCTCOG offices) and the Addendum to the NCTCOG specification bound in this document in Appendix C. These specifications shall be considered as minimum requirements, and such additional requirements of the City or the developer may consider appropriate should be added as supplements.

1.4 UTILITY ASSIGNMENTS

In general, utilities are to be located in public rights-of-way in the location shown in Appendix "B." The City Engineer shall determine the location of utilities where special circumstances prevent the standard utility assignments from being used.

1.5 GENERAL NOTES

All construction plans for the projects described above shall contain the applicable general notes listed in Appendix "D."

1.6 PLATTING ISSUES

All plats shall use all applicable portions of the Standard Owner's Dedication shown in the Subdivision Ordinance.

Contact the City Engineer for the current list of area street names to prevent duplication or similar names.

1.7 STANDARD DETAILS

Standard construction details are shown in Appendix "E." All construction plans shall either contain the details that apply or make specific reference to these details as being a part of the construction plans. Additional details shall be prepared as required to describe the construction required.

1.8 MONUMENTATION

1. The Surveyor, responsible for the plat, shall place permanent monuments at each corner of the boundary survey of the subdivision or development in accordance with Section 5.2 of the Subdivision Ordinance.

2. GPS monuments shall be constructed on at least two opposite corners of the subdivision. GPS monuments shall be constructed of a four (4) inch diameter reinforced concrete monument at least 6 feet deep set flush with the ground. A brass or aluminum disc shall be set in the top of the monument and shall have the monument number, elevation and registration number of the surveyor stamped in the disc. The surveyor shall determine the Texas State Plane Coordinates and elevation of the monument and file a survey report with the City showing this information.

3. Markers shall be set at all block corners, street and alley curve points and angle points along the boundaries and also within the subdivision. Markers shall be placed on all water line, sewer line, and drainage facility easements as well as flood way boundaries. The markers shall be set at ground level or at such an elevation that they will not be disturbed during the construction, and the top of the marker shall not be more than twelve (12) inches below finished ground level.

4. Where no benchmark is established to sea level datum or can be found within one thousand (1000) feet of the boundary of the subdivision, such benchmark shall be established to sea level datum. Said bench mark shall be established; shall be readily accessible and identifiable on the ground; and set as a separate monument of the same concrete construction as described for GPS monuments with the elevation engraved on a bronze plate embedded flush in the top surface of the monument. Large subdivisions may require more than one benchmark; in any event, such marks shall be no more than two thousand six-hundred forty (2,640) feet apart or more than two thousand six-hundred forty (2,640) feet from a previously established bench mark. All such benchmarks shall be recorded on the final plat. Where GPS monuments meet this requirement, no additional benchmarks are required.

5. Iron rods, one-half (½") inch in diameter and twenty four (24) inches long, shall be placed on all boundary corners, block corners, curve points, and angle points in water line, sanitary sewer line and drainage facility easements as well as floodway boundaries.

1.9 RETAINING WALLS

Retaining walls shall be constructed at locations where slopes exceed 4H:1V grades. Retaining walls shall be constructed of concrete, manufactured stone or concrete materials, or natural stone materials. Retaining walls installed in drainage ways shall have a properly designed foundation that cannot be undermined by flow of the water.

Retaining walls over two feet in height shall require an engineering design and shall be have a factor of safety of at least 1.5 with regard to sliding, overturning, and global slope stability. Long term stability shall also be analyzed.

1.10 RECORD DRAWINGS

Record Drawings ("As Built Drawings") are required to be submitted for all public works construction in the City of Terrell. Record Drawings shall meet the requirements set forth in the City's addendum to the NCTCOG Specifications. In addition, the final plat and plans of any subdivision shall be submitted to the City in AutoCAD® format on electronic media plus one mylar and printed copy of the documents.

1.11 OVERSIZE POLICY

The City of Terrell may choose to oversize certain improvements as part of the development process. Streets will be oversized in the manner described in the Subdivision Ordinance. New developments are required to size drainage for pass through of fully developed conditions, so it is not likely the City will participate in oversize storm drainage facilities. During the review process, the City may identify certain water and sanitary sewer improvements to be oversized to serve future needs or other purposes of the City.

When the initial utility plans are reviewed for a subdivision, a determination will be made if the City wants to participate in oversizing certain facilities. When water and sanitary sewer lines are oversized, the City will enter into a developer's agreement based on the difference in cost to design and construct the required facilities for the proposed development and the cost to design and construct the oversized facilities. Should the cost difference be prohibitive, the City reserves the right not to oversize the facilities and may require additional easements for future construction of the facilities for future capacity.

An improvement agreement, in accordance with Section 6.2(c) of the Subdivision Ordinance, shall be required in order to reimburse any oversize facilities constructed by the developer.

PART 2 - PAVING

2.1 STREET AND THOROUGHFARE CLASSIFICATIONS

City streets and thoroughfares are classified into several types according to their use and locations as indicated in Table 2-1 and Typical Pavement Sections in Appendix B. The basic types include the residential streets including "Rural Residential" that provide direct access and frontage to adjacent properties, collectors that serve as the distributor-collector arteries and provide direct access to adjacent properties, and parkways and major arterial thoroughfares that carry higher volumes of traffic through urban areas. Each traffic artery is made up of elements that are related to the use of that particular facility. These elements include right-of-way, pavement width, median width if required, arrangement of traffic lanes and parking lanes, curb radii at intersections and other characteristics.

2.2 STREET AND THOROUGHFARE GEOMETRICS

A. General

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

B. Design Vehicles

The geometrics of City street and thoroughfare intersections vary with the different dimensions of the intersection facilities. Criteria for the geometric design of intersections must be based on certain vehicle operating characteristics, and vehicle dimensions. The American Association of State Highway and Transportation Officials (AASHTO) has standardized vehicle criteria into three general designs, and this vehicle data is published in the AASHTO Publication, "A Policy on Geometric Design of Highways and Streets." In the design of street and thoroughfare intersections for Terrell, these vehicle designs are adopted for use. Table 2-2, Design Vehicle Criteria, shall serve as a guide in the selection of the design vehicle to be used in the design of intersections.

TABLE 2-1
STREET AND THOROUGHFARE
GEOMETRIC STANDARDS

Street Description	Type	FF/Curb Pvmt Width	Min ROW Width	Lanes [1]	Parking [1]	Parkway	Median	Min. Pvmt Thickness	Min Design Speed
Major Arterial	AA	48'	160' – 180'	4-12'	0	22.0'	20.0'	10"	45
Major Thoroughfare	A	36'	120'	3-12'	0	16.0'	16.0'	9"	40
Major Thoroughfare	B	33'	100'	2-12'	1 – 9'	9.5'	15.0'	9"	35
Secondary Thoroughfare	C	22'	80'	2-11'	0	11.0'	14.0'	9"	30
Major Collector	D	40'	60'	1-12'	1-8'	10.0'	0	8" [2]	30
Minor Collector	E	36'	60'	1-12'	1-6'	12.0'	0	7"	30
Residential/ Local Street	F	26'	50'	1-13'	0	12.0'	0	6"	30
Rural Residential	G	24'	60'	1-12'	1-3'	15.0'	0	6"	30
Alley[3]	NA	10'	15'	1-10'	0	2.5'	0	6"	10
Alley[4]	NA	15'	20'	1-15'	0	5.0'	0	6"	10

NOTE: All dimensions are to face of curb or edge of pavement. The geometric design for alleys shall be in accordance with NCTCOG design standards.

[1] Pavement width each direction

[2] Pavement minimum thickness of 10" in nonresidential districts

[3] Residential, alley flares to 12 feet wide are required at turns and tees.

[4] Business & Industrial District

TABLE 2-2
DESIGN VEHICLES

Intersecting Street Types	Design Vehicle Used in Intersection Design	
	Single Unit Truck (SU)	Tractor Semi-Trailer Combination (WB-50)
AA or A with AA or A		X
B, C, or D with AA or A		X
B, C, or D with B, C, or D		X
E, F, or G with AA or A	X	
E, F, or G with B, C, or D	X	
E, F, or G with E, F, or G	X	

NOTES:
a. Single Unit Trucks Design shall use a minimum of 20 ft. radius on curbs and turnouts.
b. Tractor Semi (WB-50) design shall use a minimum of 30 ft. radius.
c. Streets that intersect at other than 90° shall have a radius that will accommodate the specified design.

C. Design Speed

The design speed is a primary factor in the horizontal and vertical alignment on City streets and thoroughfares. Design features such as curvature, superelevation, radii for turning movements and sight distance are directly related to the design speed. The design speed also affects features such as lane widths, pavement width, pavement cross-fall, pavement crown, and clearance.

The design speed is defined as the approximate maximum speed that can be maintained safely by a vehicle over a given section of road when conditions are so favorable that the design features of the roadway govern. The speed limit of posted speed is the maximum legal speed set by local authorities for a certain roadway or area. The design speed should always be greater than the likely legal speed limit for secondary and major thoroughfares.

The various street and thoroughfare classifications, which make up the system within the City, require different design speeds according to their use and location. Presented in Table 2-1 are the minimum design speeds for the various classifications within the City of Terrell. Lower design speeds may be required for all classifications for unusual conditions of terrain or alignment.

D. Horizontal Geometrics

1. General

The horizontal geometrics of City streets and thoroughfares include the segment of geometric design associated with the alignment, intersections, pavement widths, and related geometric elements. The various classifications, utilizing the design speed as a control, must have certain horizontal and vertical geometrics to provide a safe economical facility for use by the public.

2. Horizontal Curves and Superelevation

The alignment of City streets and thoroughfares is usually determined by the alignment of the existing right-of-way or structures that cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing a simple curve having a radius that is compatible with the speed of vehicular traffic. To increase the safety and reduce discomfort to drivers traversing a curved portion of a street or thoroughfare, the pavement may be superelevated.

Curvature in the alignment of major thoroughfares and collectors is allowed under certain conditions, but greater traffic volume and higher vehicle speeds that accompany these facilities tend to increase accidents on curving roadways. Curves in the alignment of residential streets usually provide aesthetic values to the residential neighborhoods without affecting the orderly flow of traffic or sacrificing safety.

A recommended minimum radius of curvature for vehicle design speed and pavement cross-slopes is shown in Table 2-3. These are based on traffic consisting of typical present day automobiles operating under optimum weather conditions. There are other important considerations in the design of curves on City streets and thoroughfares including the location of intersecting streets, drives, bridges and topographic features. When superelevation is required on collectors and major thoroughfares, the following basic formula shall be used:

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

Where:

e = rate of roadway superelevation, foot per foot

f = Side friction factor (See Table 2-4)

V = vehicle design speed, mph

R = radius of curve in feet

For local residential streets the minimum centerline radius may be 150 feet when the design speed can be considered to be less than 30 MPH. This decision will be made by the City Engineer by considering the type of proposed development, location of street and length of street.

TABLE 2-3
MINIMUM CENTERLINE RADIUS
FOR THOROUGHFARES

Rate of Superelevation (Ft./Ft.)	DESIGN SPEED (MPH)			
	30	35	40	45
-0.042	510	720	945	1310
-0.031	470	660	865	1190
-0.021	435	610	795	1090
-0.010	405	565	740	1005
0	375	530	690	935
+0.010	355	495	645	870
+0.021	335	465	610	815
+0.031	315	440	575	770
+0.042	300	415	545	725

TABLE 2-4
SIDE FRICTION FACTORS
FOR THOROUGHFARES

Street Type	Side Friction Factor (f)
AA or A	0.145
B, C, or D	0.155
E, F, or G	0.160

3. Turning Lanes

Turning lanes are provided at intersections to accommodate left-turning and right-turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in advance of the intersection or to a safe speed for the turn in case a stop is unnecessary. Left turn lanes at intersections are usually 10 feet in width. When turning traffic is too heavy for a single lane and the cross street is wide enough to receive the traffic, two turning lanes may be provided. Availability of right-of-way may limit locations where this is feasible.

The location of the median nose at the end of the left turn lane should be so located that left turning traffic will clear the median nose while making a left turn. Other considerations include adequate clearance between the median nose and through traffic on the intersecting thoroughfare and locations of the median nose to properly

clear the pedestrian crosswalks.

The minimum length of right turn/deceleration lanes shall be 100'. For Type AA, A, B, C, and D street intersections, a traffic impact study will be required to establish if the minimum length is adequate.

The minimum length of left turn lanes for streets is further defined in Table 2-7.

4. Street Intersections

a. Standard

The intersection, at grade, of major thoroughfares, collector streets, and residential streets at or near right angles form the standard Intersection. At the intersection of these arterial types the various geometrics including pavement widths, lane widths, curb radii, median widths, turning lane data, crossfall, crown height and other features differ.

b. Special Intersections

Street and thoroughfare types in the City often intersect at angles less than 90 degrees. The radii required to fit the minimum paths of the design vehicles are longer than those for standard or 90 degree intersections. Special intersections shall be designed using data for the design vehicles as specified in Table 2-2.

5. Sidewalks

The purpose of the public sidewalks is to provide a safe area for pedestrians. The City of Terrell requires that sidewalks be constructed with the paving of streets or when building construction occurs, in residential areas, provided an improvement agreement and security is provided in the form of a bond or other instrument acceptable to the City Council and City Attorney. All sidewalks must conform to state laws for barrier free construction.

The standard concrete sidewalk is 4 feet in width for residential and 5 feet in width for commercial. The edge of the sidewalk located nearest the street right-of-way is normally 1 foot from the right-of-way line for all districts. In areas where screening walls are required, sidewalks shall be constructed against the screening wall and have a minimum width of 5 feet. Sidewalk alignments may be varied to avoid the removal of trees or the creation of excessive slopes when approved by the City Engineer. Tree root barriers shall be installed in accordance with the construction details in Appendix E.

E. Vertical Alignment

1. Street Grades (See Appendix "A")

The vertical alignment of City streets and thoroughfares should be designed to ensure the safe operation of vehicles and should allow easy access to adjacent property. A travelway that is safe for vehicles is dependent on criteria that consider operating speeds, maximum grades, vertical curves and sight distance. In addition to these considerations, other factors related to vertical alignment include storm drainage, crown and crossfall and the grade and right-of-way elevation relationship. The grade of street or thoroughfare, particularly at its intersections with another grade, is of prime importance in providing a safe, comfortable riding surface. The intersection design of two Type AA or A streets shall include grades that will result in a plane

surface or at least a surface that approximates a plane surface. A vehicle traveling on either thoroughfare should be able to traverse the intersection at the design speed without discomfort. To accomplish a smooth transition, crossfall toward the median of one lane of each thoroughfare may be required. The use of storm drainage inlets in the median shall be avoided if possible.

In drawing the grades of intersecting thoroughfares in the profile view of plan/profile sheets, profiles of all four curbs shall be shown as a continuous line through the intersection.

a. Minimum Grades

Minimum longitudinal grades for streets and thoroughfares are required to ensure proper flow of surface drainage toward inlets. Minimum grade is five-tenths percent (0.5%) for all pavement having curbs. Where valley gutters are used for intersecting drainage, the minimum grade for valley gutters is five-tenths percent (0.5%) for concrete.

b. Maximum Grades

Maximum longitudinal grades shall be compatible with the type of facility and the accompanying characteristics including the design speed, traffic conditions and sight distance.

Major and secondary thoroughfares and major couplets must move large volumes of traffic at faster speeds and flatter grades will better accommodate these characteristics. Truck and bus traffic on these type facilities often controls traffic movement, particularly if steep grades prevent normal speeds. The normal maximum street grades allowed are shown in Table 2-5. Steeper grades may be permitted for short lengths where dictated by topographical features or restricted alignment.

TABLE 2-5
MAXIMUM STREET GRADES

Street Type	Normal Maximum Grade in Percent
AA or A	6%
B, C, or D	6%
E, F, or G	8%

2. Vertical Curves

When two longitudinal street grades intersect at a point of vertical intersection (PVI) and the algebraic difference in the grades is greater than one percent (l%), a vertical curve is required. Vertical curves are utilized in roadway design to effect a gradual change between tangent grades and should result in a design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The vertical curve shall be formed by a simple parabola and may be a crest vertical curve or a sag vertical curve.

3. Stopping Sight Distance

a. Crest Vertical Curve

When a vertical curve is required, it must not interfere with the ability of the driver to see the length of street ahead. This length of street, called the stopping sight distance, should be of sufficient length to enable a person in a vehicle having a height of 3.675 feet above the pavement and traveling at design speed to stop, before reaching an object in his path that is 0.5-foot in height.

The minimum stopping sight distance is the sum of two distances: one, the distance traversed by a vehicle from the instant the driver sights an object for which a stop is necessary, to the instant the brakes are applied; and the other, the distance required to stop the vehicle after the brake application begins.

The minimum safe stopping sight distance and design speeds are shown in Table 2-6. These sight distances are based on each design speed shown and a wet pavement. The length of crest vertical curve required for the safe stopping sight distance of each street type may be calculated using the formula L = KA and the values of K for a crest vertical curve shown in Table 2-6.

b. Sag Vertical Curve

When a sag vertical curve is required, the vertical curve shall be of sufficient length to provide a safe stopping sight distance based on headlight sight distance. The minimum length of sag vertical curve required to provide a safe stopping sight distance may be calculated using the formula L = KA and values of K for a sag vertical curve are shown on Table 2-6.

TABLE 2-6
MINIMUM LENGTH OF VERTICAL CURVE

CREST VERTICAL CURVE

L = KA where

L = Minimum Length Vertical Curve required for safe stopping

K = Horizontal Distance in feet required to effect a one percent change in gradient

A = Algebraic Difference in grade

SAG VERTICAL CURVE

L = KA where

L = Minimum Length Vertical Curve required for headlight control

K = Horizontal Distance in feet required to effect a one percent change in gradient

A = Algebraic Difference in grade

Street Type	Design Speed	Safe Stopping Distance	Normal Crest Vertical Curve K	Normal Sag Vertical Curve K	Minimum Length of Curve
AA	45	400	100	80	120
A	40	300	65	60	100
B, C, or D	35	250	55	55	100
E, F, or G	30	200	30	35	100

4. Intersection Grades

The grade of an intersecting street with the principal street gutter should not be generally more than four percent (4%) either up or down within the first 20 feet beyond the curb line of the principal street. Grade changes greater than one percent (l%) will require vertical curves.

5. Street Cross Section

For curbed streets, the crown shall be graded to drain to the gutter at a slope of 1/4" to 1/3" per foot as defined in Table 2-12. Street back slopes and embankment slopes shall not be steeper than 4:1.

2.3 SIGHT DISTANCES AT INTERSECTIONS

An important consideration in the design of City streets and thoroughfares is the vehicle attempting to cross the street or thoroughfare from the side street or drive. The operator of the vehicle attempting to cross should have an unobstructed view of the whole intersection and a length of the thoroughfare to be crossed sufficient to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception and reaction time and during braking. This sight distance, which is termed intersection sight distance, can be calculated for different street or thoroughfare widths and for various grades upwards and downwards. Intersection sight distance shall be as set forth in AASHTO publication "A Policy on Geometric Design of Highways and Streets, 2001."

2.4 MEDIAN OPENINGS

Arterial thoroughfares in the City of Terrell shall have raised medians. Arterials having two way left turn lanes are discouraged and may only be utilized in special circumstances when approved by the City Council.

Median openings at intersections shall be from right-of-way to right-of-way of the intersecting street, unless otherwise justified by a traffic impact analysis. The left turn storage area width shall be a minimum of ten (10) feet and the width of the median shall be in accordance with Table 2-1.

The geometric design standards for median openings are shown in Table 2-7 and Figure 2-1.

2.5 CUL-DE-SAC

The maximum length of any cul-de-sac shall be 600 feet measured from curb line of the intersecting street to the radius point of turn around. Right-of-way and pavement widths shall be as follows:

STREET TYPE	RIGHT-OF-WAY RADIUS	PAVEMENT RADIUS
Rural Residential	60	43
Local Street-Residential	55	43
Local Street-Non Residential	60	48

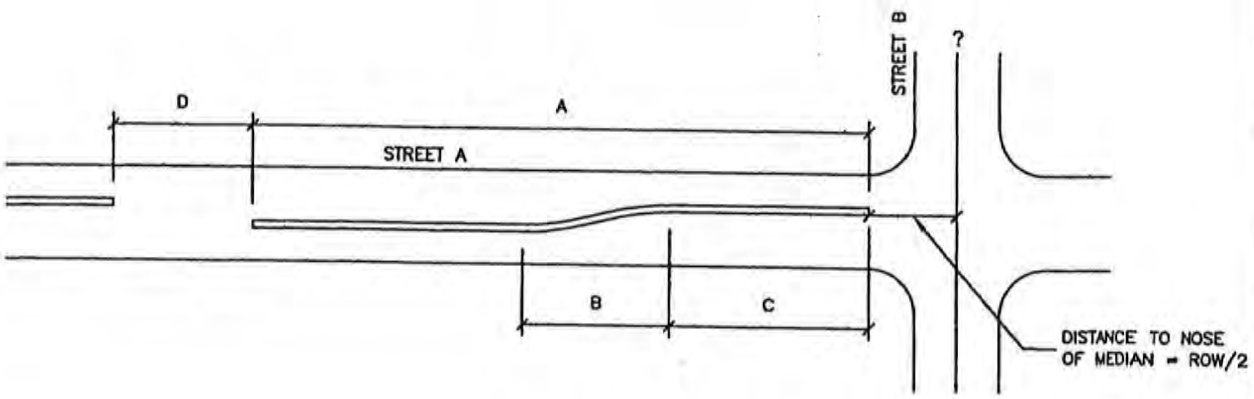


TABLE 2–7

INTERSECTING STREET TYPE		MINIMUM LENGTH (FEET)			
STREET A	STREET B	A	B	C (1)	D (2)
AA or A	AA or A	310	100	150	60
AA or A	B, C, or D	260	100	100	60
AA or A	E	260	100	100	60
AA or A	F or G	220	100	60	60
B, C, or D	AA or A	310	100	150	60
B, C, or D	B, C, or D	260	100	100	60
B, C, or D	E	260	100	100	60
B, C, or D	F or G	220	100	60	60

1. THESE ARE MINIMUM LENGTHS AND SHALL BE INCREASED AS WARRANTED BY A TRAFFIC IMPACT ANALYSIS.
2. THE WIDTH OF OPENING SHALL BE 60 FEET OR THE WIDTH OF THE STREET PLUS 8 FEET, WHICHEVER IS GREATER, BUT SHALL NOT EXCEED 70 FEET.

FIGURE 2-1

SCALE: NONE

DATE: MARCH 2004

DESIGN STANDARDS

MEDIAN DESIGN STANDARDS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS

2.6 DRIVEWAY STANDARDS

A. Maximum Number of Driveways; Minimum Corner Clearance

The maximum number of driveways per platted lot and the minimum spacing between such driveways shall be as provided for in Table 2-8.

TABLE 2-8
MAXIMUM NUMBER OF DRIVEWAYS AND
MINIMUM SPACING BETWEEN DRIVEWAYS
(PER PLATTED LOT)

Land Use	Frontage (Feet)	Maximum Number of Driveways Per Property	Minimum Spacing Between Driveways on Same Property
Single-Family	90'or more	2	20
Single-Family	Less than 90'	1	N/A
Attached Housing	90'or more	2	20
Attached Housing	Less than 90'	1	N/A
Commercial	Less than 250'	1	N/A
Commercial*	More than 250'	2	100

- One additional driveway may be added for each additional 500 feet of lot width in excess of 250 feet. For driveways on Class 1 thoroughfares, only one driveway is allowed for each 500 feet of lot width instead of 250 feet of width.

NOTE: State standards, if more restrictive, shall apply for properties fronting state or federal roads.

The minimum corner clearance between a driveway and an intersection shall be as provided for in Table 2-9 and as illustrated in Figure 2-2. Table 2-9 shall apply to all non-residential streets.

Corner clearance shall be defined as follows:

1. For Curbed Streets

   The distance between the intersection of the projected curb lines of the two streets and the point of tangency of the driveway curb returns at the street curb.

2. For Rural Residential Streets

   The distance between the intersection of the projected edge of pavement lines of the two streets and the intersection of the edge of driveway pavement at edge of pavement of the street shall not be less than the corner clearance shown in Figure 2-2.

In no case shall the driveway curb return or the edge of the driveway pavement encroach into the curb return or edge of pavement radius of a street intersection. Encroachment by the curb return or edge of pavement of a driveway onto the frontage of an adjoining property is not permitted.

TABLE 2-9
MINIMUM CORNER CLEARANCES
BETWEEN DRIVEWAY AND INTERSECTION
NON-RESIDENTIAL STREETS

Type of Street Driveway is On	Type of Street Intersected	MINIMUM CORNER CLEARANCE	
		Approach Side of Intersection	Departure Side of Intersection
AA or A	AA or A	150	100
AA or A	B, C, or D	150	75
AA or A	E	150	50
B, C, or D	AA or A	100	100
B, C, or D	B, C, or D	100	75
B, C, or D	E	100	50
E	AA or A	75	100
E	B, C, or D	75	75
E	E	50	50

NOTES:

1) The above distances notwithstanding, any platted lot may have at least one (1) minimum width driveway.

2) Service roads shall be classified as an arterial for driveway purposes.

3) Residential driveways on Type AA, A, B, C, or D streets are not permitted unless an exception is granted by the City Council.

4) These clearances are minimum and shall be larger if warranted by a traffic impact study.

B. Design Standards; Storage Length

Driveway design standards shall be as provided for in Table 2-10.

Driveway storage shall be defined as the distance between the street right-of-way line and the near side of the first intersecting interior aisle. For businesses, the minimum length of this storage shall be as provided for in Table 2-11.

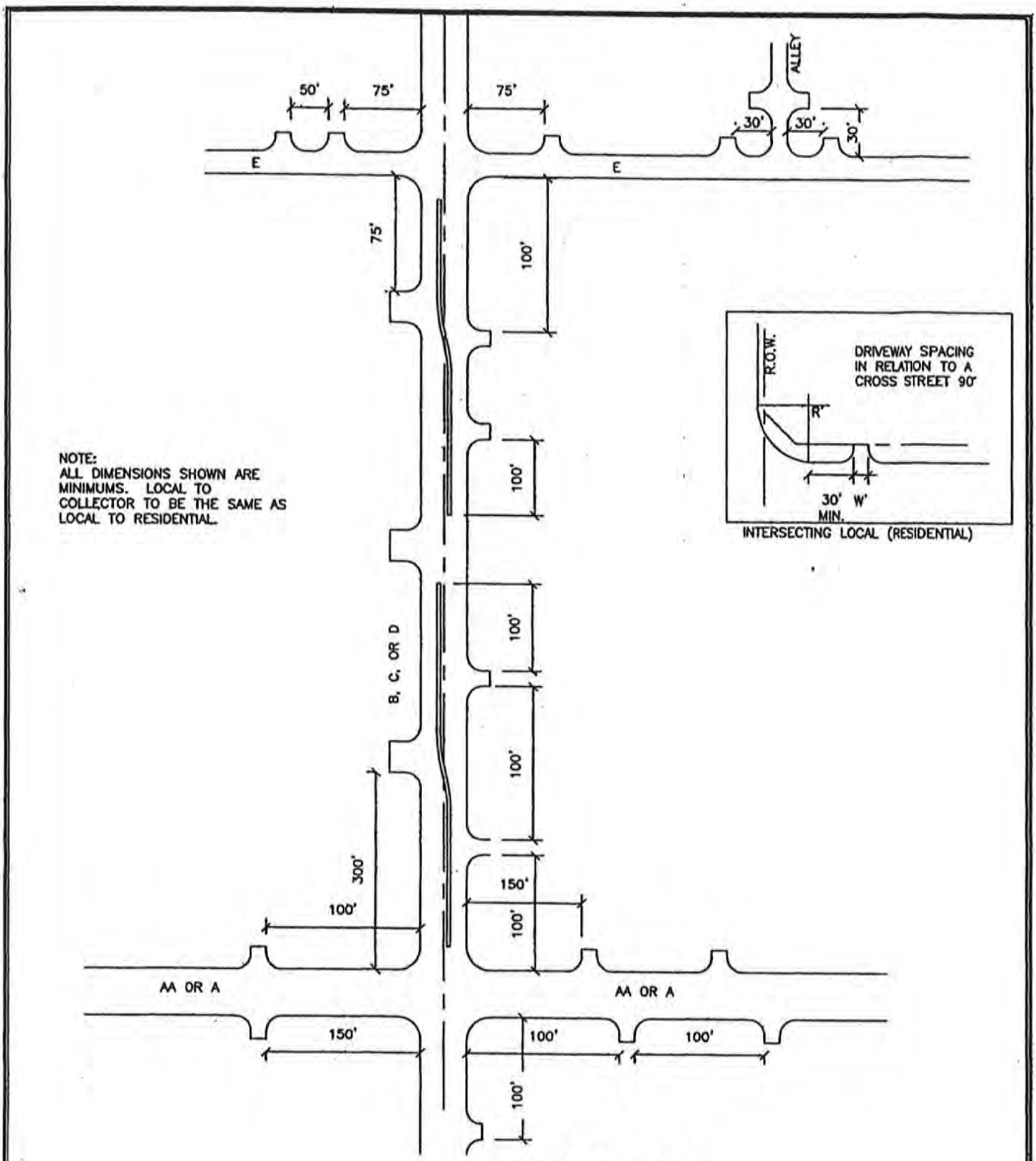


FIGURE 2-2

SCALE: NONE

DATE: MARCH 2004

DESIGN STANDARDS

MININUM DRIVEWAY SPACING AND CORNER CLERANCE

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS

TABLE 2-10
DRIVEWAY DESIGN STANDARDS

Land Use	Driveway Approach*			
	Approach Width in Feet		Curb** Radius in Feet	
	Minimum	Maximum	Minimum	Maximum
RESIDENTIAL				
Single Family	10	17	5	10
Attached Housing	20	24	15	30
NON RESIDENTIAL (Undivided Driveways)				
Office	24	30	15	30
Retail (except Service Station)	24	30	15	30
Service Station	24	40	15	30
Industrial	24	45	25	50
DIVIDED DRIVEWAYS***				
Multi-Family, Office or Retail	18	24	15	40

* Flares that meet the requirements of NCTCOG are also allowed.
** Or chamfer distances where driveway attaches to a Rural Residential or Parkway.
*** Must have raised, landscaped median at least 6 feet wide; approach widths are for each side.

NOTES:

1) The minimum and maximum approach widths are for the point where curb radii (from the public street) end or the approach width at the right-of-way line.

2) Where the width of an aisle change or where the approach width is different from the width of the aisle or driveway farther into the property, the following formula shall be used to determine the minimum taper length:

$$L = 20 \times W$$

Where: L = taper length and

W = difference in width

TABLE 2-11
MINIMUM DRIVEWAY STORAGE LENGTH

Number of Parking Spaces Per Driveway	Minimum Storage Length* (Feet)
Less than 50	18
50 to 200	50
More than 200	78

* Storage length is defined as the distance between the street right-of-way line and the first intersecting aisleway on site.

C. Driveway Grades

The normal driveway grade within the street right-or-way is set at one-quarter inch (1/4") per foot rise above the top of curb at the property line. The minimum elevation of a driveway at the right-of-way line is two inches (2") above the top of curb. Barrier free sidewalk construction requires a maximum driveway grade as measured from the gutter of eight percent (8%).

Where driveway construction or reconstruction must occur off the street right-of-way, the usual maximum grade is fourteen percent (14%). The maximum change in grade without vertical curve is twelve percent (12%) for any 10 feet in distance. Driveways should be profiled for a distance of at least 25 feet outside the right-of-way to ensure adequate replacement design.

Due to state laws requiring barrier free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveways.

D. Driveways Connecting to Rural Residential Streets

Driveways connecting to Rural Residential Streets and located on public right-of-way shall be constructed according to details adopted by the City. The size of the drainage pipe or opening shall be established by a Registered Professional Engineer to pass the 100 year storm with the proper tailwater and headwater contained within the ditch. Design calculations shall be submitted to the City Engineer for review before driveway construction begins.

E. Driveway Access to Roadways

Residential driveway access is limited in accordance with Section 3.1(u) of the Subdivision Ordinance.

2.7 PAVEMENT DESIGN

A. Standard Street and Thoroughfare Pavement Design

Table 2-12 shows the required pavement thickness for rigid pavement and the subgrade requirements for various street and thoroughfare types within the City of Terrell.

B. Alternate Pavement Design

The City Engineer will consider an alternate pavement design in lieu of selecting a design from Table 2-12, particularly when there are circumstances that warrant an individual design.

TABLE 2-12
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN

Facility Type	Usual Crown	Subgrade Requirements	Concrete Pavement Thickness
Major Arterial (AA)	1/4" per ft	6" Lime	10"
Major Thoroughfare (A)	1/4" per ft	6" Lime	9" or 10"
Secondary Thoroughfare (C)	1/4" per ft	6" Lime	9" or 10"
Collector (D or E)	1/4" per ft	6" Lime	7", 8", or 10"
Residential/Local Street (F)	1/3" per ft	6" Lime	6"
Rural Residential (G)	1/4" per ft	6" Lime	6"
10 ft. Alley	5" Invert	6" Compacted	6"
15 ft. Alley	6" Invert	6" Compacted	6"

NOTE: 1) Twenty-eight day concrete compressive strength of rigid pavement shall not be less than 3,600 P.S.I (Class "C") and flexural strength shall not be less than 600 P.S.I. for beams per ASTM C78.

2) Thickness for a Minor Collector is 7", a major Collector in residential is 8", and a Major Collector in nonresidential is 10" thick.

3) Thickness for a Major Thoroughfare is 9" in residential and 10" in non-residential areas.

C. Testing

Testing shall be performed in accordance with the requirements of NCTCOG. However, one set of companion beams shall be made for each 300 CY of concrete (one per two sets of compressive cylinders) with a minimum of one per day. If the concrete batch design for the project has specific beam break data to correlate with compressive strength, the number of beams made on the project may be reduced by up to 50 percent.

D. Tree Root Barriers

Tree root barriers shall be installed in accordance with the construction details in Appendix E.

2.8 PERMANENT LANE MARKINGS

A. Purpose

The purpose of this section is to describe the typical layout of permanent lane markings used by the City of Terrell. The typical layout shall be in accordance with the information contained in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

B. Types of Markings

Lane markings shall be in accordance with the TMUTCD.

C. Types of Layouts

The pavement markings shall be laid out in accordance with the TMUTCD.

2.9 STREET SIGNS AND STREET LIGHTING

A. Street Signs

The developer shall pay the City of Terrell to purchase and install all streets' signs required for the development in accordance with the sign plan included in the construction plans. The minimum signage is as follows:

1. One street sign at each street intersection displaying the name of each street.
2. Stop signs and yield right-of-way signs at locations designated by the City Engineer.
3. For each street terminating in a cul-de-sac, a "Dead End Street or No Outlet" sign.

Other signage shall be installed as required by the City Engineer to provide for the safety of the public.

B. Street Lights

The developer shall erect street lights. A lighting plan shall be included in the construction plans for the project. The developer shall be responsible for all costs, including extra costs for decorative poles or other non-standard items normally installed by the local power provider. Street lights shall be installed at a spacing of not more than 400 feet and at each street intersection and each cul-de-sac. Street lights shall be installed in accordance with the National Electrical Code and the power provider's standards.

2.10 CONSTRUCTION PLAN PREPARATION

A. General

All paving plans for constructing street and thoroughfare improvements in the City of Terrell shall be prepared in accordance with the City of Terrell's procedures.

Plans for subdivision construction should be adequate to allow for review and construction inspection.

If the paving project includes storm drainage improvements, the hydraulic design of the proposed storm shall be accomplished based on procedures and criteria outlined in this manual.

B. Plan Set

Plans shall include a cover sheet, paving plan-profile sheets, typical paving section, paving cross sections, drainage area map, drainage plan-profile sheets and drainage cross sections if required.

C. Paving Plan-Profile Sheets

Usually, paving plan-profile sheets shall be prepared on a vertical scale of one-inch equals five feet. Plans shall be prepared on 24" x 36" sheets.

1. Plan

a. In the plan view the centerline of the street shall be drawn and stationed at one hundred foot intervals and each sheet shall begin and end with even or fifty foot stations.

b. Sufficient data including monuments and other survey controls shall be shown on the plans to permit establishment and staking of the centerline of the project from the construction plans.

c. If a survey line or transit line is required to locate the street or right-of-way, it shall be properly identified and dimensioned from the centerline. Also shown on the plan view shall be the geometrics and dimensions of the proposed paving improvements including curbs, curb and gutter, median, pavement edges, driveways, sidewalks, alley approaches, street headers, temporary pavement. Where the cut or fill at the property line exceeds one foot, the top of the cut slope or the toe of the fill slope shall be shown on the plan.

d. Property line and right-of-way line information shall include dimensions of existing and proposed property lines and right-of-way lines. Right-of-way dimensions shall be shown on the proposed street and on intersecting streets. Each lot fronting on the proposed street shall be dimensioned and the lot and block number, house number, and ownership shown on the plan.

e. The proposed paving improvements may be shaded as necessary to clarify the intent of the plans. Pavement dimensions, unless otherwise noted, shall be to the face of the curbs.

f. Proposed storm drains and inlets shall be shown on the plan and the paving station at the centerline of the inlet shall be shown as well as the inlet size, type inlet, top of curb elevation and inlet flow line. Existing storm drains and utilities shall be shown located by dimension and the name and size of each noted.

g. Other data shown on the plan shall include a benchmark which will remain after construction of the improvements, flow arrows indicating direction of storm water runoff, street names, match lines, scale and north arrow.

2. Profile

a. The profile portion of the plan-profile sheet shall show the existing ground profile at each right-of-way line, the proposed top of curb profile at each side of the street. If the street has a median, the profiles of the median curbs shall also be shown. At street intersections, the top of the curb elevation at the horizontal P.C. and P.I. of the curb radius and the paving station shall be shown in the profile and the name of the intersecting street shall also be shown.

b. Street grades should be set according to the procedure in Appendix "A". Of overriding importance is the safety of all persons and vehicles using the street.

c. The proposed street grade shall be indicated in percent to the nearest one hundredth percent, vertical curve data shown including length of vertical curve; external distance, station and elevation at point of vertical curvature, PVC and station and elevation at point of vertical tangency, PVT.

d. Elevations of the proposed top of curb shall be shown at each one hundred-foot station and fifty-foot station including elevations on vertical curves at these stations. Low points on sag vertical curves and high points on crest vertical curves shall also be shown and stationed.

3. At some convenient locations (preferably on a separate detail sheet), one or more typical paving sections shall be presented including the required dimensions of pavement width, lane widths, right-of-way width, type and thickness of pavement, subgrade, curb, driveway grades and the location of walks.

4. Special Details and Specifications

   a. Special details not shown on Standard Construction Details shall be included in the plans. Structural details for bridges, special retaining walls, headwalls, junction boxes, culverts, and special inlets shall be provided as well as bridge railings, hard railings, special barricades (permanent and temporary) and warning signs. Material and installation specifications not included in the NCTCOG Specifications for Public Works Construction shall be submitted in writing as a part of the Special Provisions. A sequence of Construction shall be prepared where applicable which will allow two way traffic movement through projects along existing streets.

   b. Structural analysis computations shall be provided in a legible form for any existing structure which will act as a support or supplement to the designed facility. Items on the plans requiring special provisions and special construction techniques shall be clearly delineated on the plans and specifically called to the City's attentions by letter prior to final plan submission.

PART 3 - DRAINAGE

3.1 STORM DRAINAGE SYSTEM

The City of Terrell is participating with NCTCOG in preparation of an integrated approach to the design and construction of drainage facilities resulting from land development projects. When fully implemented in the future, the integrated Storm Water Management (iSWM) design and construction methods will result in reduced impact on property up and downstream of individual projects. At the current time, the iSWM available for use is the iSWM Design Manual for Construction dated December 2003. All construction projects in the City of Terrell shall be designed and constructed in accordance with this manual. When the future design procedures for determination of storm water runoff quantities are implemented by iSWM, those design procedures shall replace the procedures described below.

Drainage facilities shall be designed and constructed at such locations and of such size and dimensions to adequately serve the development and the fully developed contributing drainage area above the development. The developer shall provide all the necessary easements and right-of-ways required for drainage structures including storm drains and open channels, lined or unlined. Easement widths for storm drain pipelines shall not be less than twenty (20') feet. Easement widths for open channels less than ten (10') feet from top of bank to top of bank shall be at least twenty-five (25') feet wide with a fifteen (15') foot access easement on one side. For open channels wider than ten (10') feet from top of bank to top of bank, a minimum fifteen (15') foot wide access easement shall be provided on both sides of the channel. In all cases, easements shall be of an adequate size to allow proper maintenance.

The design flows for the drainage system shall be calculated by the Rational Method in accordance with standard engineering practice and in accordance with the requirements set forth in this document. Curbs, inlets, manholes, etc., shall be designed and constructed in accordance with the Standard Details. Materials and construction procedures shall conform to the requirements of the Standard Specifications for Construction.

A lot grading plan shall be provided for all development work. No lot-to-lot drainage will be allowed unless specific and private drainage easements are shown on the plat and provisions are made to prevent blocking the easements with fences or other appurtenances. The easements shall not be to the City of Terrell and will not be maintained by the City of Terrell and shall be specified as such on the Final Plat.

The developer shall comply with all requirements of the Environmental Protection Agency, the U.S. Army Corps of Engineers, and the Texas Commission on Environmental Quality (TCEQ) and shall obtain all permits required by these agencies.

The developer shall provide plans and specifications and design calculations for all drainage structures. The drainage facility requirements will depend on the type of street used within the subdivision as follows:

A. Subdivisions Utilizing Rural Residential and Parkways

1. Storm water may be carried in drainage ditches located adjacent to and parallel to the roadway.

2. Ditch slopes shall not be steeper than 5:1 on the front slope and 4:1 on the back slope. Slopes steeper than 6:1 shall be solid block sodded with Bermuda grass sod.

3. For clay (CL, CH, and SC classified) soils, the velocity of the storm water in the drainage way shall not exceed 6 fps at a ten-year frequency storm event unless erosion control devices meeting the approval of the City Engineer are used. For sandy soil conditions, the velocity of the storm water in the drainage way shall not exceed 3 fps at a ten-year frequency storm event without approved erosion control devices.

4. Ditch flow line slopes shall not be less than 0.75%.

5. Ditch depth shall not be less than 1.5 feet measured from the edge of pavement.

6. If any of the above criteria cannot be met, the storm water shall be carried in an enclosed pipe system.

B. Subdivisions Utilizing Curbed Streets

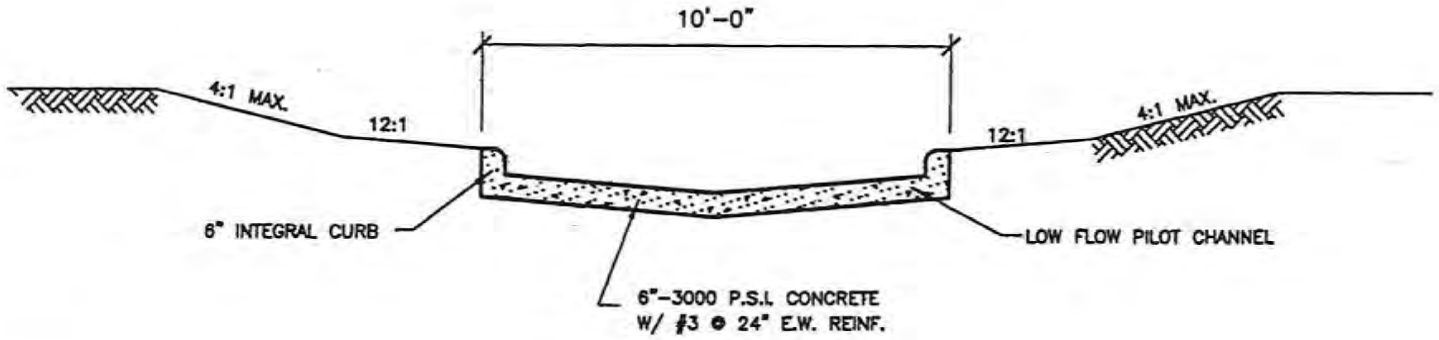
All storm water shall be carried within the paved street surface or in an enclosed pipe system or both.

For flows that exceed the capacity of an equivalent 84-inch pipe, an unlined open channel with a concrete pilot channel constructed in accordance with Figure 3-1 may be used.

The design, size, type and location of all storm drainage facilities shall be subject to the approval of the City Engineer. The requirements set forth herein are considered minimum requirements. The developer and his engineer shall bear the total responsibility for the adequacy of design. The approval of the facilities by the City Engineer in no way relieves the developer of this responsibility.

The developer shall be responsible for the necessary facilities to provide drainage patterns and drainage controls such that properties within the drainage area, whether upstream or downstream of the development, are not adversely affected by storm drainage from facilities on the development.

Storm drainage released from the site will be discharged to a natural water course of an adequate size to control the peak runoff expected after development.



TYPICAL EARTHEN CHANNEL SECTION

SECTION LOOKING SOUTH OR WEST

FIGURE 3-1

SCALE: NONE DATE: MARCH 2004 SHEET:

DESIGN STANDARDS

TYPICAL CHANNEL SECTION

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

3.2 HYDROLOGY

A. Design Criteria

The Rational Method for computing storm water runoff is to be used for the hydraulic design of facilities serving a drainage area of less than 600 acres. For drainage areas 600 acres to 1200 acres, the runoff is to be calculated by both the Rational Method and the Unit Hydrograph Method with the larger of the two values being used for hydraulic design. For drainage areas of 1200 acres and larger, the Unit Hydrograph or the U.S. Army Corps of Engineers HEC-1 Computer program shall be used. For developments which impact designated Federal Emergency Management Agency (FEMA) flood plains, HEC-1 or other methods designated by FEMA shall be used.

B. Rainfall Intensities

When calculating the quantity of storm runoff, rainfall intensity will be determined from the U.S. Department of Commerce Technical Paper No. 40, "Rainfall Frequency Atlas of the United States." For design of hydraulic facilities in the City of Terrell, the applicable formulas are as follows:

$$I_{100} = \frac{103.645}{(t_c + 14.0)^{0.75823}}$$

$$I_{10} = \frac{78.197}{(t_c + 13.0)^{0.78786}}$$

Where: t_c = Time of concentration in minutes.

I = Rainfall intensity for a 10 year and 100 year storm.

The above equations are represented graphically in Figure 3-2.

The storm frequency used for this determination will be according to the facility to be designed as listed in Table 3-1. Emergency overflows where used are to be located at sags and T-intersections of streets and designed to prevent erosion and surface water damage.

RAINFALL INTENSITY CURVES
CITY OF TERRELL

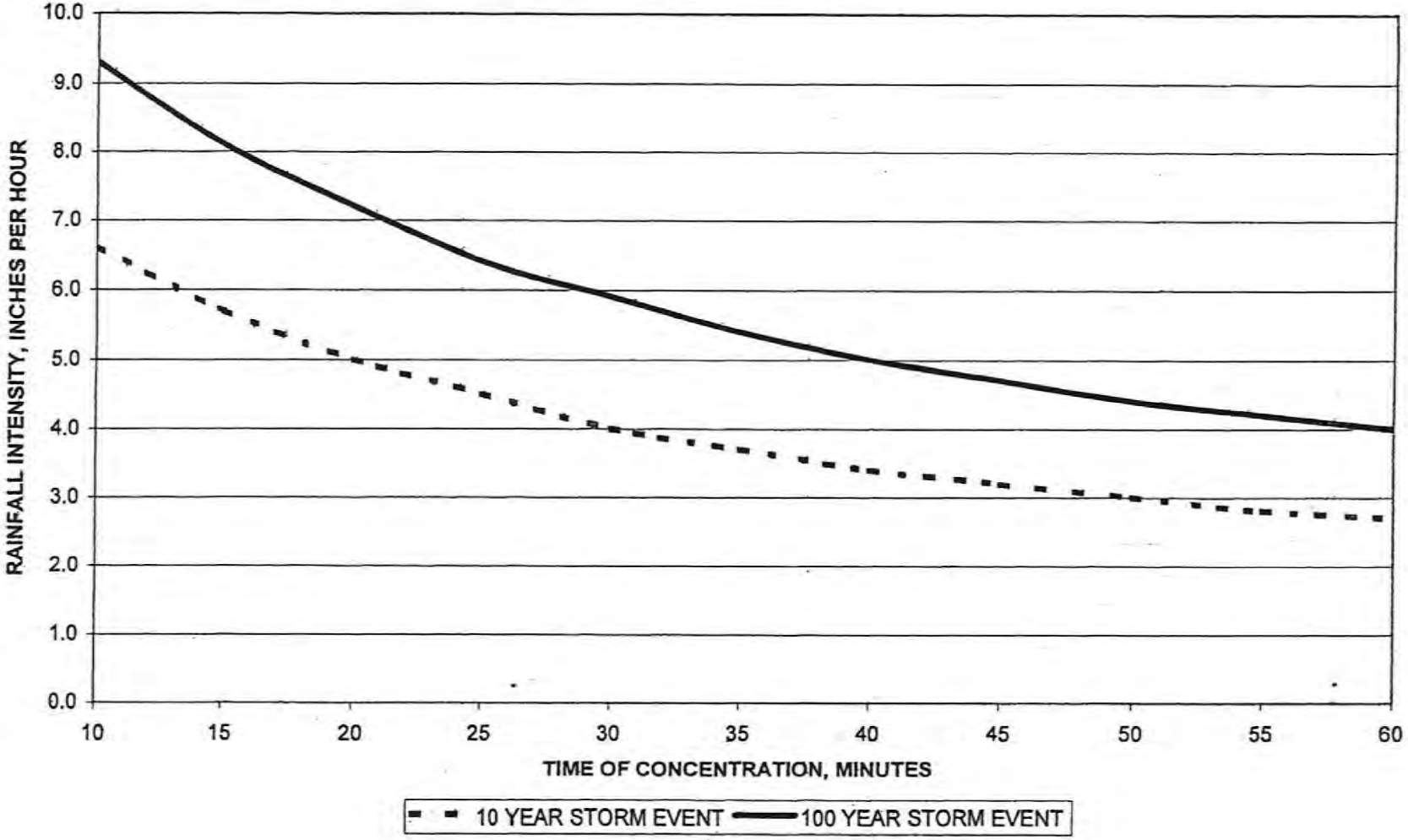


FIGURE 3-2

TABLE 3-1
DESIGN STORM FREQUENCY

Drainage Facility	Storm Frequency
Drainage ditches located in street right-of-way used in conjunction with Rural Residential and Parkway street construction with no freeboard	100 years
Pipe storm sewers with emergency overflow to give a combined capacity of 100-year frequency	10 years
Pipe storm sewer with no emergency overflow	100 years
All open channels with a minimum of 2 feet freeboard above to the top of the bank.	100 years
Culverts (pipe or concrete box)	100 years
Bridges, low point of bridge beams or similar bridge deck supporting structure to be 2 feet above 100-year storm or highest flood recorded, whichever is greater.	100 years

C. Rational Method

The rational method as described in Chapter 5 of the Texas Departments of Transportation "Hydraulic Manual" shall be used to calculate runoff. The storm frequency used for this determination will be according to the facility to be designed as listed in Table 3-1. Emergency overflows, where used, are to be located at sags and T-intersection of streets and designed to prevent erosion and surface water damage.

The time of concentration to any inlet shall be determined from finished grade slopes but in no case may be more than listed in Table 3-2.

D. Unit Hydrograph Method

For watersheds sized between 600 and 1,200 acres, the unit hydrograph method shall be compared to the Rational Method results and the higher of the two used for design purposes. The unit hydrograph method described in Section 7, Chapter 5 of the TxDOT Hydraulic Design Manual dated March 2004 shall be used.

E. Design According to FEMA-FIA Requirements

All streams having floodway or flood plain designation by FEMA-FIA must be designed to meet the requirements of these agencies.

3.3 RUNOFF COEFFICIENTS AND TIME OF CONCENTRATION

Runoff coefficients, as shown in Table 3-2, shall be the maximum used, based on total development under existing land zoning regulations. Where land uses other than those listed in Table 3-2 are planned, a coefficient shall be developed utilizing values comparable to those shown. Larger coefficients may be used if considered appropriate to the project by the City Engineer.

TABLE 3-2
RUNOFF COEFFICIENTS AND MAXIMUM INLET TIMES

Zone	Zoning District Name	Run-off Coefficient "C", for Sandy Soils	Run-off Coefficient "C", for Clay Soils	Max. Inlet Time in Minutes
AR	Agricultural Residential	0.30	0.40	20
F-1	Single Family Residential	0.4	0.5	15
1F-2	Single Family Residential	0.5	0.6	15
2F	Two Family Residential	0.55	0.65	15
GR	General Residential	0.55	0.65	15
MF	Multi-Family	0.70	0.80	10
R	Retail District	0.85	0.85	10
CA	Central Area District	0.90	0.90	10
C	Commercial District	0.90	0.90	10
LI	Light Industrial	0.70 to 0.90	0.70 to 0.90	10
HI	Heavy Industrial	0.70 to 0.95	0.70 to 0.95	10
PD	Planned Development	0.55	0.65	20
NON-ZONED LAND USES				
Church		0.7	0.9	10
School		0.5	0.9	10
Park		0.3	0.7	10
Cemetery		0.3	0.5	15
Street & Highway ROW		0.95	0.95	10

Times of concentration shall be computed as shown in Chapter 2, HYDROLOGY, of the Texas Department of Transportation, "Hydraulic Manual," latest edition.

3.4 DESIGN OF DRAINAGE FACILITIES

A. Flow in Gutters and Inlet Locations

Storm drain conduits shall begin at the point where the depth of flow based on the 100-year storm frequency reaches a point not greater than 1 inch over the top of curb. For pavement sections that do not have curbs, including alleys, the 100-year storm shall be contained within the right-of-way. Inlets are then located as necessary to remove the flow based on a 10-year storm frequency. If, in the judgement of the Engineer, the flow in the gutter would be excessive under either of these conditions, then consideration should be given to extending the storm sewer to a point where the gutter flow can be intercepted by more reasonable inlet locations. Multiple inlets at a single location are permitted in extenuating circumstances. Where possible, inlets should be placed upstream from an intersection to prevent large amounts of water from running through intersections. Inlets should also be located on the approach street to an intersection and in alleys where necessary to prevent water from entering these intersections in amounts that would cause the allowed street capacity to be exceeded.

The use of the street for carrying storm water shall be limited to the following:

SPREAD OF WATER - 10 YEAR STORM FREQUENCY

Type AA, A, B, or C Streets - One traffic lane on each side to remain clear.

Type D or E Streets - One traffic lane to remain clear.

Type F Streets - Six inch (6") depth of flow at curb or no lanes completely clear.

Alleys - Contained within the paved surface.

For Rural Residential (Type G) and Parkway thoroughfares, the spread of water shall be based on a 100-year storm frequency. All storm water must be contained within the right-of-way. The depth of flow shall not exceed the roadway crown elevation.

SPREAD OF WATER - 100 YEAR STORM FREQUENCY

Notwithstanding the requirements above, all storm water in the 100-year storm frequency shall be contained within the street or alley right-of-way or with in the drainage easement. The water depth shall not be greater than 1" over any curb.

B. Capacity of Streets and Alleys

Figure 3-3 includes a nomograph for flow in triangular channels that may be used for computing the capacity of streets and alleys having a straight cross slope. All street and alley capacities shall be calculated using a roughness coefficient of n = 0.0175.

C. Capacity of Swales

The capacity of swales shall be calculated according to the Manning Equation as given in Chapter 3 of the Texas Department of Transportation "Hydraulic Manual." All calculations shall be made using a roughness coefficient based on Table 3-5.

D. Valley Gutters

The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:

1. A Type AA or A street shall not be crossed with a valley gutter.

2. Wherever feasible, a Type B, C, or D street shall not be crossed with a valley gutter.

3. At any intersection, perpendicular valley gutters will not be permitted and parallel valley gutters should cross only the lower classified street.

E. Alley Capacities

In residential areas where the standard alley section capacity is exceeded, curbs may be used to provide needed capacity. However, all storm drainage shall be contained in the alley right-of-way and may not encroach on to private property especially at connecting driveways.

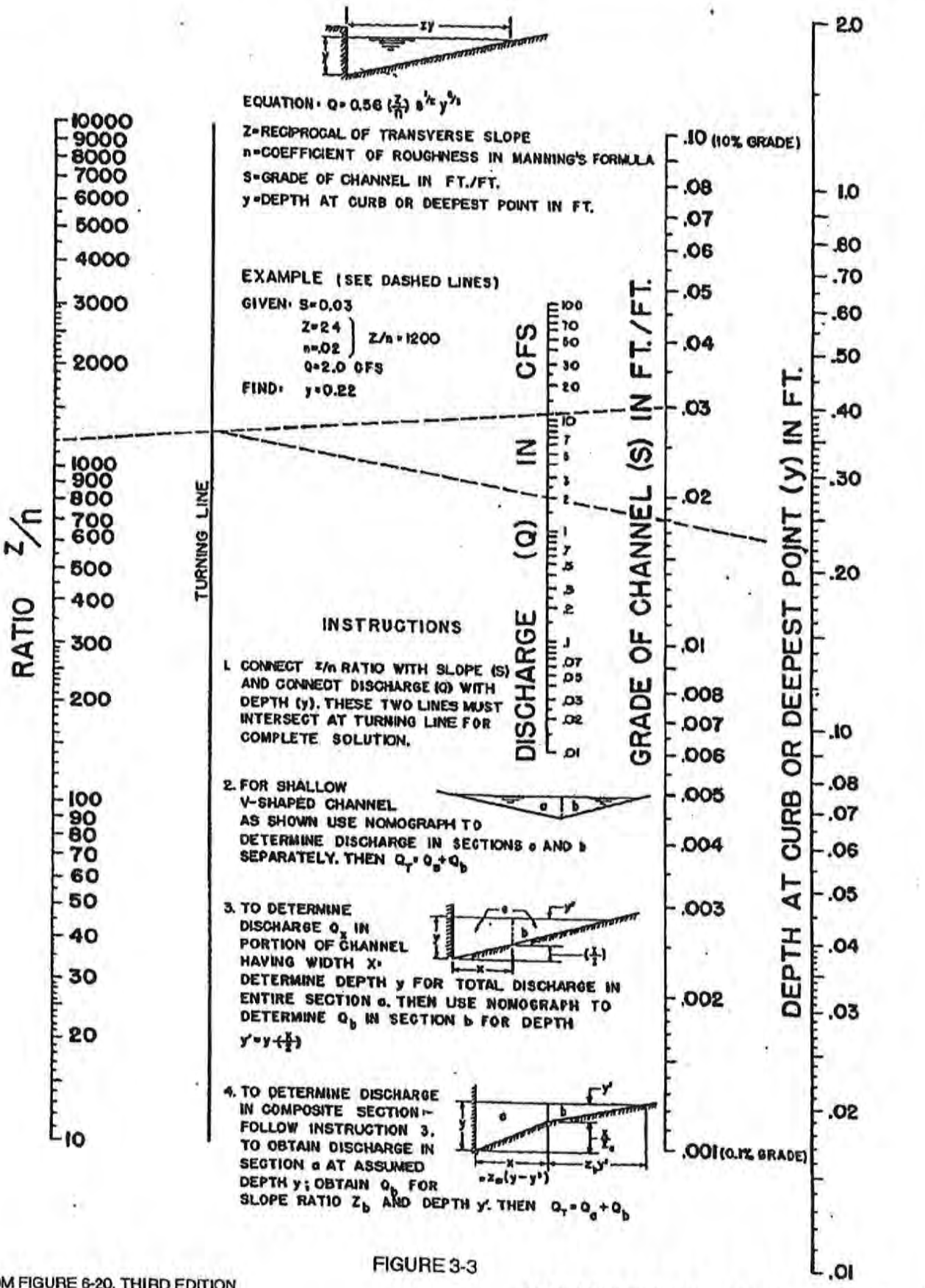


FIGURE 3-3

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

ADAPTED FROM FIGURE 6-20, THIRD EDITION BRIDGE DIVISION HYDRAULIC MANUAL, STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION OF TEXAS, DECEMBER 1985.

F. Sizing and Location of Inlets

For determining the size and locations of inlets, the following shall be used as a minimum:

TABLE 3-3
INLET OPENING REQUIREMENTS

Street Grade	Length of Inlet Opening for Each C.F.S. of Gutter Flow
Sags	0.6 Feet
Less than 2%	1.0 Feet
Greater than 3.5%	2.0 Feet

Inlets shall be spaced no closer than 300 feet apart without special permission from the City. The maximum length of an inlet at one location shall be 20 feet on each side of the street.

No more than 5 cfs can cross intersections in residential areas and no bypass of storm water across major intersections shall be allowed.

G. Hydraulic Gradient of Conduits

After the computation of the quantity of storm runoff entering each inlet, the size and gradient of pipe required to carry off the design storm are to be determined. All hydraulic gradient calculations shall begin at the outfall of the system. The following are the criteria for the starting elevation of the hydraulic gradient:

1. The 100-year water surface elevation in a creek, stream or other open channel is to be calculated for the time of peak pipe discharge in the same storm and that elevation used for beginning the hydraulic gradient.

2. When a proposed storm sewer is to be connected to an existing storm sewer system that has a design flow less than the proposed, the hydraulic gradient for the proposed storm sewer should start at the elevation of the existing storm sewers hydraulics gradient based on the proposed design year of the upstream system.

H. Hydraulic Design of Closed Conduits

All closed conduits shall be hydraulically designed for full flow as shown in Chapter 6, STORM DRAINS, of the Texas Department of Transportation, "Hydraulic Manual."

The crown of the pipe should be near the elevation of the hydraulic gradient, in most cases, to eliminate excessive excavation. The hydraulic gradient shall not be designed above the top of any inlet. The permissible difference between the hydraulic gradient and top of curb is normally 2 feet or 1.5 $V^2/2g$ where V is the velocity in feet per second and g is 32.2 feet per

second. The hydraulic gradient in the inlet shall not be higher than 1 foot below the top of the inlet.

I. Velocity in Closed Conduits

Pipe grade shall be set to produce a velocity of not less than 3 feet per second (fps) when flowing full. Grades producing velocities of less than 3 fps will not be allowed. All storm sewer pipe and driveway culverts shall be a minimum of 18 inches in diameter. Discharge velocity shall be calculated with a tailwater depth not greater than the lesser of the top of the pipe at the pipe outlet or the actual 100-year water surface elevation in the channel.

Table 3-4 shows the maximum allowable velocities in closed conduits:

TABLE 3-4
RECOMMENDED MAXIMUM VELOCITY

Type of Conduit	Maximum Velocity
Culverts	15.0 fps
Inlet Laterals	15.0 fps
Storm Sewers	12.5 fps

Discharge velocities cannot exceed the permitted velocity of the channel or conduit at the outfall.

J. Roughness Coefficients for Conduits

The recommended value for the roughness coefficient "n" for concrete conduits with smooth joints and good alignment is 0.013. Where engineering judgement indicates a value other than 0.013 be used, the appropriate adjustments should be made in the calculations and the variance noted.

K. Head Losses

1. Head losses and gains for wyes and pipe size changes will be calculated by the formulas:

Where $V_1 < V_2$

$$H_l = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

Where $V_1 > V_2$

$$H_l = \frac{V_2^2}{4g} - \frac{V_1^2}{4g}$$

Where:

H_l = the head loss in feet measured at the point of wye or pipe size change.
V_1 = upstream velocity
V_2 = downstream velocity

2. Head losses and gains for manholes and junction boxes will be calculated by the formula:

$$H_l = \frac{V_2^2}{2g} - K\frac{V_1^2}{2g}$$

Where:

H_l = the head loss in feet measured from the downstream water surface elevation.
V_1 = upstream velocity or velocity in the lateral
V_2 = the downstream velocity
K = 0.35 for 90° Lateral
K = 0.43 for 60° Lateral
K = 0.50 for 45° Lateral
K = 0.25 for Thru Line

3. Head losses for pipe bends will be calculated by the formula:

$$H_l = K\frac{V^2}{2g}$$

Where:

H_l = the head loss in feet measured at the upstream end of the bend
V = the pipe velocity
K = 0.50 for 90° Bend
K = 0.43 for 60° Bend
K = 0.35 for 45° Bend
K = 0.20 for 22.5° Bend

The use of pipe bends is discouraged and will be allowed only in special situations with the permission of the City Engineer.

4. In the case where the inlet is at the very beginning of a line, the equation becomes the following without any velocity of approach:

$$H_l = K_l\frac{V^2}{2g}$$

Where: $K_l = 1.75$

5. If the head loss calculated is less than 0.1 foot, the minimum head loss to be used at wyes, junctions, manholes, and pipe size changes for design of storm drainage system is 0.10 foot.

L. Open Channels

A wide variety of lined, partially lined or unlined channels are permitted except that lined channels may not be constructed in single family, multi-family or townhouse residential developments. All lined channels must be screened by continuous adjacent landscaping of at least 4 feet in height. In general, the use of existing channels in their natural condition is encouraged. Low flow pilot channel lining of earthen channels will be required for any earthen channel carrying more than the capacity of an equivalent 84" diameter pipe. The design of the low flow pilot channel shall be as shown in Figure 3-1.

For residential developments, no more than two barrel box culverts will be permitted for stream crossings, except in unusual conditions. For unlined channel sections, the maximum side slopes are 4:1 and the maximum permitted mean velocity in the channel is 6 feet per second. Hydraulic mulching shall be applied to channel side slopes that are steeper than 5:1 in accordance with Section 202.6.4.4 of the NCTCOG Specifications and addenda. Temporary erosion control per Section 201 of the NCTCOG specifications is required for all channels.

Paved and rip-rapped slopes are to have a side slope of 2:1 maximum. Permitted velocities in totally lined channels are 15 feet per second for finished concrete and 10 feet per second for rock rip-rap. Discharge velocities from lined channels may not exceed 6 feet per second for clay soils and 3 feet per second for sandy soils. The minimum velocity in any channel shall be greater the 2 fps, including roadway ditches.

M. Hydraulic Design of Open Channels

The water surface as designed in an open channel is to be a minimum of 1 foot below the top of the channel section for concrete lined channels and 2 feet below the top of the channel section for rock rip-rap and earthen channels to provide a margin of safety for channel obstructions and for flows that exceed the design storm frequency.

The design engineer must provide sufficient depth in the channel at entrances to closed conduits and culverts to provide for the headwater requirements. The downstream depth of flow in the proposed ditch shall be used as the tailwater condition. Exit velocity for the 10 year storm event shall be checked as well as the 100 year storm event.

On all channels the water surface elevation, which is coincident with the hydraulic gradient, shall be calculated and shown on the construction plans.

Maximum allowable velocities and roughness coefficients for open channels are shown in Table 3-5. When the normal available grade would cause velocities in excess of the maximums, it may be necessary to design special drops or channel retards.

N. Hydraulic Design of Culverts

In the design of culverts, the Engineer shall keep head losses and velocities within reasonable limits while selecting the most economical structure. This normally requires selecting a structure that creates a head water condition and has a velocity of flow safely below the allowed maximum.

The vertical distance between the upstream design water surface and the roadway or bridge elevation is termed "freeboard." The dimension is included as a safety factor to protect against unusual clogging of the culvert and to provide a margin for future modifications in surrounding physical conditions. Normally, a minimum of 2 feet shall be considered a reasonable freeboard when the structure is designed to pass a design storm frequency of 100 years. Unusual surrounding physical conditions may be cause for a change in this requirement. Hydraulic design of culverts shall be in accordance with Chapter 4, CULVERTS, of the Texas Department of Transportation, "Hydraulic Manual."

TABLE 3-5
OPEN CHANNEL DESIGN PARAMETERS

Description	Minimum Roughness Coefficient	Maximum Channel Velocity, fps Clayey Soil/Sandy
NATURAL STREAMS		
Moderately Well-defined Channel		
Grass & Weeds, Little Brush	0.030	6/3
Dense Weeds, Little Brush	0.040	6/3
Weeds, Light Brush on Banks	0.045	6/3
Weeds, Heavy Brush on Banks	0.060	6/3
Weeds, Dense Willows on Banks	0.080	6/3
Irregular Channel With Pools and Meanders		
Grass & Weeds, Little Brush	0.045	6/3
Dense Weeds, Little Brush	0.050	6/3
Weeds, Light Brush on Banks	0.060	6/3
Weeds, Heavy Brush on Banks	0.070	6/3
Weeds, Dense Willows on Banks	0.100	6/3
Flood Plain, Pasture		
Short Grass, No Brush	0.035	6/3
Tall Grass, No Brush	0.050	6/3
Flood Plain, Cultivated		
No Grass	0.035	6/3
Mature Crops	0.050	6/3
Flood Plain, Uncleared		
Heavy Weeds, Light Brush	0.070	6/3
Medium to Dense Brush	0.160	6/3
Trees With Flood Stage Below Branches	0.120	6/3
UNLINED VEGETATED CHANNELS		
Mowed Grass, Clay Soil	0.030	6/3
LINED CHANNELS		
Smooth Finished Concrete	0.015	15/15
Rip-Rap, Rubble or Gabions	0.040	10/10

O. Headwalls

Headwalls are to be used to protect the embankment from erosion and the culvert from displacement. Sloped headwalls on a 4H:1V slope shall be constructed at the end of all pipe drainage facilities and vertical headwalls with wingwalls and aprons shall be constructed for all rectangular shaped hydraulic structures. Standard TxDOT details shall be used as the basis for design of headwalls.

Special headwalls and wingwalls may be required at the entrance of all hydraulic structures where approach velocities are in excess of 8 feet per second. Culvert exit and headwall shall be designed such as the flow line of the culvert is coincident with the flow line of the stream or channel into which the culvert discharges.

The culvert exit and headwall shall be designed such that the flow line of the culvert is coincident with the flow line of the stream or channel into which the culvert discharges. The maximum exit velocity from the culvert is limited to the maximum velocity allowed in the stream or channel.

Due to the geometry of the culvert-stream intersection, turbulence or other conditions may tend to produce erosion. Concrete rip-rap will be used to protect the stream bed from scour and erosion. The rip-rap shall be reinforced and have toe walls to prevent undermining.

The maximum exit velocity from the culvert is limited to the maximum velocity allowed in the stream or channel depending on channel geometry and soil type. Concrete rip-rap and energy dissipaters are required to protect the stream bed from scour and erosion when velocities exceed the capacity of grass lining to protect the underlying soil. The rip-rap shall be reinforced and have toe walls to prevent undermining.

P. Bridge Design Hydraulics

Once a design discharge and a downstream depth of flow have been determined, the size of the bridge opening can be determined. Determination of head losses through bridge structures shall be calculated.

The City of Terrell has the following policy with regard to the hydraulic design of bridge structures:

1. Minor head loss due to the structure is allowed. Normal losses due to channel cross sections are allowable.

2. Excavation of the natural channel is not normally allowed as compensation for loss of cross sectional area.

3. Channelization upstream or downstream of the proposed bridge will normally not be permitted.

4. Hydraulic design for bridges shall conform to the requirements of Chapter 5, BRIDGES, of the Texas Department of Transportation, "Hydraulic Manual."

5. A 2-foot freeboard is required between the designed water surface and the bottom of the lowest beam.

6. Bridge design shall meet all FEMA requirements when a designated floodway is crossed.

3.5 CONSTRUCTION PLANS PREPARATION

A. Drainage Area Map

The site drainage area map shall have a minimum scale of 1' = 200', and show the street right-of-way. For large drainage areas, including off-site drainage, a map having a larger scale may be used. The following items/information shall be included:

1. Acres, coefficient, and intensity for each drainage sub-area;
2. Inlets, their size and location, the flow bypass for each, the direction of flow as indicated by flow arrows, the station for the centerline of the line;
3. A chart including data shown shall be submitted with the first review, and included on the map with the final review;
4. Existing and proposed storm sewers;
5. Sub-areas for alleys, streets, and off-site areas;
6. Points of concentration;
7. Runoff to all inlets, dead-end streets, and alleys or to adjacent additions and/or lots;
8. A table for runoff computations;
9. Flow arrows to indicate all crests, sags and street and alley intersections;
10. North arrow;
11. Any off-site drainage shall be included;
12. Street names shall be indicated;
13. 100-year floodplain shall be indicated on the drainage area map.

When calculating runoff, the drainage area map shall show the boundary of the drainage area contributing runoff into the proposed system. This boundary should be determined from a map having a maximum contour interval of 2 feet. The area shall be further divided into sub-areas to determine flow concentration points or inlet locations. The centerline of all streets will normally be a boundary of a drainage area, to ensure that inlets are sized and positioned to fill the need without depending on storm water crossing over the street crown for proper drainage.

In residential areas, the centerline of the street will only be used as a drainage area boundary if the flow in either gutter has not exceeded the street crown elevation.

Direction of flow within streets, alleys, natural and man-made drainage ways, and at all system intersections, shall be clearly shown on the drainage area map and/or paving plans. Existing and proposed drainage inlets, storm sewer pipe systems and drainage channels shall also be clearly shown and identified on the drainage area map. Storm sewer plans shall show and mark station ticmarks at 100-foot intervals. Plan-profile storm sewer or drainage improvement sheet limits and match lines shall be shown with pipes and channels identified.

The drainage area map should show enough topography to easily determine its location within the City.

B. Plan-profile Sheets

1. Inlets

Inlets shall be given the same number designation as the area or sub-area contributing runoff to the inlet. The inlet number designation shall be shown opposite the inlet. Inlets shall be located at or immediately downstream of drainage concentration points. At intersections, where possible, the end of the inlet shall be ten feet from the curb return P.T., and the inlet location shall also provide minimum interference with the use of adjacent property. Inlets in residential areas should be located in streets and alleys so the driveway access is not prohibited to the lots. Inlets located directly above storm sewer lines, as well as laterals passing through an inlet, shall be avoided. Drainage from abutting properties shall not be impaired, and shall be designed into the storm drainage system.

Data opposite each inlet shall include paving or storm sewer stationing at centerline of inlet, size and type of inlet number or designation, top of curb elevation and flow line of inlet as shown on construction plans.

2. Laterals

Inlet laterals leading to storm sewers, where possible, shall enter the inlet and the storm drain main at a 60-degree angle from the street side. Laterals shall be four feet from top of curb to flow line of inlet, unless utilities or storm sewer depth requires otherwise. Laterals shall not enter the corners or bottoms of inlets. Lateral profiles shall be drawn showing appropriate information including the hydraulic gradient and utility crossings. Short laterals (30 feet or less) crossing utility lines will be profiled.

3. Storm Sewer

In the plan view, the storm sewer designations, size of pipe, and length of each size pipe shall be shown adjacent to the storm sewer. The sewer plan shall be stationed at one hundred (100) foot intervals, and each sheet shall begin and end with even or fifty (50) foot stationing. All storm sewer components shall be stationed.

The profile portion of the storm sewer plan-profile sheet shall show the existing and proposed ground profile along the centerline of the proposed sewer, the hydraulic gradient of the sewer, the proposed storm sewer, and utilities that intersect the alignment of the proposed storm sewer. Also, shown shall be the diameter of the proposed pipe in inches, and the physical grade in percent. Hydraulic data for each length of storm sewer between interception points shall be shown on the profile. This data shall consist of pipe diameter in inches, the 100-year design storm discharge in cubic feet per second, slope of hydraulic gradient in percent, Manning capacity of the pipe flowing full in cubic feet per second, velocity in feet per second, and $V^2/2g$. Also, the head loss at each interception point shall be shown.

Elevations of the flow line of the proposed storm sewer shall be shown at one hundred (100) foot intervals on the profile. Stationing and flow line elevations shall also be shown at all pipe grade changes, pipe size changes, lateral connections, manholes and wye connections. All soffits shall be connected.

4. Creek Cross-Sections

The plan view of creek crossing shall include topographic information for the creek channel at least 200 feet up and downstream of the crossing and shall include the location

and type of trees in excess of 3-inch caliper. Sufficient information shall be provided to determine accurate cross-sections of the natural creek and creek bank. The profile shall include the depth of flow and velocities in the existing creek channel for the 100 year storm event. This depth of flow shall be used as the tailwater when analyzing the hydraulic impacts of the proposed crossing. The resulting headwater and exit velocity from the proposed crossing shall be included on the profile.

All plan sheets shall be drawn in AutoCAD® format on 24" x 36" sheets, to a standard engineering scale, and shall be clearly legible when sheets are reduced to half scale. Each plan-profile sheet shall have a benchmark shown. Review plan markups shall be returned with each subsequent submittal of revised plans.

3.6 CHECK LIST FOR STORM DRAINAGE PLANS

A. Drainage Area Map

1. Normally, use 1" = 200' scale for on-site, and 1" = 400" for off-site. Show match lines between any two (2) or more maps.
2. Show existing and proposed storm drains and inlets with designations.
3. Indicate sub-areas for alley, street, and off-site areas.
4. Indicate existing and proposed contours on map for on and off-site.
5. Use design criteria as shown in design manual.
6. Indicate zoning on drainage area map.
7. Show points of concentration and their designations.
8. Indicate runoff at all inlets, dead-end streets and alleys, or to and from adjacent additions or acreage.
9. Provide runoff calculations for all areas showing acreage, runoff coefficient, and inlet time. (Q = CIA table)
10. For cumulative runoff, show calculations.
11. Indicate all crests, sags, and street and alley intersections with flow arrows.
12. Identify direction of north to top page or to the left.
13. Show limits of 100-year fully developed flood plain on drainage area map.

B. Storm Sewers

1. Diversion of flow from one natural drainage area to another will not be allowed.
2. Show plan and profile of all storm sewers.
3. Specify Class III pipe unless otherwise noted.
4. Use heavier than Class III pipes where crossing railroads, areas of deep fill and areas subjected to heavy loads.

5. Specify concrete strength for all structures. The minimum allowable is 3,600 psi.

6. Provide inlets where street capacity is exceeded. Provide inlets where alley runoff exceeds intersecting street capacity.

7. Do not allow storm water flow from streets into alleys.

8. Do not use high velocities in storm sewer design. A maximum discharge velocity of six (6) fps for clay soil and 3 fps for sandy soils is required at the location where grass lined ditches begin. Velocity dissipation may be necessary to reduce erosion.

9. Flumes may not be allowed unless specifically designated, and will not be allowed on AA, A, B, C, or D thoroughfares.

10. Provide headwalls and aprons for all storm sewer outfalls. Provide rip-rap around headwalls where slopes exceed 4:1.

11. Discharge flow lines of storm sewers to be two (2) feet above the flow line of creeks and channels (where topography allows), unless channel lining is present. Energy dissipation shall be provided when specified by the City Engineer.

12. Where fill is proposed for trench cut in creeks or outfall ditches, compaction shall be 95% of the maximum density as determined by ASTM D 698.

13. Investigations shall be made by the engineer to validate the adequacy of the storm sewer outfall to a major stream.

14. Outfall area must have adequate capacity to carry the discharge. Provide Erosion control facilities with hydraulic data.

15. Any off-site drainage work or discharge to downstream property will require an easement. Easements shall be sized such that the developed flows can be conveyed within the easement. The easement shall also be large enough to provide access along the top bank for maintenance and access from public right-of-way. Submit field notes for off-site easement that may be required.

16. For 24" and smaller storm sewer, manholes shall be spaced at junctions and at a maximum of 500-foot centers. For storm sewer larger than 24", manholes shall be placed at junctions and a maximum of 800' centers.

C. Plan and Profile

1. Indicate property lines and lot lines along storm sewers, and show easements with dimensions.

2. If necessary, provide separate plan and profile of storm sewers. The storm drain pipes should also be shown on paving plans with a dashed line, and on sanitary sewer profiles showing the full pipe section.

3. Tie storm sewer system stationing with paving stations.

4. Show pipe sizes in plan and profile.

5. Show hydraulics on each segment of pipe profile to include: Q_{10}, Q_{100}, C = Manning full flow capacity; S, V, $V^2/2g$.

6. Show curve data for all storm sewer system.

7. Show all existing utilities in plan and profile. On storm sewer profiles, as a minimum, the sanitary sewer profile will be shown.

8. Indicate existing and proposed ground line and improvements on all street, alley, and storm sewer profiles.

9. Show future streets and grades where applicable.

10. Where connections are made to existing storm sewer show computations on existing system when available. HGL will be calculated from the outfall to the connection point including the designed flows of the added on systems.

11. Indicate flow line elevations of storm sewers on profile, show pipe slope (percent grade). Match top inside of pipe where adjacent to other size pipe.

12. Intersect laterals at sixty (60) degrees with trunk line.

13. Show details of all junction boxes, headwalls, storm sewers, flumes, and manholes, when more than one pipe intersects the drainage facility or any other item is not a standard detail.

14. Pipe direction changes will be curves using radius pipe unless approved by the City Engineer.

15. Bends in pipe may be used in unusual circumstances with approval of the City Engineer. No bend at one location may exceed thirty (30) degrees.

16. Do not use 90-degree (90) turns on storm sewers or outfalls. Provide good alignment with junction structures or manholes (for small systems).

17. Profile outfall with typical flat bottom section.

18. Show all hydraulics, velocity head changes, gradients, and computations.

19. Show water surface at outfall or storm drain.

20. On all dead-end streets and alleys, show grade out to "daylight" for drainage on the profiles and provide erosion control. Show typical section and slope of "daylight" drainage. Side slopes shall not exceed 4:1.

21. At sags in pavement, provide a positive overflow (paved sidewalk in a swale) to act as a safety path for failure of the storm drain system. Minimum finished floor elevations will be shown on the plat to protect building against flooding should the positive overflow be used.

22. Where quantities of runoff are shown on plans or profiles, indicate storm frequency design.

23. Provide sections for road, railroad and other ditches with profiles and hydraulic computations. Show design water surface on profile.

24. For drainage ditches located in street right-of-way running parallel to street paving, show the size of each driveway culvert on the ditch profile. Assume the maximum number and

width of driveways allowed for each lot. Show the hydraulic grade lines as required herein.

D. Laterals

1. Show laterals on trunk profile with stations.

2. Provide lateral profiles for laterals exceeding thirty (30) feet in length.

3. Where laterals tie into trunk lines, place at sixty (60) degree angles with centerlines. Connect them so that the longitudinal centers intersect.

4. Calculate hydraulic grade line for laterals and inlets to ensure collection of storm water. Check 1.5 $V^2/2g$, using trunk line velocity on laterals less than 80-feet long. Final the H.G. at the gutter or inlet lip by adding the 1.5 $V^2/2g$ to the hydraulic gradient of the trunk line at the lateral connection. For all inlets, provide HGL. and hydraulic data on profile for all profiled laterals. Laterals longer than eighty (80) feet require special analysis.

5. All inlets shall have minimum eighteen (18") inch laterals.

E. Inlets and Intakes

1. Provide inlets where street capacity is exceeded. Provide inlets where runoff from alley causes the capacity of the intersecting street to be exceeded.

2. Indicate runoff concentrating at all inlets and direction of flow. Show runoff for all stub outs, pipes and intakes.

3. On plan view, indicate size of inlet, lateral size, flow line, top-of-curb elevations, paving station, and inlet designation number.

4. Use standard curb inlets in streets. Use recessed inlets in divided streets. Use combination inlets in alleys when on a straight run. Do not use grate or combination inlet unless other solution is not available (special situation).

5. Use type "Y" or special "Y" inlets in ditches or swales. No "Glory Holes" allowed as intake for a storm sewer or at a culvert. A three (3) foot concrete apron shall be constructed around "Y" inlets.

F. Paving

1. Provide six (6) inch curb on alleys parallel to creek or channel on creek side of alley.

2. For a proposed driveway turnout, curb return P.T. must be 10 feet upstream from any existing or proposed inlet, or 5 feet downstream of a standard inlet.

3. Check the need for curbing at all alley turns and "T" intersections. Flatten grades ahead of turns and intersections.

4. Where inlets are placed in an alley, provide curbing for 10 feet on each side of combination inlets.

G. Detention Basins

1. Provide drainage area map and show all computations for runoff affecting the detention basin.

2. Provide a plot plan with existing and proposed contours for the detention basin and plan for structural components. Determine if TCEQ permit is required for a small dam.

3. Where earthen embankment is proposed for impoundment, furnish a geotechnical report, typical embankment section and specifications for fill including a profile for the outflow structure.

4. Provide structural details and calculations for any item not a standard detail.

5. Provide detention basin volume calculations and elevation versus storage curve.

6. Provide hydraulic calculations for outflow structure and elevation versus discharge curve.

7. Provide routings or modified rational determination of storage requirements, demonstrating that critical duration is used (for areas of 600 acres or less).

8. Provide a ramp into the pond for maintenance. A pilot channel (minimum grade 0.5%) will be required for all ponds with a bottom grade sloping less than 1%.

H. Bridges

1. Clear the lowest member of the bridge by 2 feet above the design water surface, unless otherwise directed by the City Engineer.

2. Show geotechnical soil boring information on plan.

3. Show bridge sections upstream and downstream.

4. Provide structural details and calculations with dead load deflection diagram.

5. Provide vertical and horizontal alignment.

6. Show soil erosion protection measures and concrete rip-rap.

PART 4 - WATER AND SEWER LINES

4.1 WATER MAINS

A. General

All facilities shall be designed, constructed, and tested in accordance with TCEQ and NCTCOG guidelines. Water mains shall be placed on the north and west sides of a street. Refer to the Utility Assignment Sheets 1 to 9 in Appendix B in this manual for location of water lines.

1. Mains over 1,200 feet in length or mains supplying more than one fire hydrant, shall be a minimum size of 8-inch diameter pipe in residential districts. For mains in commercial and manufacturing districts, a minimum of 12-inch diameter pipe will be required if the main is over 600 feet in length.

2. In residential districts and in those supplying only one fire hydrant, a 6-inch diameter pipe is required for mains less than 1,200 feet in length. Dead end mains shall not exceed 600 feet in length, and at least one fire hydrant or blow-off valve will be required, usually at or near the end of the main.

3. In commercial and industrial districts, minimum 8-inch mains are required. In any event, water mains must be of adequate size to provide for the building total fire flow. Fire flow shall be Needed Fire Flow (NFF) as determined from the "Fire Suppression Rating Schedule" as published by the Insurance Services Office. Fire flow requirements shall be met at peak day demand.

4. Water mains in Type AA, A, B, C, and D streets shall be 12-inch minimum.

B. Water Main Material

1. All water mains shall be AWWA C900 or C905 PVC, DR 18. Double bell couplings may not be used for jointing pipe. Ductile iron fittings shall be used.

2. For water mains 24-inches in diameter and larger, Reinforced Concrete, Pretensioned Reinforced (Steel Cylinder Type), complying with AWWA C303, Class 150 may be considered on a case by case basis.

3. Profiles with elevations shall be provided for mains 16-inches in diameter and larger.

4. All private fire services that supply fire sprinkler systems shall be minimum 200 PSI working pressure and U.L. listed.

5. All water line easements shall be a minimum of fifteen feet wide.

C. Water Valves

Valves 12-inches and smaller shall be placed at or near street intersections and shall be spaced at a maximum of 800 feet apart in residential, duplex and apartment districts and not over 500 feet apart in all other districts. They shall be placed in such a manner as to require preferably two, but not more than three valves to shut down each City block, or as may be required to prevent shutting off more than one fire hydrant. On cross-feed mains without services, a maximum of four valves shall be used to shut down each block. Also, valves shall be placed at or near the ends of mains in such a manner that a shut down can be made for a future main extension without causing loss of service on the existing main. The location of valves larger than 12-inches will be as approved by the City Engineer. Valves 12-inches and under will be Resilient Seat Gate Valves (RSGV). Sixteen inch and larger valves shall be non-rising stem double disc gate valves.

D. Fire Hydrants

1. Number and Locations

A sufficient number of fire hydrants shall be installed to provide hose stream protection for every point on the exterior wall of the building. There shall be sufficient hydrants to concentrate the required fire flow, as recommended by the publication "Fire Suppression Rating Schedule" published by the Insurance Services Office, around any building with an adequate flow available from the water system to meet this required flow. In addition, the following guidelines shall be met or exceeded:

a. Single Family and General Residential

Fire hydrants shall be located at all intersecting streets and at intermediate locations between intersection at a maximum spacing of 500 feet between fire hydrants as measured along the route that fire hose is laid by a fire vehicle.

b. Attached Housing

Fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 400 feet as measured along the length of the center line of the roadway. The front of any structure at grade shall be no further than 400 feet from a minimum of two fire hydrants as measured along the route that a fire hose is laid by a fire vehicle.

c. Other Districts

Fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 300 feet as measured along the length of the center line of the roadway. The front of any structure at grade shall be no further than 300 feet from a minimum of two fire hydrants as measured along the route that a fire hose is laid by a fire vehicle.

d. Protected Properties

Fire hydrants required to provide a supplemental water supply for automatic fire protection systems shall be within 100 feet of the fire department connection for such system.

e. Fire Sprinkled Buildings

Fire sprinkled buildings shall be provided an 8-inch fire line stub-out with valve. A smaller stub-out can only be used with Fire Department approval.

f. Fire hydrants shall be installed along all fire lane areas as follows:

(1) Attached Housing

(a) Within 150 feet of the main entrance.

(b) At maximum intermediate spacing of 400 feet as measured along the length of the fire lane.

(2) Non-Residential Property or Use

(a) Within 150 feet of the main entrance.

(b) Within 100 feet of any fire department connection.

(c) At a maximum intermediate spacing of 300 feet as measured along the length of the fire lane.

(3) Fire lanes shall be a minimum of 24-feet wide. All radii shall be set to accommodate a standard SU vehicle.

(4) Generally, no fire hydrant shall be located closer than fifty (50') feet to a non-residential building or structure unless approved by the City Engineer.

(5) In instances where access between the fire hydrant and the building that it is intended to serve may be blocked, extra fire hydrants shall be provided to improve the fire protection. Railroads, expressways, major thoroughfares and other man-made or natural obstacles are considered as barriers.

2. Restrictions

a. All required fire hydrants shall be as required by the North Central Texas Council of Governments Specifications and Addenda and shall be placed on water mains of no less that six (6") inches in size.

b. Valves shall be placed on all fire hydrant leads.

c. Required fire hydrants shall be installed so the break away point will be no less than two (2") inches, and no greater than six (6") inches above the grade surface.

d. Fire hydrants shall be located as shown in Appendix "B." The fire hydrant shall not be in the sidewalk.

e. In non-residential developments an 8-inch lead will be required on all fire hydrants that are located more than 50 feet from the looped main.

f. All required fire hydrants placed on private property shall be adequately protected by either curb stops or concrete filled steel posts or other methods as approved by the Engineer and shall be in easements. Such stops or posts to be the responsibility of the landowner on which the said fire hydrant is placed.

g. All required fire hydrants shall be installed so that the pumper nozzle connection will face the fire lane or street, or as directed by the Engineer.

h. Fire hydrants, when placed at intersections or access drives to parking lots, when practical, shall be placed so that no part of the fire truck will block the intersection or parking lot access when connections to the fire hydrant are made.

i. Fire hydrants, required by this article, and located on private property, shall be accessible to the Fire Department at all times.

j. Fire hydrants shall be located at street or fire lane intersections, when feasible.

k. Fire hydrants shall be painted with two coats of paint meeting NCTCOG specifications. The following color code shall be used:

City of Terrell System	chrome silver '
Private System	red
Non-potable System	violet

3. Main Size for Hydrant Supply

Six-inch lines shall be connected so that not more than one hydrant will be between intersecting lines and not more than two hydrants on an 8-inch main between intersecting lines. The maximum length of a six-inch fire hydrant lead is 150'.

4. Fire Line Metering

Generally, the City of Terrell will own and maintain from the water main to the valve on the fire line. All fire lines shall be designed and constructed in accordance with the City's standards and shall be placed in an easement dedicated to the City for this purpose. All sprinkler service lines, fire line connections and other fire lines shall be equipped with either a water meter or a detector check valve having a capacity equal to the required fire flow. Water meters and detector check valves shall be constructed in accordance with NCTCOG standard drawings.

E. Minimum Cover

In general, the minimum cover below the street grade or finished grade (whichever is lower) should be as follows: 8-inch and smaller, 4.0 feet; 10-inch and 12-inch, 4.5 feet to 5 feet; 16-inch, 5.0 feet to 5.5 feet. Lines larger than 16-inch shall have a minimum of 6 feet of cover and it shall be sufficient to allow water and sewer and other utilities to go over the large main. For water lines to be constructed along "county type" roads, which are commonly built with a high crown about the surrounding property, increase the cover as required to allow for future paving grade changes.

F. Meter Box and Service

A service with a meter box is constructed from the main to a point 3'-0" to 3'-6" behind the curb line, usually in advance of paving. The location of the meter box is as shown on the Utility Assignments detail sheets. On multiple apartments and business properties, the desired size and location are usually specified by the owners. Minimum requirements for water service sizes are:

1. One-inch water services are required to serve all residential lots including Townhouse lots, patio homes and duplexes. Separate meter connections shall be provided for each of the family units and no bullhead connections will be allowed.

2. The size of apartment, condominium, multi-family services or commercial meters will depend on the number of units served with a minimum of one meter per building.

3. All multi-family and business properties shall have individual meters in accordance with TCEQ requirements.

4. The City will have final authority to determine the required size and location of meter needed for each facility.

G. Service Connections - Hydrants

A service connection shall not be allowed on fire hydrant leads except as authorized by the City Engineer.

4.2 SANITARY SEWERS

A. General

All platted lots must be served by an approved means of wastewater collection and treatment designed, constructed, and tested in accordance with TCEQ and NCTCOG guidelines. In most cases, lots will be served by a municipal sewer system. Where, in the opinion of the City Engineer, connection to the municipal system is not economically feasible, on site treatment of wastewater may be allowed.

B. Location of Sewer Lines

Minimum sizes and grades for sanitary sewers shall be designed in accordance with TCEQ guidelines. Sewers shall be constructed with extensions to the development boundary to allow for direct connection by future developments. If feasible, sewers shall be placed in streets. Sewers are usually located in the center of the street for residential development. Refer to Utility Assignments, Sheets 1 to 9 in Appendix B for location. Each addition has its individual problems, therefore, no fixed rules will apply to all cases. Where easements are used, they shall be not less than fifteen feet wide.

C. Minimum Cover

Minimum cover shall be 3.5 feet; exceptions authorized by the City Engineer shall have concrete protection. For sanitary sewers in streets, the minimum cover shall be 5.0 feet. In general, the minimum depth required for the sewer to serve given property with a 4-inch lateral shall be 3 feet (4.5 feet if the water line is on the same side of the street as the lateral in question) plus 2% times the length of the house lateral (the distance from the sewer to the center of the house). Thus, for a house 135 feet from the sewer, the depth would be 3 feet plus 2% x 135 feet = 2.7 plus 3.0 = 5.7 feet. The depth of the flow line of the sewer should then be at least 5.7 feet below the elevation of the ground at the point where the service enters the house. Profiles of the ground line 20 feet past the building line will be required to verify that these criteria are met. A minimum of 3 feet of cover on sewer services is required at all points in Street R.O.W. where swales are constructed. On lines deeper than 10 feet, a parallel sewer line will be required when laterals are to be attached.

D. Sewage Flows, Size and Grades

Sewage flow shall be computed in accordance with the following formula:

$$Q = \frac{C^{0.89}}{295}$$

Where:

Q = Peak wastewater flow (million gallons per day)
C = Equivalent single family connections

This equation is graphically displayed in Figure 4-1. Equivalent single family connections are based on a density of 2.7 persons per dwelling unit. Densities for other residential and non-residential uses shall be determined by the Design Engineer, subject to approval by the City Engineer.

Pipes should be placed on such a grade that the velocity when flowing full is not less than two feet or more than ten feet per second. Minimum grades shall be as provided in the TCEQ guidelines.

When the slope of a sewer changes, a manhole will be required. The capacity of the downstream sewer shall not be less than the capacity of upstream sewer.

E. Manholes, Wyes, Bends, Taps, and Cleanouts

The sizes and locations of manholes, wyes, bends, tap connections, cleanouts, etc., shall be as designated by the Design Engineer. In general, manholes shall be placed at all four-way connections and three-way connections. The diameter of a manhole constructed over the center of a sewer should vary with the size of the sewer. For 6", 8", and 10" sewers, the manhole shall be 4.0 foot minimum diameter; for 12", 15", and 18" sewers - 4.5 foot minimum diameter; for 21", 24" and 27" - 5.0 foot minimum diameter; 30" - 5.5 foot minimum diameter; and 36" - 6 foot minimum diameter. In Flood Plains, sealed manholes "Type S" are used. Clean-outs shall be placed on the ends of all lines that will not be extended. Manholes shall be installed in accordance with TCEQ guidelines on lines that will be extended. Drop manholes shall be required when the inflow elevation exceeds the outflow elevation by more than 30 inches.

In order to provide access for sewer lines for cleaning, manholes and/or cleanouts shall be so located that 250 feet of sewer rod can reach any point in the line. This means that manhole spacing shall be a maximum of 500 feet; that spacing between a manhole and an upstream cleanout shall be limited to 300 feet. Cleanouts may be located at the end of the line only.

F. Laterals

The sizes and locations of laterals shall be as designated by the Design Engineer. In general, for single family dwellings, the lateral size shall be 4" minimum; for multiple units, apartments, local retail and commercial - 6" minimum; for manufacturing and industrial, the size should be 8" or larger as required. House laterals usually come out 10 feet downstream from the center of the lot, and shall have a 10-foot lateral separation from the water service. Manholes will be required on 6-inch and larger laterals where they connect to the main line. Laterals will not be attached to sewer mains that are deeper than 10 feet. A minimum of one lateral per building shall be required. Also, a minimum of one lateral per residential lot shall be required. The cleanout shall be located at the right-of-way in accordance with the detail in Appendix E.

G. Railroad, Highway and Creek Crossings

Railroad, State Highway and creek crossings, etc., shall be as approved by the City Engineer.

H. Sewer Line Materials

1. All sewer pipe shall be PVC.

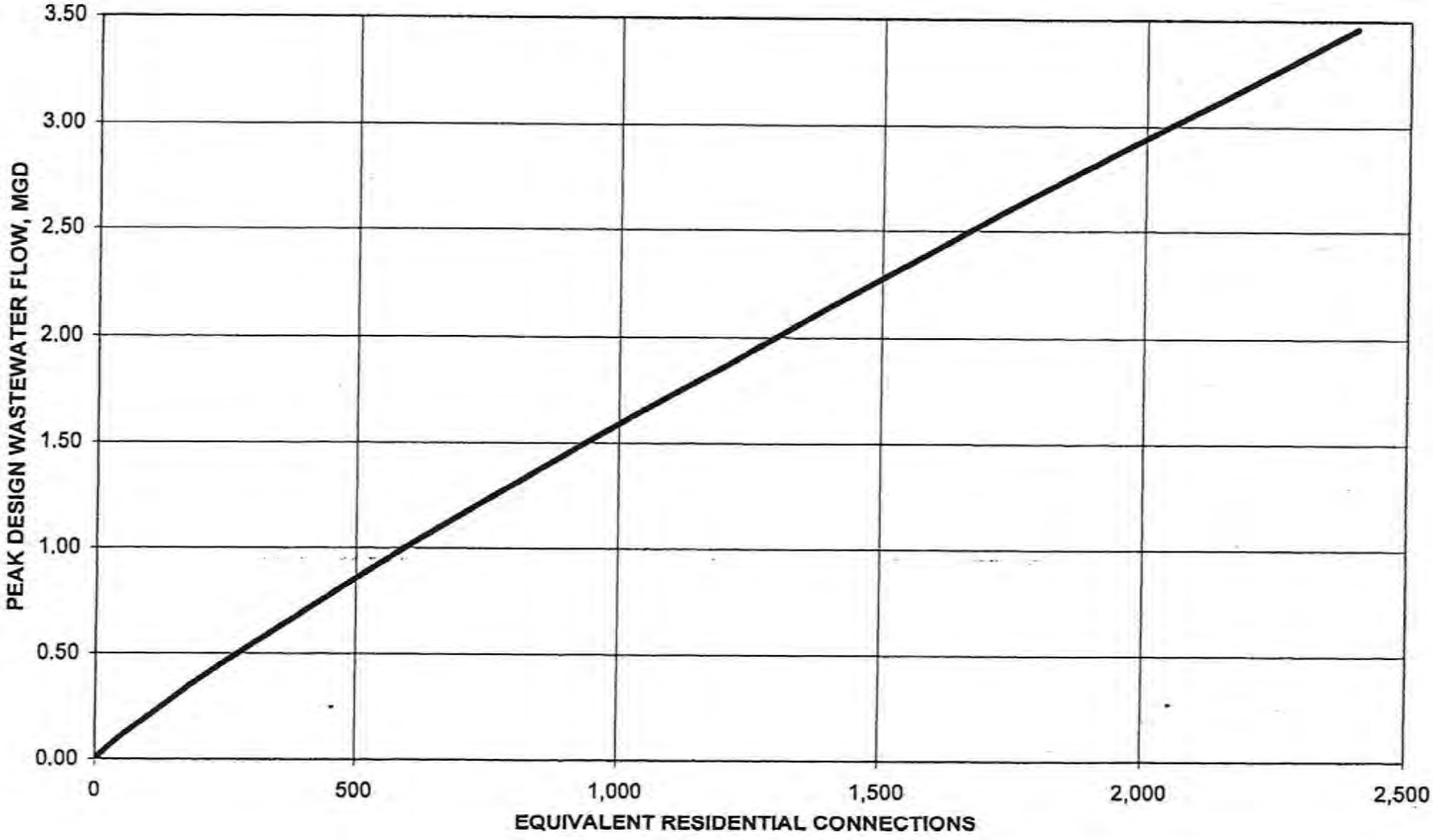
2. Sewer pipe shall conform to the North Central Texas Council of Governments (NCTCOG) Specifications and associated addenda.

3. Sewer pipe joint materials shall have resilient properties, conforming to the NCTCOG Specifications and associated addenda.

I. Sample Ports

Single family dwellings are not required to have a sample port. The sample port for manufacturing and commercial connections shall be 8-inch minimum. All other sample ports shall be 6-inch minimum. Larger sizes may be required, depending upon individual circumstances as required by the City Engineer. Sample ports shall be accessible to the City at all times.

PEAK WASTEWATER FLOW RATES
CITY OF TERRELL



Source: Modified Babbitt Curve using Black and Veatch Data by FMI, 1988.

FIGURE 4-1

4.3 PREPARATION OF WATER AND SEWER PLANS

A. Form of Plans

1. Plans shall be clear, legible, and neatly drawn on bordered sheets, size 24" x 36". Each sheet shall clearly display the Texas Professional Engineer's seal of the Engineer under whose direction the plans were designed. A title block in the lower right-hand corner shall be filled in to include: (1) project name; (2) Engineer's name, address, and telephone number.

2. The plan sheet should be drawn so that the north arrow points to the top or to the left side of the sheet. It is important that the plan show sufficient surrounding streets, lots, and property lines so the existing water and sewer may be adequately shown and so that proper consideration may be given to future extensions. Proposed water and sewer lines shall be stubbed out to the addition extremities in order that future extensions may be made with a minimum of expense and inconvenience. Unless it would make the plan very difficult to read, water, storm sewer, and sewer lines should be shown on the same sheet. The lines on the profile sheet shall be drawn in the same direction as on the plan. Lettering shall be oriented to be read upward or to the left.

3. On large additions or layouts requiring the use of more than six sheets (total of plan & profile), key sheets will be required on a scale of 1' = 400' or 1" = 1000". They shall show the overall layout with the specific project clearly indicated with reference to individual sheets.

4. The use of "off-standard" scales will not be permitted. A plan shall be drawn to scales of 1" = 100', or 1" = 40'. Plans for water and sewer that do not involve great detail should be drawn on a scale of 1" = 100'. If required for clarity, a separate sheet on 1" = 40' scale may be used to show details. Plans in and along creeks, heavily wooded sections, streets with numerous utilities, or as may be required to produce a clean and legible drawing, shall be drawn on plan-profile sheets or separate plan and profile sheets on a scale 1" = 40'. If the plan is in an extremely congested area, a scale of 1" = 20' may be necessary and will be permitted. All profiles shall be drawn on a vertical scale as required for clarity (generally 1/10 scale of the horizontal scale), and the horizontal scale shall be the same as for the plan unless otherwise directed by the City Engineer.

B. Data to Be Included

1. Sewer Data to be Included on Plan Sheet

   The plan shall show the existing and proposed water and sewer lines and all appurtenances thereto. The plan should also have the storm sewer system dashed in. All lines shall be numbered, lettered or otherwise designated on both plan and profile sheets. All lines shall show sizes and direction of flow on both plan and profile sheets. Stationing shall be shown to the nearest 0.1 foot and each new line shall begin at 0+00 at the outlet and increase up the sewer. Station pluses at all junctions or sewers, wyes, cleanouts, manholes, the centerlines of all cross streets and railroads, and all crossing utilities, etc., shall be shown on both plan and profile. Sewer laterals shall be shown at a location most convenient to serve the property. Sewer laterals will usually be near the center of the lot, either at the street or alley. If the lateral is to be adjacent to the water service, then show the lateral 10 feet downstream. The location shall be designated on the plans. Include notation to provide necessary embedment or encasement of crossing and parallel water and sanitary sewer lines as required by TCEQ.

2. Sewer Data to be Included on the Profile Sheet

All sanitary sewer mains shall be shown on profile sheets. The data for the profile sheet shall be obtained by running a line of levels along the actual route and by taking any other necessary observations. Profiles shall show the elevations to the nearest 0.1 foot of the ground at the centerline of the sewer and to the right and left of the centerline of the sewer at the location of the approximate center of the proposed houses or buildings to be served, and the approved street or alley grade. Profiles shall also show the sewer pipe, manholes, cleanouts, etc. The size of the sewer, the direction of the flow, and the grade to the nearest 0.01 percent should be indicated just over the "pipe" and the total linear footage of line, kind of pipe, and type of embedment or encasement shown below the "pipe." All of the information pertaining to the horizontal data, station, appurtenances to be built, etc., is usually shown just above the ground line.

The flow line (invert) elevations shall be shown to the nearest 0.01-foot. Invert elevations shall be recorded at all junctions (all lines-in and out), at grade breaks, the ends of lines, or other points as requested by the City Engineer. Benchmarks used shall also be clearly shown, giving the descriptive locations and elevations. Elevations must be from sea level datum, not assumed. Bench level circuits should begin at a USGS monument and benchmark of second order accuracy established at least every one-half mile through the project. All existing water, sewer, gas, storm sewer crossing the proposed sewer or water line shall be adequately designated as to size, type, and location. TCEQ required embedment or encasement shall be shown on the profiles. Drainage area maps and capacity calculations for each main 10" and larger will be required. Provide design required capacity, pipe capacity, and velocity for all line segments. If the velocity exceeds 9 fps when flowing full, the system shall be redesigned.

3. Data to be Included for Water Plan and Profile

For water lines in new subdivisions, very little data need to be included. Indicate the location of any existing valves required for shut-down purposes and of any tees, ends, etc., to be tied into. Indicate clearly the sizes of the lines to be installed, and all proposed valves, fire hydrants, tees, crosses, bends, reducers, plugs, sleeves, wet connections, tap connections, creeks, railroad or highway crossings, tunnels, meter boxes, valve vaults, and other appurtenances at each intersection or as required. Where the pipe is in a curve, the curve data on the plat is usually sufficient unless otherwise requested. The size and type of services and the material, type of joint, and class of pipe may be indicated by adequate notation in the lower left or right-hand corners of the plan sheet. Water services and meter boxes shall be indicated and shall be located at or near the center of the front of each lot. If a water line requires a profile, then follow the general procedures as outlined for sewers, except that the grades and elevations of the proposed water line usually need not be shown closer than the nearest 0.1 foot. The location shall be designated on the plans. Include notation to provide necessary embedment or encasement of crossing and parallel water and sanitary sewer lines as required by TCEQ.

4.4 ON-SITE TREATMENT OF WASTEWATER

Where on site wastewater treatment systems are allowed, the location of the proposed drain field shall be shown on the preliminary plat. The final plat shall indicate the minimum finished floor elevation if a gravity system is used. The minimum finished floor elevation shall not be less than 3.5 feet above the highest elevation of ground at the proposed drain field unless documentation is submitted and approved that demonstrates that a lower finished floor elevation will allow the on site treatment system to function properly.

APPENDIX A

RECOMMENDED PROCEDURE FOR SETTING STREET GRADES

CITY OF TERRELL

TECHNICAL CONSTRUCTION STANDARDS AND SPECIFICATIONS

RECOMMENDED PROCEDURE FOR SETTING STREET GRADES

1. Plot profiles on plan sheets for each right-of-way line. Check for the following:

   a. Have drives, intersections, ditches, etc., been shown? Profile must give realistic picture of conditions grades must meet.

   b. If additional right-of-way is to be acquired, have profiles been plotted along proposed property line, not existing?

   c. If property line falls in a ditch, has second profile been shown to normal ground elevation?

   d. Check any sharp breaks in the profile, which might identify plotting errors.

2. Spot critical points in profile, which will control top of curb elevation. Calculate maximum curb elevation permissible at these points.

3. Lay tentative grade for low side of street. Minimum grade = 0.5%.

4. Lay matching grade on high side of street. Watch the following:

   a. On divided streets slope of traffic lanes must not be less than 0.5 foot between curbs nor more than 1/4 inch per foot any place in the roadway.

   b. Avoid fill if at all possible. If absolutely necessary to fill, try to limit height so access to abutting property will not be restricted.

   c. In extreme cases the street may slope the same direction for the full width of the street. Special permission is required for this.

   d. Occasionally the centerline of the proposed pavement can be offset to aid in matching improvements on the high side.

   e. In flat areas of City try to keep top of curb 0.5' below ground at property line. This will ensure good drainage from the abutting property.

   f. If street is in flood plain, the minimum curb elevation must be determined after consultation between paving and drainage engineers and approved by competent authority.

5. Use standard design criteria for vertical curves. Safe sight distances must not be compromised.

6. Check safe speed of all curves. Superelevation may be necessary on short radius curves to maintain safe design speed.

7. Avoid changing shape of crown (except at intersections) since this requires handwork by the contractor and increases cost.

8. Plot proposed tops of curbs on cross sections. Check for proper slope in parkway at every location. Look for places grade can be improved to serve property better. Numerous breaks in

grade to enhance value of street to abutting property are preferable to long straight grades, which may be detrimental to property.

9. Check every intersection carefully. Give special attention to:

   a. Drainage. Make sure ditches and gutters drain.

   b. Riding quality. This is very important at the intersection of two thoroughfares. Severe grade breaks must be avoided in both directions.

   c. Approach grades should not be over 4%. Steeper grades require special consideration. Vehicles should be able to see both directions clearly.

10. Check both ends of project as to drainage and riding quality. Avoid such solutions as "Grade to Drain". If necessary to drain into existing ditches show ditch profiles and proposed grades in profile. Show spot ditch elevations in plan view.

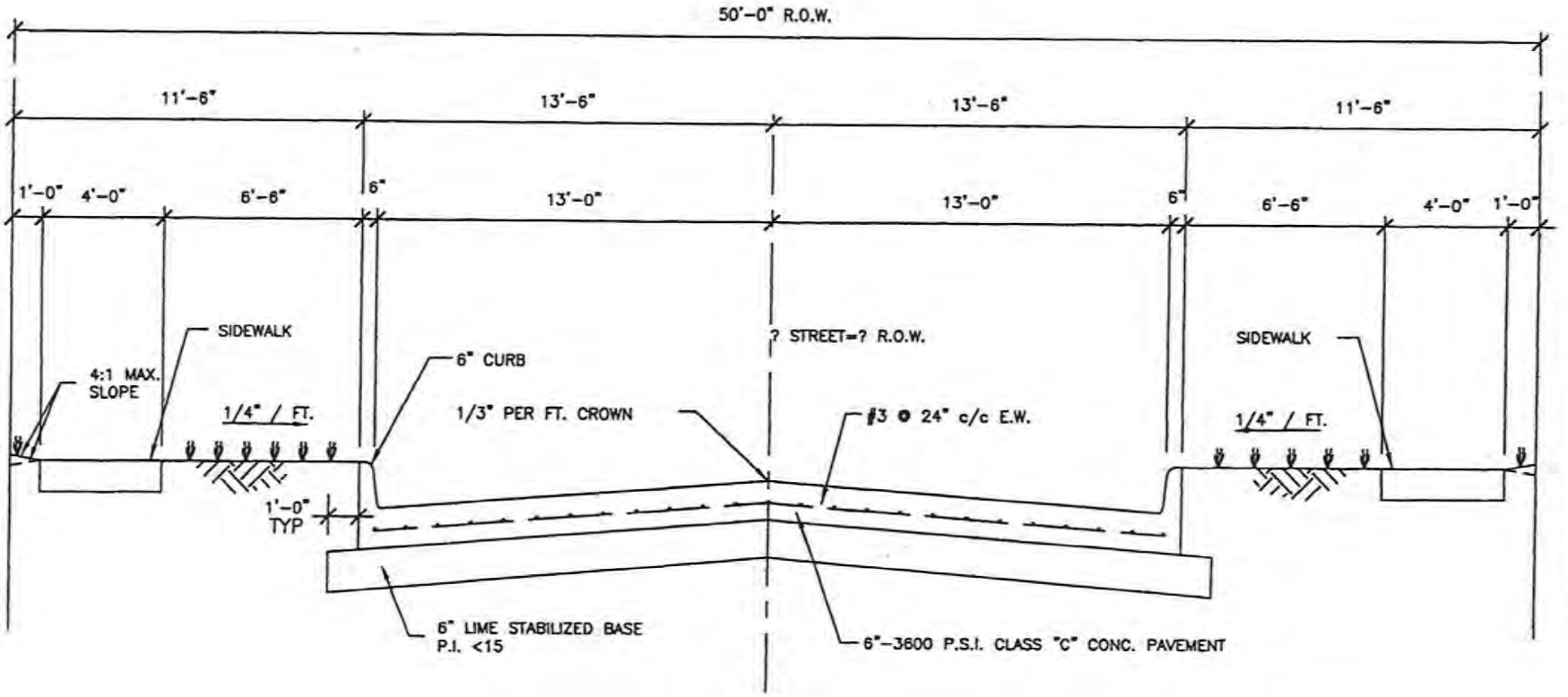
11. Sags in grades should fall at locations where inlets will cause least inconvenience to abutting property owners.

12. Median grades on divided thoroughfares follow the curb line of the through traffic lane, usually 7 to 10 feet from centerline. Therefore it is necessary to show top of curb elevations at critical points on left turn lanes. Show these in the plan view. Slope of left turn lane should match slope of adjacent through lanes if possible.

13. In general, street grades need to meet the needs and safety requirements of the traveling public, but must also serve the abutting property.

APPENDIX B

TYPICAL PAVEMENT SECTIONS
&
UTILITY ASSIGNMENTS



NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.

LOCAL STREET - RESIDENTIAL

TYPE F

SCALE: NONE

DATE: MARCH 2004

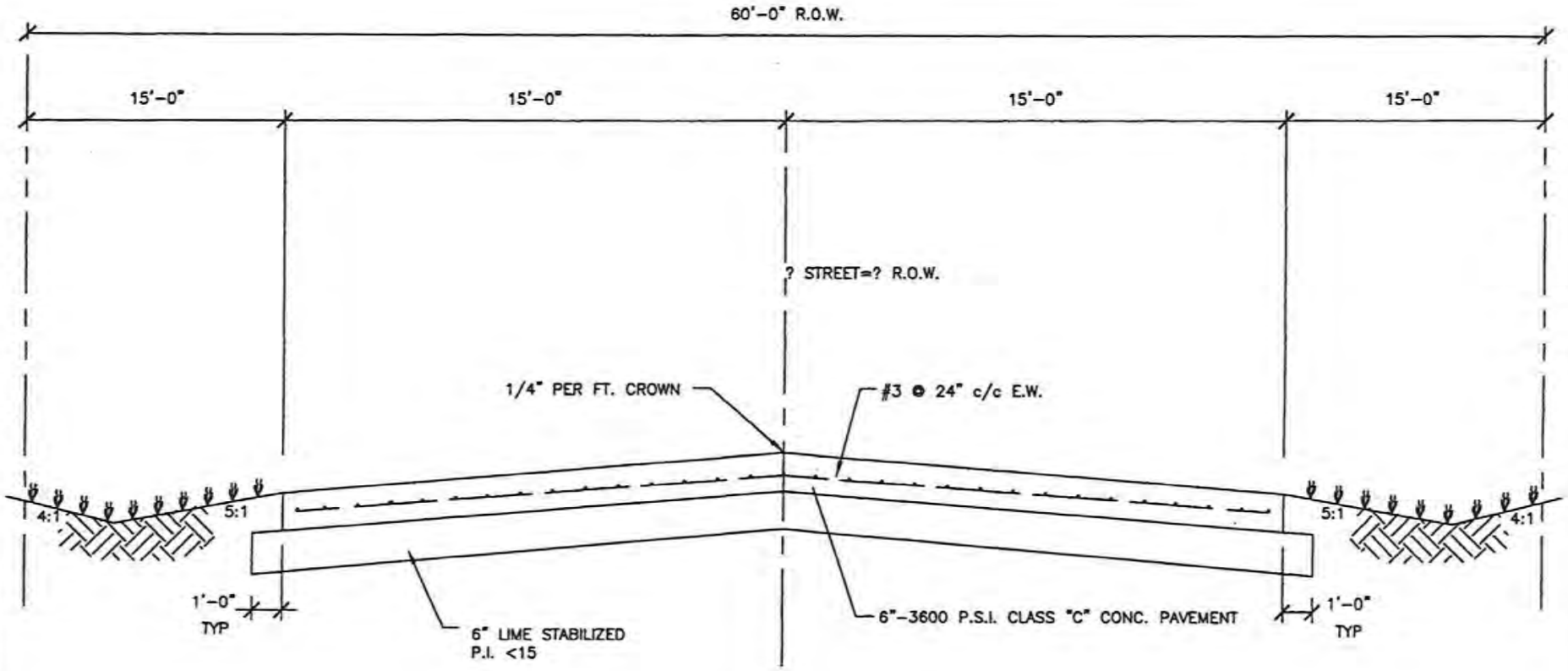
SHEET: 1

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



RURAL RESIDENTAL

TYPE G

NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.

SCALE: NONE

DATE: MARCH 2004

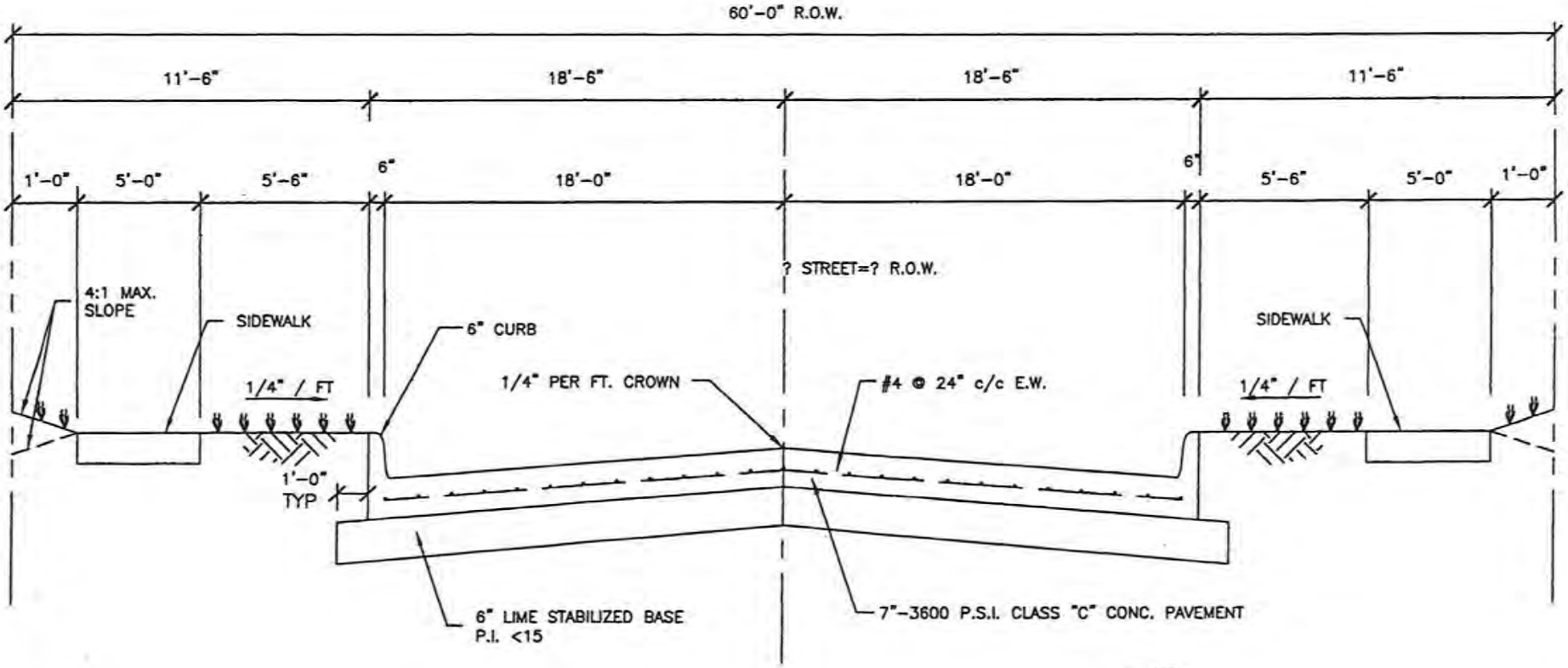
SHEET: 2

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.

MINOR COLLECTOR
TYPE E

SCALE: NONE

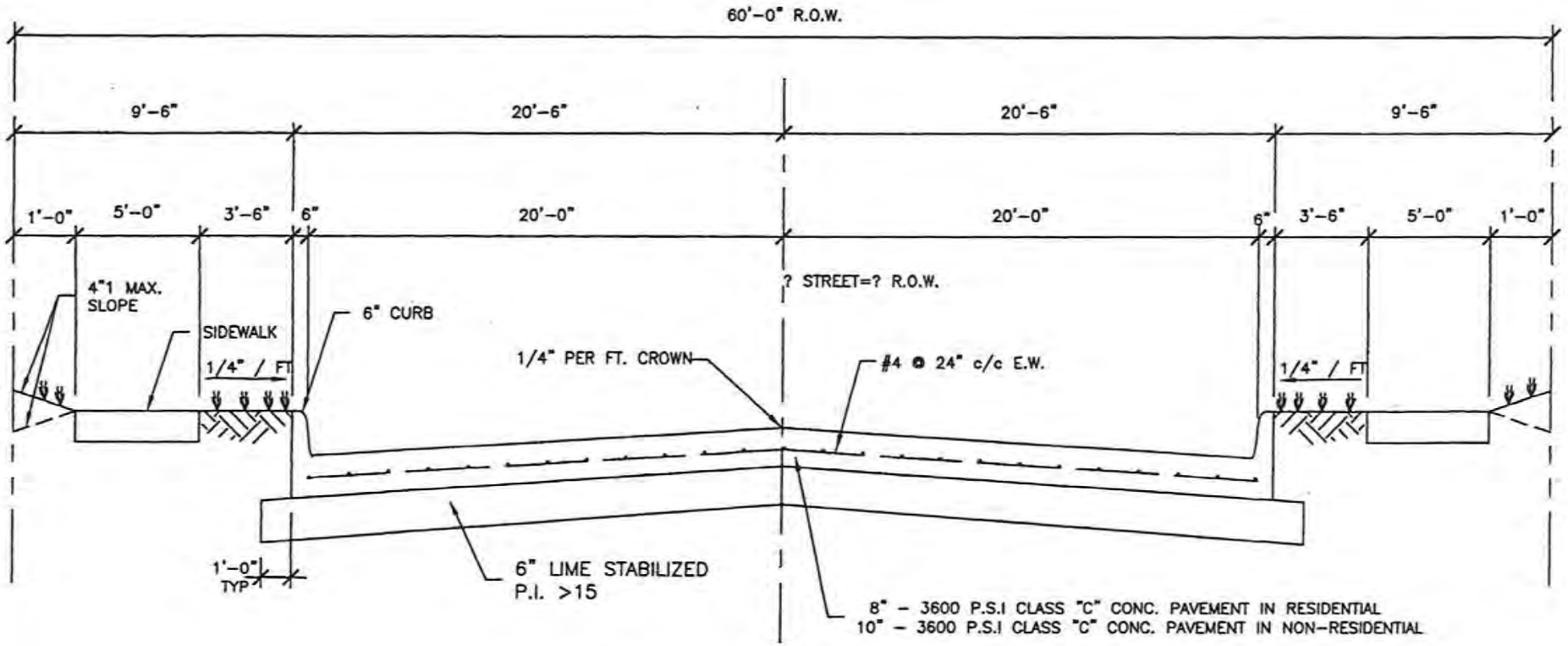
DATE: MARCH 2004

SHEET: 3

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR COLLECTOR
TYPE D

NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.

SCALE: NONE

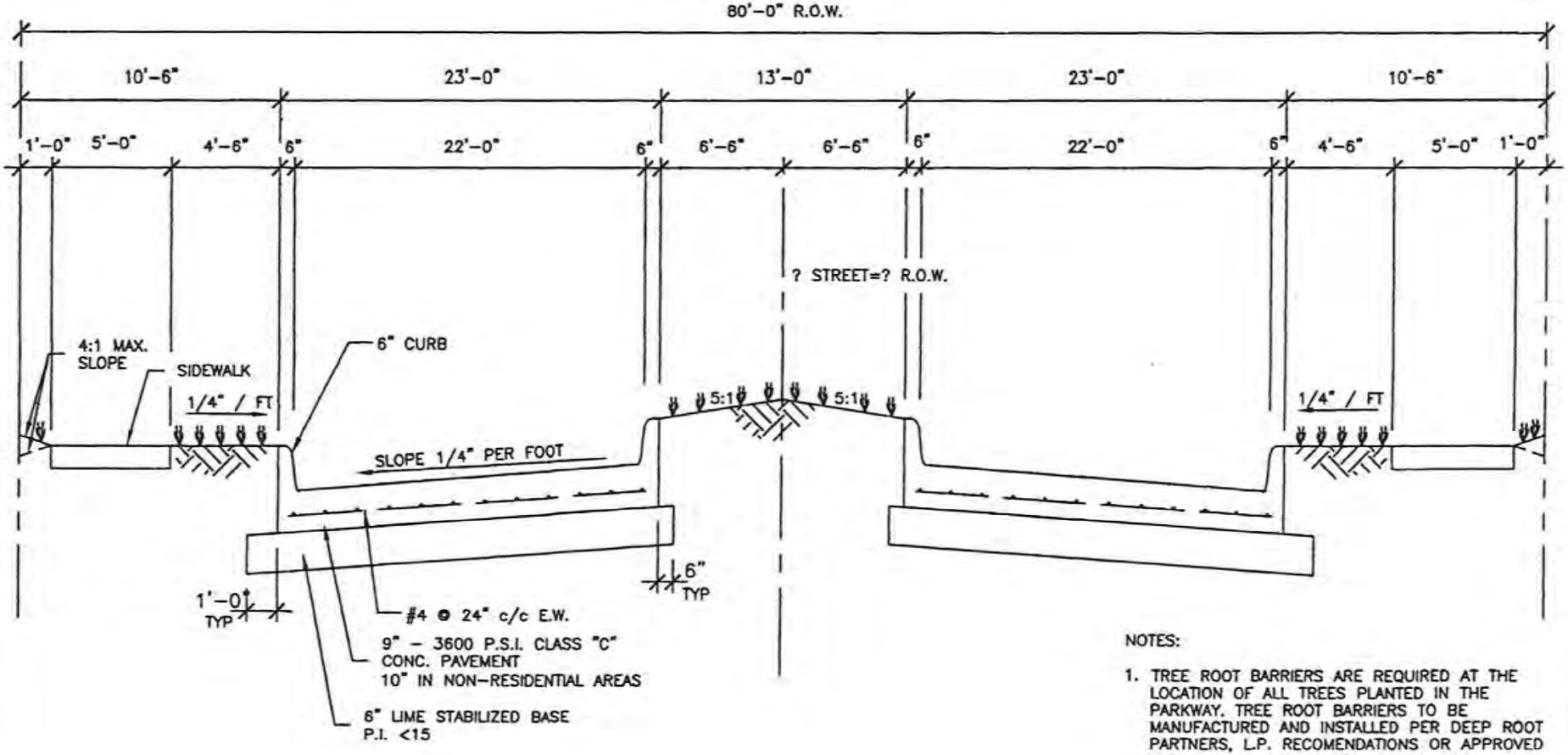
DATE: MARCH 2004

SHEET: 4

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



SECONDARY THROUGHFARE
TYPE C

NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
3. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT.

SCALE: NONE

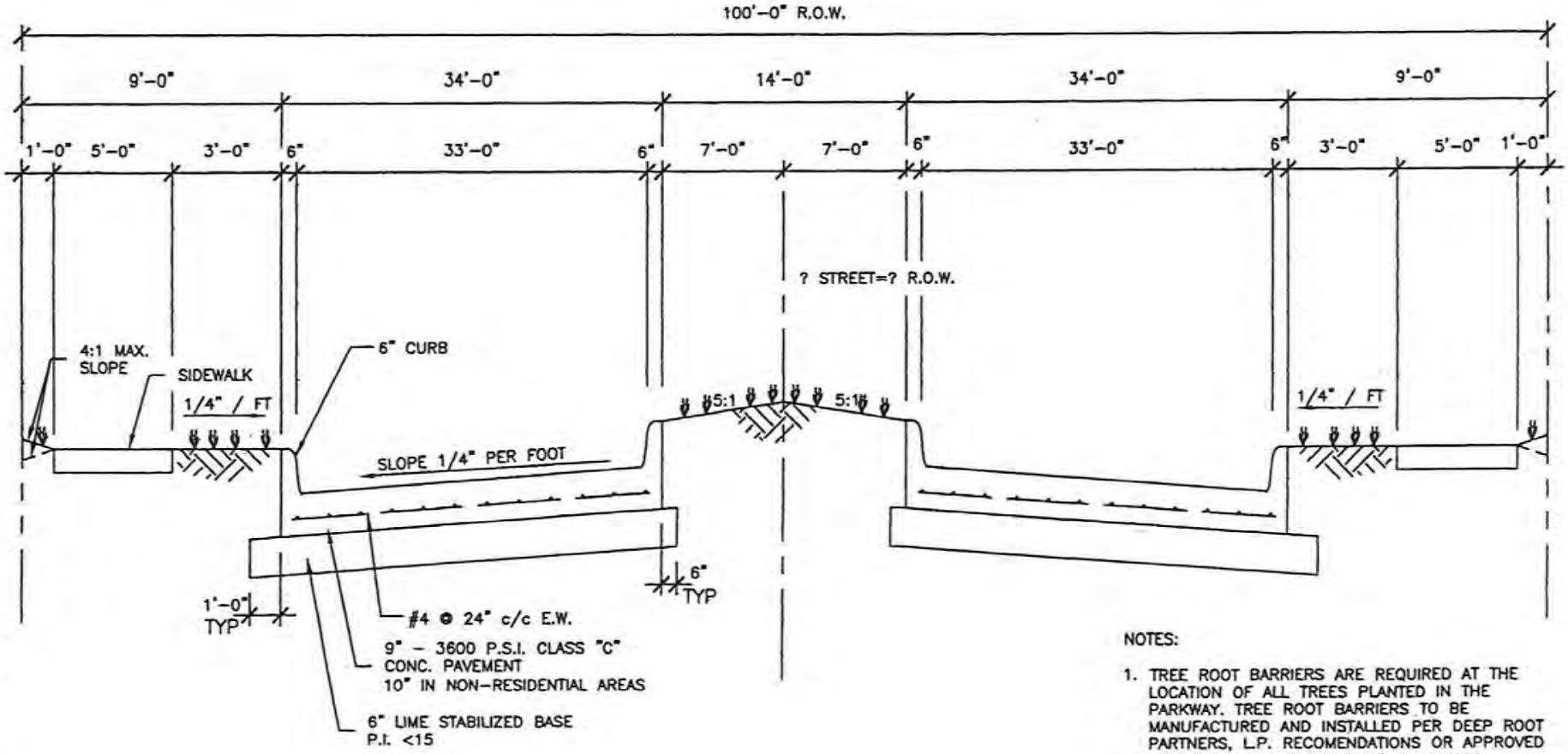
DATE: MARCH 2004

SHEET: 5

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR THROUGHFARE
TYPE B

NOTES:

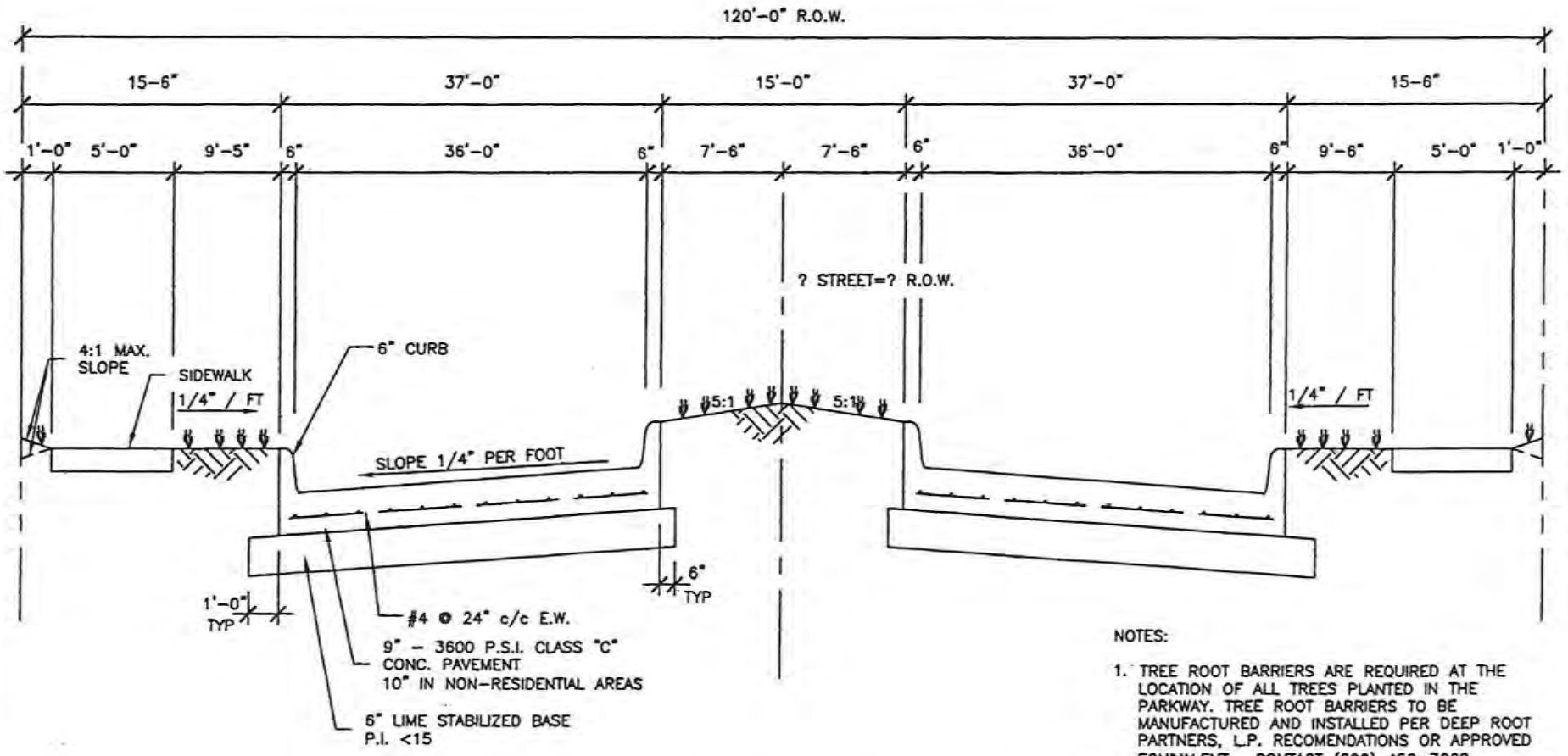
1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
3. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT.

SCALE: NONE | DATE: MARCH 2004 | SHEET: 6

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR THROUGHFARE
TYPE A

NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
3. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT.

SCALE: NONE

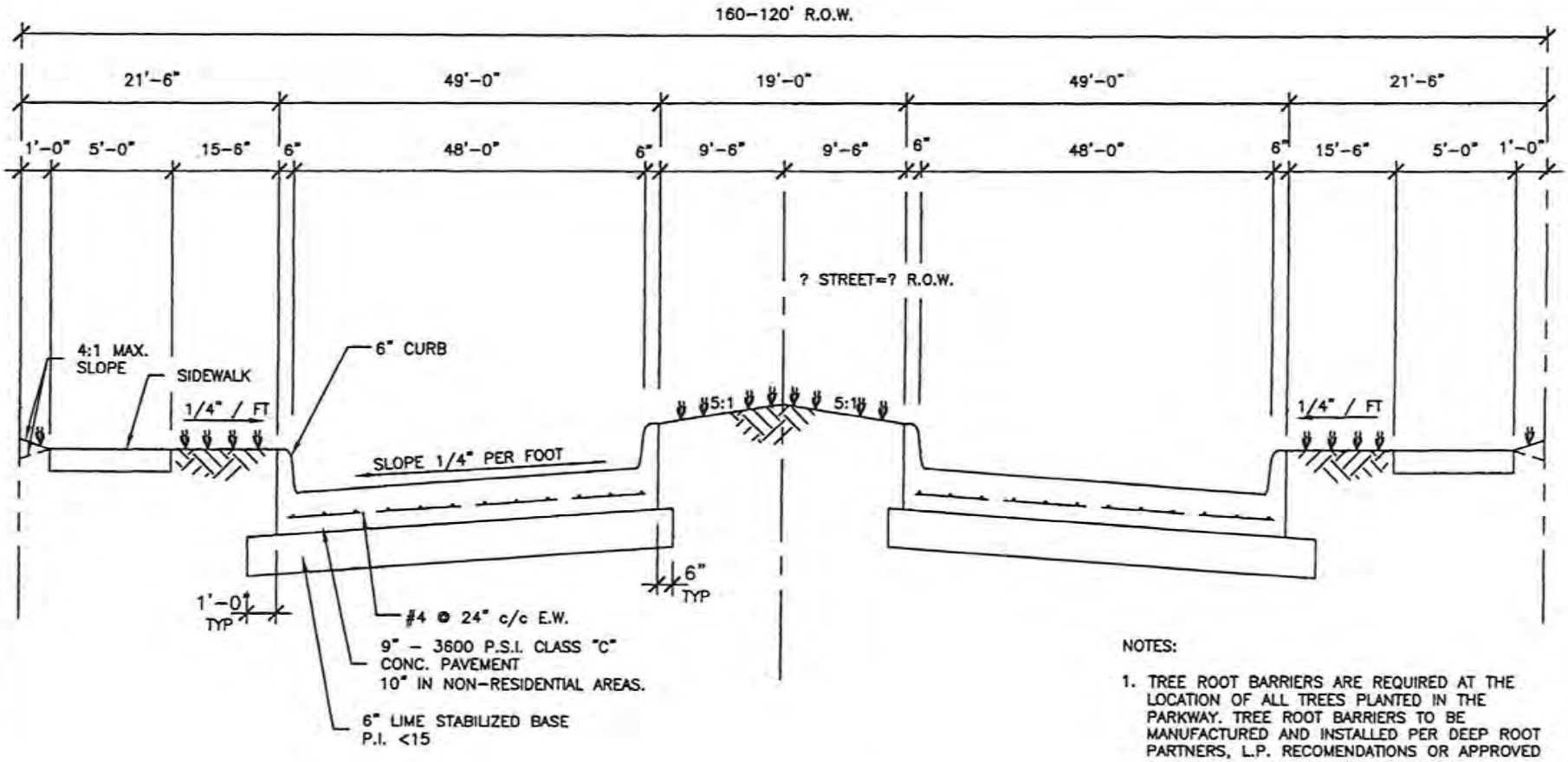
DATE: MARCH 2004

SHEET: 7

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR ARTERIAL
TYPE AA

NOTES:

1. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
2. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
3. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT.

SCALE: NONE

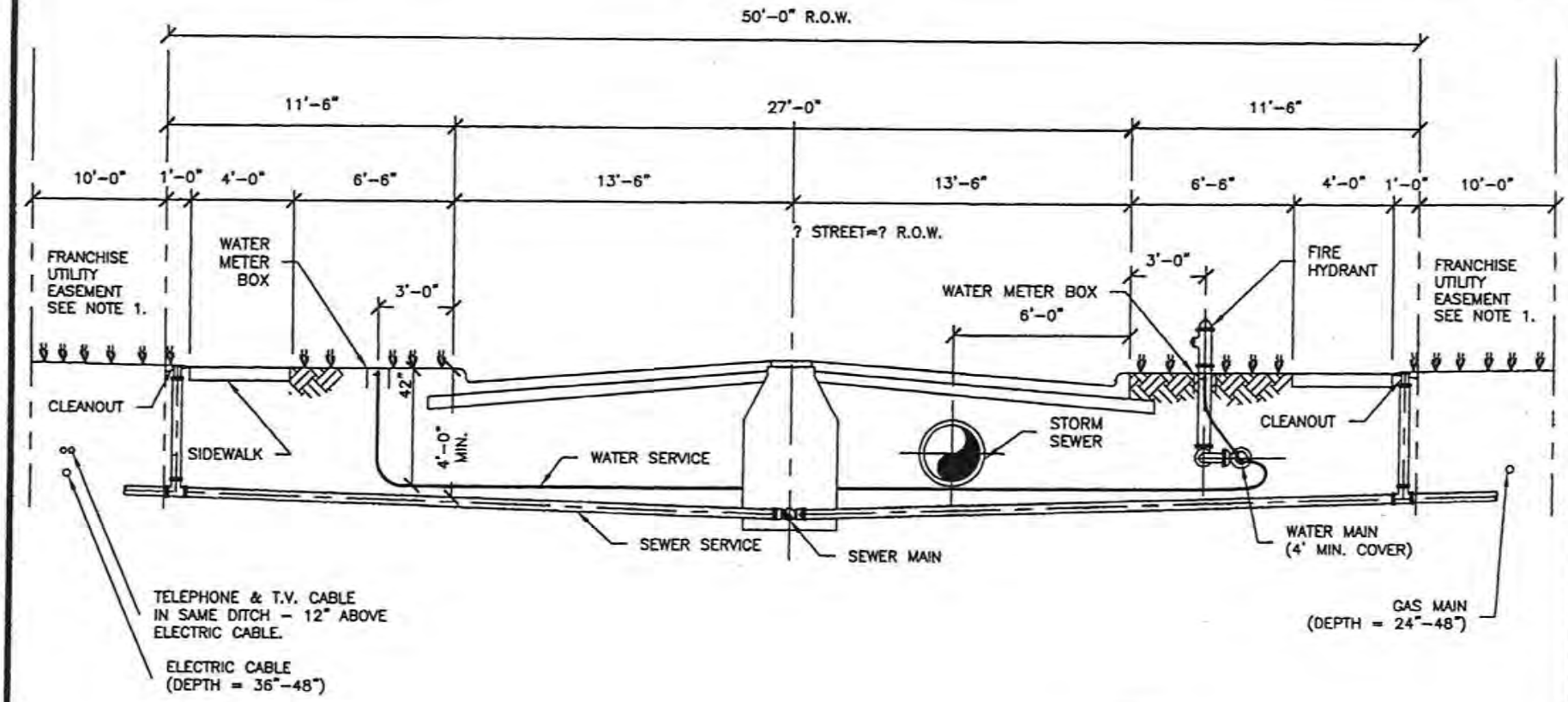
DATE: MARCH 2004

SHEET: 8

DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



LOCAL STREET - RESIDENTIAL
TYPE F
NO ALLEY

SECTION LOOKING SOUTH OR WEST

NOTES:

1. FOR LOCAL RESIDENTAL STREETS WITH ALLEYS, THE FRANCHISE UTILITIES WILL BE LOCATED IN THE ALLEY AS SHOWN ON THE ALLEY UTILITY ASSIGNMENTS, SHEET 17.
2. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 1, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

SCALE: NONE

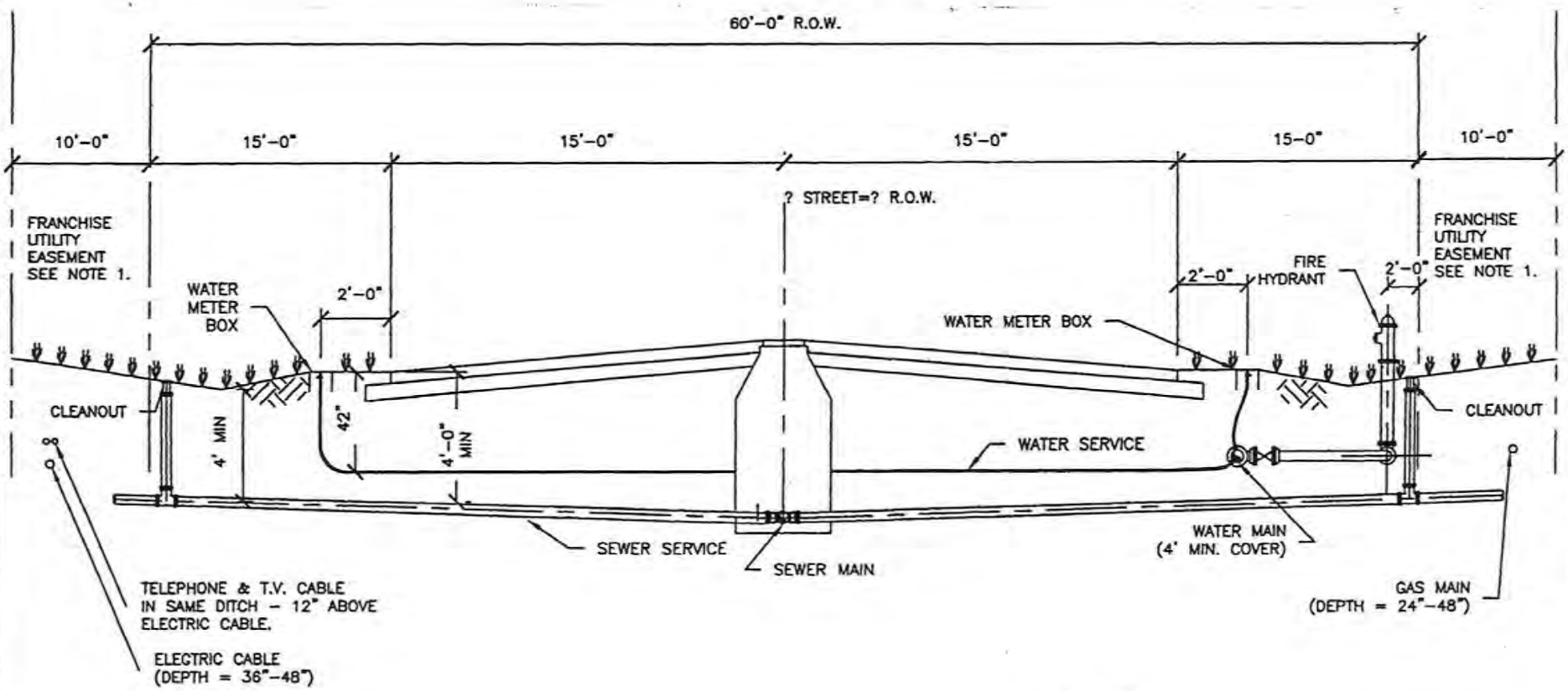
DATE: MARCH 2004

SHEET: 9

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



RURAL RESIDENTAL
TYPE G
NO ALLEY

SECTION LOOKING SOUTH OR WEST

NOTES:

1. FOR LOCAL RESIDENTAL STREETS WITH ALLEYS, THE FRANCHISE UTILITIES WILL BE LOCATED IN THE ALLEY AS SHOWN ON THE ALLEY UTILITY ASSIGNMENTS, SHEET 17.
2. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 2, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 2'-0" FROM EDGE OF PAVEMENT.

SCALE: NONE

DATE: MARCH 2004

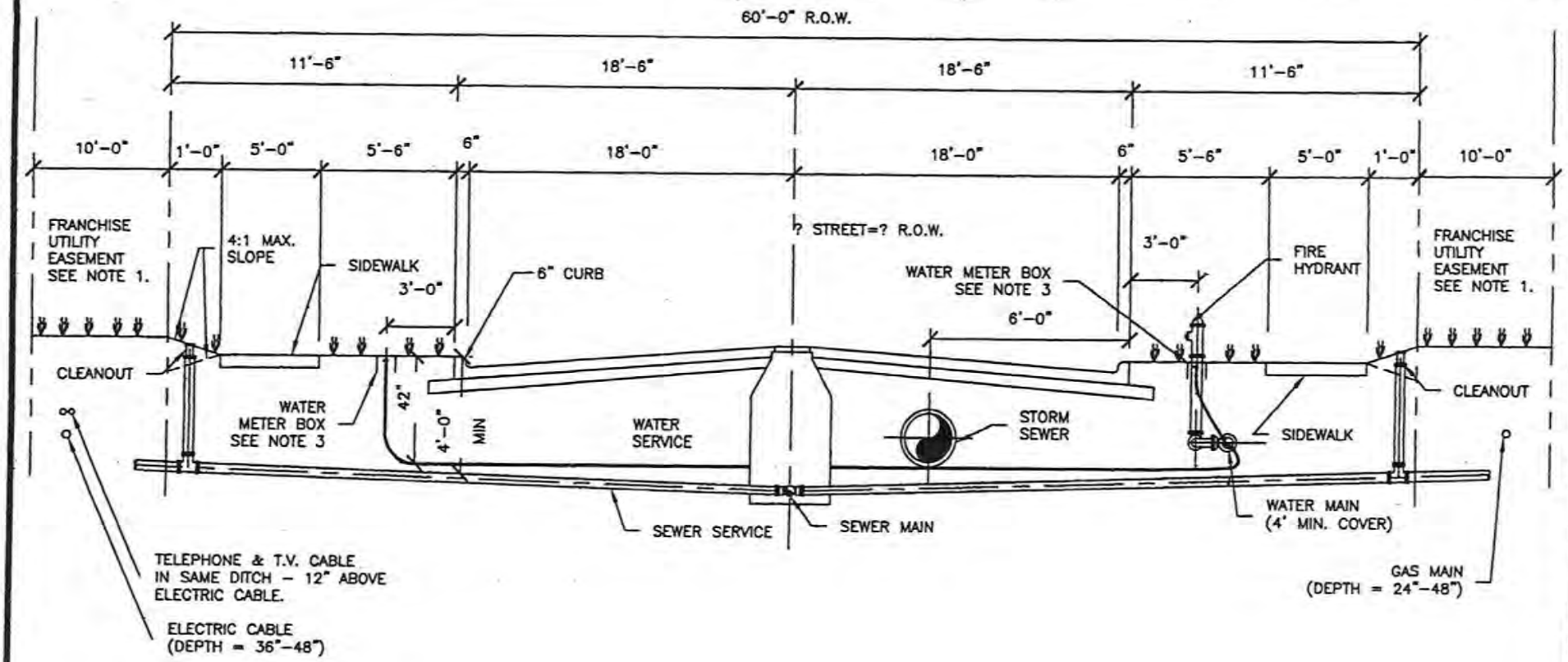
SHEET: 10

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



MINOR COLLECTOR
TYPE E
NO ALLEY

SECTION LOOKING SOUTH OR WEST

NOTES:

1. FOR LOCAL RESIDENTAL STREETS WITH ALLEYS, THE FRANCHISE UTILITIES WILL BE LOCATED IN THE ALLEY AS SHOWN ON THE ALLEY UTILITY ASSIGNMENTS, SHEET 17.
2. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 3, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

SCALE: NONE

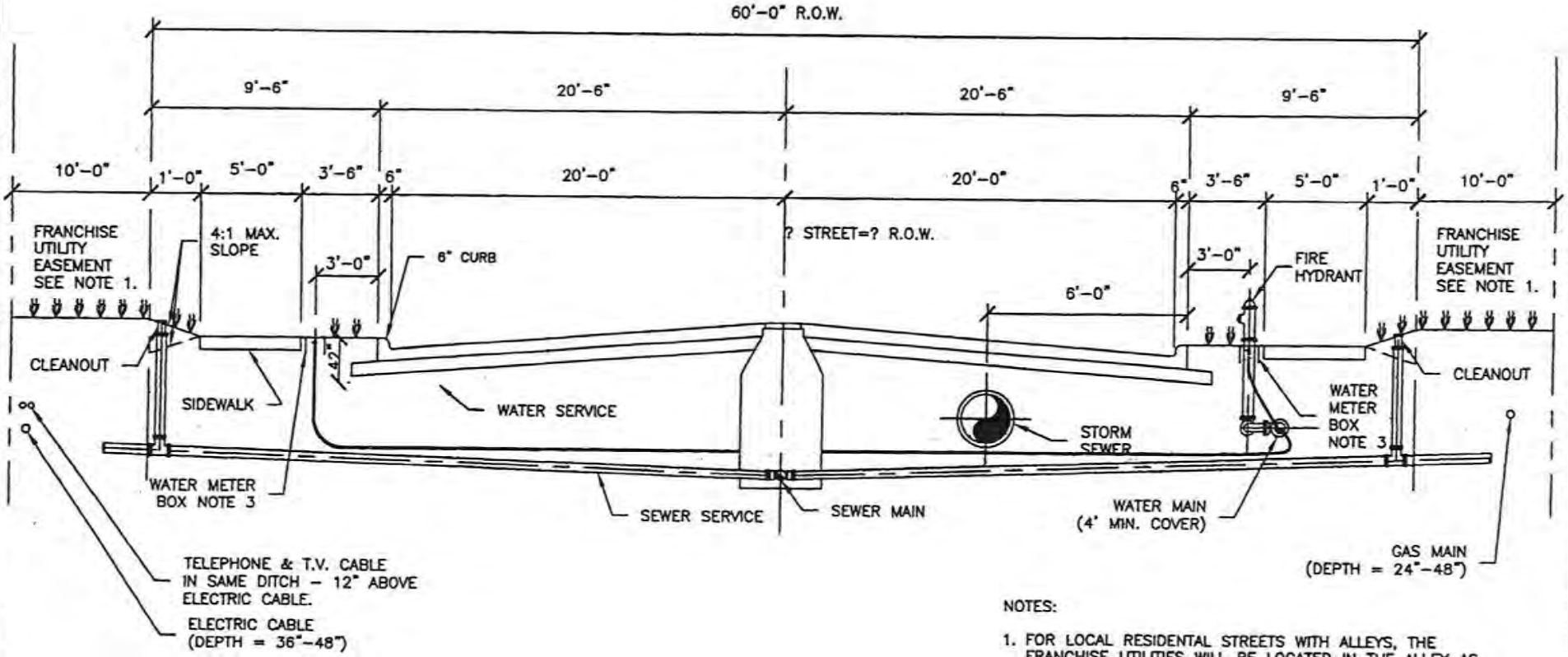
DATE: MARCH 2004

SHEET: 11

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR COLLECTOR
TYPE D
NO ALLEY

SECTION LOOKING SOUTH OR WEST

NOTES:

1. FOR LOCAL RESIDENTAL STREETS WITH ALLEYS, THE FRANCHISE UTILITIES WILL BE LOCATED IN THE ALLEY AS SHOWN ON THE ALLEY UTILITY ASSIGNMENTS, SHEET 17.
2. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 4, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.
4. RECESSED CURB INLETS REQUIRED FOR TYPE D.
5. MININUM 12-INCH WATERLINE REQUIRED FOR TYPE D.

SCALE: NONE

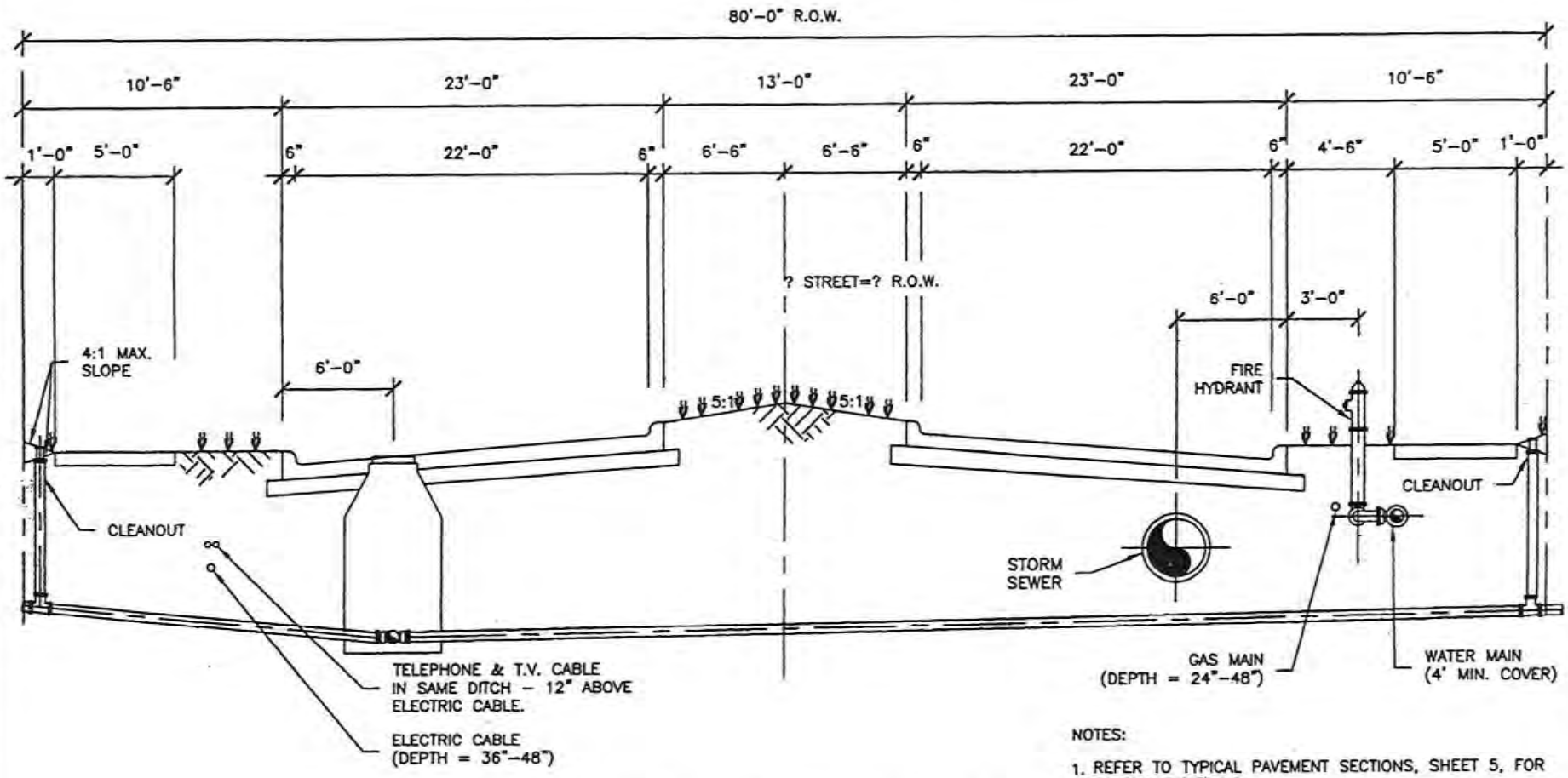
DATE: MARCH 2004

SHEET: 12

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



SECONDARY THOROUGHFARE
TYPE C

SECTION LOOKING SOUTH OR WEST

NOTES:

1. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 5, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE C.
3. MININUM 12–INCH WATERLINE REQUIRED FOR TYPE C.
4. ALL WATER METER BOXES SHALL BE CENTERED 3'–0" FROM BACK OF CURB.

SCALE: NONE

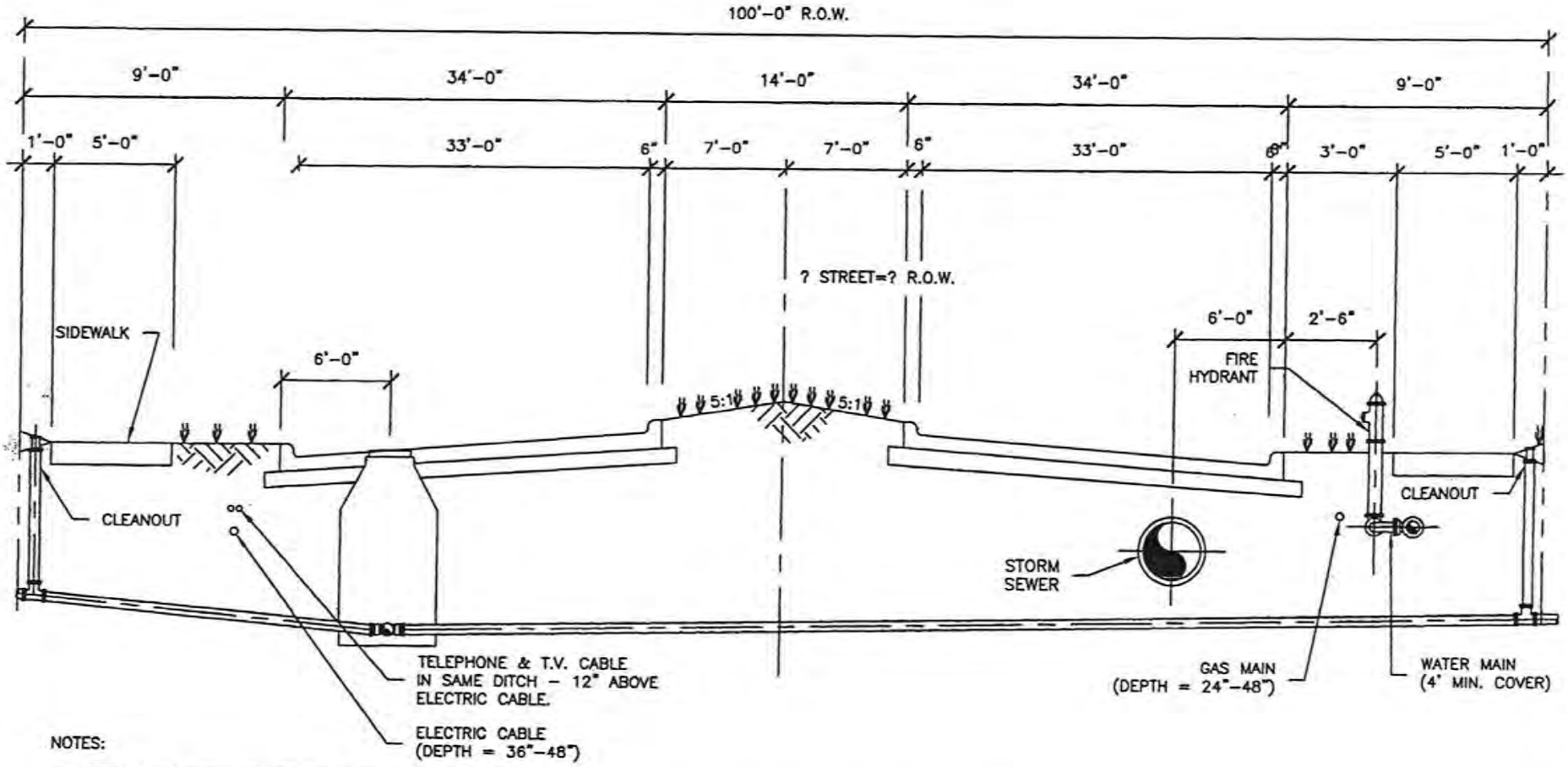
DATE: MARCH 2004

SHEET: 13

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

1. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 6, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE B.
3. MININUM 12-INCH WATERLINE REQUIRED FOR TYPE B.

MAJOR THOROUGHFARE
TYPE B
SECTION LOOKING SOUTH OR WEST

SCALE: NONE

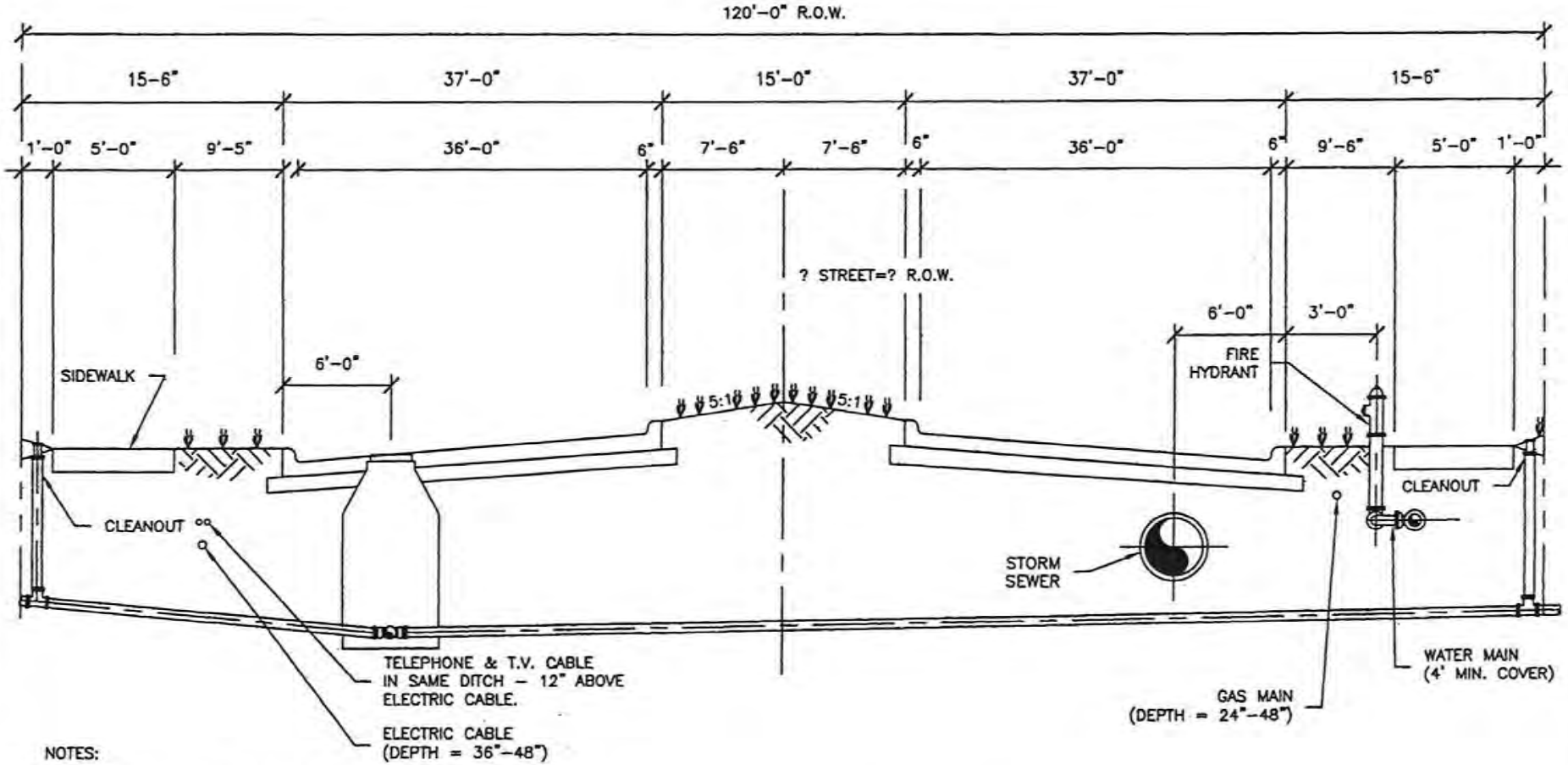
DATE: MARCH 2004

SHEET: 14

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

1. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 7, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE A.
3. MININUM 12-INCH WATERLINE REQUIRED FOR TYPE A.

MAJOR THOROUGHFARE
TYPE A

SECTION LOOKING SOUTH OR WEST

SCALE: NONE

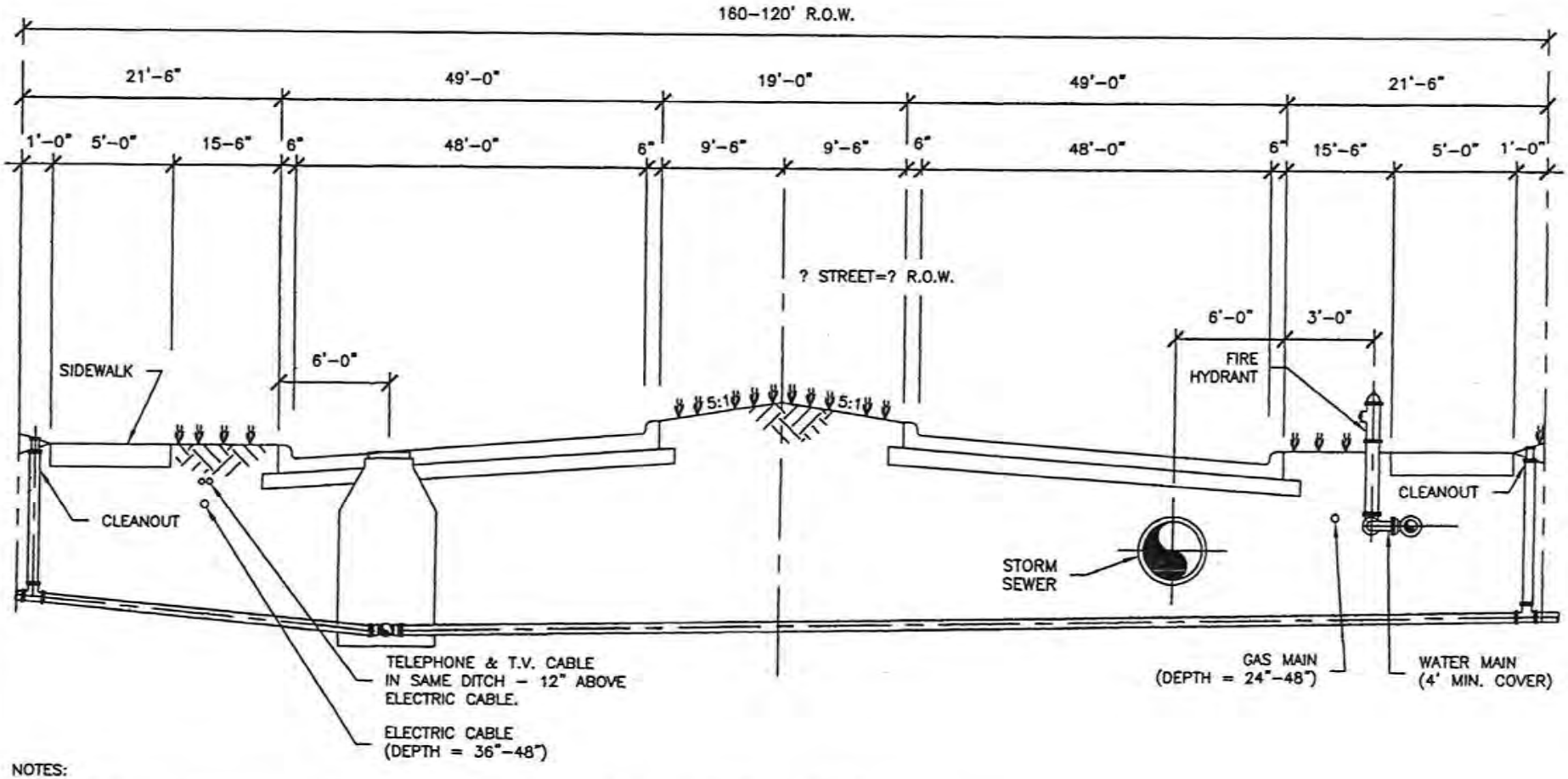
DATE: MARCH 2004

SHEET: 15

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

1. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 8, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE AA.
3. MININUM 12–INCH WATERLINE REQUIRED FOR TYPE AA.

MAJOR ARTERIAL
TYPE AA
SECTION LOOKING SOUTH OR WEST

SCALE: NONE

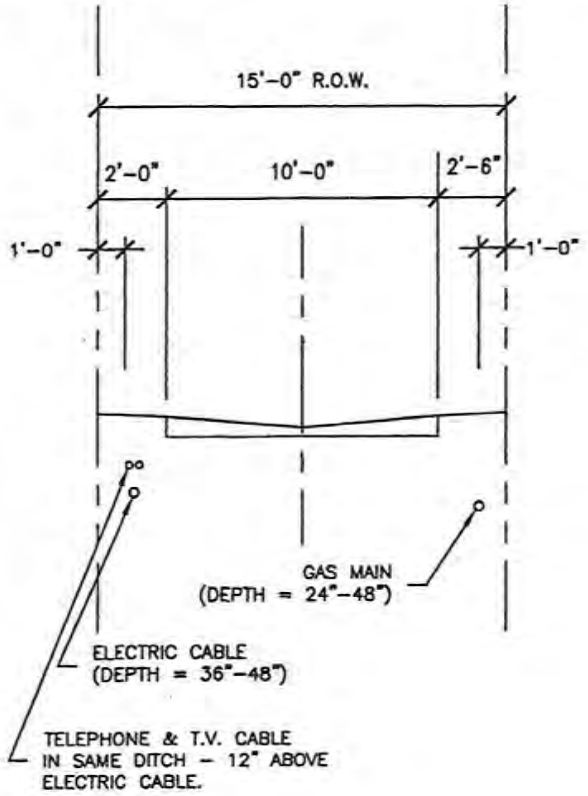
DATE: MARCH 2004

SHEET: 16

DESIGN STANDARDS

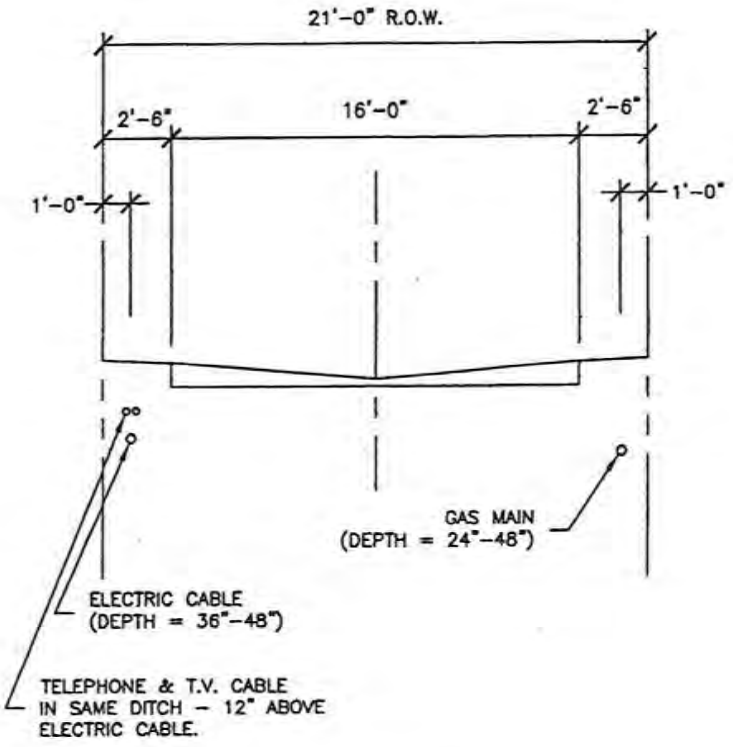
UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



10 FT. ALLEY

SECTION LOOKING SOUTH OR WEST



15 FT. ALLEY

SECTION LOOKING SOUTH OR WEST

NOTES:

1. GAS, EIECTRIC AND T.V. CABLE UTILITIES ARE TO BE LOCATED IN ALLEYS WHERE POSSIBLE.
2. REFER TO TYPICAL PAVEMENT SECTIONS, SHEET 9, FOR PAVEMENT DETAILS.

SCALE: NONE

DATE: MARCH 2004

SHEET: 17

DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS

APPENDIX C

ADDENDUM TO NCTCOG STANDARD SPECIFICATIONS

CITY OF TERRELL
ADDENDUM TO THE
NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS
STANDARD SPECIFICATIONS FOR
PUBLIC WORKS CONSTRUCTION 4th Edition

This addendum to the North Central Texas Council of Governments Standard Specifications for Public Works Construction 4th Edition, as amended, sets forth (by reference number) exceptions or requirements of the City of Terrell and thereby takes precedence over any conditions or requirements of the Standard Specifications with which it is in conflict.

101.1 Definitions

Add the following section 101.3 Special Conditions

Whenever these specifications are used to construct development work in accordance with the City of Terrell Subdivision Ordinance, the following definitions are redefined with regard to contractual obligations of the various parties completing the work:

Owner – the developer of the subdivision.

Owner's Representative – a person designated by the developer.

Engineer – the design engineer for the developer.

Inspector – a representative or designee of the design engineer.

The City of Terrell will not become the Owner, until after the improvements are complete and accepted by the City and the Final Plat is filed for record in Kaufman County. This temporary redefinition of the various roles does not allow approval of modifications by the developer or design engineer to the City of Terrell TCSS, during construction of the project.

107.19.3.3 Trench Safety Plan.

Add the following:

1. All trenches excavated within the City Limits of Terrell, Texas shall be excavated in accordance with OSHA standards.
2. After award, the Contractor shall submit to the Owner's Engineer five (5) sets of a trench excavation plan. This excavation plan must be designed and sealed by a professional engineer registered in the State of Texas with professional experience in Soil Mechanics.
3. The Contractor is responsible for obtaining borings and soil analysis as required for plan design. The trench excavation plan shall be designed in conformance with OSHA standards and regulations.
4. No trenching in excess of 5 feet below existing grade will be allowed until this plan is reviewed by the Owner's Engineer. Any changes in the trench excavation plan after initiation of construction will not be cause for extension of time or change order and will require the same review process. The

Contractor accepts sole responsibility for compliance with all applicable safety requirements.

5. A copy of the plan will be submitted to the City by the Owner's Engineer. The Contractor will be responsible to implement the plan by any construction means, methods, techniques and procedures to comply with OSHA standards and regulations. Any property damage or bodily injury (including death) that arises from use of the trench excavation plan, from Contractor's negligence in performance of contract work, or from City's failure to note exceptions to the excavation plan shall remain the sole responsibility and liability of the Contractor.

107.24 Project Clean-up. (201.4.3 Cleaning and Stabilizing Project Area)

Add the following:

The Owner will pay for eighty-five (85%) per cent of the actual quantity of pipe which has been installed and backfilled until such time that the right-of-way is finish graded, cleaned up, and revegetated. Such payment for pipe installed is additionally subject to the project retainage.

202.2 Topsoil

Add the following:

Removal and separation of topsoil is required unless otherwise noted. Finished grade shall be $\pm$ 0.1 feet of original grade unless otherwise noted. The Contractor is responsible for removing and disposing of all excess excavated materials. Such materials may not be left on public right-of-way or adjacent property without written permission to do so.

303.2.1.3.2 Gradation.

Change last sentence to read "No more than 40% difference shall be retained between any two consecutive sieves."

305.2.2.1 Concrete.

Add the following:

All concrete for sidewalks and driveways approaches shall be Class A with an air content of 3-5%.

305.2.2.2 Reinforcement.

Add the following:

Reinforcement is required in all driveways and walks.

501.7.3 Coating and Lining.

Add the following:

All ductile iron pipe and fittings shall be sheathed with polyethylene film and tape per section 502.8.

501.7.4 Fittings.

Add the following:

Bolts and nuts for mechanical joint ends shall conform to ASTM Designations A 325 (A 325M) (Type B). Bolts for buried flanged ends shall be Type 304 stainless steel unless encased in mortar. Fittings shall be cement mortar coated with a seal coat in accordance with AWWA C-104 and sheathed in polyethylene film and tape per section 502.8.

Delete:

All references to AWWA C 153 or compact fittings. Compact ductile iron fittings may not be used.

501.13.5 Grout Holes.

Change "one-half of the total number" to "one-third of the total number".

501.14.3 Dimension Ratio.

Add the following:

PVC pipe shall have a pressure class of 150 psi, be minimum thickness DR 18, and have cast iron outside dimensions.

501.14.5 Fittings.

Add the following:

Fittings shall be sheathed in polyethylene film and tape per section 502.8.

The bolts and nuts for direct buried flanges shall be Type 304 stainless steel.

Add the following:

501.14.6 The embedment to be used for PVC water pipe shall be Class B-3 or B-4 (section 504.5.2) unless otherwise noted.

502.1.1.1.1 Joints.

Add the following:

Joints shall have trapped O-ring rubber gaskets in accordance with Item 501.5.4.

502.3.1 Materials.

Add the following:

Fire hydrants shall be 5 ¼" Mueller Super Centurion.

502.3.2 Installation.

Add the following:

Fire hydrants shall be located in accordance with the Utility Assignments in the TCSS.

Above grade, fire hydrants shall be painted as follows:

a) Clean all surfaces to receive paint to remove all dirt, oil and other contaminants.

b) Apply one 5 mil dry film thickness coating of epoxy mastic equal to Carboline 801 or Sherwin Williams B58.

c) Apply two 1.5 mil dry film thickness coats of aliphatic urethane equal to Carboline 134 or Sherwin Williams B65.

d) Color of the urethane coatings for the barrel and bonnet of the hydrant shall be silver.

e) All colors except grey shall be safety colors per ANSI Z53.1. Grey color shall be per ANSI Z55.1.

A Blue Stimsonite, Fire-Lite reflector (or approved equal) shall be placed in the center of the street opposite fire hydrants.

502.3.3 Measurement and Payment.

Add the following:

Blocking shall be included in payment for fire hydrants and shall not be paid separately.

502.6 VALVES

Add the following:

The following valves types shall be used unless special permission is given to do otherwise:

502.6.1	Gate Valves (AWWA C 500) 14" through 48"
502.6.2	Resilient Seat Gate Valves (AWWA C 509) 2" through 12"
502.6.3	Air Valves
502.6.4	Brass Wheel Valves 1-1/2" and smaller

Valves shall be sheathed in polyethylene film per section 502.8.

502.6.1 Metal Seated Gate Valves for Ordinary Waterworks Service

Add the following:

Drawings - The manufacturer shall have on file with the City for approval a detail drawing of each type and size of valve to be furnished under these specifications.

Offerings having exceptions or modifications to these specifications must be accompanied by new detailed drawings and statement of changes effected. Failure to meet these requirements shall be sufficient cause for rejection.

502.6.2.1 General Description.

Add the following paragraph:

Valve Seats - Resilient seats shall be applied to the gate. The seating surface in the body of the valve shall be machined and shall be metallic. Resilient seats shall be secured to the gate mechanically by stainless steel screws.

Valves shall be Mueller or approved equal.

502.6.2.3 Ends.

Reads as follows:

Valves shall have flanged, push-on, or mechanical-joint ends, or any combination of these as may be specified. Bolts for mechanical joint ends shall meet ASTM A-325M (Type B). Bolts for direct buried flanges shall be Type 304 Stainless Steel.

502.6.2.6 Stuffing Boxes.

Add the following:

Stuffing box bolts and nuts shall be Type 304 Stainless Steel.

A minimum of two (2) 0-rings shall be used in stuffing box.

Packing shall not be used.

502.6.2.8 Hand Wheels and Operating Nuts.

Add the following:

Hand Wheels and Operating Nuts - All valves 2" (5.08 cm) in diameter and above shall be nut operated unless otherwise shown or specified. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications.

All valves shall open by turning counterclockwise.

502.6.5.1(7) General.

Delete: split-V packing.

502.6.5.1(8) General.

Add the following:

Discs shall be epoxy coated.

502.6.5.1(10) General.

Add the following:

The interior of the valve shall be epoxy coated.

502.6.5.1(11) General.

Add the following:

Valves shall be Class 150-B unless otherwise noted.

502.6.5.3 Ends.

Add the following:

Unless otherwise noted, valves for direct burial service shall have mechanical joint ends and exposed valves shall have flanged ends.

502.6.5.4.1 Manual Actuators: (Location)

Add the following:

1. Operator shall be located on the side of the valve, suitable for buried service.

2. Manufacturing Experience - Five (5) years minimum manufacturing experience is required.

502.6.5.4.1 Manual Actuators: (Closure)

Add the following:

Operator shaft extensions are required and shall be stainless steel. Shafts shall be of sufficient length to bring operating nut to within 6" of the bottom of the valve cover.

502.6.6.1 Gate Valves.

Add the following:

All valve stacks shall be of cast iron pipe or PVC pressure pipe and of one continuous piece to the finished grade. Furnish and install stainless steel valve operator extensions when operating nut is more than four (4') feet below finished grade.

502.10.2.1 Service Clamps.

Add the following:

The two sections or halves type saddle may only be used on PVC pipe. Single strap clamps will not be permitted on any type pipe.

Delete reference to single strap clamps.

502.10.3.1.1 Taps

Delete Item 1, direct tap.

502.10.3.1.2 Tap Assemblies.

Add the following:

Service fittings for copper water service tubing shall be as follows:

a. Corporation Stops – per TCSS Construction Details.

b. Coppersetter – per TCSS Construction Details.

502.10.3.1.2 Tap Assemblies.

Add the following:

Only soft copper (Type K) tubing will be allowed and a curb stop will be required in lieu of a brass gate valve.

502.10.3.1.7 Tapping PVC Pipe.

Add the following:

1. Direct tapping of PVC pipe will not be permitted.
2. Taps may be made on PVC pipe using the following devices.
3. Service Saddles – Smith-Blair #317/CC or JCM 405/CC. Any other service saddle must be submitted to the Engineer for approval before installing.
4. Main Line Fitting - Taps may be made in a mechanical joint plug installed in the branch of a tee.
5. All Water Services shall be marked on the end of services with a blue plastic tape with the word "Water" stamped thereon.
6. All water deadheads shall have a meter box installed with a 2-inch flush valve.

502.10.3.2 Services and Bullheads.

Add the following:

Bullhead services are not allowed.

503.3.3.5 Construction by Tunneling.

Add the following:

In the first sentence of the sixth paragraph - after "tunnel lining shall be" add "backfilled with Class B concrete or".....

504.4.2.1 Water for Construction.

Add the following:

All construction water shall be furnished at standard commercial rates by the City from the nearest convenient City main. A water meter shall be used to determine the amount of water used. The Contractor may rent water meters from the City or furnish his own meters at the choice of the City. If City water is unavailable, Contractor shall be responsible for purchasing water from a local supplier or another city. The City reserves the right to designate the time of day in which water can be withdrawn from City mains.

504.5.2.12 Class "D+" Embedment.

Change "select material" to "granular material".

504.5.3.2 Compaction.

Add the following paragraphs:

The moisture content shall be at or above optimum moisture content.

The Contractor shall guarantee the backfilling of excavation and trenches against excessive (as determined by the Engineer) settlement for a period of two years after the final completion of the contract under which the work is performed. Make all repairs or replacements necessary by settlement including refilling and compacting the upper portion of the ditch and repairing broken or settled pavements within thirty (30) days after notice from the City of Terrell.

504.5.3.2.1 Densities – Areas Subjected to or Influenced by Vehicular Traffic.

Add the following:

Excavations within five (5') of pavement or sidewalks shall be considered to be influenced by vehicular traffic.

504.5.3.2 Compaction

Modify the moisture content to +2 % or higher of optimum moisture.

504.5.3.2.4 Limitations

Add the following:

Density tests shall be performed by an independent testing laboratory and paid for by the City at the rate specified in 504.5.3.2. If the work is performed in conjunction with a development project, the Developer shall reimburse the City for the cost of testing in accordance with the Subdivision Ordinance. The City may

perform additional density tests at their expense. Density tests which fail shall be retested at the Developer or Contractor's expense.

506.3 Laying Water Conduit

Add the following:

Underground marking tape shall be installed 6"-12" above the top of all PVC pipe. Marking tape shall consist of a 0.5 inch wide layer of aluminum foil bonded between two pieces of polyethylene film. The dimensions of the marking tape shall be not less than 5.5 mils thick nor less than 2 inches wide. Marking tape shall be blue in color for water pipe and shall have the wording "Caution Water Line Buried Below" displayed prominently and continuously along the tape. The ends of the marking tape shall be brought up inside each main line valve box.

506.7.5.4 Sampling

Substitute the word "Contractor" for "Owner."

507.3 Laying Wastewater Conduit

Add the following:

Underground marking tape shall be installed 6"-12" above the top of all PVC pipe. Marking tape shall consist of a 0.5 inch wide layer of aluminum foil bonded between two pieces of polyethylene film. The dimensions of the marking tape shall be not less than 5.5 mils thick nor less than 2 inches wide. Marking tape shall be green in color for wastewater pipe and shall have the wording "Caution Sewer Line Buried Below" displayed prominently and continuously along the tape. The ends of the marking tape shall be brought up inside each clean out.

507.5.2.3 Criteria for Acceptance of TV-Inspected Pipe

Add the following:

(6) No standing water deeper than 3/8".

701.2 Structural Excavation.

Add the following:

2000 psi concrete will be used in inaccessible locations when a mechanical device cannot compact to required densities and as directed by the City, i.e.: under pipes, road washouts, under paving, etc.

Backfill shall be placed and compacted in not greater than 6" layers. The minimum backfill density shall be 95% at optimum moisture or above for all backfill. All other backfill shall be placed at a density equal to adjacent, undisturbed soil, but in no case shall it be less than 90%. Backfill density tests shall be determined in accordance with ASTM D698 by an independent testing laboratory selected by the City. The City shall pay for all costs of testing backfill densities. For development projects, the Developer shall reimburse the City in accordance with the Subdivision

Ordinance. One density test shall be performed at each location for each 500 C.Y. of backfill placed. The location of the backfill test shall be selected by the testing laboratory. The City may perform additional backfill density tests.

702.2.4.1 Consistency.

Add the following:

All structural concrete shall be Class C.

702.2.4.5 Tests.

Add the following:

Testing of structural concrete strength shall be performed by an independent testing laboratory. The Contractor shall furnish all materials, equipment and labor required to perform all concrete tests at his expense.

702.4.9 Finishing Concrete.

Add the following:

No water or dry cement shall be added to surface of concrete for finishing.

702.6.1 Description.

Add the following:

Pneumatically Placed Concrete may be used only where specifically called for on the plans or where special permission has been obtained from the City.

802.1.2 Materials.

Add the following:

All concrete for concrete steps shall be Class A with an air content of 3-5%.

802.2.2.1 Concrete.

Add the following:

All concrete for retaining walls shall be Class C.

805.2.2 Drawings.

Add the following:

All supplied extra material to make systems operational must be shown on "As-built" drawings with copies provided to the City.

805.4 Conduit Construction Methods

Delete the entire fourth paragraph beginning with "Unless otherwise specified...".

OTHER PROVISIONS:

1. Measurement and Payment

   Only those items in the Proposal will be measured and paid for. All other items of work required to complete the project shall be considered subsidiary to the pay items in the proposal and no claims whatsoever for extra work for such subsidiary items will be considered.

2. Record Drawings

   The Contractor shall furnish two (2) sets of prints of the drawings marked with the location of all water and sewer services, electrical cables and any changes in the plans to the Engineer.

3. Concrete Class

   Unless otherwise noted or specified, concrete shall be Class C.

3. Light fixture shall be Trimble House No. 415 with CR-1 arm. Light fixture shall be 150 watt high pressure sodium.

4. The following materials may be used only with special permission by the City:

   Gray Cast Iron Pipe and Fittings, ABS Truss Pipe for Sanitary Sewers, Corrugated Metal Sanitary Sewer Pipe, Corrugated Steel and Plastic Storm Sewer Pipe.

APPENDIX D

GENERAL NOTES FOR CONSTRUCTION PLANS

CITY OF TERRELL

TECHNICAL CONSTRUCTION STANDARDS AND SPECIFICATIONS

APPENDIX "D"

GENERAL NOTES

GENERAL

1 All construction shall be in accordance with the North Central Texas Council of Governments "Standard Specifications for Public Works Construction" latest edition and the City of Terrell's addendum thereto.

2 Before beginning construction, the contractor shall prepare a construction sequence schedule. The construction schedule shall be such that there is the minimum interference with traffic along or adjacent to the project.

3 Construction may not be begun earlier than 7:00 A.M. on weekdays nor continued after dark without permission from the City of Terrell. Construction on Saturday may not be begun before 8:00 A.M. and work on Sunday is prohibited without special permission. No excavation work shall be permitted on Saturday, Sunday, or City of Terrell holidays.

4 Utilities shown on the plans were taken from field surveys and information provided by the utility companies. The completeness and the accuracy of this data is not guaranteed.

The contractor is responsible for verifying the location of all underground utilities and structures and protecting them from damage during construction.

Contact Texas One Call System 1-800-245-4545 at least 48 hours before excavating.

5. Work may not be backfilled or covered until it has been inspected by the developer's design engineer.

6. Material testing shall be performed by an independent testing laboratory and paid for by the City. The City will be reimbursed for testing fees by the developer as outlined in Section 7.1 of the Subdivision Ordinance.

7. All excavation on the project is unclassified.

8. Utility companies and contractors shall obtain a street cut permit before disturbing any pavement in public right-of-way.

9. The contractor shall maintain two-way traffic at all times along the project.

10. Remove, salvage and replace all street and traffic control signs, which may be damaged by the construction of the project, at the direction of the City.

11. All trenching and excavation shall be performed in accordance with OSHA standards.

GRADING

1. Top soil shall not be removed from residential lots or used as spoil, but shall be stripped and redistributed so as to provide at least six (6) inches of cover on the lots, parkways and medians. Permanent erosion control measures shall be provided throughout the development prior to final acceptance of the improvements. - 1

2. Temporary erosion control shall be used to minimize the spread of silt and mud from the project on to existing streets, alleys, drainage ways and public and private property. Temporary erosion controls may include silt fences, straw bales, berms, dikes, swales, strips of undisturbed vegetation, check dams and other methods as required by the City Engineer or his representative and as specified in the North Central Texas Council of Governments Construction (N.C.T.C.O.G) iSWM Design Manual for Construction.

3. All street rights-of-way, regardless of slope; all finished grade slopes that are steeper than 6:1; and the flow lines of all drainage ditches and swales shall be completely covered with erosion control matting as specified in the North Central Texas Council of Governments Construction (N.C.T.C.O.G) iSWM Design Manual.

4. Grass shall be established on the slopes of all drainage channels that are steeper than 6:1. Grass shall meet the requirements of the Standard Specifications of the Texas Department of Transportation.

5. All permeable surfaces within the development shall be graded to a smooth and uniform appearance that can be easily mowed with a small residential riding lawn mower.

PAVING

1 All embankment, subgrade, and treated soils shall be compacted at a moisture content of +2% or higher of optimum moisture at a minimum density of 95%. Standard Proctor (ASTM D-698) should be used for clay soils and Tex 113 E should be used for base materials and treated soils in accordance with TxDOT methods.

2 All streets and alleys shall be placed on lime stabilized subgrade with a lime content of not less than 6% to achieve a P.I. less than 15. The optimum amount of lime may be determined using the pH method as determined by TxDOT methods.

3 The minimum 28 day compressive strength of concrete street paving shall not be less than 3,600 psi (Class "C") and flexural strength of 600 psi and shall be air entrained. Water may not be applied to the surface of concrete paving to improve workability.

4 All curb and gutter shall be integral with the pavement.

5 Streets and alleys shall be constructed with provisions for sidewalk ramps at all intersections.

DRAINAGE

1 Storm sewer pipe shall be reinforced concrete, Class III, unless otherwise noted.

2 All structural concrete shall be Class "C" (3,600 p.s.i. compressive strength at 28 days), air entrained.

3 The contractor shall install plugs in storm sewer lines or otherwise prevent mud from entering the storm sewer system during construction.

4 Embedment for storm sewer shall be in accordance with the manufacturer's recommendations as specified by the design engineer.

WATER AND SANITARY SEWER

1. Water mains shall be AWWA C-900 PVC DR 18 unless otherwise noted. Minimum cover for waterlines is 48" or as required to clear existing utilities, whichever is greater. Backfill shall be compacted to 95% Standard Proctor (ASTM D-698) density at a moisture content of +2% or higher of optimum moisture. Tex 113 E or Tex 114 E may be used where ASTM D-698 does not apply.

2. Tracer marking tape shall be installed over PVC mains.

3. Fittings for PVC water lines shall be ductile iron and be encased in a polyethylene sheath.

4. Compact ductile iron or cast iron fittings may not be used.

5. Valves shall be Mueller resilient seat gate valves or approved equal.

6. All direct burial valves shall be provided with cast iron valve boxes with PVC stacks. Valve stacks shall be vertical and concentric with the valve stem. Stainless steel valve extensions are required on all valves where the operating nut is greater than 4 feet below finished grade.

7. Fire hydrants shall be 5 ¼" Mueller Super Centurion and be field painted with two coats of silver paint meeting NCTCOG specifications according to North Central Texas Council of Governments and Addenda.

8. The distance from fire hydrants to the street curb or edge of a fire lane shall not be less than 1.5 feet or exceed five feet unless otherwise permitted by the Fire Marshall.

9. All exposed bolting on any buried equipment or material shall be stainless steel and polywrapped. Included are:

   Bonnet and stuffing box bolts on valves.
   Shoe bolts on fire hydrants.
   Flange bolts.

   "Cor-ten" mechanical joint "T" bolts are acceptable for direct burial service.

10. Meter boxes shall be as shown in the Construction Details, Appendix E for 1-1/2" and smaller meters. Larger meters shall be installed as directed by the City of Terrell.

11. All underground water system pipe fittings shall fitted with polywrapped Meg-a-Lug joint restraints.

12. Sanitary sewer mains and laterals shall be a minimum of SDR 35 PVC.

13. The contractor shall install and maintain water tight plugs in all connections to the City 's sanitary sewer system until the project is accepted by the City.

14. All sanitary sewer lines and manholes shall be leak tested before the project is accepted. Deflection testing of PVC sewer lines is required.

15. Embedment for water lines shall be either B-3 or B-4 as specified by the design engineer.

16. Embedment for sanitary sewer lines shall be either B+, B-1, or B-2 as specified by the design engineer.

17. All sanitary sewer main and service connections shall be video taped after installation of the service connections, prior to paving of the project. The lines shall be flushed with water and turned off prior to making the video. The size and slope of the pipe shall be shown on the video. All sanitary sewer will be re-video taped by the developer three months prior to the expiration of the two year maintenance agreement. The purpose of the second sewer video is to identify any problems that may have occurred since acceptance such as settlement, cutting of the lines by franchise utilities, etc.

CONSTRUCTION MATERIALS ENGINEERING

1. The developer will be responsible for hiring the design engineer to provide Construction Materials Engineering (CME) services to review and approve all submittals for materials and shop drawings associated with improvements to be maintained by the City of Terrell. Upon review for conformance with City of Terrell standards, the engineer will submit the information to the City of Terrell City Engineer with a letter, confirming conformance with the City of Terrell requirements. This must occur before installation of any improvements.

2. The engineer providing CME services will be responsible for ensuring that the proper number and location of tests are made and will review results for conformance with the project specifications. Sanitary sewer tapes shall be reviewed and approved prior to liming of subgrade for pavement. A set of tapes shall be made available to the City of Terrell for their review, also, prior to paving of the project. Upon completion of the project, the CME will provide a written report summarizing the testing performed and that results meet the requirements of the City of Terrell. The report shall be bound in a three ring binder and shall contain at a minimum the conformance letter from the CME, copies of all warranties and bonds, shop drawings and approvals, testing by category, as-built drawings, and sanitary sewer tapes on CD.

3. The developer will notify the City Engineer in writing with the name of the engineer that will provide the CME services.

4. The CME shall attend the pre-construction conference for the project.

FINAL PLAT ACCEPTANCE

1. The final plat cannot be filed with Kaufman County until after all franchise utilities are installed, grass is established, punch list items are addressed, and all public improvements are accepted by the City of Terrell.

WARRANTY

1. The Contractor shall maintain the required public improvements for a period of two (2) years following acceptance by the City and shall provide a maintenance bond in the amount of 100% of the costs of the improvements.

2. Thirty days prior to the expiration of the warranty, the Contractor shall notify the City of the approaching end of the two-year warranty and shall request a final inspection of the improvements to identify any items requiring repair. In the event the Contractor fails to notify the City of the end of warranty, the warranty and bond shall automatically be extended to end thirty days after notice of end-of-warranty is filed with the City.

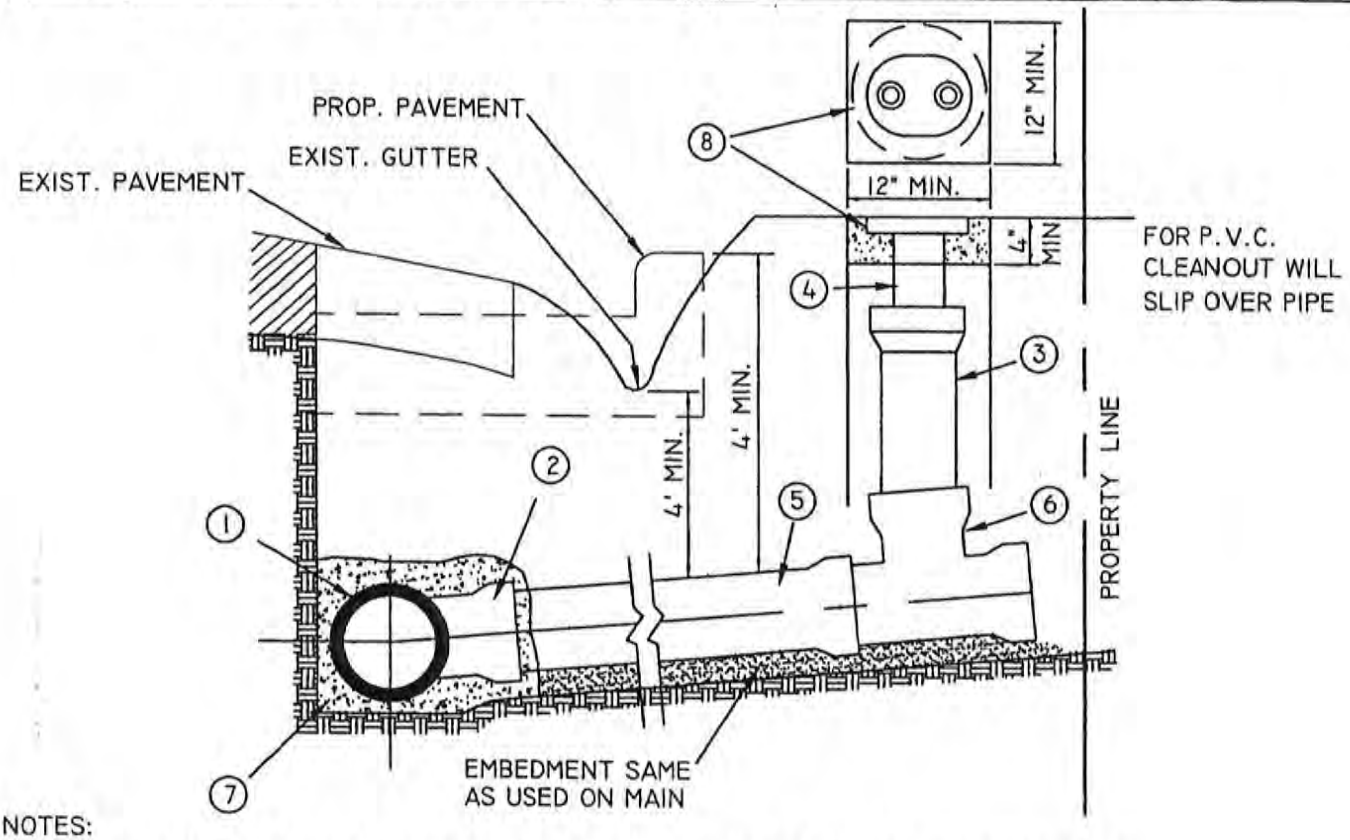
3. If the Contractor fails to re-video the sanitary sewer or fails to make satisfactory repairs indicated necessary on the sewer re-video or final inspection, the warranty and maintenance bond shall automatically to extended to 30 days after satisfactory repairs are made.

APPENDIX E

CONSTRUCTION DETAILS

KEY:

(1)	WASTEWATER MAIN	(5)	4" SDR 35 (MIN) PVC (LENGHT VARIES)
(2)	4" WYE	(6)	4" CLEANOUT TEE
(3)	4" STACK (LENGHT VARIES)	(7)	SPECIFIED EMBEDMENT
(4)	4" WASTEWATER LAT. CLEANOUT CASTING	(8)	SEE STD. DRAWING 5140



NOTES:

1 LATERAL SHALL BE CONSTRUCTED IN SUCH A MANNER AS TO CLEAR EXISTING AND PROPOSED FACILITIES. VERTICAL BENDS (22.5° MAX.) MAY BE USED IF NECCESSARY.

2 SUBSTITUE 6" FOR 4" FITTINGS IF PLANS OR SPEC. COND. CALL FOR 6" LATERALS.

3 SLOPE OF LATERAL TO BE 1% MIN., 2% MAX. UNLESS OTHERWISE APPROVED BY CITY.

4 THE MAINLINE LATERAL CONNECTION TO THE PRIVATE BUILDING LATERAL SHALL BE AS CLOSE TO THE PROPERTY LINE AS POSSIBLE.

VERTICAL

5 THE CLEANOUT IS TO BE PLACED IN THE PARKWAY OR IF NECESSARY IN VEHICLE TRAFFIC AREAS,

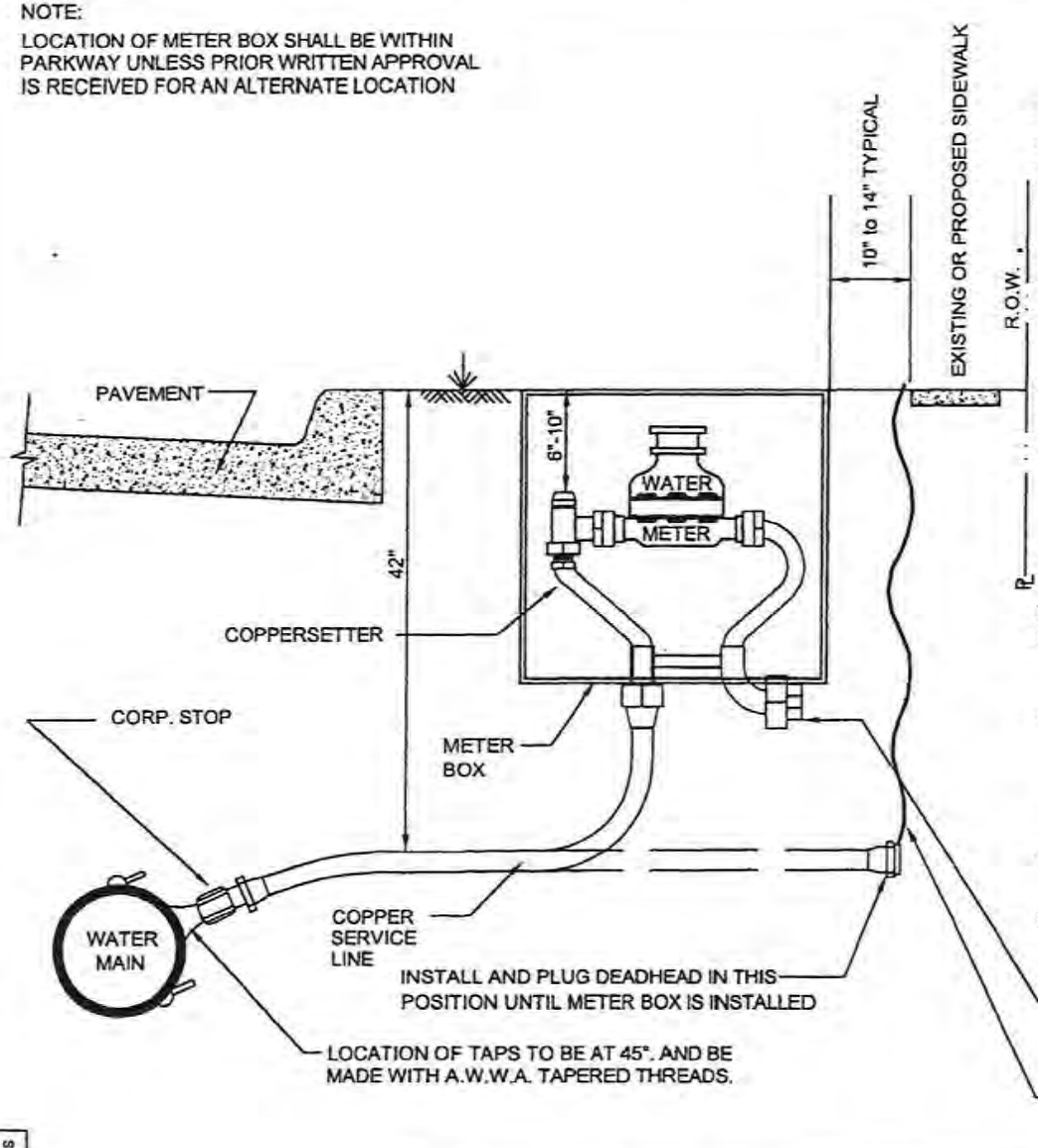
RESERVED

6 RESERVED

7 RESERVED

4" WASTEWATER LATERALS	CITY OF TERRELL, TEXAS	STANDARD SPECIFICATION REFERENCE: NONE	
		DATE: MARCH 04	STANDARD DRAWING NO.: COT-5120

NOTE:
LOCATION OF METER BOX SHALL BE WITHIN PARKWAY UNLESS PRIOR WRITTEN APPROVAL IS RECEIVED FOR AN ALTERNATE LOCATION



CITY OF TERRELL
WATER SERVICE MATERIAL STANDARDS

SERVICE SADDLE:

SMITH - BLAIR #317/CC OR JCM405/CC
OTHER AS APPROVED BY CITY

CORPORATION STOP: FORD

1 ½" FORD FB1000-6-Q
OTHER AS APPROVED BY CITY

SERVICE LINE:

DOMESTIC MADE, NSF 61 APPROVED, TYPE K COPPER TUBE WITH NO JOINTS

METER BOX: BASS & HAYS

1 1/2" METER "59P24 with LOCKING LID" SERIES PLASTIC METER BOXES WITH 2 (TWO) SLOTS 3X8" AND CAST IRON RINGS AND BLUE CITY OF TERRELL LOCKING LIDS

COPPERSETTERS: FORD

1/2" TAP x 1 1/2" METER VV76-86-11HB-66

WATER METER

MASTER METER 3G RADIO READ

STD. DRAWING NO. COT-4140

SCALE: NONE

WATER SERVICE INSTALLATION
1 1/2" METER

CITY OF TERRELL, TEXAS

STANDARD SPECIFICATION REFERENCE: NONE

DATE: NOV. 09 | STD. DRAWING NO.: COT-4140

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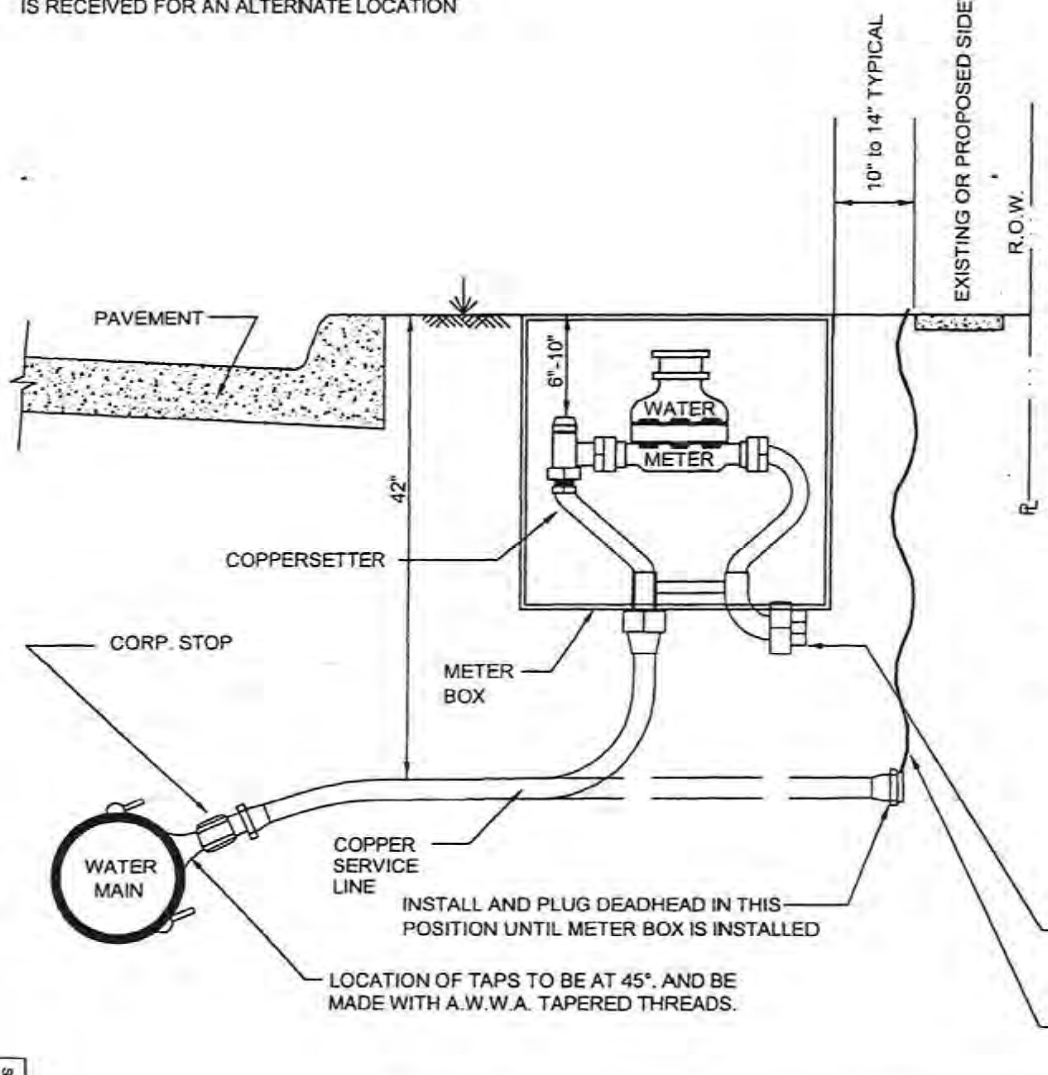
NOTE:
LOCATION OF METER BOX SHALL BE WITHIN PARKWAY UNLESS PRIOR WRITTEN APPROVAL IS RECEIVED FOR AN ALTERNATE LOCATION



CITY OF TERRELL
WATER SERVICE MATERIAL STANDARDS

SERVICE SADDLE:

SMITH-BLAIR #317/CC

JCM 405/CC

OTHER AS APPROVED BY CITY

CORPORATION STOP:

1" FORD # FB1000 -4-Q

OTHER AS APPROVED BY CITY

SERVICE LINE:

DOMESTIC MADE, NSF 61 APPROVED, 1" TYPE K COPPER TUBE WITH NO JOINTS

METER BOX:

BASS & HAYS # 34P18
PLASTIC METER BOXES WITH 1 (ONE) SLOT 3X8
AND CAST IRON RINGS WITH A BLUE CITY OF TERRELL LOCKING LID

COPPERSETTERS:

1" TAP x 5/8" x3/4" METER FORD # V72-82-41-44-Q

1" TAP x 1" METER FORD # V74-84-41-44-Q

WATER METER

MASTER METER 3G RADIO READ

STD. DRAWING NO. COT-4130

SCALE: NONE

WATER SERVICE INSTALLATION
1" AND SMALLER METER

CITY OF TERRELL, TEXAS

STANDARD SPECIFICATION REFERENCE: NONE

DATE: NOV. 09 | STD. DRAWING NO.: COT-4130

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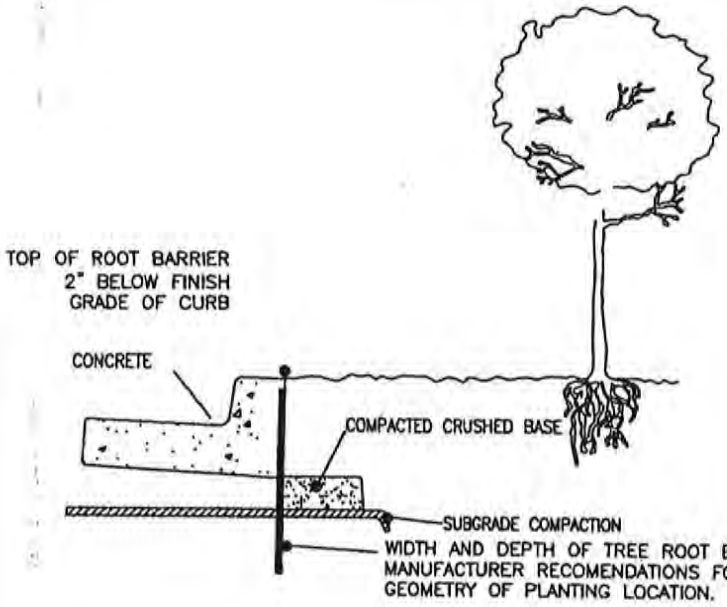
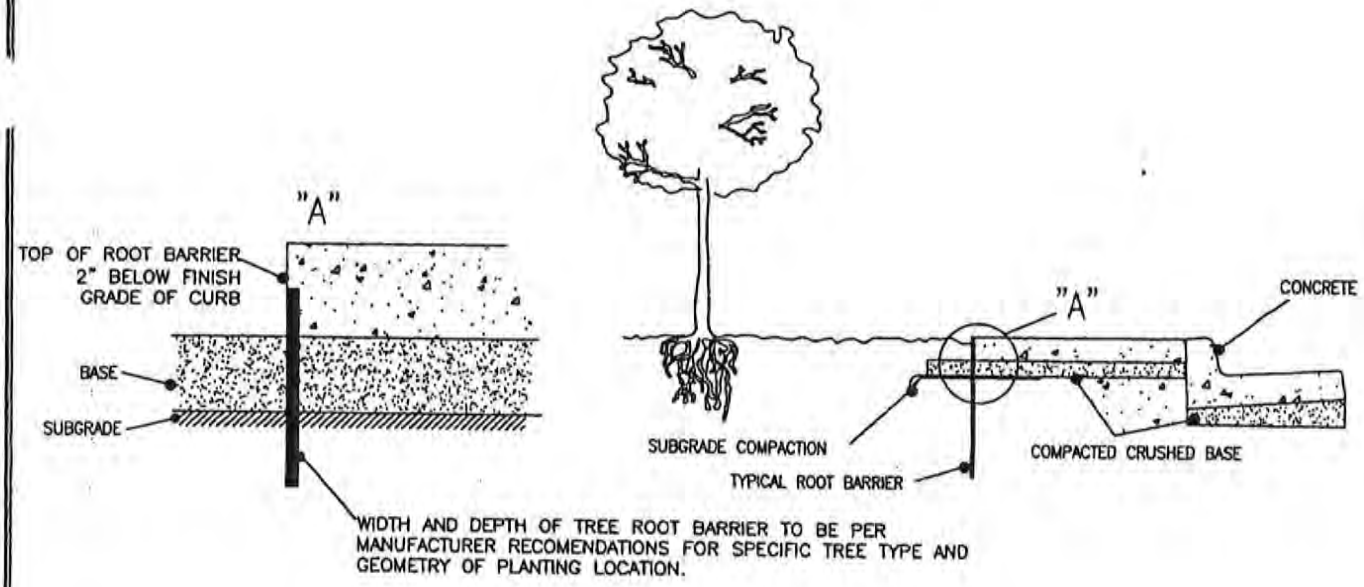
NOTES:

(1) TYPICAL SECTION OF CURB AND GUTTER WITH TREE ROOT BARRIER INSET INTO CONCRETE. BARRIER INSTALLED IN A TRENCH IN SUBGRADE WHICH IS THEN COMPACTED. BARRIER IS SET SO THAT TOP EDGE WILL BE 2" BELOW FINISH GRADE OF CURB, OR SIDEWALK AND SET FLUSH WITH EDGE OF CURB OR SIDEWALK. BARRIER RIBS FACE TOWARD TREE ROOTS.

(2) TREE ROOT BARRIER TO BE AS MANUFACTURED BY DEEP ROOT PARTNERS, L.P. OR APPROVED EQUAL. CONTACT PHONE NUMBER (800) 458-7668.



TYPICAL FOR CURB AND GUTTER – NO SIDEWALK.



TYPICAL FOR SIDEWALK.

SCALE: NONE

DATE: MARCH 2004

DESIGN STANDARDS

TYPICAL TREE ROOT BARRIER INSTALLATION

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS