CITY OF TERRELL

TECHNICAL CONSTRUCTION STANDARDS AND SPECIFICATIONS

DECEMBER 2022

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TERRELL CONSTRUCTION STANDARDS AND SPECIFICATIONS

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PART 1 – GENERAL

1.1 PURPOSE

The purpose of the Technical Construction Standards and Specifications (TCSS) 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, contractors 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. In the event there is a conflict between referenced NCTCOG standards, TCSS and the plans and specifications, the more stringent shall control. 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 B and typical pavement sections are included in Appendix F.

1.3 STANDARD SPECIFICATIONS FOR CONSTRUCTION

Standard specifications for construction as adopted by the City of Terrell shall be in accordance with the latest edition of "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 A. These specifications set forth minimum requirements. Additional design or construction considerations of the City or the developer may be required.

1.4 UTILITY ASSIGNMENTS

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

If a landscape buffer is dedicated as defined and outlined in our Subdivision Ordinance, it shall not overlap with any dedicated public or private easement.

1.5 GENERAL NOTES

All construction plans for the projects described above shall contain the applicable general notes listed in Appendix D. These are considered minimum requirements and

design Engineers shall review the needs of each individual project.

1.6 PLATTING

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 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 1,000 feet of the boundary of the subdivision, such benchmark shall be established to sea level datum. Said benchmark 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 benchmark. 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 or as directed by the City Engineer or his designee. 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 sealed by a Texas registered professional Engineer 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") shall be submitted for all projects involving construction of public works improvements in the City of Terrell or its ETJ. 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 (or other common mapping versions or formats the City requests) on electronic media 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 authorized by City Council, 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.

1.12 City Engineer's Approval

In general, any exceptions to the TCSS specifications requires City Engineer or his designee's approval. Although not inclusive, below is a list of items that are subject to review and approval.

1. Drainage Facilities -
   a. Design, size, type, and location; impacts to adjacent properties. Standard pipe in public ROW shall be Class III RCP. HDPE shall only be allowed on private drainage systems.
   b. Use of bends in drainage pipe (typically not allowed)
   c. Pipeline direction changes, in lieu of radius pipe
   d. Drainage calculations; provide for existing and post-construction conditions. Include layout of drainage area(s) and individual calculations to develop flows.
   e. Erosion control measures
   f. Approval of design if runoff velocity > 6 fps. Supporting data must be provided as to why the velocity cannot be controlled at less than or equal to 6 fps.
   g. Variance to runoff coefficients provided herein
   h. Requirement and design of energy dissipation devices
   i. Exceptions to 2 feet minimum above 100 year flood elevation
2. Geotechnical Report
3. Location of utilities if proposed locations vary from standard utility assignments
4. Street Name assignments
5. Street configurations, including residential street to lot layout, radius and design speeds
6. Alignment and slope of sidewalks in unique situations
7. All alternative pavement designs
8. Location of stop signs, traffic signals, and yield ROW signs
9. All signage related to public safety
10. Location of water main valves above 12 inches in size
11. Exception to fire hydrants no closer than 50 feet to a building
12. Exception to allow a service line off a fire hydrant lead
13. Allowance of septic system
14. Exception to minimum required cover for water and sewer mains

1.13 Developments

Since there are numerous items that must be accomplished to get to an approval stage, this section is intended to provide a general approach to the requirements.

Specific design requirements and standards are set forth in other sections of this document.

A Pre-Development meeting will be required to meet with City Staff from both Municipal Development and Engineering Departments. The initial contact needs to be with the Municipal Development Director or Coordinator. A Development Review Committee (DRC) will provide review and input into the requirements and provide input and design review comments during the development and design phase of the project.

Prior to issuing a permit and/or a construction plat, fees shall be paid for engineering plan review and inspection of the public improvements portion of the project. Fees shall be based on current City ordinance(s) at the time of issuance.

Some of the key requirements and expectations are:

a. Addressing all plat and zoning changes. A Construction Plat must be approved by both the P&Z Commission and the City Council. Approval will generally take a minimum of 4 to 6 weeks after City staff approves the construction plat. Approval of the construction plat by City staff means civil drawings are approved as well.
b. Drainage plans will need to provide runoff calculations for both existing and developed conditions and an overview of drainage upstream and downstream.
c. Developer is responsible for clearing the properties related to any and all environmental conditions, such as issues related to wetlands and contaminated soil, and obtaining the necessary permits and approvals prior to construction.
d. A Traffic Impact Analysis (TIA) will be required for large developments or locations as determined by the City Engineer.
e. A Fire Lane suitable for access to the property and fire protection must be in place prior to "going vertical." Developers should front-load the project schedule to meet these requirements. Any exception must be approved by the Fire Marshal.
f. Ensure that all requirements of a Planned Development (PD) are met, if one exists for the property.
g. A lighting plan must be submitted showing the illumination levels and how the proposed changes coordinate with existing street or adjacent property lighting. Design shall meet the current lighting requirements in the Zoning Ordinance.

1.14 Geotechnical and Sub-grade

All projects for proposed Developments and City improvements shall include a Geotechnical Report that includes sufficient review and recommendations for the project site(s) to provide the following. A copy of the report shall be furnished to the City

Engineer for review along with civil plans and specifications.

As a minimum, the report shall include:

1. Sufficient number of bores at adequate depths to represent the site conditions.
2. Description of sub-grade conditions and types of soil identified at various depths and locations.
3. Location map of the project and detailed map showing bore locations.
4. Recommendations for sub-grade preparation, removal of material, compaction, pavement thickness and foundation support (if applicable). Note that the City of Terrell has set compaction requirements at a **minimum of +2% above optimum Moisture Content at 95% standard proctor density**. The report should reflect this criteria as a minimum condition for all public improvements.
5. **Lime Treatment** - sulfates are present throughout the City of Terrell, which can greatly impact the use of lime to treat and stabilize the sub-grade. Testing for the presence of sulfates is a critical step in completing the Geotechnical Report. Terrell's requirement is that lime cannot be used for public improvements and all use must be approved by the City Engineer or his designee. Any proposed use of lime for private portions of a development should be proven acceptable based on the sulfate levels present and addressed in the geotechnical report.

   If lime treatment is recommended by the Geo-Tech report to support subgrade for private paving, but a request is made to not use lime treated subgrade for private paving and to place it directly on compacted natural soil backfill, then a minimum of 2 inches must be added to the pavement thickness above Geo-Tech recommendations. Lime stabilization shall not be used under fire lanes or access easements.

6. For vertical construction, include recommendations regarding items such as depth and size of piers and footings, structural support for shallow foundations, moisture conditioning below the foundation, and other pertinent recommendations.
7. Show safety factors used in calculations.
8. Provide clear data regarding moisture content, liquid limit, plasticity index, plastic limit, and compressive and/or bearing strength of the soil.
9. Provide recommendations regarding construction sampling and testing, especially regarding particular critical construction or vulnerable locations.

1.15 MATERIALS TESTING

Materials testing on City projects will be managed and paid for by the City of Terrell.

On Development projects the cost shall be paid by the developer or his contractor (based on their agreement). Scheduling for testing shall either be managed by the Contractor or the City. If managed by the Contractor, invoices for material testing shall be billed directly to and paid by the Contractor. Alternately, an estimated cost shall be escrowed

with the City of Terrell. The initial payment to the City shall be based on at least 3% of the value of public improvements. The City would then be responsible for paying invoices for material testing. Note: The developer or contractor shall be responsible for the actual cost of the testing and a settle-up will be done at the end of the project as either a reimbursement for escrow not spent or an additional cost owed if the escrowed amount is exceeded.

For larger developments or any other project the City determines to be beneficial, the Engineer or testing lab shall produce a grid map to reference and track the location of tests completed. The cost of developing the grid map shall not be borne by the City of Terrell. The grids shall be laid out on approximately 50 foot lines / squares, but the actual spacing shall be determined for each project.

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 F. 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 streets 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.

C. Residential Street / Lot Layout

A standard residential layout is included to Appendix H which references locations for water and sewer services, sidewalks, trees, and house setbacks in relationship to the right-of-way. Any deviations from this layout must be approved by the City of Terrell.

TABLE 2-1

STREET AND THOROUGHFARE
GEOMETRIC STANDARDS [2]

Street Description	Type (1)	FF/Curb Pvmt Width (2)	Min ROW Width	Lanes (2)	Parking (2)	Parkway	Median	Minimum Concrete Pavement Thickness	Min Design Speed
Principal Thoroughfare	AA	48'	160' – 180'	4-12'	0	19.5'	23.0'	12"	45
Principal Arterial	AA	34'	140'	1-12' 2-11'	0	23.5	23.0'	12"	45
Major Arterial	A	23'	120'	1-12' 1-11'	0	24.5'	23.0'	12"	40
Minor Arterial	B	28'	100'	2-10'	1 – 8'	15.0'	12.0'	12"	35
Principal Collector	C	27'	100'		0	15.5	13.0'	10"	35
Major Collector	D	18'	80'	1-10'	1-8'	14.5'	13.0'	10.0"	35
Minor Collector	E	16'	60'	1-12'		13.5'	0	8"	30
Local Street - Residential	F	16'	60'	1-9''	1-7'	14.5'	0	8"	30
Local Street - Residential (Optional)	F	15'	60'	1-15'	0	14.5'	0	8"	30
Rural Residential	G	15.5'	60'	1-15.5'	0	14.5'	0	8"	30
Alley (3)	NA	10'-15'	15' or 21'	1-10' or 15'	0	0	0	8"	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] The following street sections will be determined and approved by the City Engineer:
Lakeside Collector (140'ROW)
Pedestrian Way (20'ROW)
Boulevard (140'ROW)
Major Rail Access Corridor (120'ROW)
Minor Rail Access Corridor (70'ROW)

[2] Pavement width each direction except alleys which are full width.

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

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, super-elevation, 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 Super-elevation

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 super-elevated.

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 are 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 super-elevation 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 Figure 2-1.

4. Street Intersections

a. Standard

Major thoroughfares, collector streets, and residential streets shall intersect at or near right angles. At the intersection of these arterial types the various geometrics differ, including pavement widths, lane widths, curb radii, median widths, turning lane data, cross-fall, crown height and other features. Grades shall be designed to provide smooth transitions as well as convey storm water flows such that minimal impacts to traffic movement occurs.

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 sidewalks be constructed with the paving of streets or when building construction occurs. This includes all residential, commercial and industrial construction. All sidewalks must conform to current state laws for barrier free construction in accordance with Texas guidelines for Americans with Disability Act.

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 to 2 feet from the right-of-way line, depending on the type of street (refer to Appendix F). For 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 "B")

The vertical alignment of City streets and thoroughfares shall be designed to ensure

the safe operation of vehicles and should allow easy access to adjacent property. A travel-way 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, cross-fall 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.

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.

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%

2.3. 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. Formula coefficients are defined as follows:

CREST VERTICAL CURVE / SAG VERTICAL CURVE

L = KA

L = Minimum Length Vertical Curve required for safe stopping for headlight control

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

A = Algebraic Difference in grade

TABLE 2-6
MINIMUM LENGTH OF VERTICAL CURVE

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

c. 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.

d. 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. 4. 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."

2.5. 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 Figure 2-1.

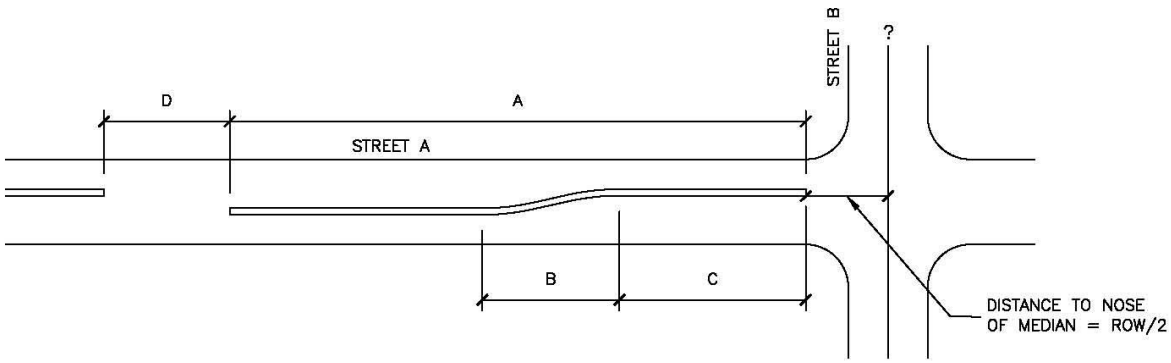
2.6. CUL-DE-SAC

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. Minimum right-of-way and pavement widths shall be in accordance with Table 2-7. However, they must also meet any updates or revisions in current City-adopted International Fire Code.

Table 2 – 7

CUL-DE-SAC R.O.W. RADIUS / DESIGN STANDARDS

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



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

DESIGN STANDARDS

MEDIAN DESIGN STANDARDS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS

2.7. 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 Type A or AA 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 public road 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. 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.

A rural residential section may only be used in the City's Extraterritorial Jurisdiction (ETJ) and at the sole discretion of the City of Terrell. Alternate sections proposed other than concrete pavement reflected in Appendix G, it must be designed with an equivalent 30 years life and be approved by the City Engineer.

B. Design Standards and Storage Length

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

For businesses, 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. The minimum length of this storage shall be as provided for in Table 2-11.

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 8.33%. Cross-slopes of sidewalks shall not exceed 2%. Individual situations that cannot meet this requirement shall be subject to review and approval by the City Engineer.

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.

TABLE 2-9

MINIMUM CORNER CLEARANCES BETWEEN DRIVEWAY AND INTERSECTION FOR 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 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.

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 tail-water 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.

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	30	30
Retail (except Service Station)	24	30	30	30
Service Station	24	40	30	30
Industrial	24	45	30	50
DIVIDED DRIVEWAYS***				
Multi-Family, Office or Retail	18	24	30	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 changes 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

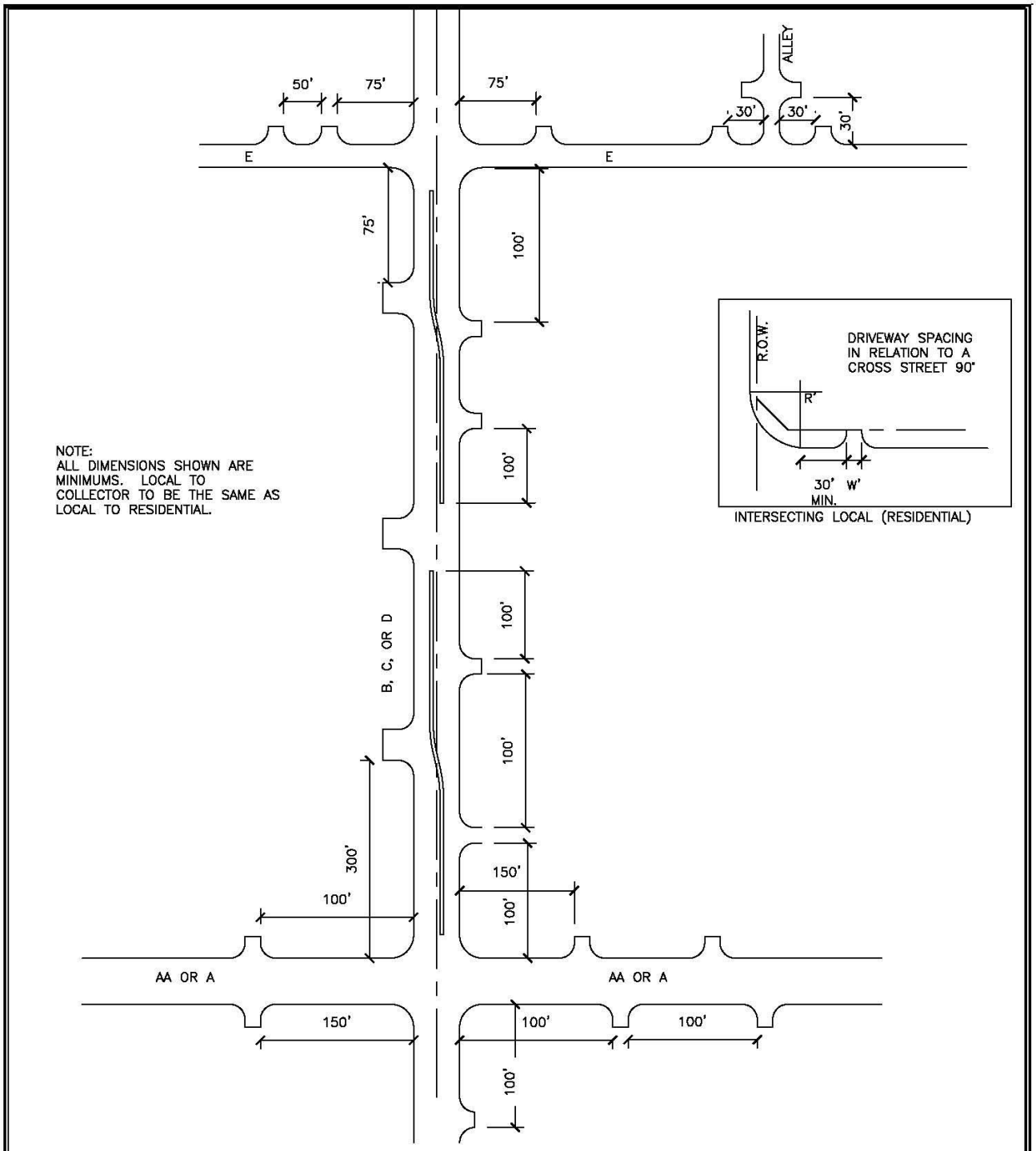


FIGURE 2-2

SCALE: NONE

DESIGN STANDARDS	CITY OF TERRELL
MININUM DRIVEWAY SPACING AND CORNER CLERANCE	KAUFMAN COUNTY, TEXAS

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 aisle-way on site.

2.8. PAVEMENT DESIGN

A. Standard Street and Thoroughfare Pavement Design

Table 2-12 shows the required pavement thickness for rigid pavement and the sub-grade requirements for various street and thoroughfare types within the City of Terrell. Pavement design thickness is based on a life cycle of 30 years as developed in a study completed by ETTL. A copy of the report may be obtained from the City Engineer upon request.

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 alternate design.

C. Testing

Testing shall be performed on public improvements in accordance with the requirements of NCTCOG. General guidelines are that cylinders for compressive strength tests shall be taken for every 100 CY's of concrete poured. The City may direct cylinders to be collected more often for any reason. Additionally, one set of companion beam cylinders shall be made for each 300 CY of concrete (one per three 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. The City reserves the right to request flexural beam tests at their sole discretion.

D. Tree Root Barriers

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

2.9. 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.

2.10 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 approved 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. The City reserves the right to require the developer to pay the City to purchase and install the required signs at the City's sole discretion.

B. Street Lights

The developer shall pay for the installation of 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 LED and installed in accordance with the National Electrical Code.

TABLE 2-12
STANDARD STREET AND THOROUGHFARE PAVEMENT DESIGN

Facility Type	Usual Crown	Minimum Sub-grade Requirements	Concrete Pavement Thickness (3)
Major Arterial (AA)	1/4" per ft	12" flexbase	12"
Major Thoroughfare, Residential (A)	1/4" per ft	10" flexbase	10"
Major Thoroughfare, Non-Residential (A)	1/4" per ft	10" flexbase	10"
Secondary Thoroughfare (C)	1/4" per ft	8 flexbase	8"
Minor Collector (D or E)	1/4" per ft	6" flexbase	6"
Major Collector, Residential	1/4" per ft	6" flexbase	6"
Major Collector, Non-residential	1/4" per ft	10" flexbase	10"
Residential/Local Street (F)	1/3" per ft	6" flexbase	6"
Rural Residential (G)	1/4" per ft	6" flexbase	6"
10 ft. Alley	5" Invert	6" Flexbase	6"
15 ft. Alley	6" Invert	6" Flexbase	6"
Fire Lane	1/4" per ft; Match Design of Surrounding Paving	6" Flexbase	7"

NOTES:

1) Placement of streets shall be done with a slip-form paver unless otherwise approved by the City Engineer. Equipment, forms, setup and quality control shall meet TxDOT 360 specifications.
2) 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.
3) These are minimum standards.
4) Pavement design is based on a life cycle of 30 years as developed in a study completed by ETTL. A copy of the report may be obtained from the City Engineer upon request.

2.11 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. A checklist of requirements is included in Appendix C. This checklist shall be provided with the set of plans submitted for review.

PART 3 - DRAINAGE

3.1 STORM DRAINAGE SYSTEM

The City of Terrell standards are developed based on integrated Storm Water Management (iSWM) design and construction methods. These standards 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 Criteria Manual for Site Development and Construction dated December 2009, Revised January 2015. All construction projects in the City of Terrell shall be designed and constructed in accordance with this manual, or latest adopted version. 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 rights-of-way required for drainage structures including storm drains and open channels, lined or unlined, as well as detention basin(s) that may be required to mitigate unacceptable storm water runoff rates. Minimum easement widths for are shown in Table 3-1. In all cases, easements shall be of an adequate size to allow proper maintenance.

TABLE 3-1: MINIMUM EASEMENT WIDTHS FOR
PUBLIC STORM DRAINAGE SYSTEMS

Drainage Facility	**Minimum Easement Width**
Storm Drain Conduit	20 feet
Open Channel less than 10-foot top width	25 feet with 15-foot access (one side)
Open Channel greater than 10-foot top width	Top width plus 15-foot access (both sides)

Note: "Top width" is width measured between each side at the top of the ditch

The design flows for the drainage system shall be calculated by either the Rational Method or the Unit Hydrograph 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, and shall be submitted at the time of Construction Plat. 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 for lot-to-lot

drainage shall not be dedicated 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.

Grading changes to residential lots (by individual Owners) shall not be done in a manner that negatively impacts adjacent lots. Generally, runoff must be contained within the lot and directed to right-of-way or a drainage easement. Planned revisions, including changes in elevations, must be presented for review at the time a grading permit is requested.

The developer shall comply with all local, state, and federal permitting regulations including, but not limited to the requirements of:

- Section 404 of the Clean Water Act
- Threatened and Endangered Species Act
- TCEQ Water Rights Permits
- TCEQ Dam Safety Requirements
- Texas Accessibility Standards

The developer shall obtain all permits required by these agencies. The City reserves the right to withhold construction permits until documentation of coordination with the appropriate local, state, and federal entities is provided.

A floodplain development permit, issued by the City, is required for any work within a Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA). A Floodplain Development Permit Application Form is available from the City's Flood Plain Administrator.

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 runoff from facilities on the development. To achieve and document this practice, a Downstream Assessment shall be required for development of property greater than 20 acres. For development of properties less than or equal to 20 acres, the design engineer may detain to the existing conditions discharge rate or document the adequate capacity to receive increased discharges in a Downstream Assessment. For non-residential infill development of properties less than or equal to 5 acres, a waiver of the Detention and/or Downstream Assessment requirement may be requested, subject to the approval of the City Engineer.

The purpose of a Downstream Assessment is to determine the potential impacts to downstream areas due to proposed development within the watershed upstream. Increased flooding potential, insufficient downstream storm drainage infrastructure, and increases in erosion are all evaluated as part of the assessment. The intent of such an analysis is to identify the necessary mitigation measures, either in the proposed upstream development or in the downstream area, necessary to offset any such impacts. The Downstream Assessment shall extend from the locations where increased discharges leave a proposed development to a point downstream as defined below:

A. A point downstream where the existing system has capacity to accept the hydraulic impacts and still meet the design requirements of this manual – OR –

A point downstream where capacity exists to support future fully developed (FFD) upstream watershed conditions.

Downstream Assessments shall analyze and document the following scenarios of hydrologic and hydraulic conditions. Scenarios are described in writing and shown in Table 3-2 below.

A. Existing hydrologic and hydraulic conditions on proposed site with existing hydrologic and hydraulic conditions on all remaining subbasin(s), both upstream and downstream, included in the analysis. This establishes the baseline scenario.

B. Existing hydrologic and hydraulic conditions on proposed site, with FFD hydrologic conditions on all portions of upstream watershed draining to proposed site, and existing hydrologic and hydraulic conditions on all downstream sub-basin(s).

C. FFD hydrologic and hydraulic conditions on proposed site and all portions of upstream watershed draining to proposed site, with existing hydrologic and hydraulic conditions on all downstream sub-basin(s).

D. FFD hydrologic and hydraulic conditions on proposed site, existing hydrologic and hydraulic conditions on the upstream watershed, with existing hydrologic conditions on all downstream sub-basin(s).

TABLE 3-2

DOWNSTREAM ASSESSMENT HYDROLOGIC AND HYDRAULIC CONDITIONS

Watershed	**Scenario A**	**Scenario B**	**Scenario C**	**Scenario D**
Upstream	Existing	FFD	FFD	Existing
Proposed Site	Existing	Existing	FFD	FFD
Downstream	Existing	Existing	Existing	Existing

The Developer shall mitigate for hydrologic impacts resulting from the proposed development, which are quantified as the difference between Scenarios B and C, above. Mitigation of impacts may be achieved by the following options:

A. Reduce onsite impervious cover and/or utilize Low Impact Design development methods that demonstrate a mitigation of impacts.

B. Provide onsite detention and outfall conditions to simulate pre-development discharge.

C. Construct offsite improvements to provide necessary capacity meeting the City's design criteria to the point of no impact.

D. Obtain easements or letters of permission from downstream property owners to the limits of impact.

Downstream assessments shall be prepared and submitted to the City at the time of construction platting. The assessment shall demonstrate that the proposed development will produce no adverse impacts. No adverse impacts may include, but are not limited to:

A. No new or increased flooding (0.00-foot increase in peak water surface elevation) of existing insurable (FEMA) structures (habitable buildings).

B. No increases in water surface elevations for the 1-, 10-, and 100-year return event storms. Drive lane and gutter capacity requirements shall also be met. An increase in water surface elevation is defined as any increase greater than or equal to 0.1 feet.

C. Post-development channel velocities shall not be increased such that they are greater than the maximum allowable channel velocities listed in this document. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion.

D. In the case that TxDOT facilities are located downstream or upstream of the project site, coordination must occur with TxDOT and the City to verify requirements. Limits of the study shall be determined by the City of Terrell.

3.1.1. ROADWAY DRAINAGE DESIGN

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

1. Subdivisions Utilizing Rural Residential and Parkways

- Storm water may be carried in drainage ditches located adjacent to and parallel to the roadway. The ditches shall carry a 10-year future fully developed (FFD) return event storm. A 100-year FFD return event storm shall be contained within an easement or right of way.
- 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.
- 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 10-year FFD return event storm 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 10-year FFD return event storm without approved erosion control devices.

- Ditch flow line slopes shall not be less than 0. 5%.
- Ditch depth shall not be less than 1.5 feet measured from the edge of pavement.
- If any of the above criteria cannot be met, the storm water shall be carried in an enclosed pipe system.

2. Subdivisions Utilizing Curbed Streets

- All storm water runoff from a return event up to the 10-year FFD shall be carried within the paved street surface or in an enclosed pipe system or both. A 100-year FFD return event storm shall be contained within an easement or right of way.
- 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 acceptance of the facilities by the City Engineer in no way relieves the developer of this responsibility.

To ensure complete review, plans submitted must address the following:

1. A map showing the drainage patterns for existing conditions for both onsite and offsite properties (entire drainage area). Contours must be provided and show all points of concentrated flow onto and off the property.
2. Proposed drainage pattern map showing how offsite water will be collected and passed through the property as well as how it will be conveyed. In changing from sheet flow or multiple smaller discharge points to a larger, single concentrated flow, a drainage easement from the downstream property owner to the water way is required. The developer will be responsible for maintenance of the drainage way.
3. Each of the maps shall show the 100-year FFD flow rates using the approved method of calculating the flow.
4. Provide a comparison table on the plans showing the existing and developed flow conditions.
5. If detention is required, provide a depth vs storage graph and a depth vs discharge graph on the plans.
6. If the existing downstream drainage was designed based on the 25-year storm, the new development must provide an analysis to show the 100-year FFD design will not flood the downstream facilities.

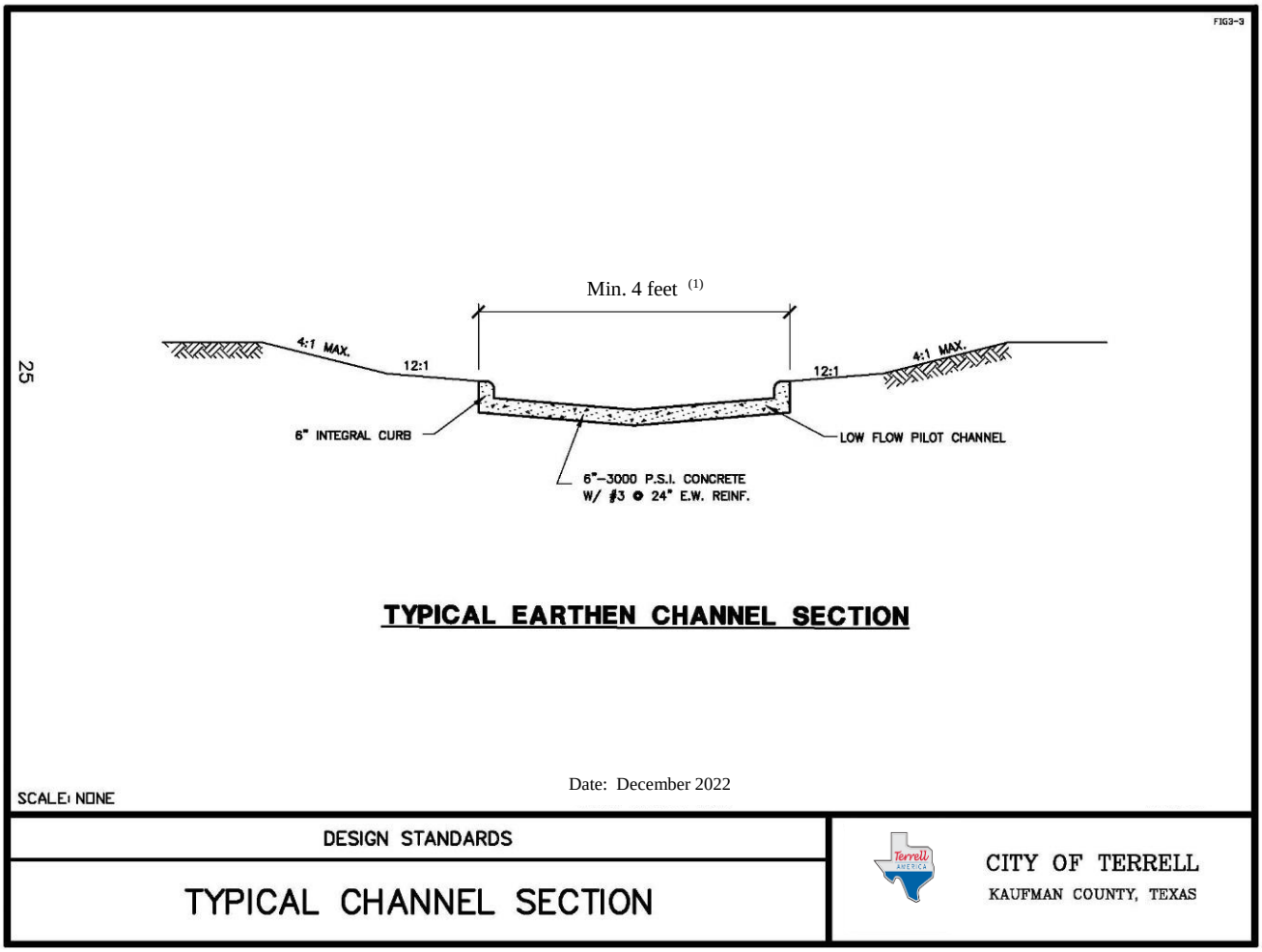


FIGURE 3-1: TYPICAL CHANNEL SECTION

(1) *Note: width of the channel flume shall be a minimum 4 feet. Exact design width will be approved by the City Engineer for individual projects based on design flow and conditions.*

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 200 acres. For drainage areas of 200 acres and larger, the Unit Hydrograph Method shall be used. For developments which impact designated Federal Emergency Management Agency (FEMA) floodplains, HEC-HMS or other methods accepted by FEMA shall be used.

B. Rainfall Intensities

When calculating the quantity of storm runoff, rainfall depth and intensity will be based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 11 Version 2: Texas.

For rational method design of hydraulic facilities in the City of Terrell, the applicable formula is as follows:

$$I_{ARI} = \frac{b}{(t_c + d)^e}$$

Where:

I = Rainfall intensity for a given annual recurrence interval (return event storm)

b = a scaling value, varies by return event storm

t_c = time of concentration, minimum of 10 (minutes)

d = an offset, varies by return event storm

e = an exponent, varies by return event storm

The coefficients for each return event storm are shown in Table 3-3 and are represented graphically in Figures 3-2 and 3-3.

TABLE 3-3

RAINFALL INTENSITY COEFFICIENTS AND

DEPTHS BASED ON ATLAS 14 VOL. 11 VER. 2

	100% (1-year)	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)	0.2% (500-year)
e	0.7680	0.7573	0.7407	0.7361	0.7149	0.7017	0.7244	0.6692
b (in.)	41.54	45.50	51.37	57.68	61.51	64.50	78.54	75.00
d (min)	9.65	9.29	8.72	8.57	7.92	7.56	8.55	6.66
24-hour Depth, inches	3.46	4.18	5.29	6.26	7.66	8.78	10.00	13.30

Note: e, b, and d values in Table 3.3 are based on a regression analysis optimized for durations up to a three-hour event and produce intensity rates within ±6% of the published Atlas 14 values for those durations. These values and the 24-hour depths are provided to simplify and standardize the design of small drainage features and facilities within the City of Terrell, and do not supersede the IDF and DDF curves of Atlas 14.

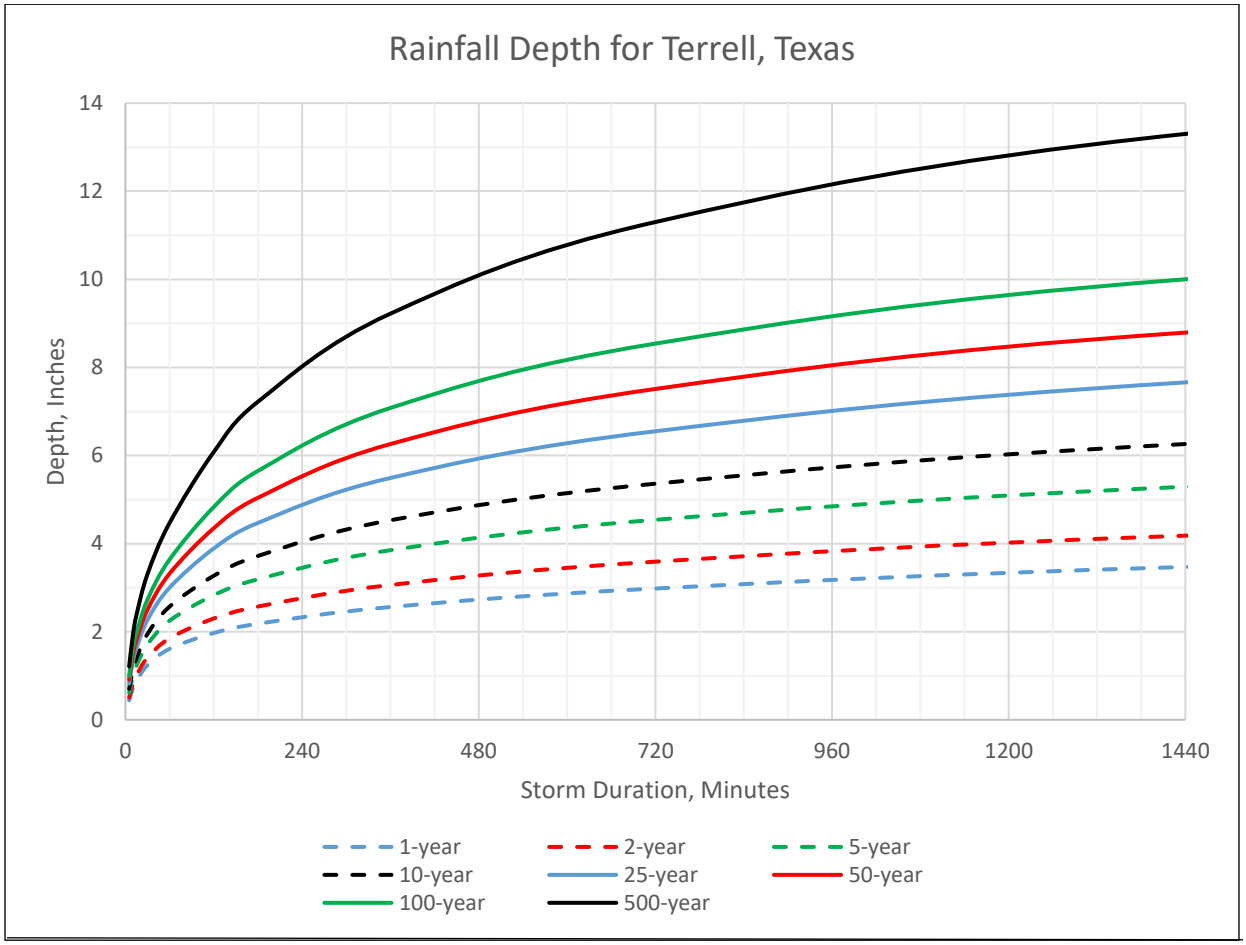


FIGURE 3-2: DESIGN RAINFALL DEPTH

Note: Figure 3-2 and Figure 3-3 are based on Partial Duration Series estimates of rainfall depth and intensity sampled at the geographic centroid of the City, 32.734873°N, 96.296244°W.

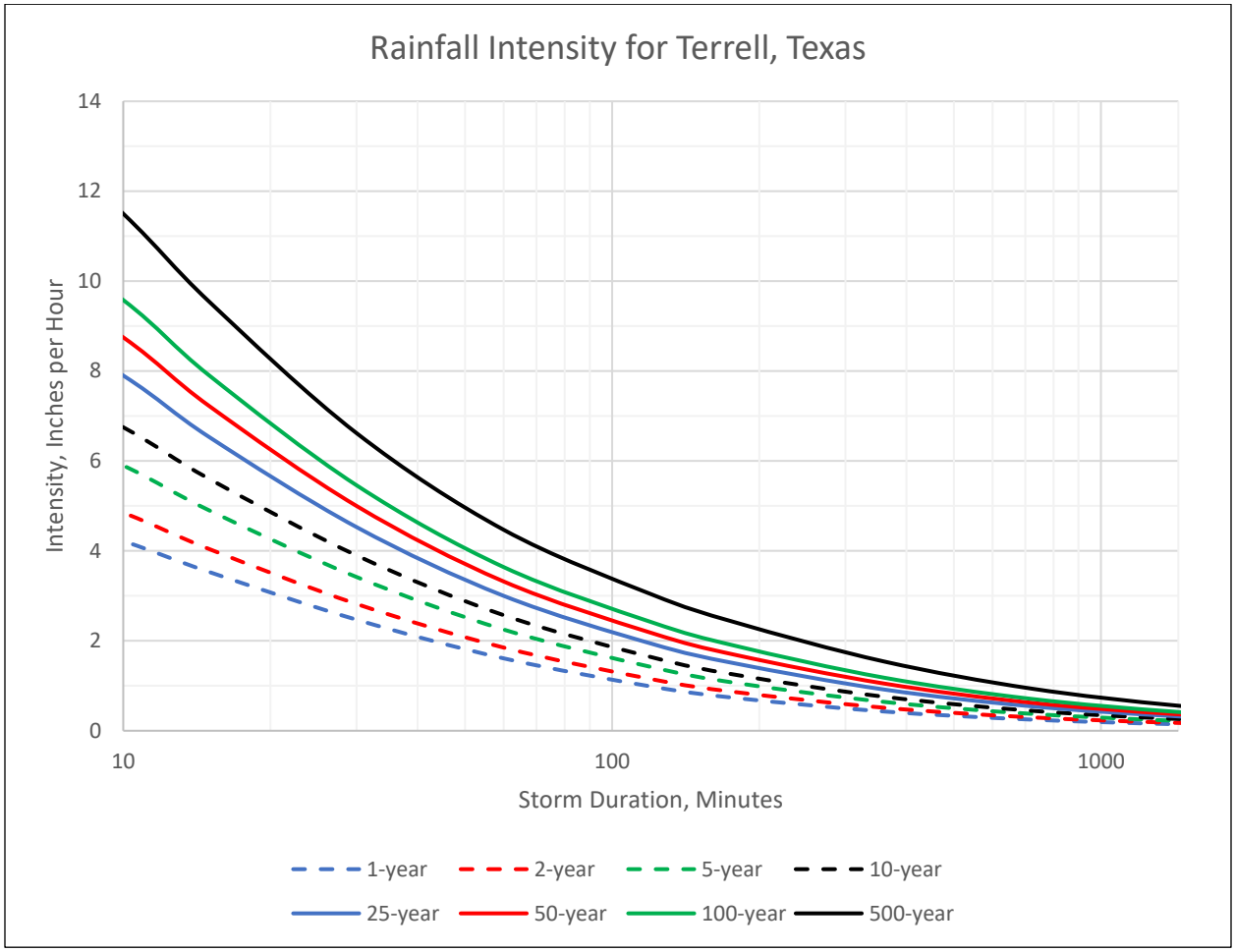


FIGURE 3-3: DESIGN RAINFALL INTENSITY

The storm frequency used for this determination will be according to the facility to be designed as listed in Table 3-4. Emergency overflows where used are to be located at sags and T-intersections of streets and designed to prevent erosion and surface water damage.

TABLE 3-4

RETURN EVENT DESIGN STORM

Drainage Facility	**FFD Storm Frequency**	**Required Freeboard**
Drainage ditches located in street right-of-way used in conjunction with Rural Residential and Parkway section types	100 years	0 feet (edge of ROW)
Pipe storm sewers with emergency overflow to give a combined capacity of 100-year frequency	10 years	0 feet (edge of ROW)
Pipe storm sewer with no emergency overflow	100 years	0 feet (edge of ROW)
All open channels	100 years	1 foot
Culverts (pipe or concrete box)	100 years	1 foot (edge of pavement)
Bridges (low point of bridge beams or similar bridge deck supporting structure)	100 years	2 feet

C. Rational Method

The rational method as described in Chapter 4 of the Texas Department of Transportation "Hydraulic Design Manual" (revised July 2016 or later) 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 3-4. 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 3-5. A minimum 10-minute time of concentration is required for all calculations.

D. Unit Hydrograph Method

For watersheds greater than 200 acres, the Soil Conservation Service (SCS)/National Resources Conservation Commission (NRCS) Curve Number or the Snyder's Unit Hydrograph Method shall be used. The unit hydrograph method is described in Chapter 4, Section 13 of the TxDOT Hydraulic Design Manual dated July 2016 (or most recent

version).

Unit Hydrograph Method runoff shall be computed based on the NRCS Type-III rainfall distribution.

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, in conformance with City Code Chapter 4, Section 10, “Floodplain management regulations”.

3.3 RUNOFF COEFFICIENTS AND TIME OF CONCENTRATION

Runoff coefficients, as shown in Table 3-5, shall be the maximum used, based on total development under existing land zoning regulations. Where land uses other than those listed in Table 3-6 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.

Times of concentration shall be computed according to the NRCS method (also known as the TR-55 method), described in Chapter 4, Section 11 of the TxDOT Hydraulic Design Manual dated July 2016 (or most recent version).

3.4 DETENTION ANALYSIS

A. Methodology

There are two acceptable methods for designing detention basins. For detention basins with no upstream detention basins, and with a single drainage area of 25 acres or less, the Modified Rational Method may be used. If the above criteria are not met, the Unit Hydrograph Method shall be used. The hydrologic model shall extend to the appropriate point downstream of the basin, as determined based on the Downstream Assessment. Future fully developed conditions shall be assumed for all hydrologic design calculations, unless otherwise specifically stated.

The Modified Rational Method is allowed for watersheds of 25 acres and less. However, this method is not acceptable for basins in series. The Modified Rational Method uses the peak flow calculating capability of the Rational Method in conjunction with assumptions about inflow and outflow hydrographs to compute an approximation of storage volumes for simple detention calculations.

TABLE 3-5

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
AG	Agricultural	0.30	0.40	30
EE	Executive Estate	0.30	0.40	30
EE-32	Executive Estate - 32	0.35	0.45	30
SF-16	Single Family - 16	0.40	0.50	15
SF-10	Single Family - 10	0.50	0.60	15
SF-7.5	Single Family - 7.5	0.55	0.65	10
SF-6	Single Family - 6	0.65	0.75	10
TH-12	Townhouse Residential - 12	0.70	0.80	10
MF-22	Multi-Family Residential - 22	0.70	0.80	10
MH	Manufactured Home	0.70	0.80	
NS	Neighborhood Service	0.80	0.85	
C	Commercial	0.90	0.90	10
CBD	Central Business District	0.90	0.90	10
O	Office	0.90	0.90	10
R	Retail	0.85	0.85	10
LI	Light Industrial	0.70 to 0.90	0.70 to 0.90	10
HC	Highway Corridor	0.95	0.95	10
PD	Planned Development	0.55	0.65	20
NON-ZONED LAND USES				
Church		0.70	0.90	10
School		0.50	0.90	10
Park		0.30	0.70	10
Cemetery		0.30	0.50	15
Street & Highway ROW		0.95	0.95	10

The following equations are used to calculate the required volume:

$$Inflow = T_d * Q * 60$$

Where:

T_d = storm duration (min)

Q = flow rate calculated for given T_d (cfs), calculated using Rational Method as described in Section 3.2.1

$$Outflow = 0.5 * (T_c + T_d) * Q_0 * 60$$

Where:

T_c = time of concentration for proposed conditions (min)

T_d = storm duration (min)

Q_0 = existing conditions flow rate (cfs)

$$V = \frac{(Inflow - Outflow)}{43{,}560}$$

Where:

V = required storage volume (acre-ft)

This process of estimating inflow, outflow and required detention volume is iterated assuming multiple storm durations in order to find the critical storm duration that maximizes the required volume.

Outlet works for the basin shall be sized to match pre-development discharge rate and velocity. In all cases, an emergency overflow route downstream of the basin shall be identified to prevent unintended basin overflow from flooding downstream structures.

B. Design Criteria Detention basins shall be designed based upon the following minimum criteria:

1. Detention shall be provided for the 1-, 2-, 5-, 10-, 25-, and 100- year design storms based on the results of the Downstream Assessment. Sites without a Downstream Assessment will be required to provide detention to pre-development runoff rates. Should the Downstream Assessment results demonstrate that downstream facilities are adequate and on-site detention is

not required, fully developed off-site conditions shall be taken into account for the on-site design facilities.

2. All detention/retention facilities shall demonstrate an acceptable outfall location. Acceptable outfall locations include an existing drainage system, within an easement, meeting the FFD criteria conditions described in this document. Post-development discharges shall mimic pre-development discharges in flow rate, velocity and location.

3. Earthen embankments may be used to temporarily or permanently impound surface water for the purpose of detention. They shall be designed by a Professional Engineer, licensed in the State of Texas, and shall be constructed according to specifications required based on geotechnical investigations of the site, as well as all regulatory requirements. The steepest side slope permitted for a vegetated embankment is 4 horizontal to 1 vertical (4H:1V); however, steeper side slopes may be permitted by the City Engineer on a case-by-case basis if hard-armoring of the slope is proposed. If the proposed embankment meets the definition of a dam according to Texas Administrative Code, Title 30, Part I, Chapter 299 (TAC §299) effective January 2009, or most current version, it shall be required to comply with all Texas Commission on Environmental Quality (TCEQ) dam safety criteria.

4. The effective crest of any detention embankment shall be a minimum of one foot above the 100-year water surface elevation.

5. Detention facilities shall be designed with an overflow spillway to protect the embankment in the event that the primary outfall ceases to function as designed, and/or in the event of a larger storm event than that used to design the primary outfall. The overflow spillway shall be designed to pass a minimum of the 100-year flood event while still providing for the minimum one foot of freeboard between the water surface elevation and the crest of the embankment. The overflow spillway shall not engage in a 25-year or more frequent event.

6. The detention basin bottom shall be designed to provide positive drainage to the outlet, with a minimum slope of 0.4%. If a variance is required on the minimum slope, a pilot channel is required to drain the pond.

7. Parking lots may be used to provide temporary detention of storm water; however, the maximum allowable depth of ponded water shall be six inches during the 100-year, 24-hour event. No fire lanes may be located within the portion of a parking lot designated as detention storage.

8. Detention/retention basins shall comply with all applicable federal, state and local regulations. These may include, but not be limited to, dam safety, water rights, and environmental regulations. Developer shall submit a statement signed by the Developer at the time of preliminary drainage plan submittal acknowledging that the proposed facilities will comply with all applicable federal, state and local regulations.

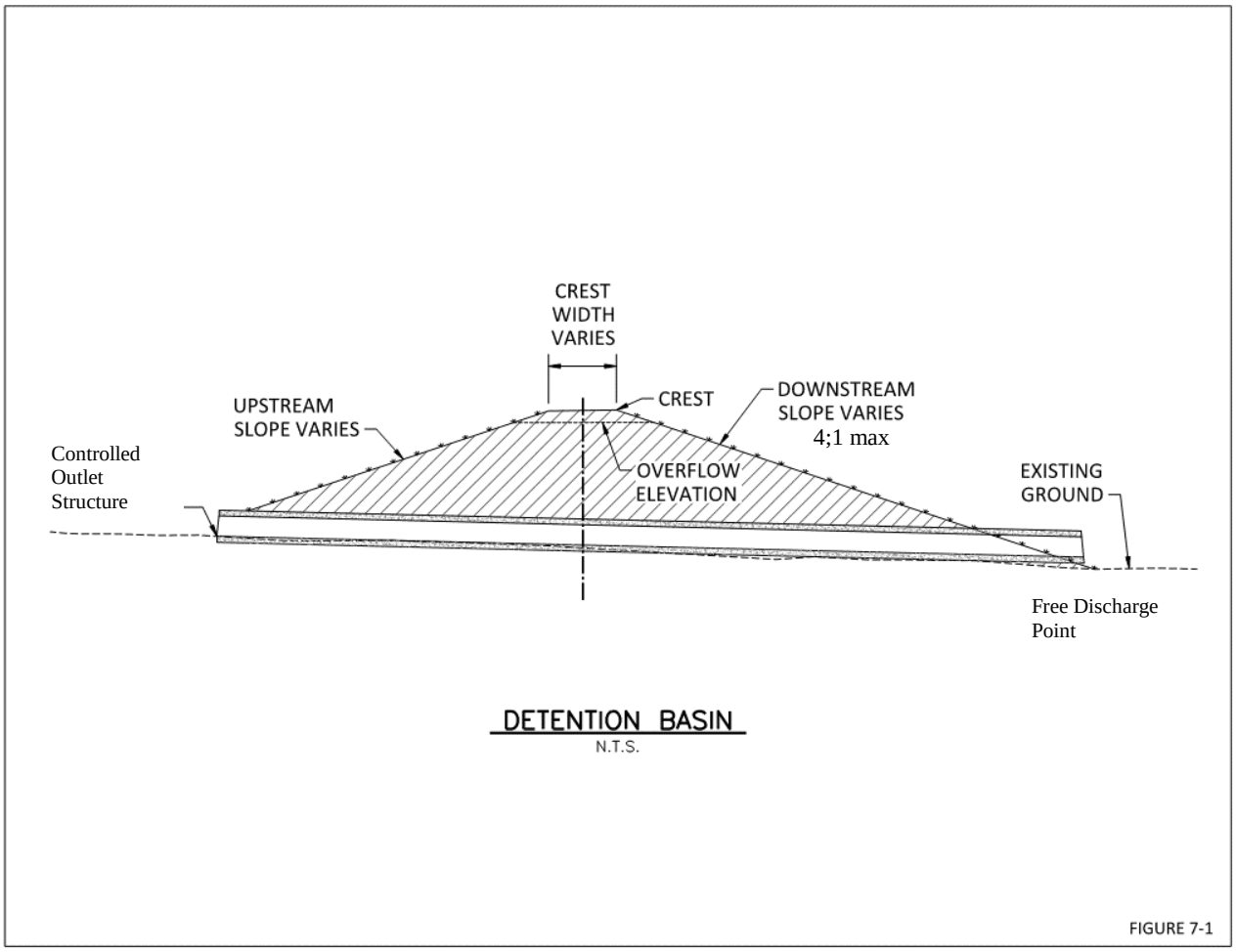


FIGURE 3-4: TYPICAL DETENTION BASIN CROSS SECTION

C. Maintenance

A Facilities Maintenance Agreement is required for all detention/retention basins, subject to approval by the City of Terrell.

D. Wet-Bottom Detention

Wet-bottom detention basins are allowed, and are subject to the following minimum criteria:

Wet-bottom detention basins shall be aerated.

Volume below the normal pool elevation of the pond is not to be counted toward the detention volume available for the mitigation of impacts of development.

The minimum depth of the wet-bottom shall be 8 feet to allow for proper aquatic vegetation.

Design shall incorporate a "safety slope" for embankments that require a design steeper than 4:1.

Fencing shall be installed for the public's protection.

3.5 EROSION HAZARD ZONE FOR PROPOSED DEVELOPMENT

An Erosion Hazard Zone (EHZ) shall be delineated for any development adjacent to a natural drainage feature as reflected in Figure 3-5. The floodplain easement shall fully encompass the EHZ, and no development, including fencing, shall be located within the EHZ. The EHZ shall be determined as the horizontal area encompassed by projecting the toe of the bank on a 4:1 (horizontal to vertical) slope to the natural ground. Detailed topographic data such as field survey must be used when developing the EHZ. Alternatively, the EHZ can be delineated based on expected long-term longitudinal stream degradation and lateral slope stability, supported by engineering calculations and subject to the approval of the City Engineer.

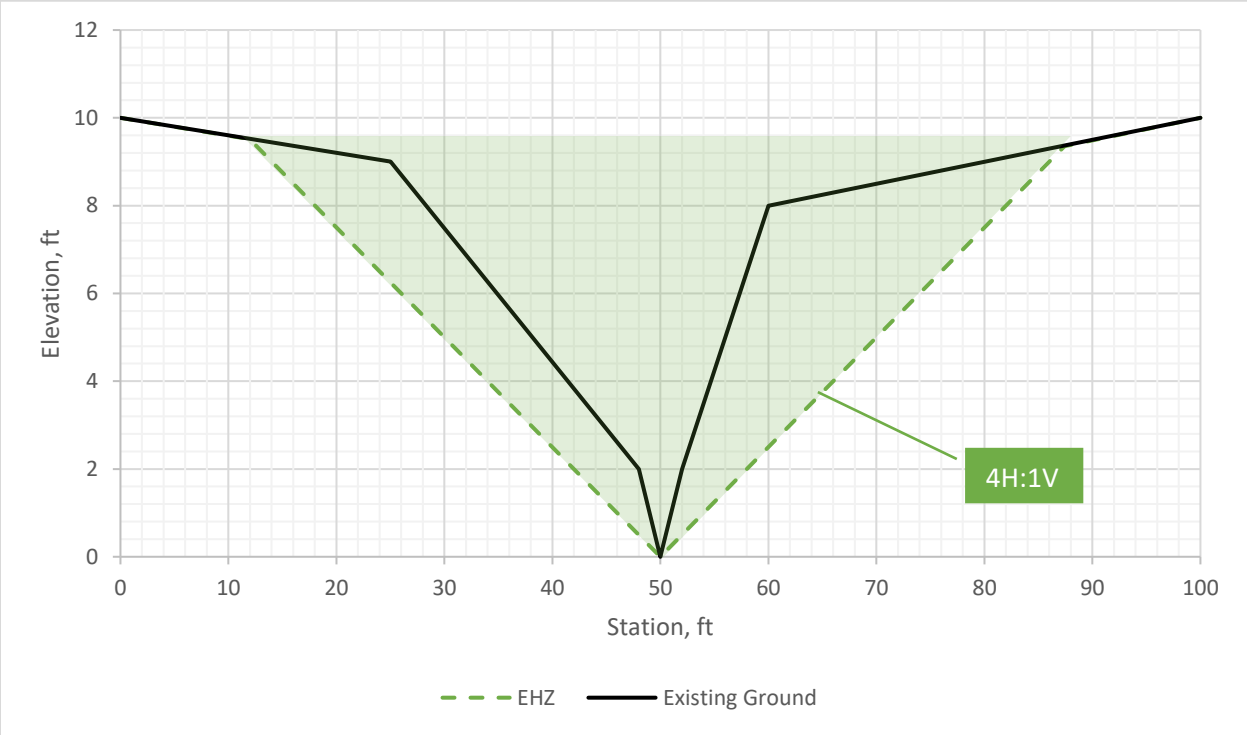


FIGURE 3-5: EROSION HAZARD ZONE

3.6 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 City 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.

In all cases, inlets in sump must have a clear overflow path, free of structures. In sag or sump conditions, the storm drain and sump inlets should be sized to intercept and convey the 25-year storm, provided that a positive overflow is provided for the remainder of the 100-year storm. When the overflow route is between residential lots or otherwise constricted, the positive overflow structure must be concrete or other acceptable non-earthen structure with a minimum bottom width of 6 feet extending from the sump inlet to the storm sewer outfall. If the upstream pipe already conveys more than 25-year peak discharge, then the downstream pipe must have at least the same capacity from sump to outfall, and an inlet must still be installed at sump to allow for emergency overflow. In the event that a structural overflow is not practical, then the underground system must be sized to convey the 100-year storm.

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 within a dedicated drainage easement. In all cases, water depth shall not be greater than 12" above gutter flow-line (ie., 6 inches over the top of curb).

B. Capacity of Streets and Alleys

Gutter flow for a triangular street section shall be calculated according to the following formulas:

$$Q = \left[\frac{0.56}{n}\right] \times S_x^{\frac{5}{3}} \times S^{1/2} \times T^{8/3}$$

Where:

Q= Gutter flow rate, cfs

Sx = Pavement cross slope (ft/ft)

S = Longitudinal slope (ft/ft)

T = Width of flow in roadway (ft)

n= 0.0175, standard manning's n roughness for use in the city

Depth of flow in the gutter can be calculated using the following modified form of the equation above:

$$y_0 = z\left(\frac{QnS_x}{S^{1/2}}\right)^{3/8}$$

Where:

y0= depth of water in the curb and gutter cross section (ft)

z=1.24

C. Capacity of Swales

Swales are defined as a triangular-shaped open channel that conveys runoff flow within the road ROW, is parallel to the road, and is less than or equal to 3 feet in depth. Swales shall have a maximum side slope of 4 horizontal to 1 vertical. Steeper slopes must be justified with a geotechnical analysis and subject to the approval of the City Engineer or his designee.

The capacity of swales shall be calculated according to the Manning Equation as given in Chapter 6 of the Texas Department of Transportation "Hydraulic Design Manual"

July 2016 Version or later. All calculations shall be made using a roughness coefficient based on Table 3-6.

TABLE 3-6

SWALE ROUGHNESS COEFFICIENTS

Channel Lining	Manning's Roughness
Mowed Grass	0.035
Un-mowed Grass	0.050
Smooth-Finished Concrete	0.013
Riprap	0.040

D. Valley Gutters

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

1. 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.
4. No more than 5 cfs can cross intersections in residential areas and no bypass of storm water across major intersections shall be allowed.

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. In no cases may depth of flow in an alley exceed 6-inches.

F. Sizing and Location of Inlets

For determining the size and locations of inlets, the following shown in Table 3-7 shall be used as a minimum:

TABLE 3-7

INLET OPENING REQUIREMENTS

Street Grade	Length of Inlet Opening for Each cfs 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 further 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.

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.
3. Storm sewer systems that outfall into a larger creek may use a coincidental peak analysis to determine the beginning hydraulic gradient, according to table 1.10 in the iSWM Technical Manual, reproduced in Table 3-8 below.

TABLE 3-8

100-YEAR COINCIDENT STORM EVENT DESIGN

Area Ratio	Main Stream	Tributary (Storm Drain)
10,000:1	2	100
	100	2
1,000:1	10	100
	100	10
100:1	25	100
	100	25
10:1	50	100
	100	50
1:1	100	100
	100	100

H. Hydraulic Design of Closed Conduits

All closed conduits shall be hydraulically designed for full flow as shown in Chapter 10, STORM DRAINS, of the Texas Department of Transportation, "Hydraulic Design Manual"

The crown of the pipe should be near the elevation of the design storm 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 of the closed conduit 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 slope shall be set at a minimum of 0.4%. If site constraints are not conducive to a 0.4% pipe slope, a lower slope shall be permissible, subject to the approval of the City Engineer. All storm sewer pipe and driveway culverts shall be a minimum of 12 inches in diameter, but consistent with any improvements recommended in the City's Drainage Masterplan. Discharge velocity shall be calculated with a tail-water 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 3-9 shows the maximum allowable velocities in closed conduits:

TABLE 3-9

MAXIMUM CONDUIT 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, as described in section Table 3-10.

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:

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

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:

$$H_l = \frac{V_2^2}{2g} - \frac{KV_1^2}{2g}$$

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

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

K = 0.35 for 90^o Lateral

K = 0.43 for 60^o Lateral

K = 0.50 for 45^o Lateral

K = 0.25 for Thru Line

$$H_l = \frac{KV^2}{2g}$$

Where:

K = 0.50 for 90^o Bend

K = 0.43 for 60^o Bend

K = 0.35 for 45^o Bend

K = 0.20 for 22.5^o 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:

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

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 permissible 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.

Multiple barrel box culvert arrays shall be designed and constructed to be consistent with the upstream and downstream channel geometry to limit the deposition of sediments. If more than two barrels are used in a culvert array, one barrel shall be placed at the flowline of the channel to maintain positive drainage for lower daily flows.

Hydraulic mulching shall be applied to channel side slopes in accordance with Section 204.6.4.4 of the NCTCOG Specifications and addenda, Fifth Edition. Temporary erosion control per Section 202 of the NCTCOG Specifications is required for all channels.

Channel side slopes lined with concrete will have a maximum of 2:1 slope. Permitted velocities in all open channels are listed in Table 3-10.

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 to provide a margin of safety for channel obstructions and for flows that exceed the design storm frequency.

On all channels, including drainage swales, 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 3-10. When the normal available grade would cause velocities in excess of the maximums, it may be necessary to design special drops or channel revetments.

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 to the top of curb shall be considered a reasonable freeboard when the structure is designed to pass a design storm frequency of 100 years. Variances to this requirement may be allowed subject to approval by the City Engineer. Hydraulic design of culverts shall be in accordance with Chapter 8, CULVERTS, of the Texas Department of Transportation, "Hydraulic Design Manual" 2016 Version or latest.

TABLE 3-10

OPEN CHANNEL DESIGN PARAMETERS

Description	Minimum Roughness Coefficient	Maximum Channel Velocity, fps Clayey Soil/Sandy
NATURAL STREAMS		
Moderately Well-defined Channel	0.030	6/3
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	0.050	6/3
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. Current 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 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. Where velocities indicate erosion potential, concrete rip-rap shall 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.

Grouted rip-rap shall have a nominal size of 6-8 inches, to be sized by the design engineer and subject to the approval of the City Engineer.

Gabion designs shall include epoxy-coated wire to maximize the life-span of the structures and are subject to the approval of the City Engineer.

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 9, BRIDGES, of the Texas Department of Transportation, "Hydraulic Manual."

5. A freeboard of 2-feet 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 floodplain is crossed. The City engineer shall be consulted for LOMR and CLOMR requirements.

3.7 CONSTRUCTION PLANS PREPARATION

A. Drainage Area Map

Refer to Appendix C for a checklist and requirements for plan development.

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 subareas 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 tic-marks 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 plan view 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. It shall also show 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 V2/2g. Include 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 (inside top of pipe) 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. Survey data and coordinates shall be tied to the State Plane Coordinate System. 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.

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 Assignments in Appendix G 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, the standard pipe size is 8 inch. Dead end mains shall not exceed 600 feet in length, and at least one fire hydrant or blow-off valve will be required 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, and C streets shall be 12-inch minimum.
5. The City has developed design standards for water and sewer flows which includes different types of developments. All designs for projected flows from a development or study area shall be determined using these design standards unless otherwise approved by the City Engineer or his designee. A copy of the design standards may be obtained from the City Engineer.

B. Water Main Material

1. Distribution system water mains shall be AWWA C900 or C905 PVC (based on pipe size) and DR 18, unless otherwise noted on the plans.
2. Fire lines shall be PVC, DR 14.
3. Double bell couplings may not be used for jointing pipe. Full-body ductile iron fittings shall be used.
4. 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.
5. Profiles with elevations shall be provided for mains 16-inches in diameter and larger and for specific area for smaller mains as required to define clearances and installation requirements where clarity is needed.

6. All private fire services that supply fire sprinkler systems shall be minimum 200 PSI working pressure and U.L. listed.
7. 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 shutdown 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. All valves shall be Resilient Wedge Gate Valves (RWGV) unless otherwise approved by City Engineer.

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 intersections 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 as laid by a fire vehicle.

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 as laid by a fire vehicle.

d. Protected Properties

Fire hydrants required to provide supplemental water supply for automatic fire protection systems shall be within 100 feet of the fire department connection (FDC) for such system. No obstruction shall exist between the fire hydrant and FDC.

e. Fire Sprinkled Buildings

Fire sprinkled buildings shall be provided an 8-inch fire line stub-out with valve. A transition to a 6 inch pipe may be provided near the building if fire flow calculations prove that a 6 inch pipe is adequate. Any exceptions must be determined to be adequate by the fire system design Engineer and approved by the Fire Marshal.

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. Minimum curb / pavement radius shall be 30 feet for inside radius and 50 feet for outside radius.

(4) Generally, no fire hydrant shall be located closer than fifty (50') feet to a nonresidential 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 barriers.

2. Restrictions
   a. All required fire hydrants shall be as required by the North Central Texas Council of Governments (NCTCOG) Specifications and City of Terrell Addenda and shall be placed on water mains six (6") inches in size and larger.
   b. Valves shall be placed on all fire hydrant leads.
   c. Required fire hydrants shall be installed so the break away flange 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 "G, Standard Utility Assignments." The fire hydrant shall not be in the sidewalk.
   e. In non-residential developments a minimum 8-inch lead will be required on all fire hydrants that are located more than 150 feet from the looped main. Fire hydrants shall be adequately protected by either curb stops or concrete filled steel posts or other methods as approved by the City Engineer. Such stops or posts are the responsibility of the landowner on which the said fire hydrant is placed.
   f. All required fire hydrants shall be installed so that the pumper nozzle connection will face the fire lane or street. Exceptions will be as directed or approved by the Engineer.
   g. Fire hydrants, when placed at intersections or access drives to parking lots 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.
   h. Fire hydrants located on private property, shall be accessible to the Fire Department at all times.
   i. Fire hydrants shall be located at street or fire lane intersections when feasible.
   j. Fire hydrants shall be primed with a suitable primer to accept an industrial urethane paint. Contractor shall obtain the following paints and painting fire hydrants shall be a requirement of the development or City contract. Two coats of each shall be applied after cleaning of the fire hydrant per the paint manufacturer requirements. Paint shall be Sherwin Williams Protective and Marine Coatings or approved equal. The primary color shall be Industrial Aluminum Paint. The bonnets shall be painted with Sherwin Williams protective and marine coating urethane paint using the following color schemes:

10 inch Pipe and Above	Safety Blue
8 Inch Pipe	Safety Green
6 Inch Pipe	Safety Orange

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. Any variations to the maximum number of fire hydrant connections shall be approved by the City Engineer. The maximum length of a six-inch fire hydrant lead is 150'.

4. Fire Line Monitoring / Backflow Devices

Generally, the City of Terrell will own and maintain from the water main to and including 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 a backflow device meeting the requirements of TCEQ. For fire lines less than 75 feet in length from the main to the building, a backflow device may be installed in the building riser room. Otherwise, an above ground, enclosed double-check or RPZ meeting TCEQ requirements shall be placed near the ROW line on the fire line.

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, 5 feet; 16 inch, 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 constructed along unimproved roads or "county type" roads, which are commonly built with a high crown, increase the cover as required to allow for future paving grade changes.

Separation distances and design of pipes shall meet TCEQ requirements.

F. Meter Box and Services

A service with a meter box is to be constructed from the main to a point 3'-0" to 3'-6" behind the curb line, usually in advance of paving. However, it shall not be in conflict with an existing or proposed sidewalk or driveway. Meter boxes shall not be placed in the sidewalk or driveway. The location of the meter box is as shown on the Utility Assignments detail sheets. On multiple apartments and business properties, the size and location shall be determined during the civil plan reviews as plans are provided from the Developer's engineer. Minimum requirements for water service sizes are:

1. Service lines shall be either Type K copper or HDPE, SR-9 (200 psi rated pressure).
2. Minimum size of one-inch water services are required to serve each residential unit, including Townhouse lots, patio homes and duplexes.
3. Each meter installation shall include a coppersetter (meter setter) to adjust the height of the meter inside in the meter box in accordance with the detail provided in Appendix E. A typical residential installation will include a 1 inch service line, reduced with a 1 inch x ¾ inch bushing to connect to a ¾ inch coppersetter. Separate meter connections shall be provided for each of the family units and no bullhead connections will be allowed (unless otherwise approved by the City

Engineer or his designee).

4. Separate taps shall be made for fire lines, domestic services and irrigation system services.
5. The size of apartment, condominium, multi-family services or commercial meters will depend on the number of units served. Apartments and other large complexes (such as, assisted living or senior living facilities) shall be designed with one primary meter serving the entire complex. Individual buildings may be sub-metered with private meters and managed by the owner of the complex.
6. The City will have final authority to determine the required size and location of meter(s) needed for each facility.

G. Service Connections – Hydrant Leads

A service connection is not allowed on fire hydrant leads.

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 guidelines. In most cases, lots will be served by a municipal sewer system. Connection to the City's sewer system is required if the City's sewer main is within 200 feet of the property being developed (or as may be updated by Ordinance). 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, providing all other state and county requirements are met.

B. Location of Sewer Lines

Minimum sizes and grades for sanitary sewers shall be designed in accordance with TCEQ C217 guidelines (or most current requirements). 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 in Appendix G for location. Certain additions may have a particular layout requiring exceptions to these Utility Assignments and shall be evaluated during the design review process. 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 or sleeved in ductile iron pipe, as approved by the City. 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 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).

Example: for a house 135 feet from the sewer, the depth would be 3 feet plus 2% x 135 feet = 2.7; for a total of 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 laterals is required at all points in Street R.O.W. where swales are constructed. On lines deeper than 10 feet the City Engineer may required a parallel sewer line when laterals are to be attached.

D. Sewage Flows, Size and Grades

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

$$Q = \frac{C^{0.89}}{289}$$

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 nonresidential uses shall be determined by the Design Engineer, subject to approval by the City Engineer.

All designs for projected flows from a development or study area shall be determined using these design standards unless otherwise approved by the City Engineer or his designee. A copy of the design standards may be obtained from 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. The minimum size manhole is 5 feet diameter and shall be installed over mains 6" through 27". Mains 30" and above shall require 6 foot diameter manholes as a minimum. In

Flood Plains, sealed manholes "Type S" shall be used. Mainline clean-outs shall be placed on the ends of all lines that will not be extended. If a main is designed for a future extension, the general rule is that a manhole shall be installed at the end of the main being designed with a stubout to accommodate future expansion. Drop manholes shall be required when the inflow elevation exceeds the outflow elevation by more than 30 inches. The City of Terrell's standard is to use an inside drop-connect design.

In order to provide access for sewer lines for cleaning, manholes and/or cleanouts shall be located to accommodate access by equipment. The standard spacing shall be 500 feet between manholes and no more than 300 feet between a manhole and cleanout installed at the end of the main.

F. Laterals

The sizes and locations of laterals shall be as designated by the Design Engineer. In general, the lateral size shall be 6" minimum for single family residential, multiple units, apartments, local retail and commercial. For manufacturing and industrial, the size should be 8" or larger as required based on flow calculations. House laterals usually are laid at the centerline of the and shall have a 10-foot horizontal separation from the water service. Manholes may be required on 6-inch and larger laterals where they connect to the main line. A minimum of one lateral per building shall be required and 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. Final layout shall be approved by the City Engineer or his designee.

G. Railroad, Highway and Creek Crossings

Railroad, State Highway and creek crossings, etc., shall be as required by TxDOT, railroad, or other agency providing a permit and subject to review by the City Engineer.

H. Sewer Line Materials

1. All sewer pipe shall be PVC, SDR-26
2. Sewer pipe shall conform to the North Central Texas Council of Governments (NCTCOG) Specifications and City-issued addenda. 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. If a sample port is required for a commercial and industrial facility based on the facility use and classification, the sample ports shall be 8-inch minimum unless approved by City Engineer or his designee. 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. Refer to Appendix E, Details for minimum requirements.

4.3 PREPARING WATER AND SEWER PLANS

Refer to Appendix C for a checklist for plan sheet preparation.

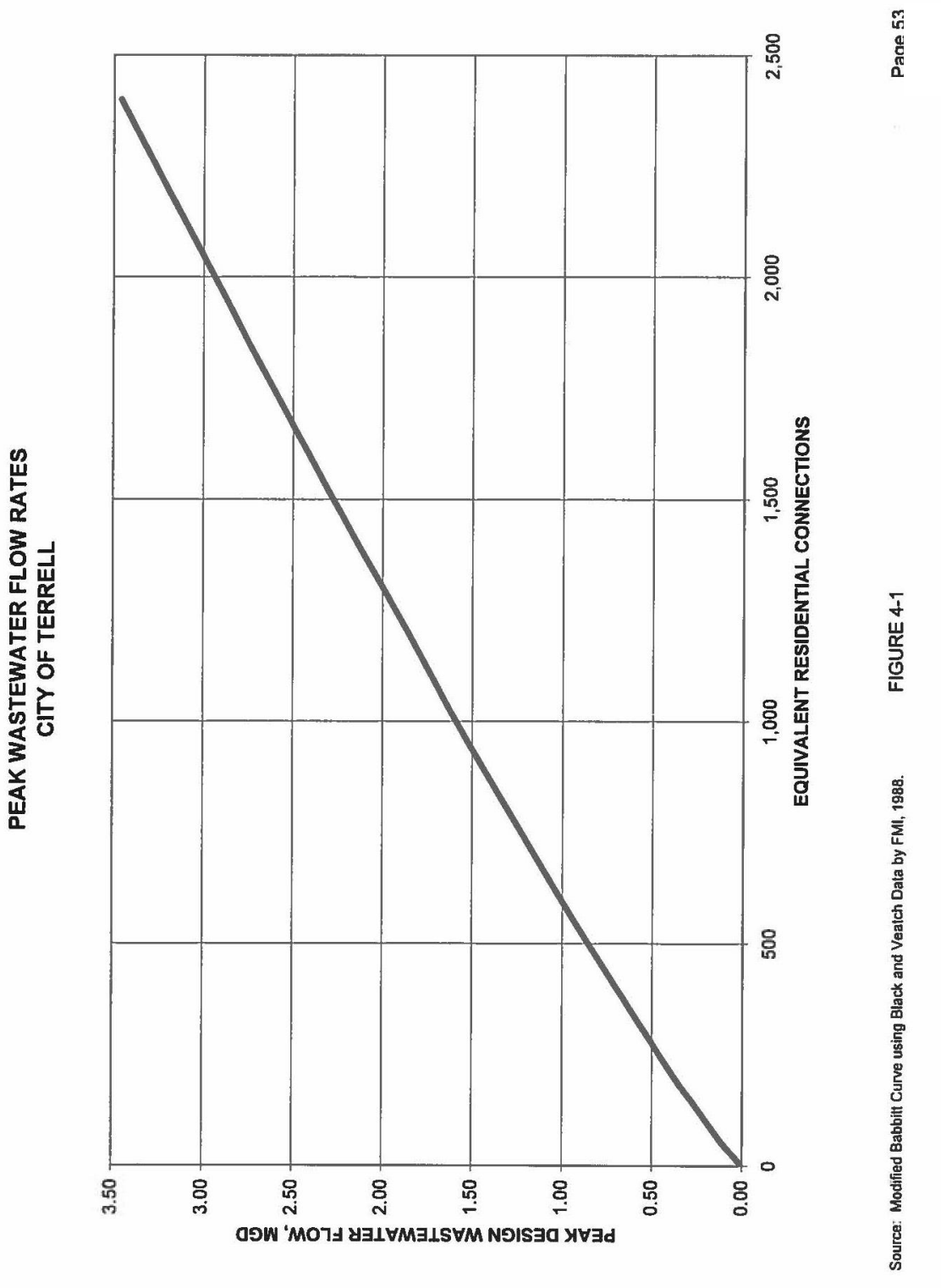
4.4 ON-SITE TREATMENT OF WASTEWATER

Generally, no on-site septic systems are allowed within the corporate limits of the City of Terrell. However, in a case where on site wastewater treatment systems may be granted or are allowed if within the ETJ, the location of the proposed drain field shall be shown on the Construction 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 onsite treatment system to function properly.

A few instances where an exception may be approved and a septic system allowed include:

* The property owner proposes one new single family structure that is on a lot greater than one acre and the distance from any adjacent public right of way or easement to an existing sanitary sewer line is greater than 100 feet, or,
* In areas zoned Agricultural (A), Texas Heritage (TX), or Executive Estate (EE) and the property owner proposes a subdivision of land upon which two or more single family structures may be constructed and the distance from any adjacent public right of way to an existing sanitary sewer line is greater than 600 feet, or,
* The property owner proposes a small scale non-residential use on a parcel greater than two acres and the distance from any adjacent public right of way to an existing sanitary sewer line is greater than 100 feet. In such case, the City Engineer may deem it infeasible to service by an off-site sewage treatment and may authorize temporary on-site sewage treatment until such time as off-site sewage treatment is available.
* The City reserves the right to require a gravity-system sewer lateral to be installed along with onsite septic at the City's sole discretion.

EQUIVALENT RESIDENTIAL CONNECTIONS



APPENDIX A

ADDENDUM TO NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS STANDARDS SPECIFICATIONS

APPENDIX A

CITY OF TERRELL
ADDENDUM TO THE
NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS
STANDARD SPECIFICATIONS FOR
PUBLIC WORKS CONSTRUCTION 5th Edition

This addendum to the North Central Texas Council of Governments Standard Specifications for Public Works Construction 5th 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 public 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 requirements during construction of the project.

104.1. INTENT OF CONTRACT DOCUMENTS:

Add the following:
The CONTRACTOR shall do all work as provided in the plans, specifications, special provisions, bid and contract, and shall do such additional extra work as may be considered necessary to complete the work in a satisfactory and acceptable manner. The CONTRACTOR shall furnish all labor, tools, materials, machinery, equipment, and incidentals necessary to the satisfactory prosecution and completion of the work.

(Replace Item 105.4. Construction Stakes with the following:)

105.4. CONSTRUCTION STAKING:

The CONTRACTOR shall be responsible for all required Construction Staking associated with the project. Costs for Construction Staking shall be paid under the appropriate bid

item, if included, or contingent to the rest of the project.

The survey notes shall include the final vertical and horizontal stakeout notes for all drainage, street paving, structural, water, or sanitary sewer improvements. Alignments shall be tied to horizontal control with sufficient calls provided to delineate centerline. The location or monumentation of any real property boundaries or easements required for construction be preformed by or under the direct supervision of a Registered Professional Land Surveyor in Texas as required by article 5282c of the Vernon's Texas Civil Statutes.

The CONTRACTOR is responsible for maintaining all survey control points and monuments in the construction area at all times and any costs for re-staking or re-establishing controls required shall be borne by the CONTRACTOR.

The OWNER will confirm the initial and final measurement for payment and reserves the right to field verify any stakes placed, measurements for payment made and any work performed by the CONTRACTOR.

105.10 - Add the following:

Final Acceptance and Payment: Whenever the work provided for by the contract shall have been completely performed on the part of the Contractor, the Contractor shall notify the Owner that work is ready for final inspection. The Owner will perform such final inspection and if the work is satisfactory and in accordance with the specifications, and contract documents, the Owner shall provide written notification of acceptance. The Contractor shall then submit a final invoice to the Owner, along with consent of Surety, satisfactory evidence that subcontractors and suppliers have been paid sums of money due, and Maintenance Bond(s). The final payment shall include release of retainage held during the project. All prior estimates upon which payments were made are subject to necessary adjustments, corrections or revisions for the final pay estimate.

The acceptance by the Contractor of the final payment shall operate as and shall be a release to the Owner from all claims or liabilities under the contract, including all subcontractor claims, for anything done or furnished or relating to the work under the contract or for any act or neglect of said Owner relating to or connected with the contract.

All warranties and guarantees shall commence from the date of acceptance. No interest shall be due the Contractor on any partial or final payment, or on the retainage.

107.20.3.3 Trench Safety Plan.

Add the following:

1. All trenches excavated within the City Limits of Terrell, Texas and its ETJ shall be excavated in accordance with OSHA standards.
2. After award, the Contractor shall submit to the Owner's Engineer two (2) sets of the 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.

204.2 Topsoil

Add the following:

Removal and separation of topsoil is required unless otherwise noted. Finished grade shall be +/- 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.

Add the following: "No more than 40% difference shall be retained between any two consecutive sieves."

303.2.10 Steel Wire Reinforcement – DELETE this section entirely. Steel wire reinforcement is not allowed.

303.4.3 Slip Form Paver

Add: Slip form paver shall be used to pour all streets unless otherwise approved by the City Engineer or his designee.

303.5.3 Placing Reinforcing Steel, Tie, and Dowel Bars –

ADD: Fire lanes shall be minimum #4's @ 16" OC, in accordance with the International Fire Code.

303.5.3.2 Welded Wire Mats – DELETE section in its entirety. Welded wire mats are not allowed.

303.5.6 Finishing (of Concrete)

Add: A minimal amount of water shall be added for working concrete to a get a finished surface. No slinging of water by any method is allowed.

303.5.11 Slip Form Paving

Delete the first sentence in it's entirety, which starts: "At the option of the Contractor, and with the approval of the Owner…." Replace it with: "A slip form machine shall be used for paving all streets unless otherwise approved by the City Engineer or his designee."

305.1.3.2 Reinforcing Steel (for curbs)

Add: There shall be one #4 bar in the top portion of the curb, centered longitudinally along the length of the curb. This bar is in addition to the one in the lower portion of the curb and tied to the steel mat for the street section.

305.2.2.1 Concrete. Add the following:

All concrete for sidewalks and driveways approaches shall be a minimum Class A (3,000 psi) with an air content of 3-5%.

305.2.2.2 Concrete Sidewalks, Driveway Approaches and Barrier Free Ramps; Reinforcement.

REPLACE section with the following: Reinforcement is required in all driveways and sidewalks. The minimum shall be #3 bars at 18" OC each way. No welded wire fabric or wire mesh reinforcement shall be allowed.

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. 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, except for fire lines. Fire lines shall be DR-14. Pipe shall 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.

501.14.6 Add the following section regarding Embedment:

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

501.17.3 Dimensions (for PVC wastewater pipe)

Add: All PVC wastewater pipe shall be SDR-26 for public improvements.

502.1.1.1 Manholes

Add: Precast manholes shall be poured with Conshield Additive in accordance with the manufacturer's recommendations as a corrosion inhibitor.

502.1.1.1.1 Joints.

Add the following: Joints shall have trapped O-ring rubber gaskets in accordance with Item 501.5.4. Manhole joints shall have Gator Wrap, Infi-Shield External Wrap installed at each joint.

502.1.2 Grade Adjustments

Add: The maximum height allowed for grade adjustment rings shall be 8 inches.

502.1.4.1.4 Drop Connections (at manholes)

Delete: the reference to Standard Drawing 5070.

Add: Drop connections shall be internal drops per the City of Terrell standard detail.

502.1.5 Manhole Testing

Delete Section 502.1.5.1: "exfiltration testing" is not test option.

502.3.1 Materials. Add the following:

Fire hydrants shall be 5 ¼" Mueller Super Centurion and include a stamp indicating it meets the City of Terrell specification, which includes stainless steel bolts.

502.3.2 Installation. Add the following:

Delete: the reference to Standard Drawing 4120 and replace it with City of Terrell Standard Detail.

ADD: 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) Paint and color of the coating for all components except the bonnet of the hydrant shall be Industrial Aluminum.
c) Paint for the bonnets shall be urethane equal to Sherwin Williams Series 4000 Protective Marine Coating.
d) Brush apply or spray one 5 mil dry film thickness coating (first coat).
e) Brush apply or spray a second 3 mil dry film thickness coats of Sherwin Williams Series 4000 urethane.
f) Bonnets shall be painted in safety blue, green, or orange based on pipe diameters. 6 inch shall be orange; 8 inch and 10 inch shall be green; 12 inch and larger shall be blue.
g) 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: Unless otherwise clearly identified in the plans and specifications, the bid item for fire hydrant installation shall include the complete assembly shown in the detail, including 6 inch valve, 6 inch lead pipe, fire hydrant, and blocking. Bid shall be all materials, labor and equipment required to install the fire hydrant. No individual items shall be paid separately.

502.6 VALVES

Add the following:

All valves shall open by turning counterclockwise.

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

502.6.2 Resilient Seat Gate Valves (AWWA C 509) 2" through 36"
502.6.3 Air Valves

502.6.4 Brass Wheel Valves

Add the following: 1-1/2" and smaller Valves shall be sheathed in polyethylene film per section 502.8.

502.6.2.1 General Description. Add the following paragraph:

Valve Seats - Resilient seats ("wedge") shall be included in the gate. The seating surface in the body of the valve shall be machined and shall be metallic, coated with an epoxy or other approved material.

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.

502.6.5.1(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 new section: The interior of the valve shall be epoxy coated.

502.6.5.1(11) General.

Add new section: 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 (for Butterfly Valves): (Closure)

Add the following:

If operator shaft extensions are required and shall be stainless steel with locking clips. An approved alternate may be allowed if product availability is an issue. Shafts shall be of sufficient length to bring operating nut to within 12" 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 with locking clips. An approved alternate may be allowed if product availability is an issue. Shafts shall be of sufficient length to bring operating nut to within 24" of the bottom of the valve cover.

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.

502.10.2.3 Tapping Sleeves

Add: Stainless steel tapping sleeves with SS bolts shall be used when tapping existing mains of any pipe type. The minimum length of the tapping sleeve shall be as follows:

Pipe Size Being Tapped	Minimum Length
4 or 6 inch	15 inches
8 or 10 inch	20 inches
12 inch	24 inches

For pipe larger than 12 inches diameter, the length shall be a minimum of two times the pipe diameter and approved by the City.

502.10.3 Water Conduit Connections

Add: Dresser Couplings for connecting two ends of water pipes shall be a minimum length of twice the pipe diameter. No “one-bolt” design.

502.10.3.1.1 Taps

Delete Section (1) regarding direct taps. They are not allowed.

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 for connection to blow offs used for filling water pipe, testing and chlorination.

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 406/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.

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 fire hydrant for developments and all construction that are non-City projects. For City projects, monthly reads for usage shall be provided, but there will no charge for the water. A water meter and backflow device shall be connected to a fire hydrant and used to determine the amount of water used. The Contractor may rent water meters and backflow device from the City for a deposit of $1,500 or furnish his own meter and backflow device as long as the unit is approved by 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.

504.5.3.2 Compaction.

Add the following paragraphs:

The moisture content shall be minimum +2% above optimum moisture content. This requirement shall apply to both the backfill material and for sub-base material (flexbase).

Density tests for manholes shall be accomplished by “spiral testing” in lifts. This shall be accomplished by two (2) density tests on opposite sides of the manhole, rotating 90 degrees apart from the previous lift and test location.

The Contractor shall guarantee the backfilling of excavation and trenches against excessive settlement (as determined by the Engineer) 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 minimum +2 % above optimum moisture content.

504.5.3.2.4 Limitations

Add the following:

For City Projects, density tests shall be performed by an independent testing laboratory and paid by the City. Density tests that fail to meet the minimum requirements shall be retested at the Contractor's expense.

If the work is performed in conjunction with a development project, the Developer shall hire his own independent testing firm or may escrow money with the City and City staff. If escrowed with the City, City staff will manage the testing schedule and payment to the testing lab. Escrow shall be based on 3% of the value of the public improvements, but the Developer shall be responsible for the actual costs. A “settle-up” shall be done at the end of the

project, meaning either the City will reimburse money remaining or the Developer shall pay for all additional costs. The testing lab shall be approved by the City if hired and managed by the Developer. The City may perform additional density tests for quality control purposes at their 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.

506.7.5.4 Sampling

DELETE the first paragraphs and REPLACE with:

“The Contractor is responsible for injecting chlorine to disinfect the new main, monitor the solution and collect the sample(s). If requested, City personnel will assist in verifying the chlorine residual and determining if sample is acceptable to take. Contractor shall take the sample from a suitable tap that has been properly disinfected, and then transported to the NTMWD lab for analysis. No sample shall be taken from a hose or fire hydrant.”

507.3 Laying 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.

507.5.2.2 Television Inspection Special Procedures

Revise Table 507.5.2.2(a) as follows:

For slopes less than 0.7%, for 15” and larger mains, the allowable depth shall be determined by the City Engineer or his designee, but shall not exceed 5% of the diameter of the pipe.

508.3.2.2 Box Culverts

Add: For double box culverts (side by side installation), the gap between the boxes shall be filled with flowable fill. Placement of the fill shall be completed in a way to eliminate splashing.

701.2 Structural Excavation.

Add the following:

Flowable fill with a strength of approximately 400 psi 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 minimum +2% above optimum moisture for all backfill material. 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.

One density test shall be performed at each location for each 50 C.Y. of backfill placed. The location of the backfill test shall be selected by the testing laboratory. The City may require additional backfill density tests at the City's sole discretion.

702.3.3 Concrete Mix Design and Control

Add the following: All structural concrete shall be Class C.

702.3.4.5 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. Testing shall include both compressive strength (3600 psi or as required on plans) and flexural strength (600 psi) tests.

702.5.9 Finishing Concrete (for structures).

Add the following: Minimal water or dry cement shall be added to surface of concrete for finishing. Pump up spray cans can be used at the City's sole discretion.

702.7.1 Pnenumatically Placed Concrete (Gunite)

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 (3,000 psi) with an air content of 3-5%.

802.2.2.1 Concrete. Add the following:

All concrete for retaining walls shall be Class C, 3600 psi.

803.3 RIPRAP (GROUTED)

ADD: Where riprap is required for erosion control, especially at storm water discharge points, unless otherwise specified on the plans, the rock shall be 6” to 8” crushed limestone (Bridgeport quality) and grouted with 3600 psi concrete. The overall thickness shall be a minimum of 12 inches.

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 one pdf file and one full size 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, 3,600 psi.

APPENDIX B

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. Super-elevation 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 C

CHECKLIST FOR DESIGN SHEETS - PLANS AND PROFILE

CHECKLIST FOR DRAINAGE / STORM SEWER DESIGNS

A. Drainage Area Map		Complete / Included
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 acres, coefficients, intensity for each drainage sub-area	
3	Show existing and proposed storm drains and inlets with designations.	
4	Indicate sub-areas for alley, street, and off-site areas and points of concentration.	
5	Indicate existing and proposed contours on map for on and off-site.	
6	Use design criteria as shown in design manual.	
7	Indicate zoning on drainage area map. Plan for future build out, including off-site drainage	
8	Show points of concentration and their designations.	
9	Indicate runoff at all inlets, dead-end streets and alleys, or to and from adjacent additions or acreage.	
10	Provide runoff calculations for all areas showing acreage, runoff coefficient, and inlet time. (Q = CIA table)	
11	For cumulative runoff, show calculations.	
12	Indicate all crests, sags, and street and alley intersections with flow arrows.	
13	Identify direction of north to top page or to the left.	
14	Show limits of 100-year fully developed flood plain on drainage area map.	
15	Show maximum contours of 2 ft internals.	
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. Station at 100 ft intervals.	
3	Specify Class III Concrete pipe. No HDPE for public improvements.	
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 as shown in Table 3-5 shall be 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 are steeper than 4:1.	
11	Where Riprap is required, it shall be grouted riprap with 6 to 8 inch stones. Min. 12 inch depth or as required by engineer.	
12	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.	
13	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.	
14	Investigations shall be made by the engineer to validate the adequacy of the storm sewer outfall to a major stream.	
15	Outfall area must have adequate capacity to carry the discharge. Provide erosion control facilities with hydraulic data.	
16	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.	
17	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 Sheets		
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: Q10, Q100, C = Manning full flow capacity; S, V, V2/2g.	
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	If bends in pipe are recommended in unusual circumstances, City Engineer must approve.	
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	Lateral flow lines shall be a minimum of 4 feet from the top of curb elevation	
5	Calculate hydraulic grade line for laterals and inlets to ensure collection of storm water.	

6	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	Inlets shall be located at or immediately downstream of drainage concentration points.	
4	At intersections, end of inlet shall be 10 ft from the curb return PT and should provide minimum interference with adjacent property.	
5	Design does not impair drainage from abutting properties	
6	On plan view, indicate size of inlet, lateral size, flow line, top-of-curb elevations, paving station, and inlet designation number.	
7	Use recessed inlets in streets. Use combination inlets (grate and curb inlet) in alleys when on a straight run. Do not use grate or combination inlet unless other solution is not available (special situation).	
8	Use type "Y" or special "Y" inlets in ditches or swales. A three (3) foot concrete apron shall be constructed around "Y" inlets. No "Glory Holes" are allowed as intake for a storm sewer or at a culvert. Design review shall include the determination if a trash catcher is required.	
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.	
9	A pilot channel 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.	
I. Creek Crossings / Discharge Points		
1	Plan view shall include at least 200 ft upstream and downstream of the improvements	
2	Include trees > = 3 inches in caliper	
3	Profile shall include depth and velocity information for 100 year storm event	

CHECKLIST FOR WATER AND SEWER PLAN SHEETS

A. Form of Plans		Completed
A.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.	
A.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, property lines, and addresses 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 to provide for future connections. Unless it would make the plan very difficult to read, water, storm sewer, and sewer design plans should include other utilities 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.	
A.3	On large additions or layouts requiring the use of more than six sheets (total of plan & profile), key sheets will be required to an appropriate, legible scale (generally 1' = 400' or other approved by the City). They shall show the overall layout with the specific project clearly indicated with reference to individual sheets.	
A.4	The use of "off-standard" scales will not be permitted. Plans drawn to horz scale of 1" = 40', or 1" = 20', as needed to adequately clarify the design intent. Areas such as creeks, heavily wooded sections, congested areas (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 either a 1" = 10 or 1"=20' scale. All profiles shall be drawn on a vertical scale as required for clarity (generally 1" = 4' or 1" = 5').	
A.5	Plans shall be dated, including the initial submittal and all subsequent updates during the review process.	
A.6	All callouts shall include station numbers. Coordinates may be provided	
A.7	Provide adequate benchmark data.	
A.8	All coordinates shall tie to the State Plane Coordinate System	

B. Sewer Data to be Included on the Profile Sheet		
B.1	Existing and Proposed Pipe and adjacent utilities	
B.2	All pipe and franchise utility crossings.	
B.3	Grade elevations shall be shown to the nearest 0.1 foot of the ground at the CL of the sewer and to right and left (approximate center of proposed house or buildings)	
B.4	Show the proposed street / paving / ground line profile.	
B.5	Clearly identify sewer pipe, manholes and cleanouts, including the size, length, direction and slope of the pipe.	
B.6	Provide grade elevations at 100 ft intervals, change of grade, manholes and cleanouts to the nearest 0.01 ft.	
B.7	For crossings with minimum clearance, identify sleeving, encasement, etc required to protect pipe.	
B.8	Invert elevations at manholes shall have a 0.1 foot drop across manhole invert from US to DS.	
B.9	For sewer mains 10 inch and larger provide a sewer basin service area map and flow calculations. Provide design capacity requirements, pipe capacity, and velocity for all line segments.	
B.10	Max velocity shall be 9 feet per second when flowing full	
C. Data to be Included for Water Plan and Profile		
C.1	Valve locations clearly identified in Plan view? Adequate number for isolation?	
C.2	Show and callout all tees, bends, deadends, ite-ins, etc.	
C.3	Fire hydrant spacing meet requirements? Insure all callouts are complete	
C.4	Identify location of meters/meter boxes and service lines	
C.5	Insure separation distances from sewer mains meet TCEQ requirements	
C.6	Profile - generally, water main is not required in the profile unless 16 inches or larger, except for areas needed for clarity because of congested areas or potential conflicts with other utilities.	

APPENDIX D

TYPICAL GENERAL NOTES FOR CONSTRUCTION PLANS

APPENDIX D

CITY OF TERRELL
GENERAL NOTES FOR CONSTRUCTION PLANS
TECHNICAL CONSTRUCTION STANDARDS AND SPECIFICATIONS (TCSS)

GENERAL NOTES

1. All construction shall be in accordance with the North Central Texas Council of Governments "Standard Specifications for Public Works Construction" latest edition, the City of Terrell's addendum thereto, and the 2022 UPDATED Terrell Construction Standards and Specifications (TCSS).
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 begin earlier than 7:00 A.M. on weekdays nor continue after 6 P.M. without permission from the City of Terrell. Construction on Saturday may not begin before 8:00 A.M. and work on Sunday is prohibited without special permission. No work requiring City inspection shall be permitted on Saturday, Sunday, or City of Terrell holidays without a written request at least 72 hours (by Wednesday at noon) in advance and approved by the City.
4. Utilities shown on the plans are taken from field surveys and/or 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. Call 811 prior to digging.
5. Work may not be backfilled or covered until it has been inspected by the appropriate City representative.
6. On City projects, material testing shall be performed by an independent testing laboratory and paid for by the City. The Contractor shall be responsible for all fees associated with re-testing and re-inspection due to failed tests from workmanship. Developers shall hire an independent testing lab for all required tests. The testing firm is subject to approval by the City. Test results shall be submitted to the City for review within three days after tests are completed.
7. Storm water pollution prevention plan (SWP3): The Contractor shall comply with the conditions of the SWP3 while conducting activities on the project. In addition to constructing those item indicated on the plan sheets, compliance with the SWP3 includes conformance to certain practices and procedures during project construction that are identified in the SWP3. All silt fences and material shall be removed prior to final acceptance of the project.
8. Inspection: Unless otherwise stated in the contract specifications, inspection of the work will be provided by the City of Terrell. The contractor shall perform all work required to facilitate the inspection and give sufficient notice of pending construction activities for scheduling of inspections. Acceptance of work shall be obtained from the City prior to any backfilling trenches. Contractor shall bear the responsibility of any delays in production caused by last minute notifications and the City not being able to respond. Continued late notifications for inspection may be cause to stop work without extension of

time or financial compensation.

9. Protection of Property Corners and Benchmarks: The Contractor shall protect all property corners and benchmarks. When such markers are in danger of being disturbed they shall be properly referenced, and if disturbed, shall be reset by a registered public surveyor at the expense of the Contractor.
10. Unless otherwise noted, all excavation on the project is unclassified. Contractor to review site conditions/local soils prior to bidding.
11. Utility companies and contractors installing franchise utilities shall obtain a street cut permit before disturbing any pavement in public right-of-way.
12. The contractor shall maintain two-way traffic at all times along the project unless otherwise approved by the City.
13. 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.
14. Damage to existing facilities: All utilities, pavement, sidewalks, walls, etc. not designated to be removed, but that are damaged during construction, shall be repaired or replaced to a condition at least as good as they were prior to beginning construction. This work and the expense shall solely be the responsibility of the Contractor.
15. Existing Roadways/Access: Contractor shall be responsible for cleanliness of the roadways. All costs associated with maintaining the cleanliness of the roadways shall be the responsibility of the Contractor and included in the bid amount of the contract.
16. Electrical Safety Precautions: all work around and near electrical power lines and equipment shall be properly flagged and barricaded. No work shall be done within 6 feet of high voltage electrical lines.
17. All trenching and excavation shall be performed in accordance with OSHA standards and adherence to requirements is the sole responsibility of the Contractor. A trench safety plan shall be developed by a licensed PE in the State of Texas and provided to the City.
18. The contractor shall maintain access to all areas outside of the immediate area of construction. If bus routes are impacted, coordination with Terrell ISD and/or bus company may be required.
19. Contractor shall remove and reset all mailboxes, yard lights, sprinkler systems, driveway culverts, etc. that are in conflict with the proposed construction. If mailboxes are removed, they shall be set in 5 gallon buckets of gravel for temporary use and ease of relocation. They shall be placed in a location approved by the City.
20. The Contractor shall not close any streets without prior approval from the City Engineer. All streets shall remain passable to residents at all times. Work shall be sequenced such that minimal disruption to traffic occurs. In instances where construction is taking place in streets, streets shall be backfilled and made passable at the end of each day. Contractor to provide traffic control and maintain traffic control signage consistent with the current Texas Manual on Uniform Traffic Control Devices.
21. Contractor shall not be authorized to proceed until all necessary state and local permits are obtained. All easements must be cleared within the immediate work area.
22. When the existing grades are lower than the proposed mains, all areas shall be backfilled and compacted to 95% density at a minimum +2% above optimum moisture content to the proposed finished grade prior to installing any mains.
23. For City projects, water for construction shall be provided by the City if a fire hydrant is available. Contractor is required to pay a $1,500 deposit for a meter and backflow assembly, refundable upon return provided no damage to the unit(s) occurs. Meter readings shall be provided monthly to the Utility Billing Supervisor. Developments shall

be billed at the City's current commercial rate. The Contractor may use his own meter and backflow assembly provided it is approved by the City. If a fire hydrant is not available, the Contractor shall be responsible for providing construction water in a tanker truck.

24. Measurement and Payment - only bid items provided in the contract shall be measured and paid for. Work encountered and required in the course of completing the intended scope within the contract documents shall be considered subsidiary to other items in the contract.
25. Contractor shall provide a pre-construction video and pictures of all areas impacted or potentially impacted by the scope of work in this contract. A copy shall be provided to the City and the design Engineer.
26. Materials Handling - Contractor shall keep all equipment, pipe, and materials off private property and in City right-of-way or easements unless otherwise approved. If the Contractor negotiates a storage area with a private property owner, it must be documented in writing and signed by the private property owner. A copy of the letter or agreement shall be provided to the City.
27. Record Drawings shall be provided to the City at the end of the project, after acceptance by the City. One pdf file and one full size sets of prints shall be provided. Final payment shall be withheld until Record Drawings are received and accepted by the City.

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.
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 and as approved by the City Engineer.
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. Concrete streets shall be require a slip-form paver unless otherwise approved by the City Engineer. Vibrating screed is not allowed without prior approval from City Engineer or his designee. Handpours shall be allowed only for finishing transitions and areas not accessible by slipform paver or vibrating screed (as determined by the City Engineer). Adequate vibration equipment shall be used for all concrete poured to

insure complete and satisfactory consolidation of the concrete placement.

2. Expansion joints shall be required at a maximum of 300 feet spacing as well as placed at intersection PT's and PC's. Redwood used shall be sealed prior to installation.

3. Flexbase (compacted subgrade) shall meet the requirements of TxDOT Type 247, Type D crused stone or approved equal.

4. All embankment, sub-grade, and treated soils shall be compacted at a moisture content of minimum +2% above 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.

5. All streets, fire lanes and alleys shall be placed on compacted subgrade as required by the TCSS.

6. The minimum 28 day compressive strength of concrete street paving shall not be less than 3,600 psi and flexural strength of 600 psi and shall be air entrained. A minimal amount of water may be applied to the surface of concrete paving to improve workability. The City at its sole discretion will determination if the amount is acceptable.

7. All curb and gutter shall be integral with the pavement for concrete streets.

8. Streets and alleys shall be constructed with provisions for sidewalk ramps at all intersections meeting all applicable state and federal requirements.

DRAINAGE

1. Storm sewer pipe constructed in public ROW and within fire lanes shall be a minimum Class III reinforced concrete pipe. If the depth of cover is less than 30 inches for areas subject to traffic or other heavy loading, Class IV pipe will be used. HDPE pipe or other suitable material is acceptable for private storm sewer systems and shall be clearly noted on the plan sheets.
2. All structural concrete shall be 3,600 psi. 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. Cleaning and internal television inspection of the pipe shall be required prior to acceptance. Re-cleaning and re-televising shall be required for all mains not sufficiently cleaned or if repairs are required due to installation not being suitable.
5. Embedment for public storm sewer pipes shall be Class B-2; private storm sewer pipe embedment shall be in accordance with the pipe manufacturer's recommendations as specified by the design engineer.
6. Riprap shall include 6" to 8" rock and be grouted in place with 3600 psi concrete.
7. Drainage channels that are temporarily blocked or disturbed shall be restored to better than the original condition and properly graded to provide positive flow. Seeding and protection of slopes shall be provided (as a minimum).

WATER MAINS

1. Water mains shall be AWWA C-900 PVC Class 150 DR-18 unless otherwise noted. Fire lines shall be DR-14. 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 minimum +2% above 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 Class 250 full-body ductile iron and be encased in a polyethylene sheath.
4. Tapping saddles shall be air tested to insure a tight seal exists prior to making the tap on the main. The test pressure shall be 120 psi for a minimum of 3 minutes unless otherwise directed by the City of Terrell.
5. Compact ductile iron or cast iron fittings may not be used.
6. Valves shall be Mueller resilient seat gate valves or approved equal.
7. 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 with locking clips are required on all valves where the operating nut is greater than 3 feet below finished grade.
8. Fire hydrants shall be 5 ¼" Mueller Super Centurion and be field painted with two coats of urethane paint and the bonnets painted with the correct color as outlined in the TCSS and City of Terrell Addendum to the North Central Texas Council of Governments.
9. The distance from fire hydrants to the street curb or edge of a fire lane shall not be less than 3.5 feet or exceed five feet unless otherwise permitted by the Fire Marshal.
10. All bolting on any buried equipment or material shall be stainless steel and poly-wrapped. 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, except for fire hydrants.

11. Meter boxes shall be installed as shown in the Construction Details, Appendix E. Three (3) inch and larger meters shall be placed in a concrete vault as manufactured by Park or approved equal.
12. All underground water system pipe fittings shall include poly-wrapped "Meg-a-Lug" type joint restraints designed to restrain the type of pipe being installed.
13. Existing water mains shall continue to provide service to residents and businesses until such time required for tie-ins. Isolation of mains and discontinuing service must be coordinated with the City in advance. The Contractor shall be responsible for notifying residents and businesses at least 24 hours in advance of the time water service will be disconnected. The City shall provide a flyer which can be used to indicate the date and approximate times/duration. Contractor shall distribute the flyers to impacted residents and businesses.
14. Bacteriological tests ("Bac-T") shall be completed on new water mains. Contractor is responsible for providing sample bottles for Bac-T testing of water lines, collecting the

samples and transporting them to the testing lab. Bottles shall be obtained from NTMWD laboratory (Wylie, TX) who shall perform the testing as well. Any costs associated with testing shall be included in the unit bid price for installation of the new water main. The bottles shall be labeled as a "Construction" sample and sealed with a strip of adhesive across the top of the bottle prior to transporting the NTMWD.

15 Embedment for water lines shall be B-4.

SANITARY SEWER MAINS

1. Sanitary sewer mains and laterals shall be a minimum of SDR 26 PVC.
2. 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.
3. Manholes shall be 5 feet in diameter and meet the requirements of the details. Both precast and cast-in-place manholes shall be poured using Conshield Additive and include installation of a Gator Wrap Infi-Shield External Wrap installed at each joint.
4. All sanitary sewer lines and manholes shall be leak tested before the project is accepted. Vacuum testing of manholes shall be completed after paving is completed. Deflection testing of PVC sewer lines is required. Testing requirements shall meet NCTCOG specifications.
5. Embedment for sanitary sewer lines shall be B-2.
6. All sanitary sewer main and service connections (sewer laterals) shall be video-taped after installation of the service connections, prior to paving of the project AND after the pavement is completed. The lines shall be flushed with water and turned off prior to making the video.

CONSTRUCTION MATERIALS ENGINEERING (***FOR DEVELOPMENT PROJECTS***)

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 made and will review results for conformance with the project specifications. Video files of sanitary sewer pipes shall be provided to the City of Terrell for review prior to placement of paving. 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 videos on CD or USB.
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

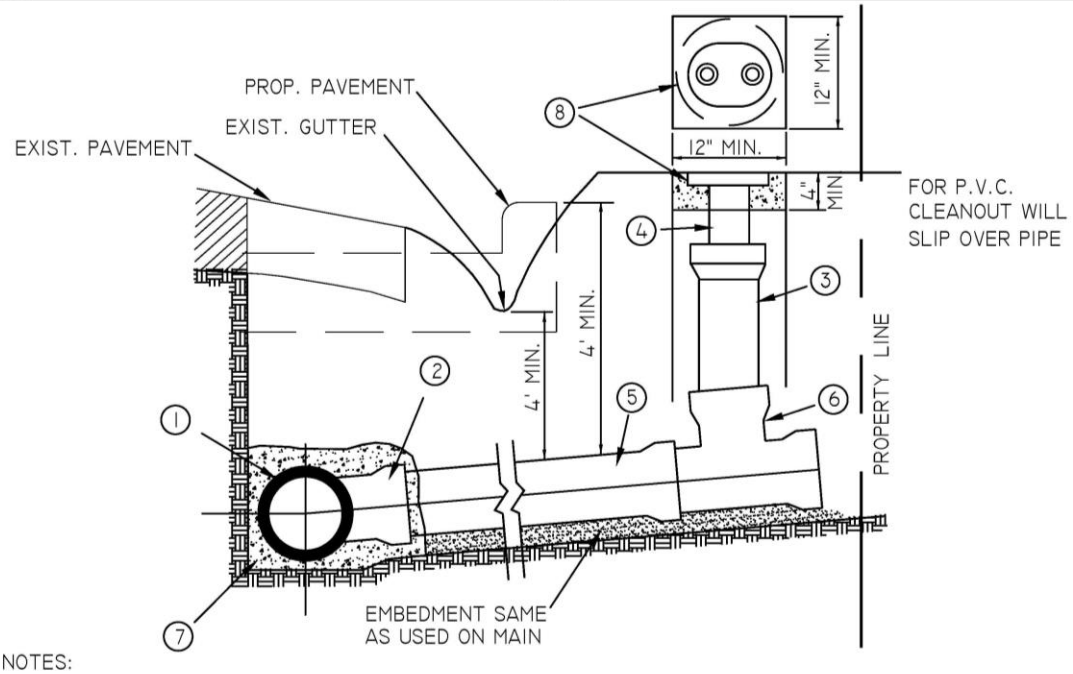
1. The Contractor shall maintain the required public improvements for a period of two (2) years following acceptance by the City and shall provide a maintenance bond in the amount of 100% of the costs of the public improvements.
2. No less than sixty (60) days prior to the expiration of the warranty, 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 and storm sewer pipes or fails to make satisfactory repairs indicated necessary on the sewer re-video or final inspection, the warranty and maintenance bond shall automatically extend to 30 days after satisfactory repairs are made.

APPENDIX E

CONSTRUCTION DETAILS

KEY:

(1)	WASTEWATER MAIN	(5)	6" SDR 26 (MIN) PVC (LENGTH VARIES)
(2)	6" WYE	(6)	6" CLEANOUT TEE
(3)	6" STACK (LENGTH VARIES)	(7)	SPECIFIED EMBEDMENT
(4)	6" WASTEWATER LAT. CLEANOUT CASTING	(8)	SEE STD. DRAWING 5140



NOTES:

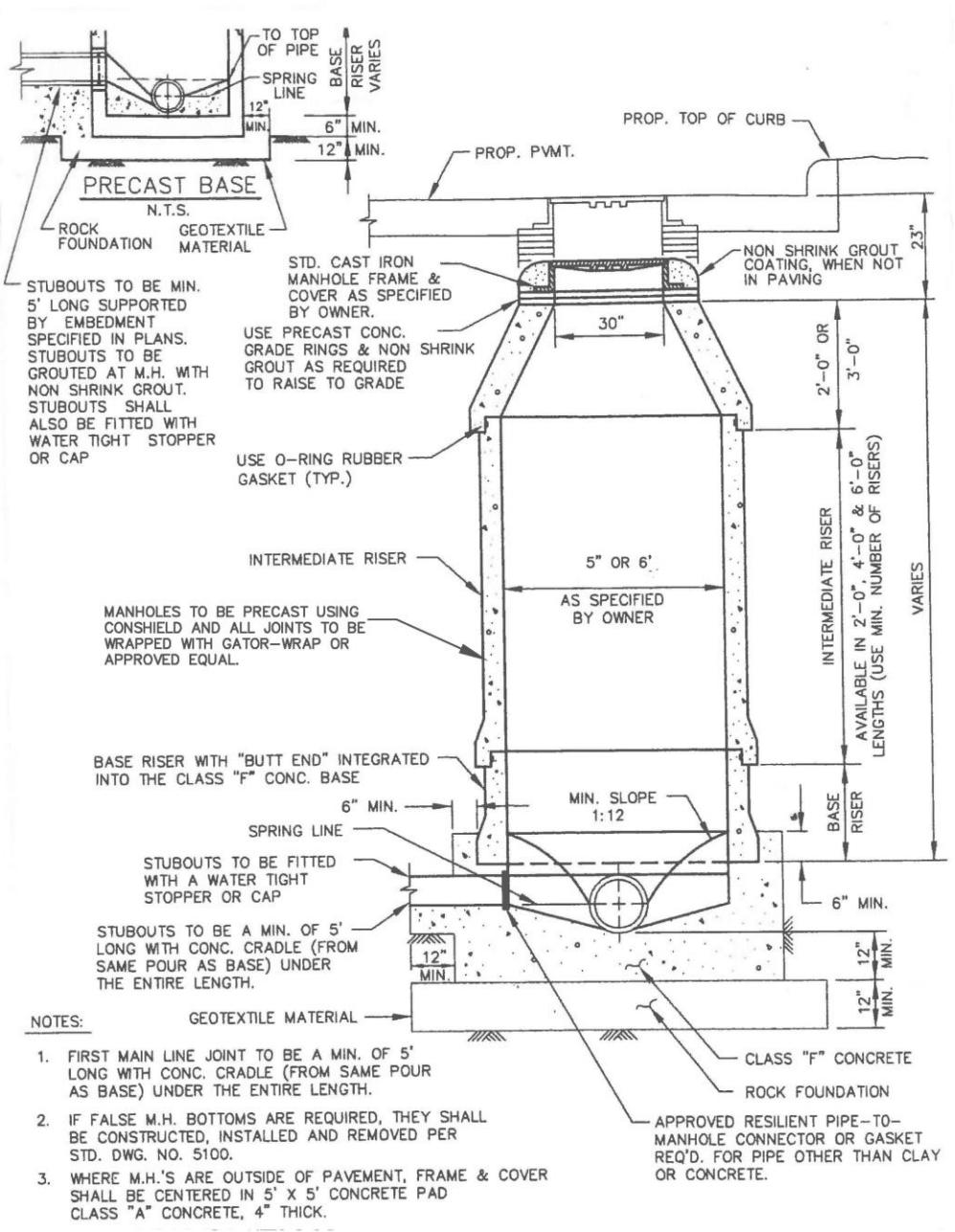
1. LATERAL SHALL BE CONSTRUCTED IN SUCH A MANNER AS TO CLEAR EXISTING AND PROPOSED FACILITIES. VERTICAL BENDS (22.5 MAX) MAY BE USED IF NECESSARY.
2. PREVIOUSLY USED; NOT CURRENTLY APPLICABLE.
3. THE CLEANOUT IS TO BE INSTALLED NEAR THE PROPERTY LINE
4. THE MAINLINE LATERAL CONNECTION TO THE PRIVATE BULDING LATERAL SHALL BE AS CLOSE TO THE PROPERTY LINE AS POSSIBLE.
5. SLOPE OF LATERAL TO BE 1% MIN AND 4% MAX UNLESS APPROVED BY THE CITY.
6. THE MAINLINE LATERAL CONNECTION TO THE PRIVATE BULDING LATERAL SHALL BE AS CLOSE TO THE PROPERTY LINE AS POSSIBLE
7. USE CLASS B-2 EMBEDMENT
8. INSTALL BOLTED CLEANOUT CAP

SCALE: NONE DATE: NOV 2022 SHEET 1

APPENDIX E DESIGN STANDARDS

6" WASTEWATER LATERALS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



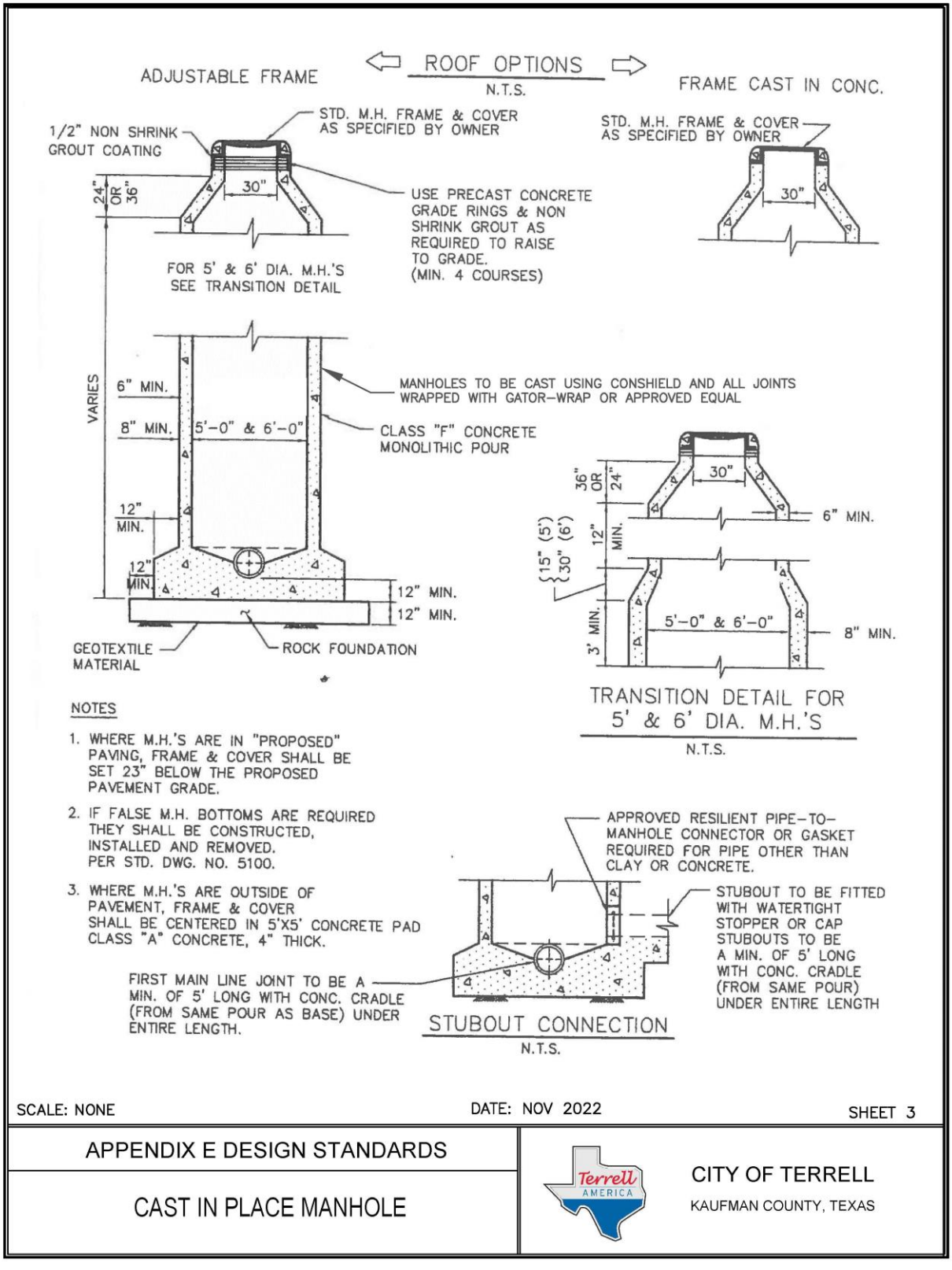
SCALE: NONE DATE: NOV 2022 SHEET 2

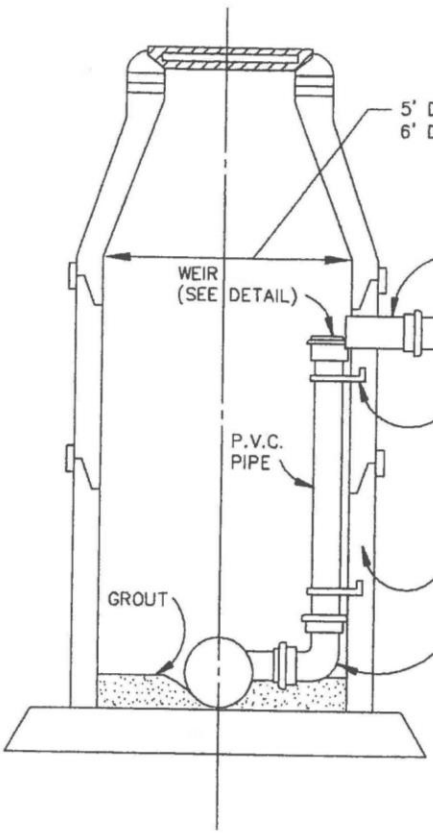
APPENDIX E DESIGN STANDARDS

WASTEWATER MANHOLE PRECAST

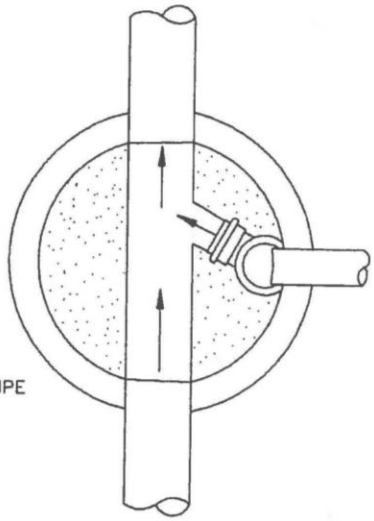
CITY OF TERRELL

KAUFMAN COUNTY, TEXAS


ADJUSTABLE FRAME
ROOF OPTIONS
N.T.S.
FRAME CAST IN CONC.
1/2" NON SHRINK GROUT COATING
STD. M.H. FRAME & COVER AS SPECIFIED BY OWNER
24" OR 36"
30"
USE PRECAST CONCRETE GRADE RINGS & NON SHRINK GROUT AS REQUIRED TO RAISE TO GRADE. (MIN. 4 COURSES)
FOR 5' & 6' DIA. M.H.'S SEE TRANSITION DETAIL
STD. M.H. FRAME & COVER AS SPECIFIED BY OWNER
30"
VARIES
6" MIN.
8" MIN.
5'-0" & 6'-0"
MANHOLES TO BE CAST USING CONSHIELD AND ALL JOINTS WRAPPED WITH GATOR-WRAP OR APPROVED EQUAL
CLASS "F" CONCRETE MONOLITHIC POUR
12" MIN.
12" MIN.
12" MIN.
12" MIN.
GEOTEXTILE MATERIAL
ROCK FOUNDATION
36" OR 24"
30"
6" MIN.
12" MIN.
(15" (5') 30" (6')
3' MIN.
5'-0" & 6'-0"
8" MIN.
TRANSITION DETAIL FOR 5' & 6' DIA. M.H.'S
N.T.S.
NOTES
1. WHERE M.H.'S ARE IN "PROPOSED" PAVING, FRAME & COVER SHALL BE SET 23" BELOW THE PROPOSED PAVEMENT GRADE.
2. IF FALSE M.H. BOTTOMS ARE REQUIRED THEY SHALL BE CONSTRUCTED, INSTALLED AND REMOVED. PER STD. DWG. NO. 5100.
3. WHERE M.H.'S ARE OUTSIDE OF PAVEMENT, FRAME & COVER SHALL BE CENTERED IN 5'X5' CONCRETE PAD CLASS "A" CONCRETE, 4" THICK.
APPROVED RESILIENT PIPE-TO-MANHOLE CONNECTOR OR GASKET REQUIRED FOR PIPE OTHER THAN CLAY OR CONCRETE.
STUBOUT TO BE FITTED WITH WATERTIGHT STOPPER OR CAP
STUBOUTS TO BE A MIN. OF 5' LONG WITH CONC. CRADLE (FROM SAME POUR) UNDER ENTIRE LENGTH
FIRST MAIN LINE JOINT TO BE A MIN. OF 5' LONG WITH CONC. CRADLE (FROM SAME POUR AS BASE) UNDER ENTIRE LENGTH.
STUBOUT CONNECTION
N.T.S.
SCALE: NONE
DATE: NOV 2022
SHEET 3
APPENDIX E DESIGN STANDARDS
CAST IN PLACE MANHOLE
Terrell AMERICA
CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



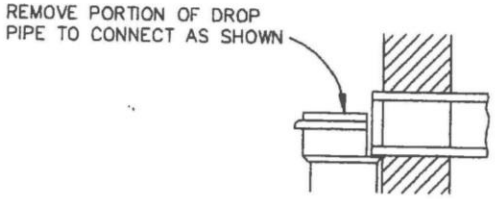
ELEVATION
N.T.S.



PLAN
N.T.S.

NOTE:

FLOW LINE OF SURCHARGE LINE NORMALLY PLACED AT TOP OF EXISTING WASTEWATER LINE UNLESS NOTED OTHERWISE ON PLANS.



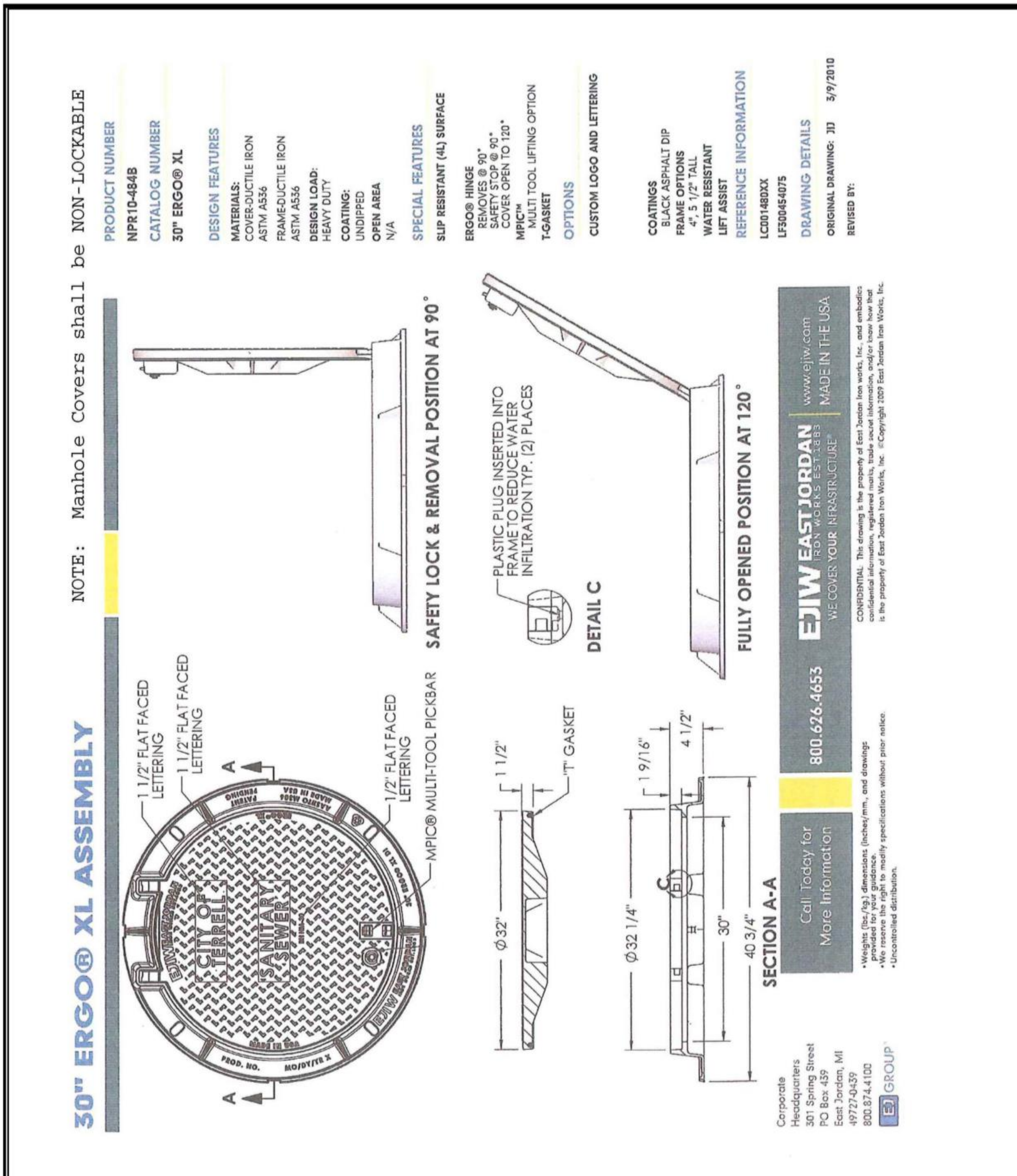
WEIR DETAIL
N.T.S.

SCALE: NONE | DATE: NOV 2022 | SHEET 4

APPENDIX E DESIGN STANDARDS

WASTEWATER MANHOLE INSIDE DROP CONNECTION

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



SCALE: NONE

DATE: NOV 2022

SHEET 5

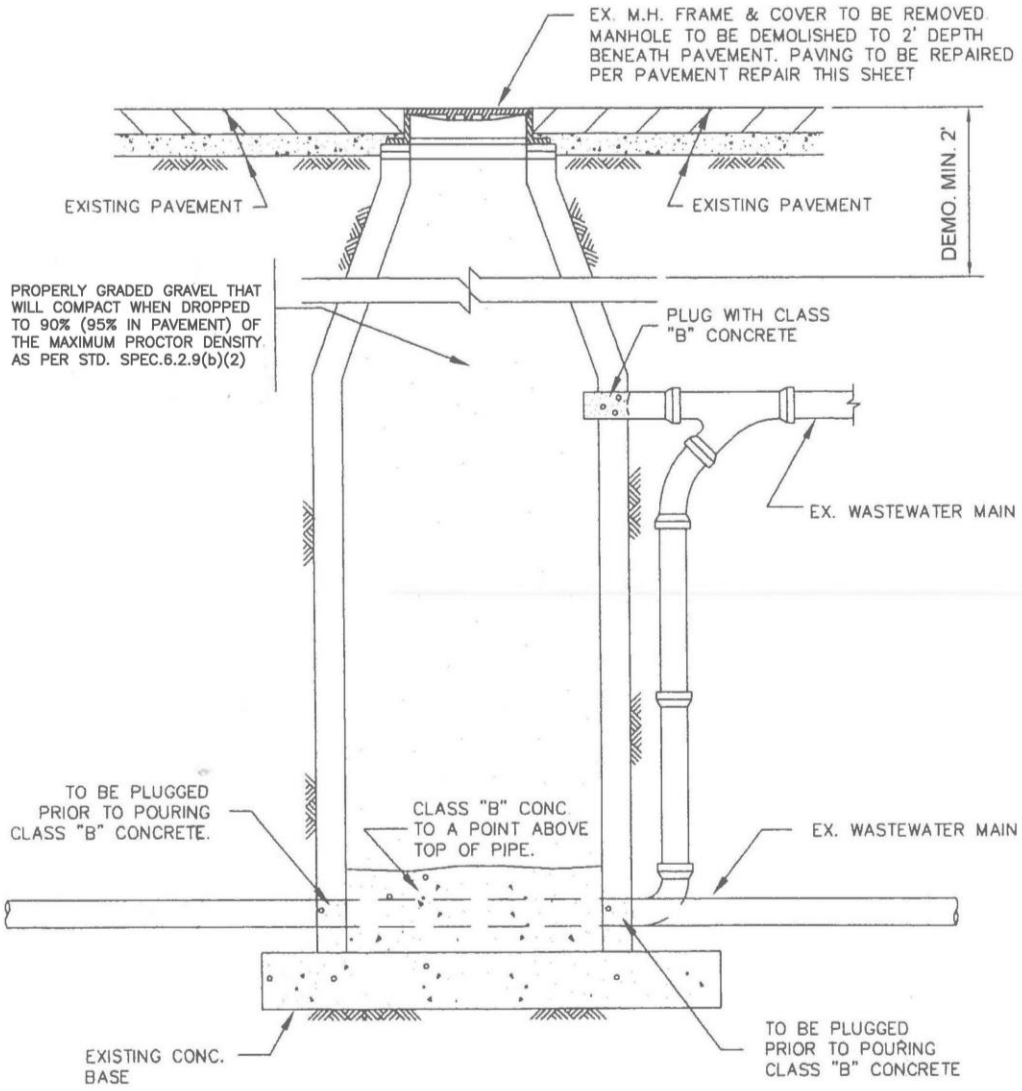
APPENDIX E DESIGN STANDARDS

30" ERGO XL ASSEMBLY

Terrell AMERICA

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



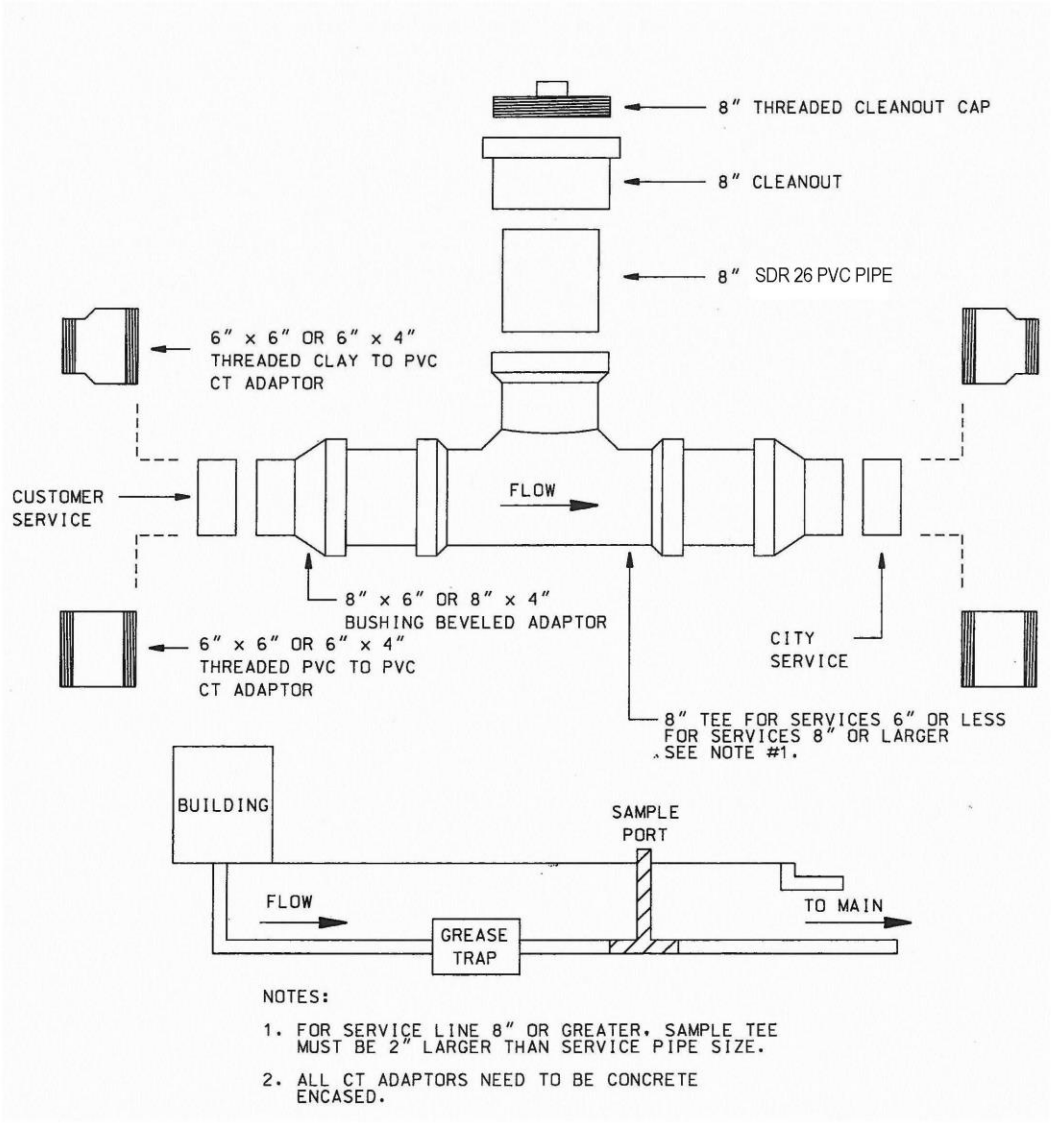
SCALE: NONE DATE: NOV 2022 SHEET 6

APPENDIX E DESIGN STANDARDS

ABANDONMENT OF MANHOLE IN OR OUT OF PAVEMENT

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



NOTES:

1. FOR SERVICE LINE 8" OR GREATER, SAMPLE TEE MUST BE 2" LARGER THAN SERVICE PIPE SIZE.
2. ALL CT ADAPTORS NEED TO BE CONCRETE ENCASED.

SCALE: NONE

DATE: NOV 2022

SHEET 7

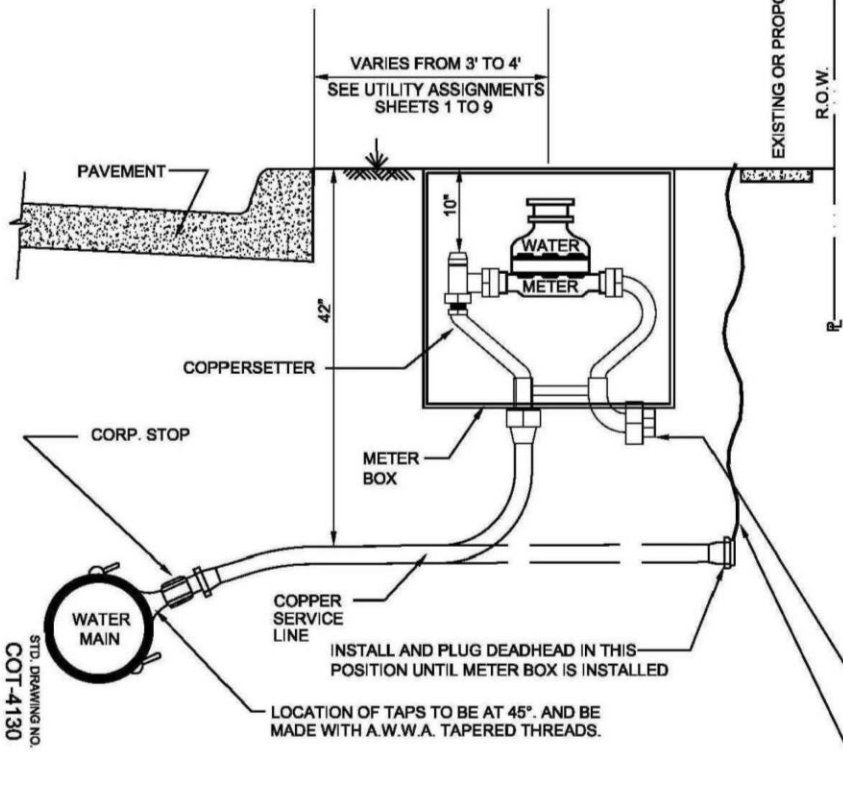
APPENDIX E DESIGN STANDARDS

SAMPLE PORT

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS

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



AB

CITY OF TERRELL
WATER SERVICE MATERIAL STANDARDS

SERVICE SADDLE:
SMITH-BLAIR #317/CC
JCM 405/CC

CORPORATION STOP:
1" FORD # FB1000 -4-Q

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 LOCKING LID

COPPERSETTERS:
1" TAP x 5/8" x3/4" METER FORD # V72-82W-21-44
1" TAP x 1" METER FORD # V74-84W-21-44

WATER METER
CURRENT CITY TYPE AND MODEL

SCALE: NONE

DATE: NOV 2022

SHEET 8

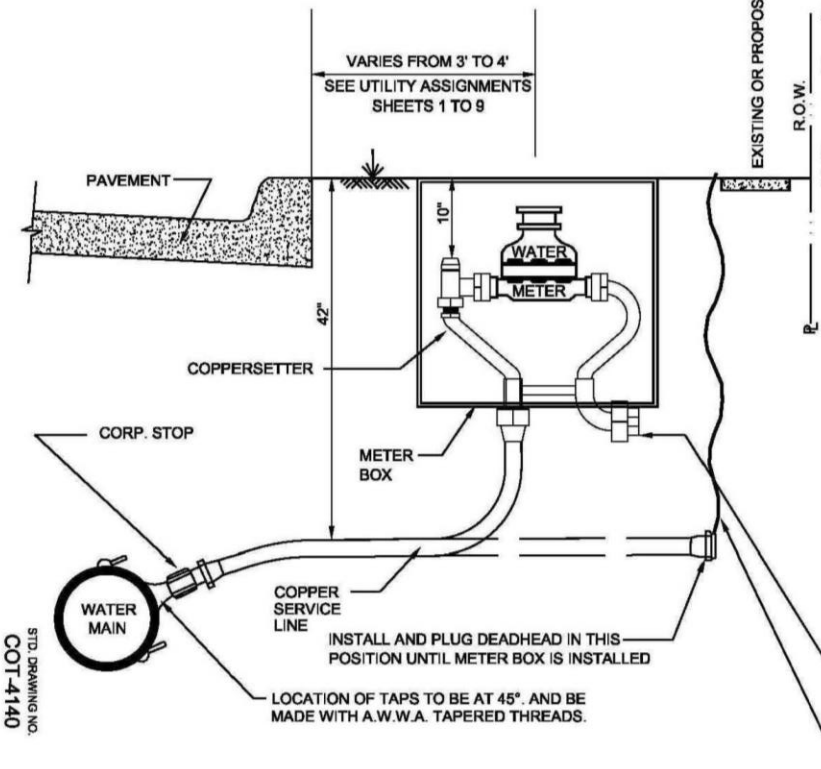
APPENDIX E DESIGN STANDARDS

WATER SERVICE INSTALLATION 1" AND SMALLER

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

AB

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
JCM405/CC

CORPORATION STOP: FORD
1 ½" FORD FB1000 -6-Q
2" FORD FM1000-7-Q

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" ANDCAST IRON RINGS AND LIDS

COPPERSETTERS:
1 1/2"TAP x 1 1/2" METER FORD VBB76-18B-41-66
2" TAP X 2' METER FORD V-77-18-41-77

WATER METER
CURRENT CITY TYPE AND MODEL

SERVICE LINE - PLUG WITH BRASS OR PVC PLUG OR CONNECT TO PLUMBERS LINE

BLUE PLASTIC TAPE TO MARK DEADHEAD LOCATION

SCALE: NONE

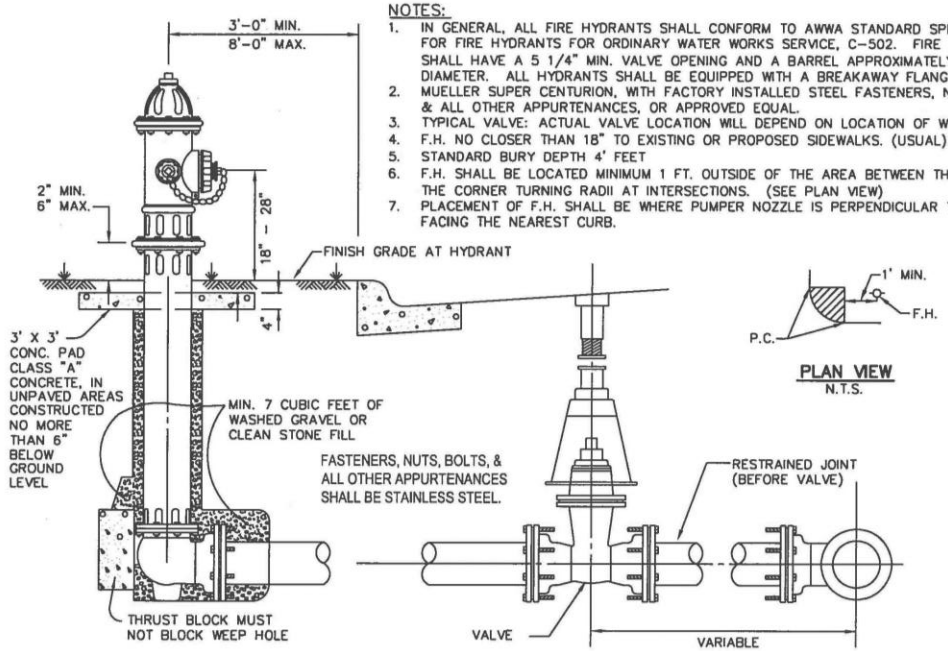
DATE: NOV 2022

SHEET 9

WATER SERVICE INSTALLATION
1-1/2" AND 2"

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

FIG F-4



NOTES:

1. IN GENERAL, ALL FIRE HYDRANTS SHALL CONFORM TO AWWA STANDARD SPECIFICATIONS FOR FIRE HYDRANTS FOR ORDINARY WATER WORKS SERVICE, C-502. FIRE HYDRANTS SHALL HAVE A 5 1/4" MIN. VALVE OPENING AND A BARREL APPROXIMATELY 7" INSIDE DIAMETER. ALL HYDRANTS SHALL BE EQUIPPED WITH A BREAKAWAY FLANGE.
2. MUELLER SUPER CENTURION, WITH FACTORY INSTALLED STEEL FASTENERS, NUTS, BOLTS, & ALL OTHER APPURTENANCES, OR APPROVED EQUAL.
3. TYPICAL VALVE: ACTUAL VALVE LOCATION WILL DEPEND ON LOCATION OF WATER MAIN.
4. F.H. NO CLOSER THAN 18" TO EXISTING OR PROPOSED SIDEWALKS. (USUAL)
5. STANDARD BURY DEPTH 4' FEET
6. F.H. SHALL BE LOCATED MINIMUM 1 FT. OUTSIDE OF THE AREA BETWEEN THE P.C.'S OF THE CORNER TURNING RADII AT INTERSECTIONS. (SEE PLAN VIEW)
7. PLACEMENT OF F.H. SHALL BE WHERE PUMPER NOZZLE IS PERPENDICULAR TO AND FACING THE NEAREST CURB.

WITH CITY OF TERRELL STENCILED ON THE BARREL

FIRE HYDRANT ASSEMBLIES SHALL INCLUDE 3', 4', OR 5' BURY DEPTHS OR GRADELOCK ASSEMBLY AT CONTRACTOR'S OPTION. ALL BURY DEPTHS AND FITTINGS SHALL BE SUBSIDIARY TO UNIT PRICE BID FOR FIRE HYDRANT ASSEMBLIES.	HYDRANT BURY DEPTH							
	5' BURY	423-534266 853 A-423 5-1/4 CENTURION OL 3-WAY HYDRANT 05'0" BURY 2-2-1/2" PENT HOSE NOZ GA 1-4-1/2" PUMPER NOZ GA NS 1-1/2" PENT OPEN LEFT 6" MJ SHOE WITHOUT FITTINGS SW POLANE SP SILVER 523-1-050-623-1085-00-75298-40560-18 853	4' BURY	423-534265 853 A-423 5-1/4 CENTURION OL 3-WAY HYDRANT 04'0" BURY 2-2-1/2" PENT HOSE NOZ GA 1-4-1/2" PUMPER NOZ GA NS 1-1/2" PENT OPEN LEFT 6" MJ SHOE WITHOUT FITTINGS SW POLANE SP SILVER 523-1-040-623-1085-00-75298-40560-18 853	3' BURY	423-534264 853 A-423 5-1/4 CENTURION OL 3-WAY HYDRANT 03'0" BURY 2-2-1/2" PENT HOSE NOZ GA 1-4-1/2" PUMPER NOZ GA NS 1-1/2" PENT OPEN LEFT 6" MJ SHOE WITHOUT FITTINGS SW POLANE SP SILVER 523-1-030-623-1085-00-75298-40560-18 853

SCALE: NONE

DATE: NOV 2022

SHEET 10

DESIGN STANDARDS

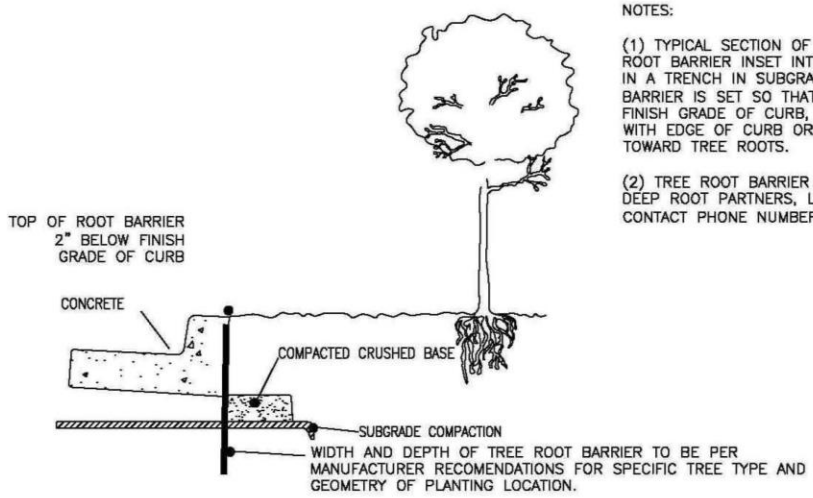
FIRE HYDRANT ASSEMBLY INSTALLATION

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

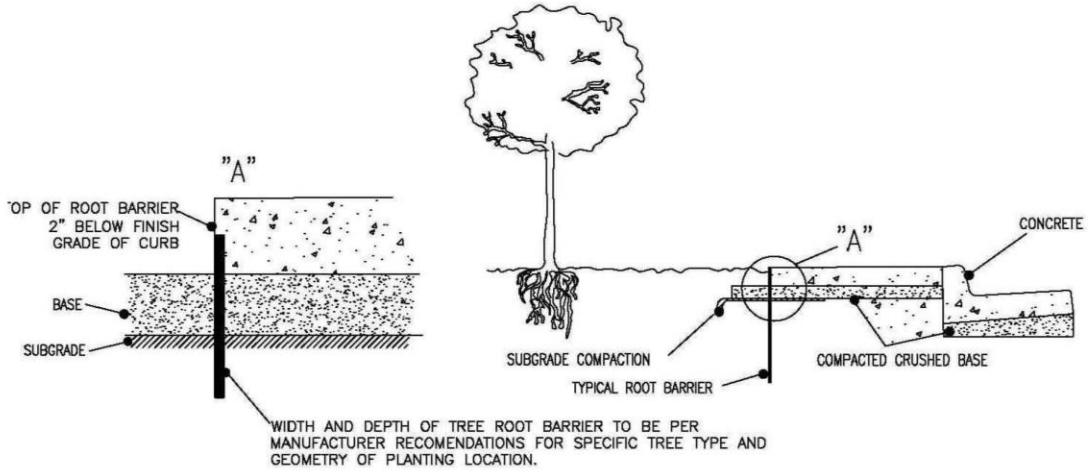
NOTES:

(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.



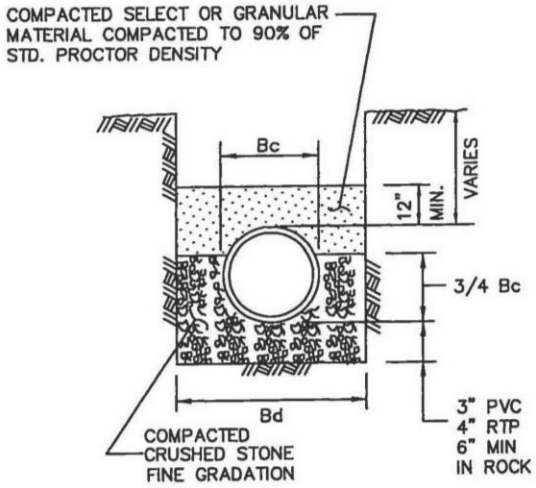
TYPICAL FOR SIDEWALK.

SCALE: NONE | DATE: NOV 2022 | SHEET 11

APPENDIX E DESIGN STANDARDS

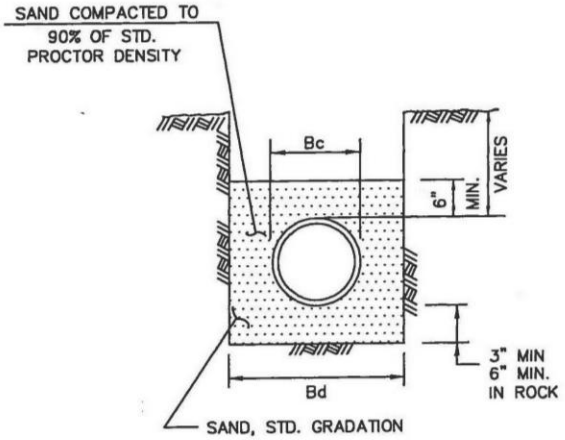
TYPICAL TREE ROOT BARRIER INSTALLATION

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



CLASS "B–2"

SANITARY AND STORM SEWER EMBEDMENT



CLASS "B–2"

WATERLINE EMBEDMENT

SCALE: NONE | DATE: NOV 2022 | SHEET 12

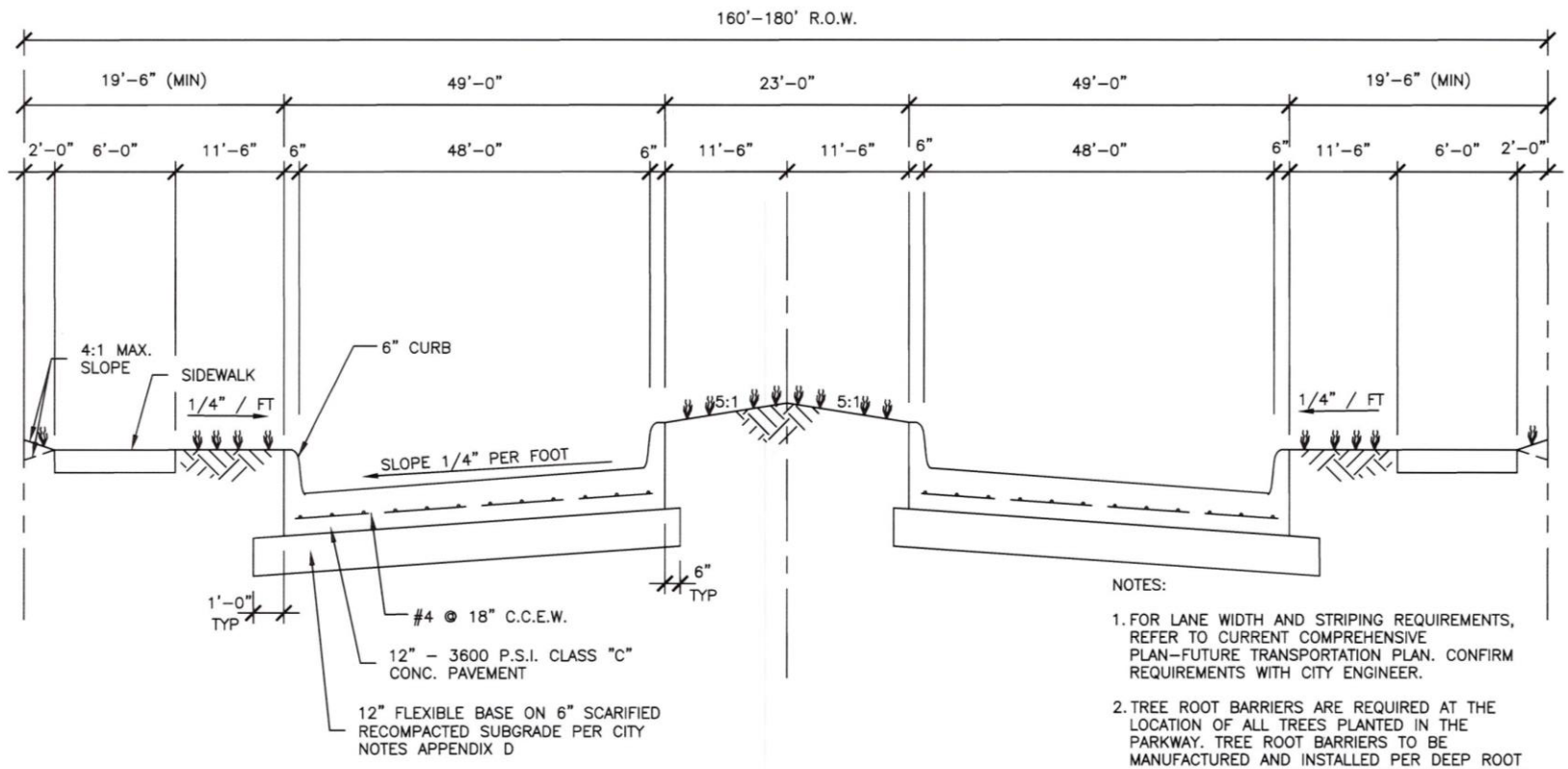
APPENDIX E DESIGN STANDARDS

SANITARY, STORM SEWER AND WATERLINE EMBEDMENT

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

APPENDIX F

TYPICAL PAVEMENT SECTIONS



PRINCIPAL THOROUGHFARE
TYPE AA

NOTES:

1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE

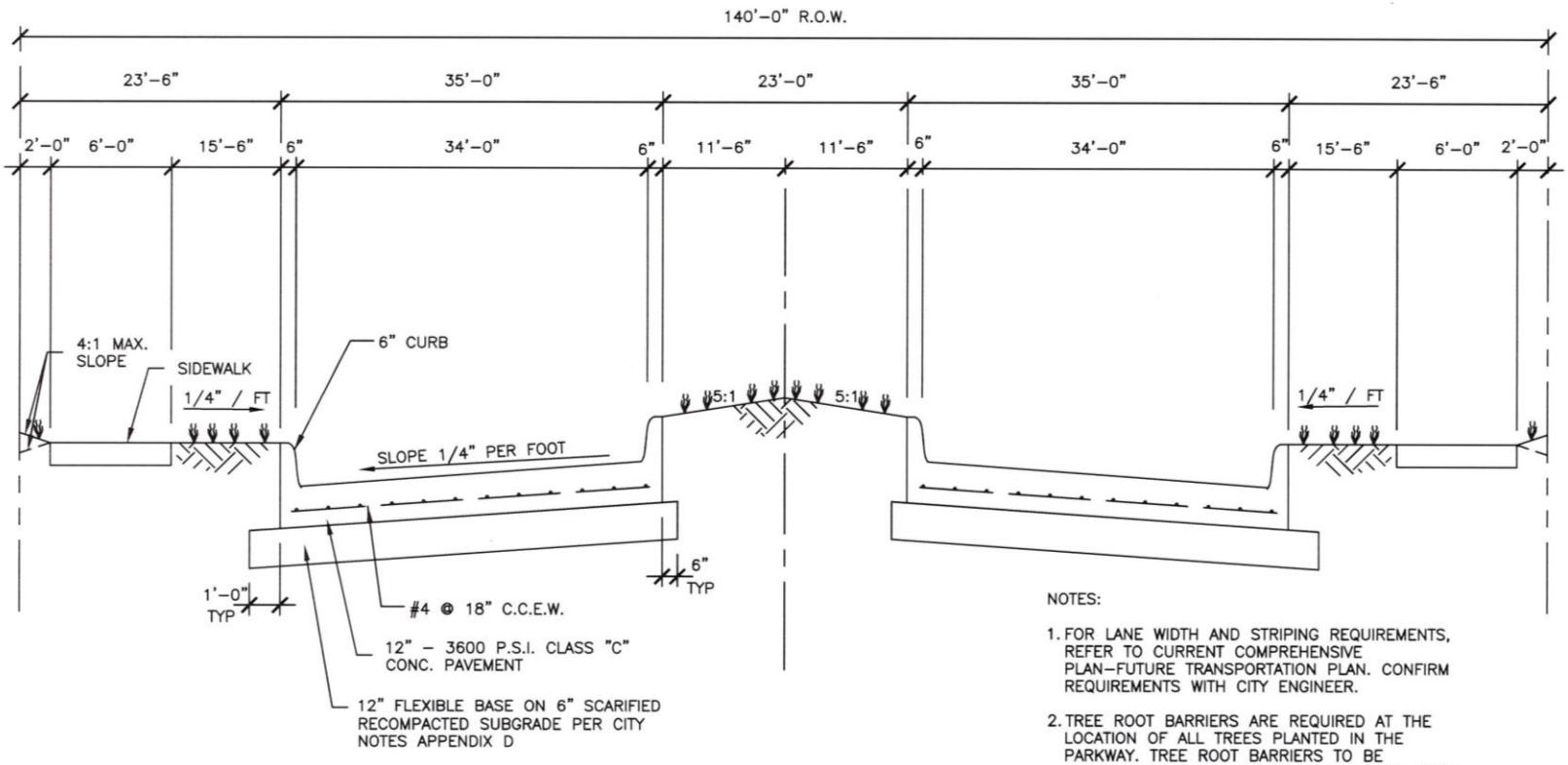
DATE: NOVEMBER 2022

SHEET: 1

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



PRINCIPAL ARTERIAL TYPE AA

NOTES:

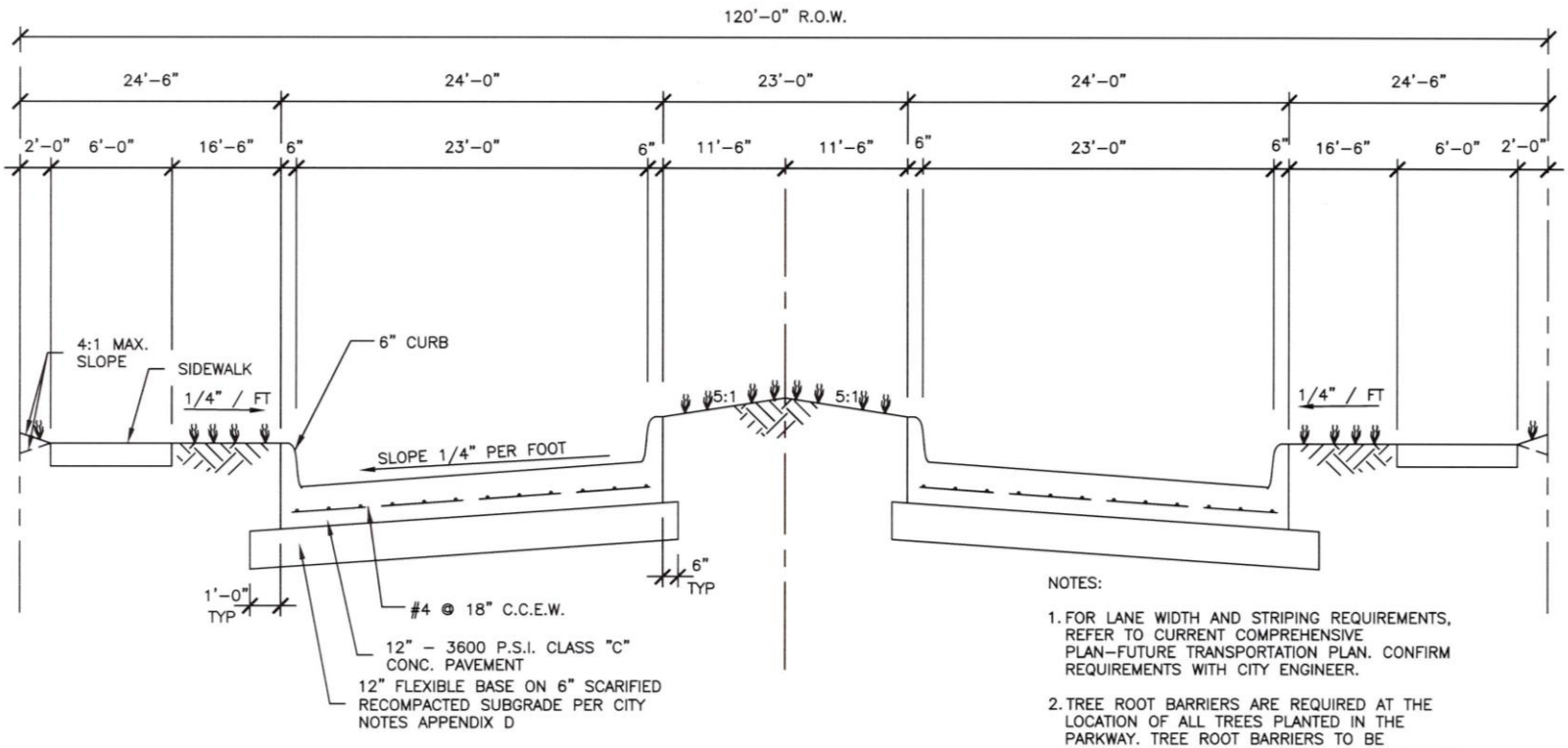
1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 2

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR ARTERIAL
TYPE A

NOTES:

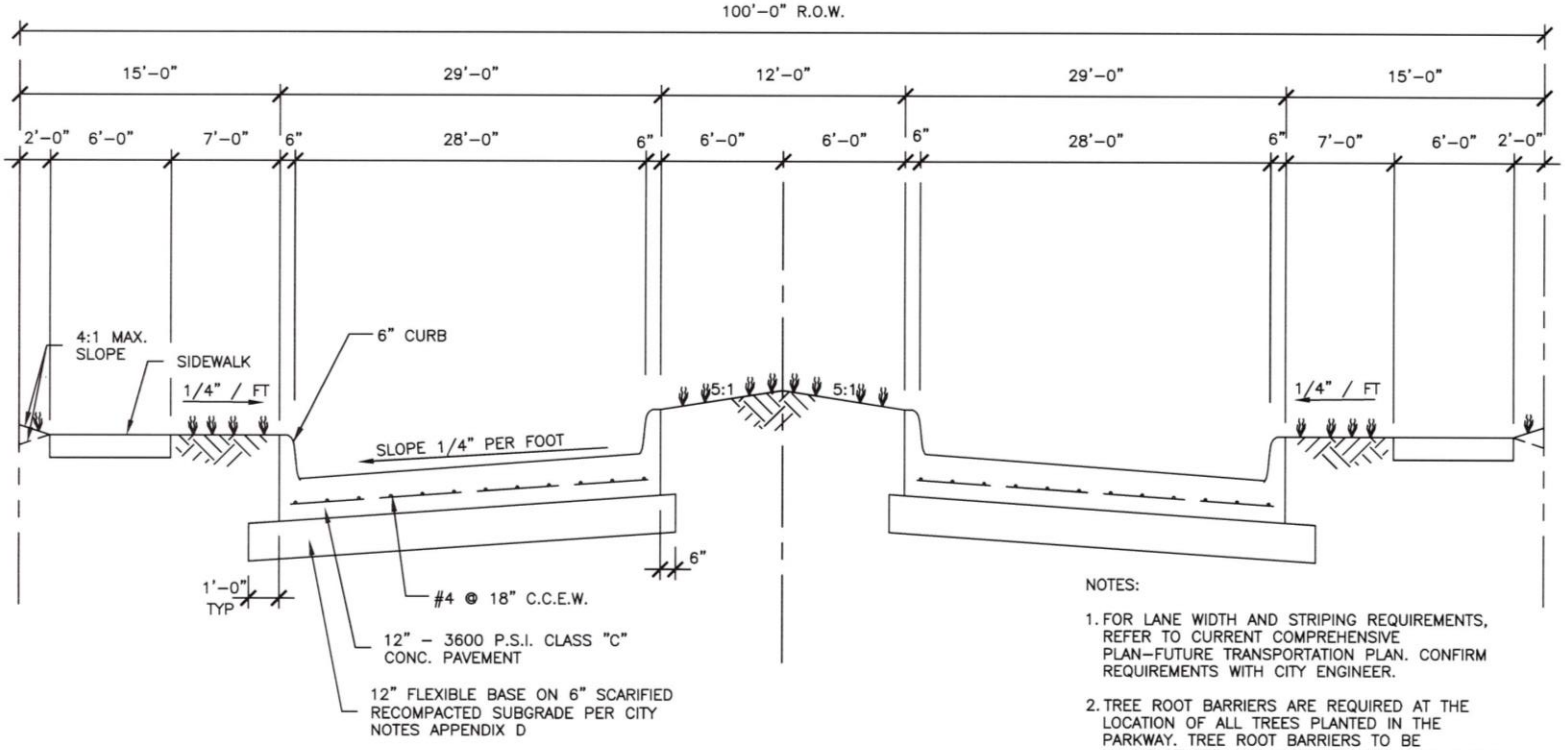
1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 3

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MINOR ARTERIAL
TYPE B

NOTES:

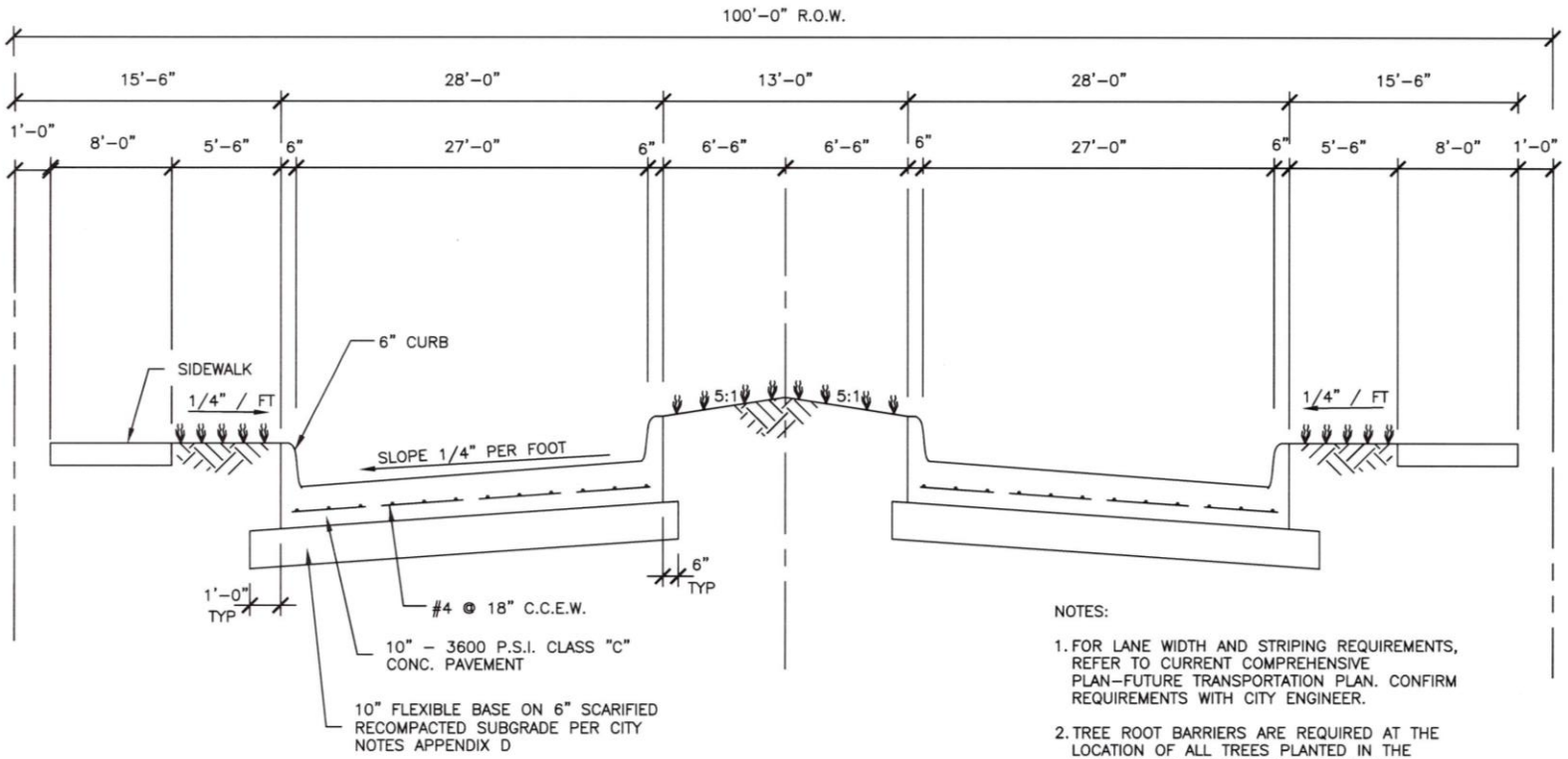
1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 4

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



PRINCIPAL COLLECTOR
TYPE C

NOTES:

1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE

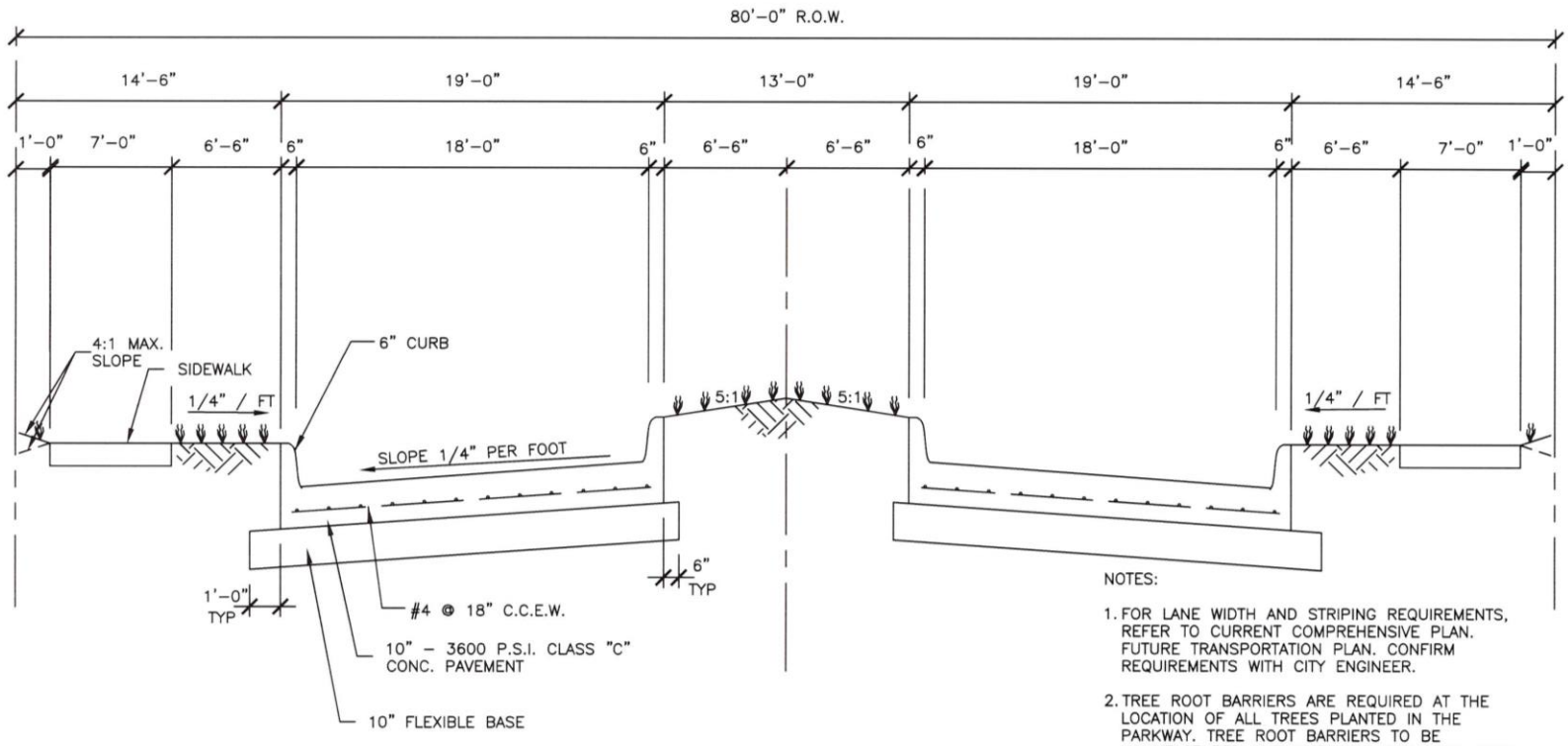
DATE: NOVEMBER 2022

SHEET: 5

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR COLLECTOR
TYPE D

NOTES:

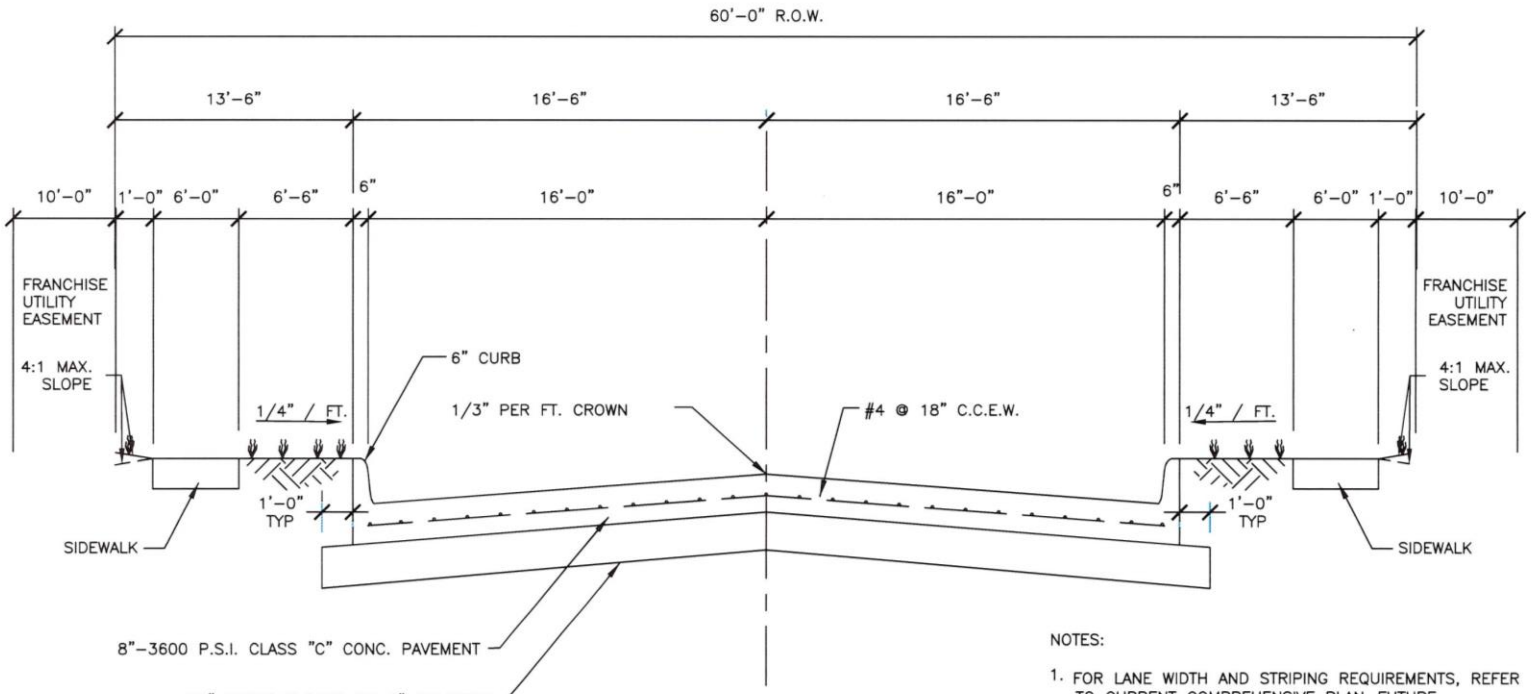
1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN. FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. TREE ROOT BARRIERS ARE REQUIRED AT THE LOCATION OF ALL TREES PLANTED IN THE PARKWAY. TREE ROOT BARRIERS TO BE MANUFACTURED AND INSTALLED PER DEEP ROOT PARTNERS, L.P. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 6

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

MINOR COLLECTOR

TYPE E

SCALE: NONE

DATE: NOVEMBER 2022

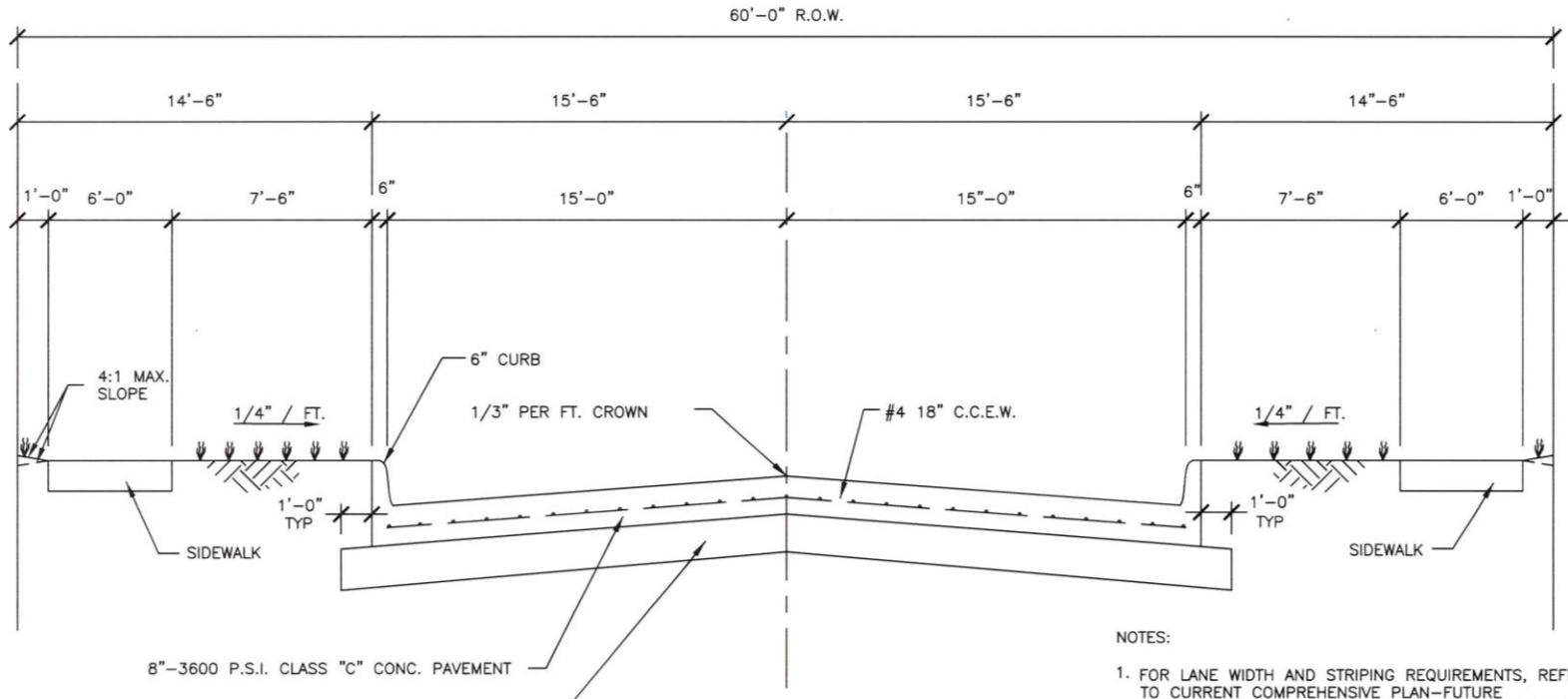
SHEET: 7

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



LOCAL STREET – RESIDENTIAL

TYPE F

NOTES:

1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

SCALE: NONE

DATE: NOVEMBER 2022

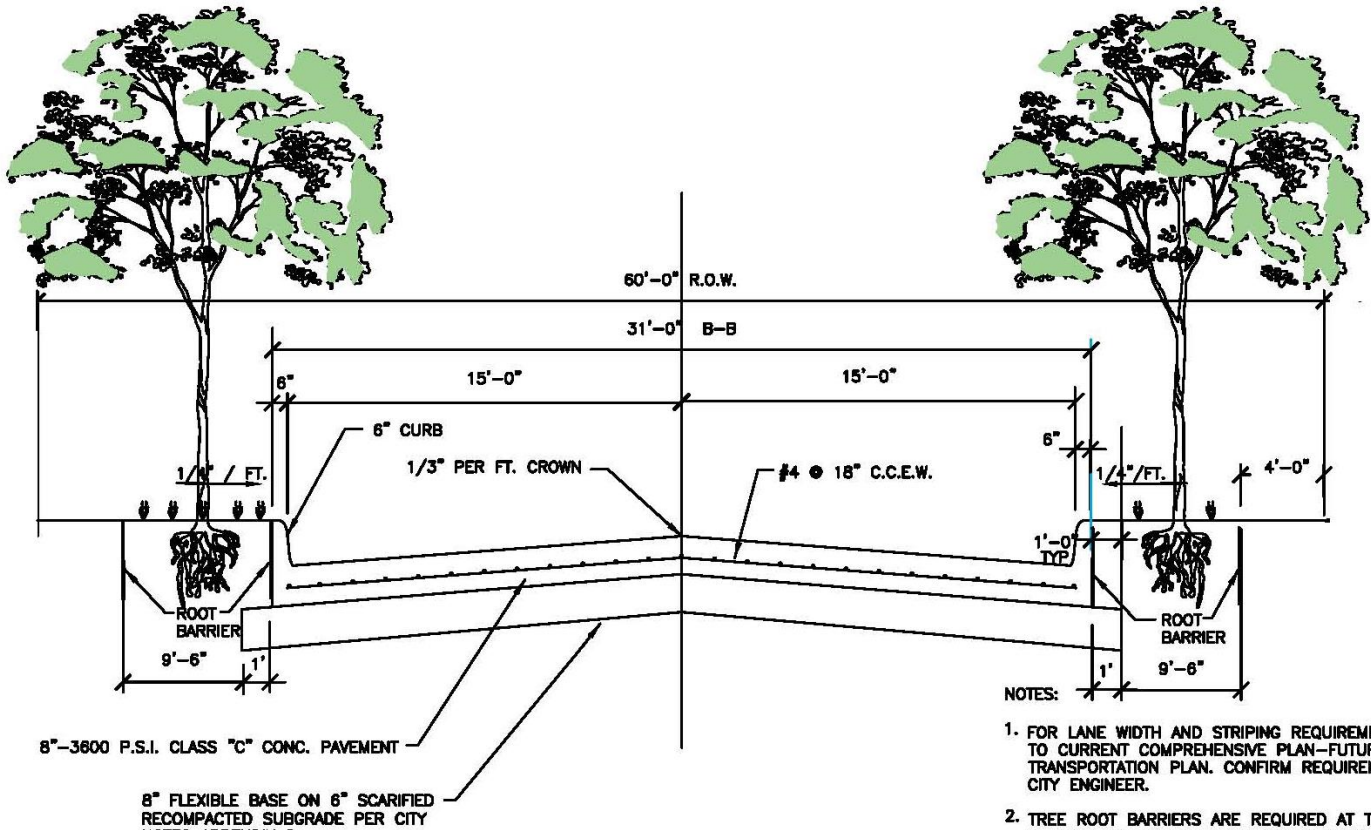
SHEET: 8

APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



NOTES:

1. FOR LANE WIDTH AND STRIPING REQUIREMENTS, REFER TO CURRENT COMPREHENSIVE PLAN–FUTURE TRANSPORTATION PLAN. CONFIRM REQUIREMENTS WITH CITY ENGINEER.
2. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458–7668.
3. REFER TO NCTCOG STANDARD DRAWINGS 2050 AND 2060 FOR PAVEMENT JOINTS.
4. AT INTERSECTIONS, WARP PAVEMENT SECTION TO FIT AND PROVIDE ADA ACCESSIBILITY.

LOCAL STREET – RESIDENTAL
OPTIONAL CROSS SECTION
TYPE F

SCALE: NONE

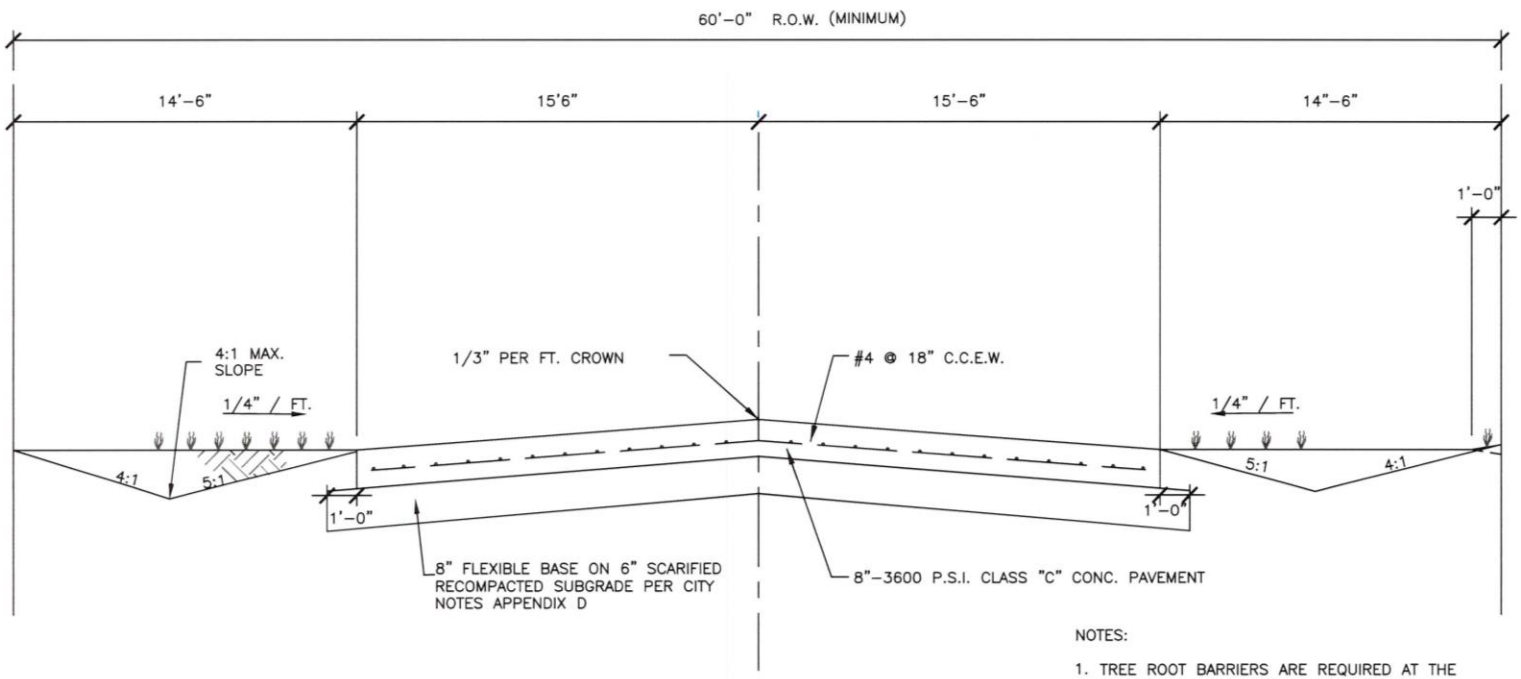
DATE: NOVEMBER 2022

SHEET: 9

APPENDIX F 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.
3. DITCHES TO BE SIZED TO PASS THE Q100 FLOW.
4. ALL DRIVEWAYS TO BE SIZED TO PASS THE Q100 FLOW.
5. DITCH SLOPES MAX 4H:1V.

RURAL – RESIDENTIAL

TYPE G

SCALE: NONE

DATE: NOVEMBER 2022

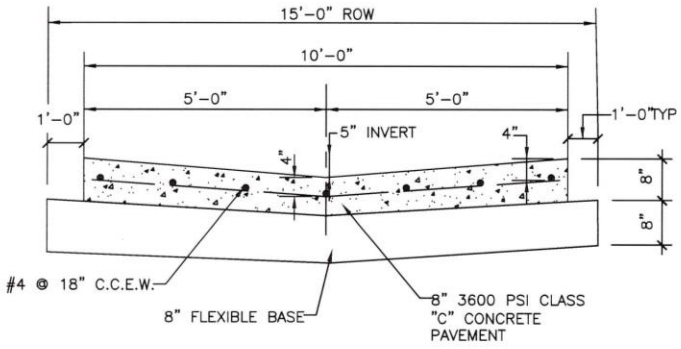
SHEET: 10

APPENDIX F DESIGN STANDARDS

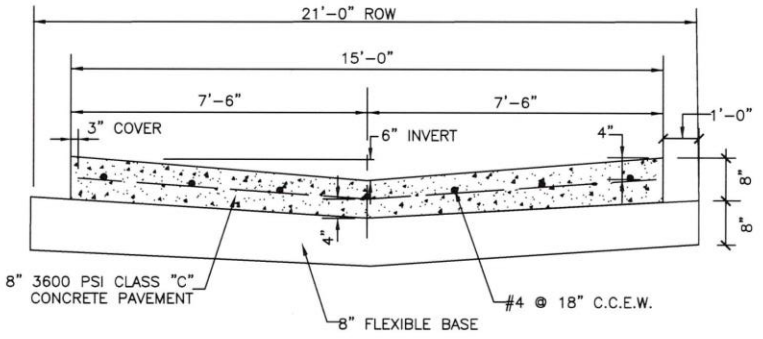
TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



STANDARD 10' ALLEY SECTION



STANDARD 15' ALLEY SECTION

10 FT. ALLEY

SECTION LOOKING SOUTH OR WEST

15 FT. ALLEY

SECTION LOOKING SOUTH OR WEST

ALLEYS

NOTES:

1. REFER TO NCTOG STANDARD DRAWING 2050 AND 2060 FOR PRESENT JOINTS.
2. AT INTERSECTIONS, WARP PRESENT SECTIONS TO FIT AS POSSIBLE ADA ACCESSIBILITY.

SCALE: NONE DATE: NOVEMBER 2022 SHEET: 11

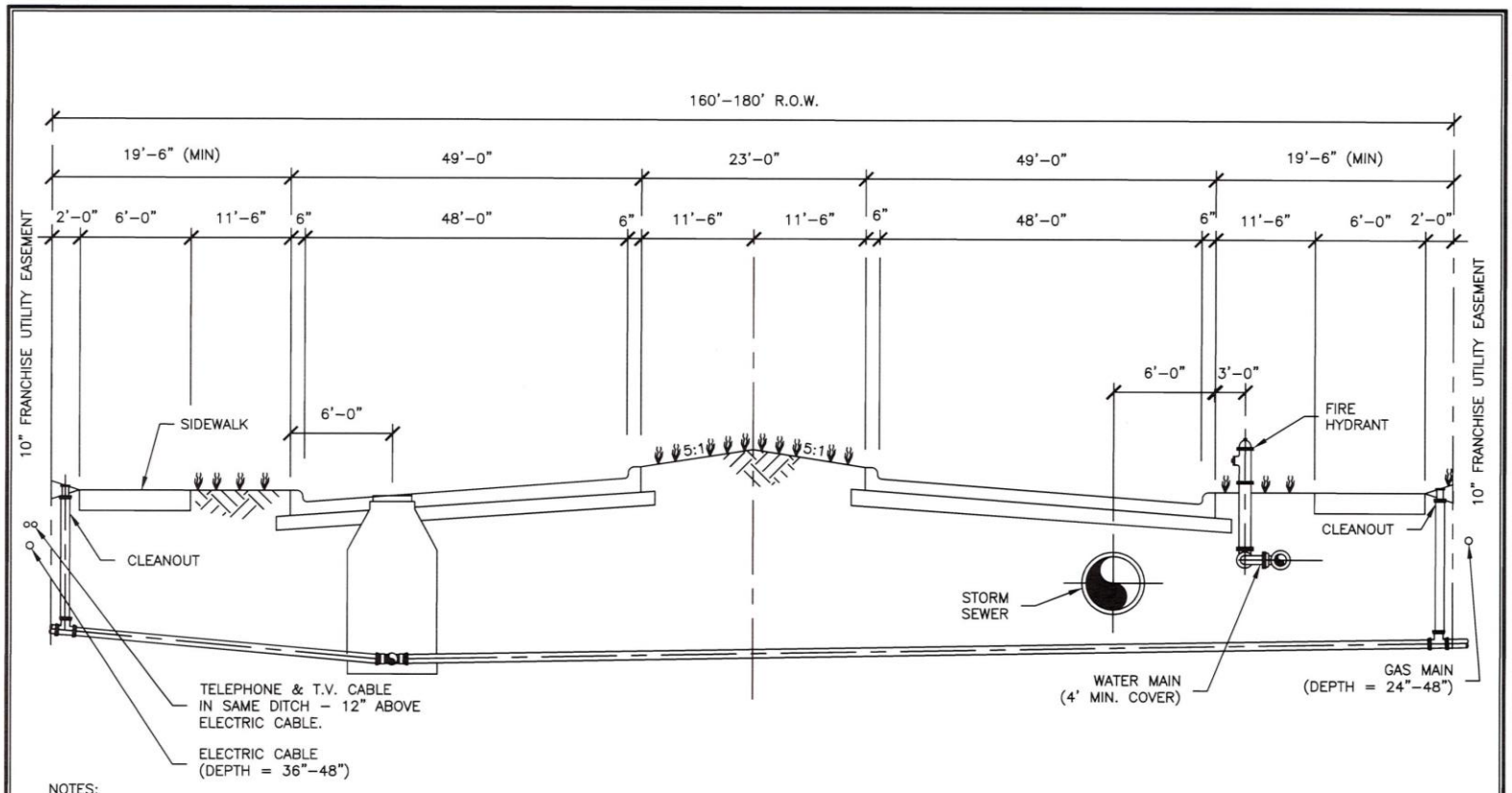
APPENDIX F DESIGN STANDARDS

TYPICAL PAVEMENT SECTIONS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

APPENDIX G

STANDARD UTILITY ASSIGNMENTS



NOTES:

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

PRINCIPAL THOROUGHFARE
TYPE AA

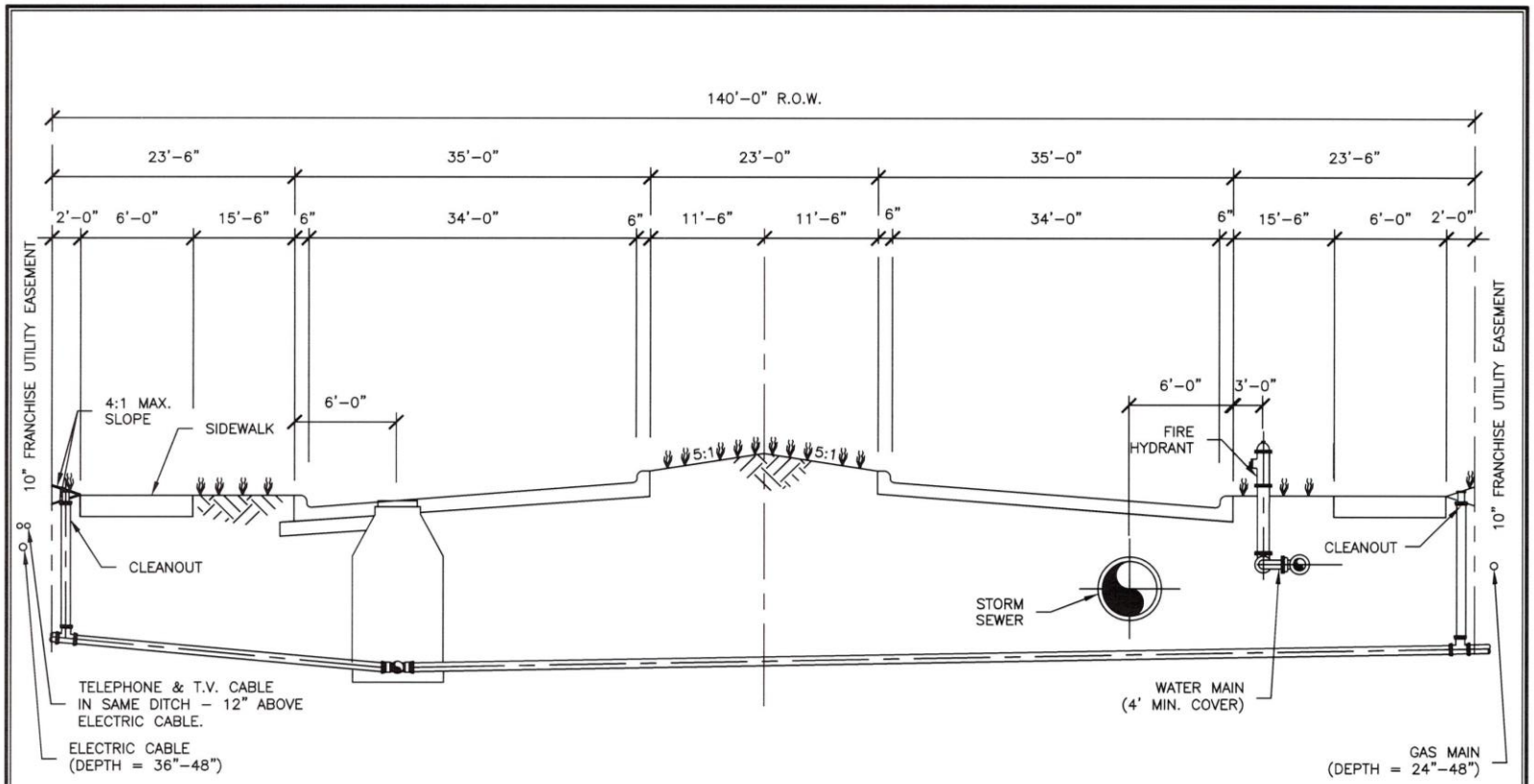
SECTION LOOKING SOUTH OR WEST

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 1

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

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

PRINCIPAL ARTERIAL TYPE AA

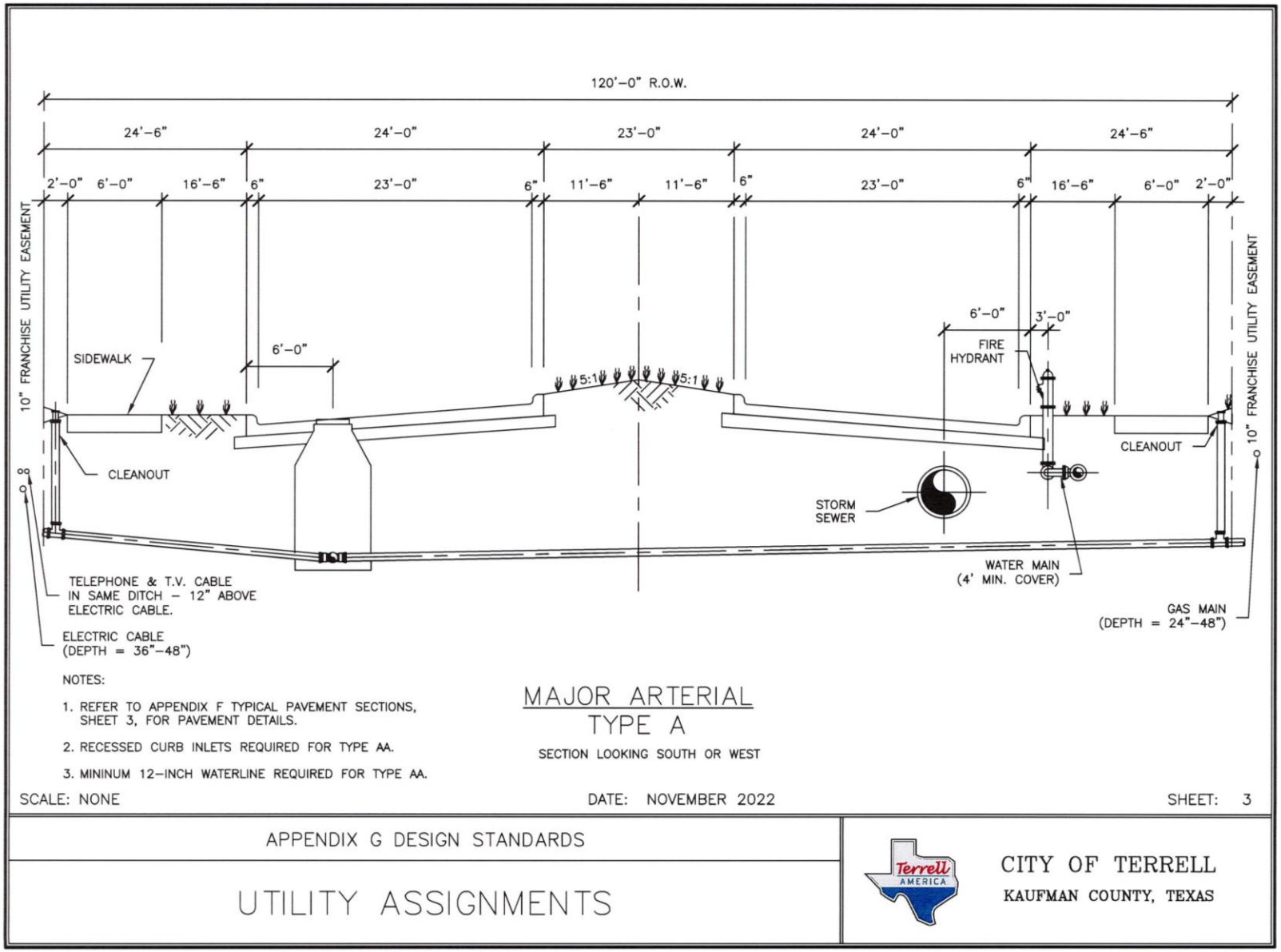
SECTION LOOKING SOUTH OR WEST

SCALE: NONE DATE: NOVEMBER 2022 SHEET: 2

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



NOTES:

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

MAJOR ARTERIAL TYPE A

SECTION LOOKING SOUTH OR WEST

SCALE: NONE

DATE: NOVEMBER 2022

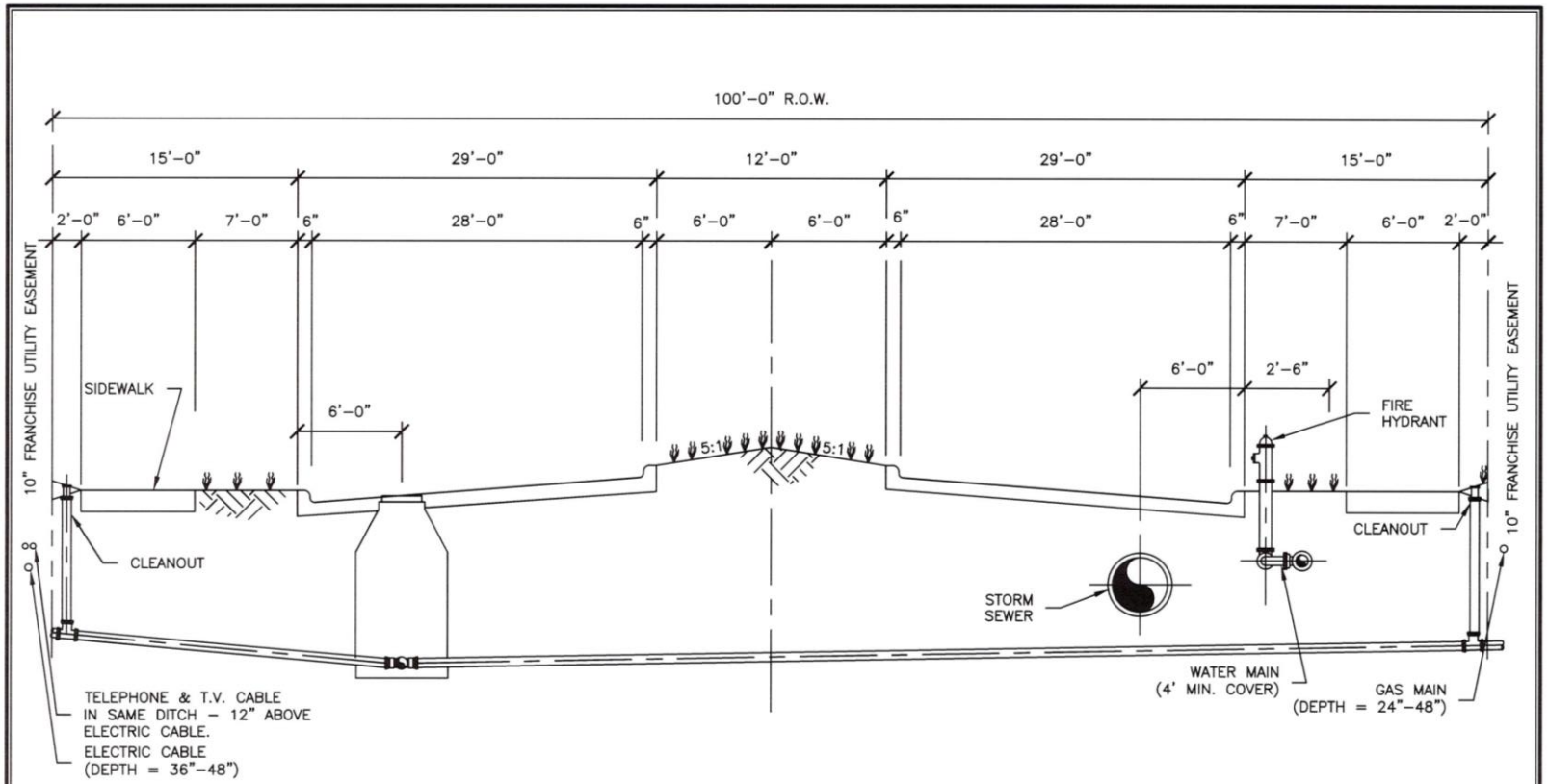
SHEET: 3

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



NOTES:

1. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 4 FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE B.
3. MININUM 12-INCH WATERLINE REQUIRED FOR TYPE B.

MINOR ARTERIAL TYPE B

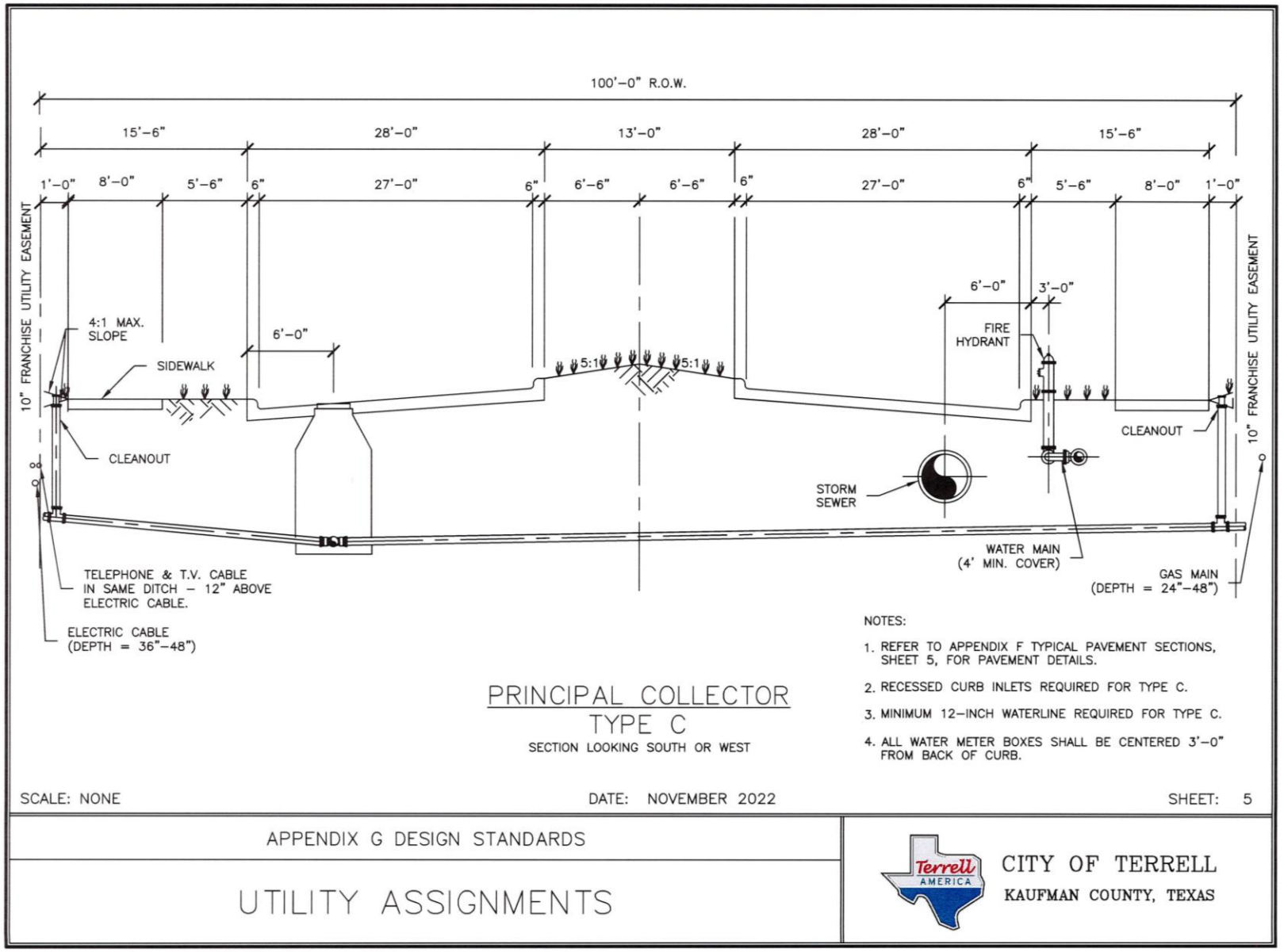
SECTION LOOKING SOUTH OR WEST

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 4

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



PRINCIPAL COLLECTOR
TYPE C
SECTION LOOKING SOUTH OR WEST

NOTES:

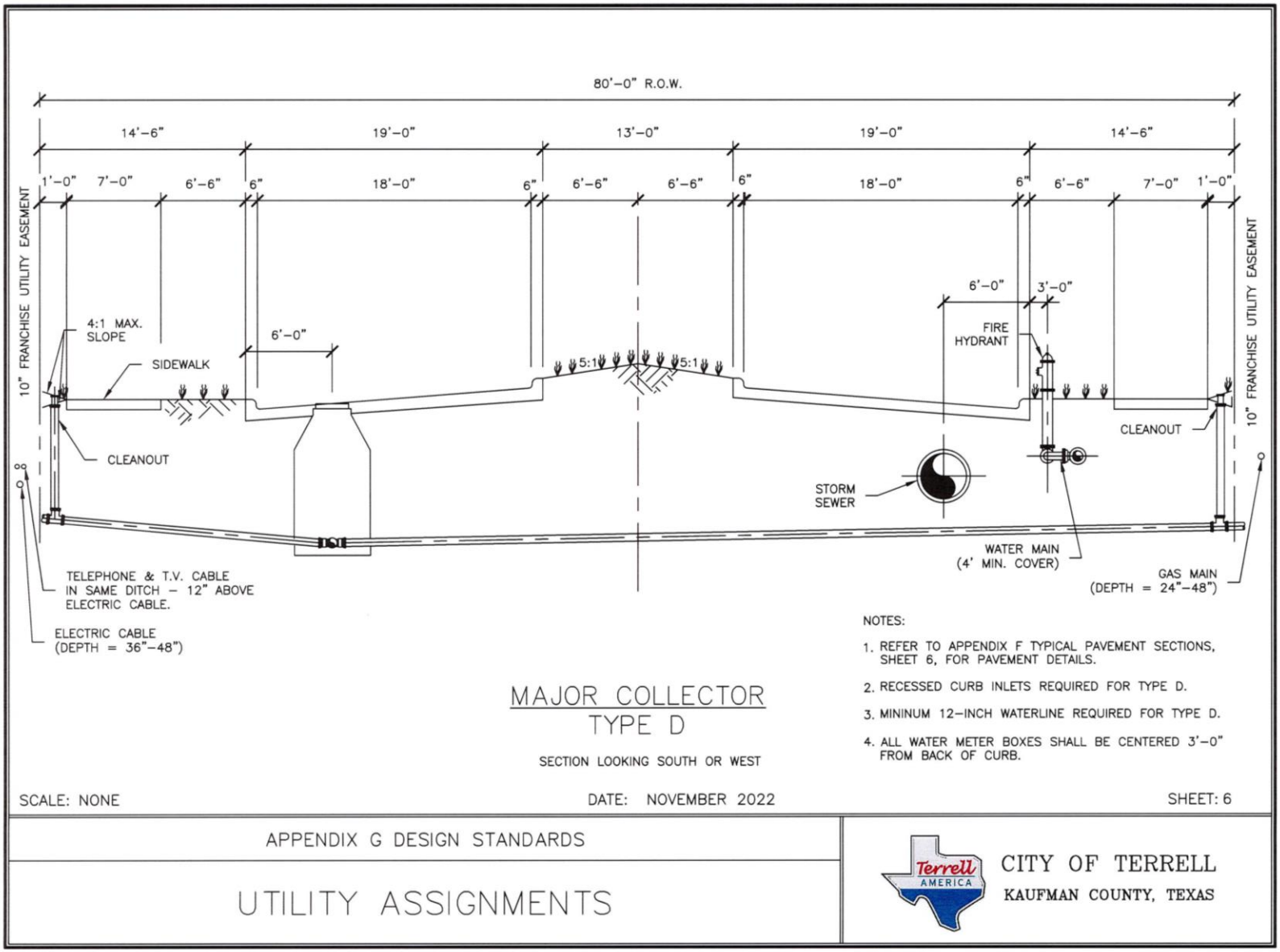
1. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 5, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE C.
3. MINIMUM 12-INCH WATERLINE REQUIRED FOR TYPE C.
4. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 5

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



MAJOR COLLECTOR
TYPE D

SECTION LOOKING SOUTH OR WEST

NOTES:

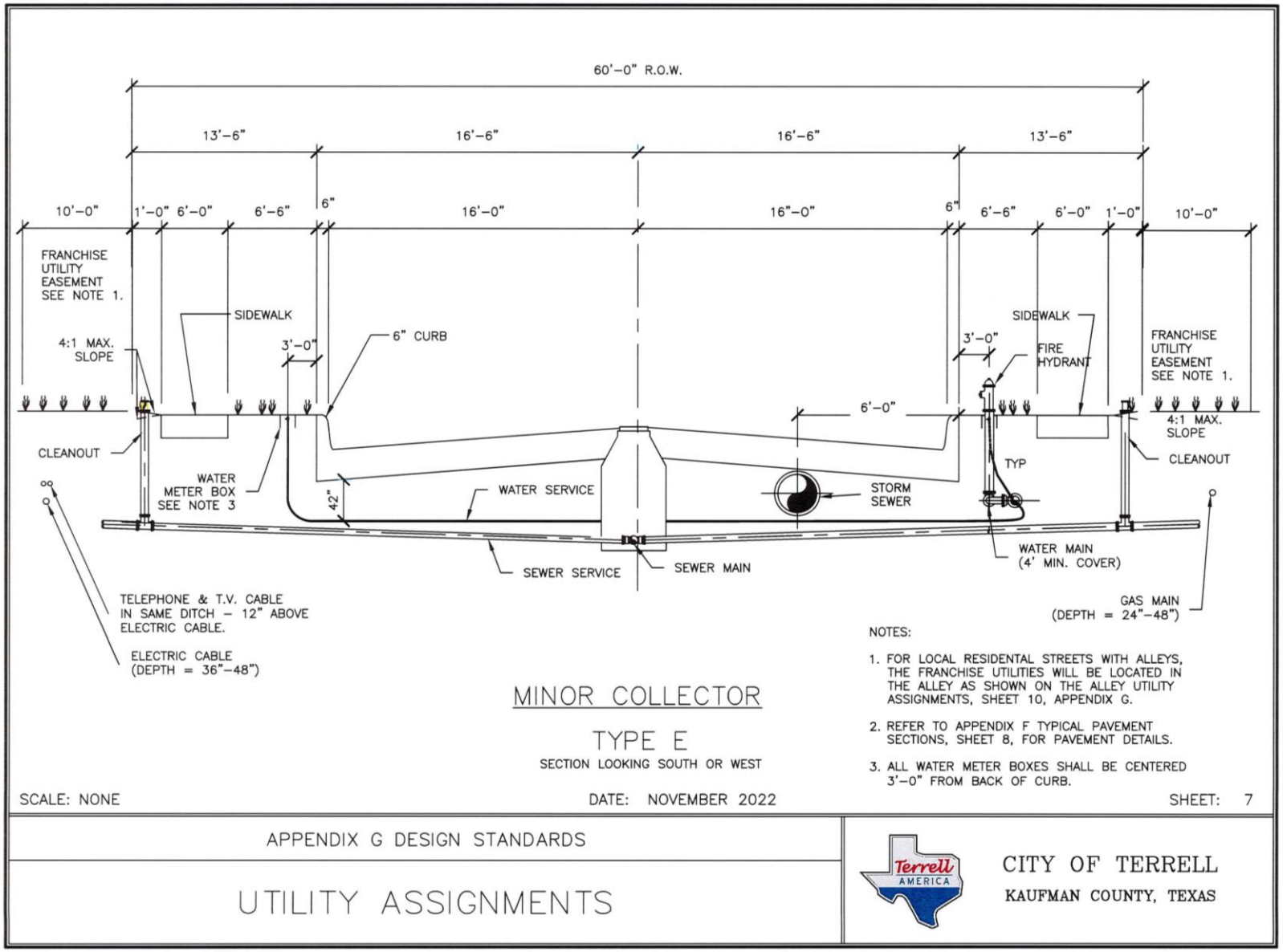
1. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 6, FOR PAVEMENT DETAILS.
2. RECESSED CURB INLETS REQUIRED FOR TYPE D.
3. MINIMUM 12-INCH WATERLINE REQUIRED FOR TYPE D.
4. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 6

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



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 10, APPENDIX G.
2. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 8, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

MINOR COLLECTOR

TYPE E

SECTION LOOKING SOUTH OR WEST

SCALE: NONE

DATE: NOVEMBER 2022

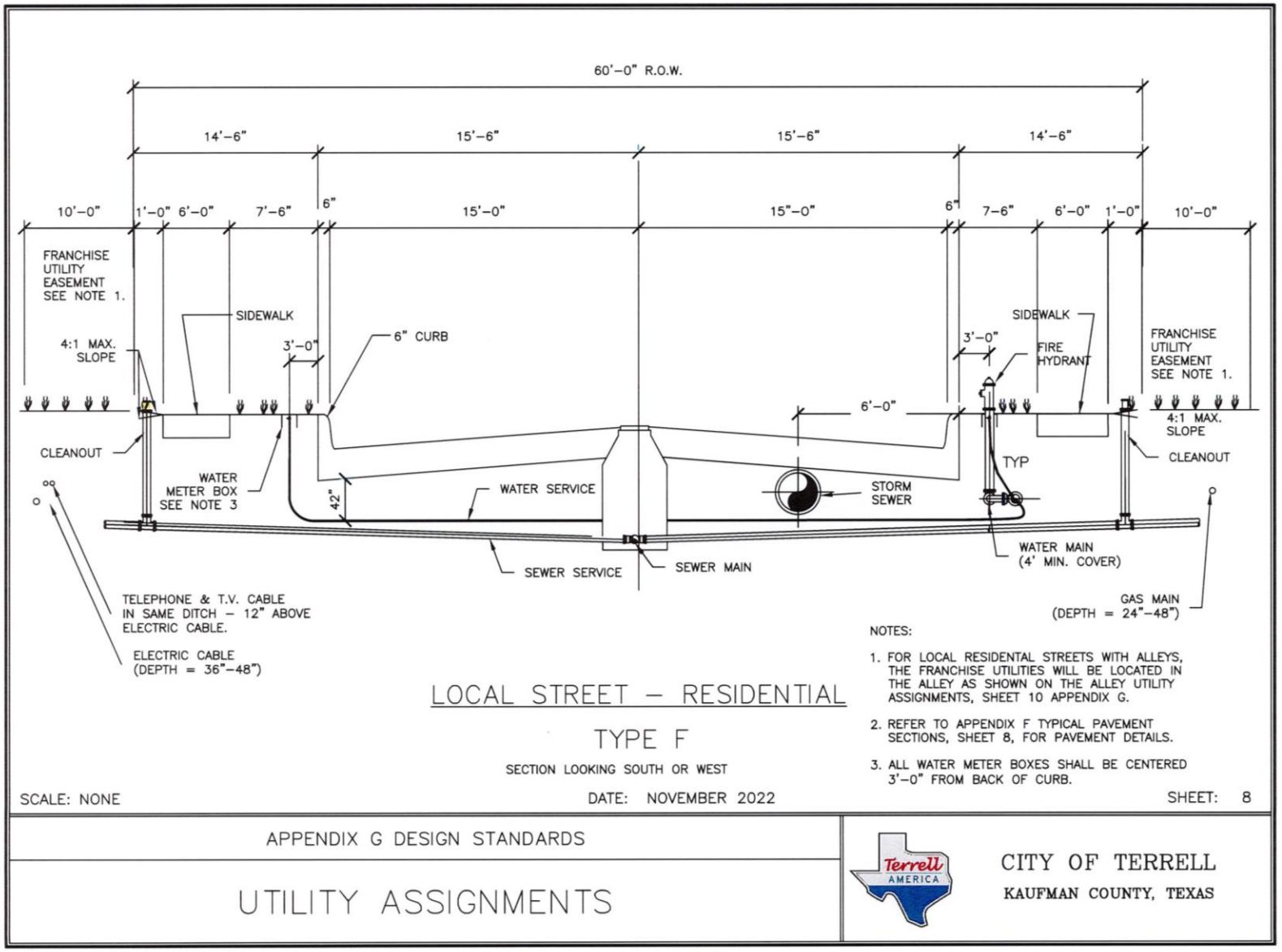
SHEET: 7

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



LOCAL STREET – RESIDENTIAL

TYPE F

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 10 APPENDIX G.
2. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 8, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.

SCALE: NONE

DATE: NOVEMBER 2022

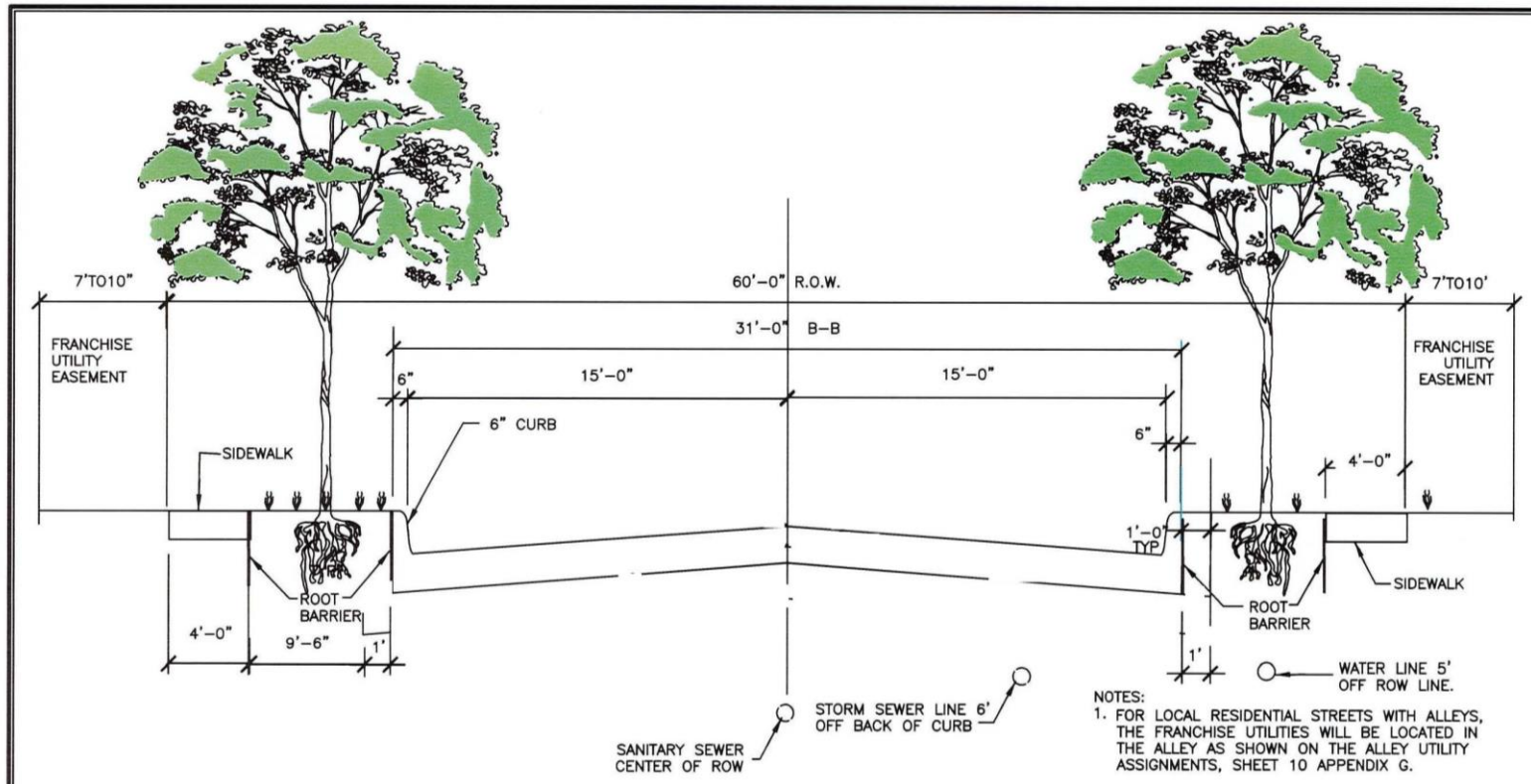
SHEET: 8

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



NOTES:

1. FOR LOCAL RESIDENTIAL STREETS WITH ALLEYS, THE FRANCHISE UTILITIES WILL BE LOCATED IN THE ALLEY AS SHOWN ON THE ALLEY UTILITY ASSIGNMENTS, SHEET 10 APPENDIX G.
2. REFER TO APPENDIX F TYPICAL PAVEMENT SECTIONS, SHEET 9, FOR PAVEMENT DETAILS.
3. ALL WATER METER BOXES SHALL BE CENTERED 3'-0" FROM BACK OF CURB.
4. 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. RECOMMENDATIONS OR APPROVED EQUIVALENT. CONTACT (800) 458-7668.

LOCAL STREET – RESIDENTIAL

OPTIONAL CROSS SECTION

TYPE F

SECTION LOOKING SOUTH OR WEST

SCALE: NONE

DATE: NOVEMBER 2022

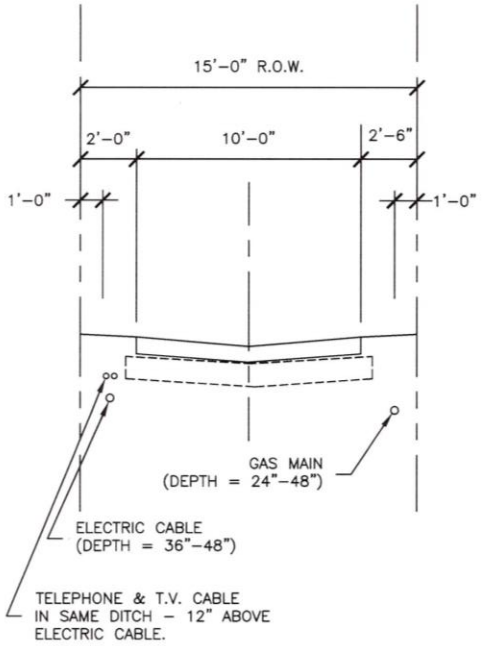
SHEET: 9

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

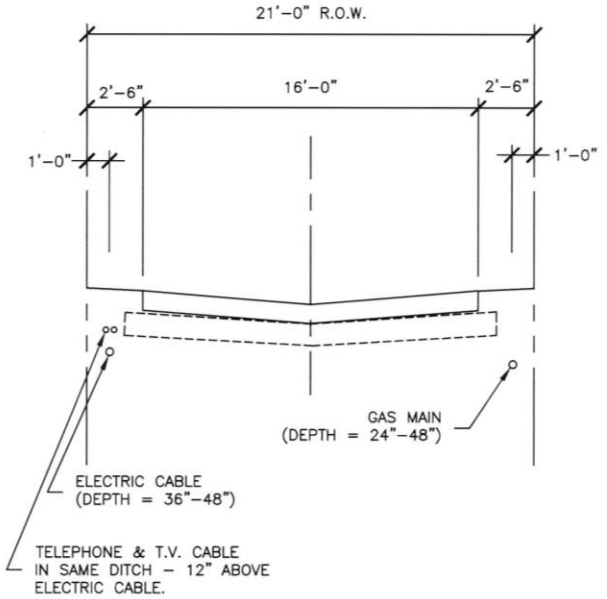
CITY OF TERRELL

KAUFMAN COUNTY, TEXAS



10 FT. ALLEY

SECTION LOOKING SOUTH OR WEST



15 FT. ALLEY

SECTION LOOKING SOUTH OR WEST

ALLEYS

NOTES:

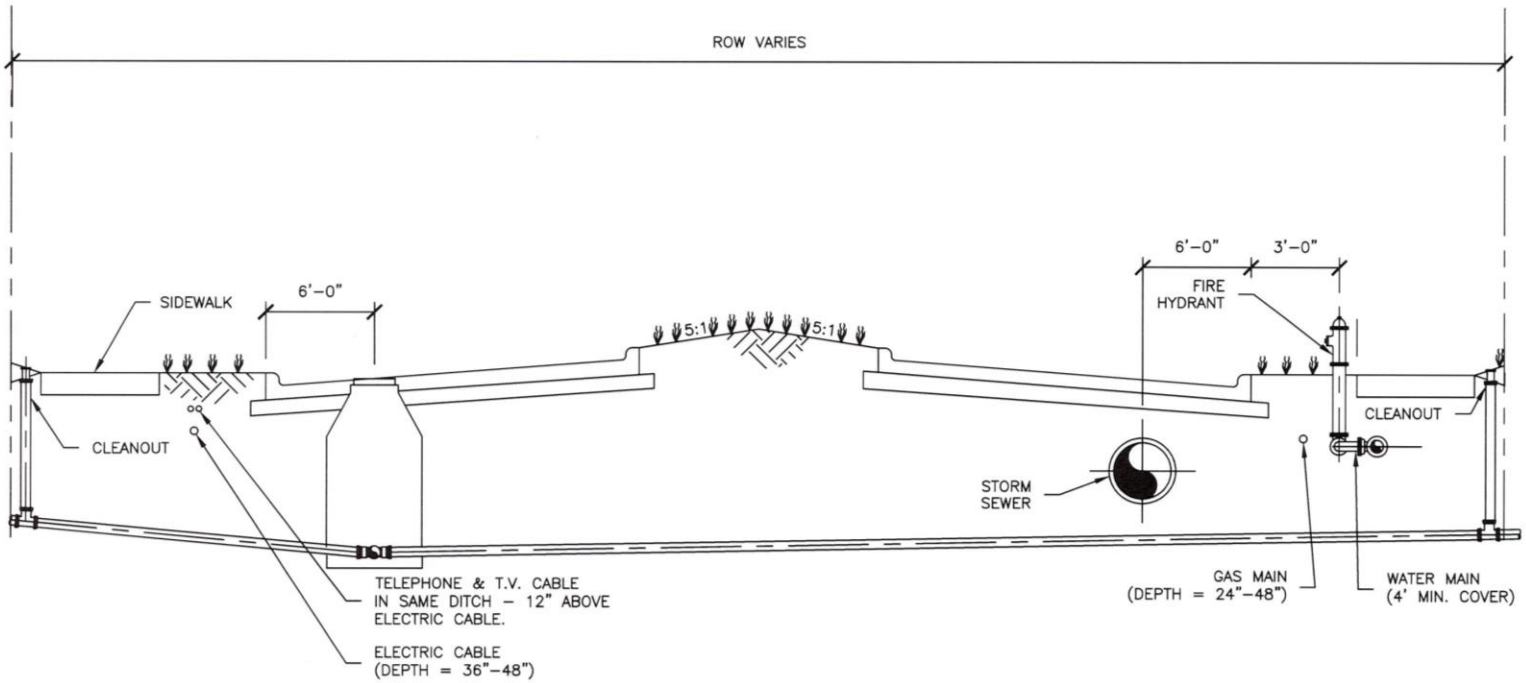
1. GAS, ELECTRIC AND T.V. CABLE UTILITIES ARE TO BE LOCATED IN ALLEYS WHERE POSSIBLE.
2. REFER TO TYPICAL PAVEMENT SECTIONS, APPENDIX F SHEET 10, FOR PAVEMENT DETAILS.

SCALE: NONE | DATE: NOVEMBER 2022 | SHEET: 10

APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS



STREETS WITH NO FRANCHISE UTILITY EASEMENT

SECTION LOOKING SOUTH OR WEST

NOTES:

1. UTILITIES TO BE LOCATE GENERALLY AS SHOWN. TO BE DETERMINED IN CONSULTATION WITH CITY ENGINEER.

SCALE: NONE DATE: NOVEMBER 2022 SHEET: 11

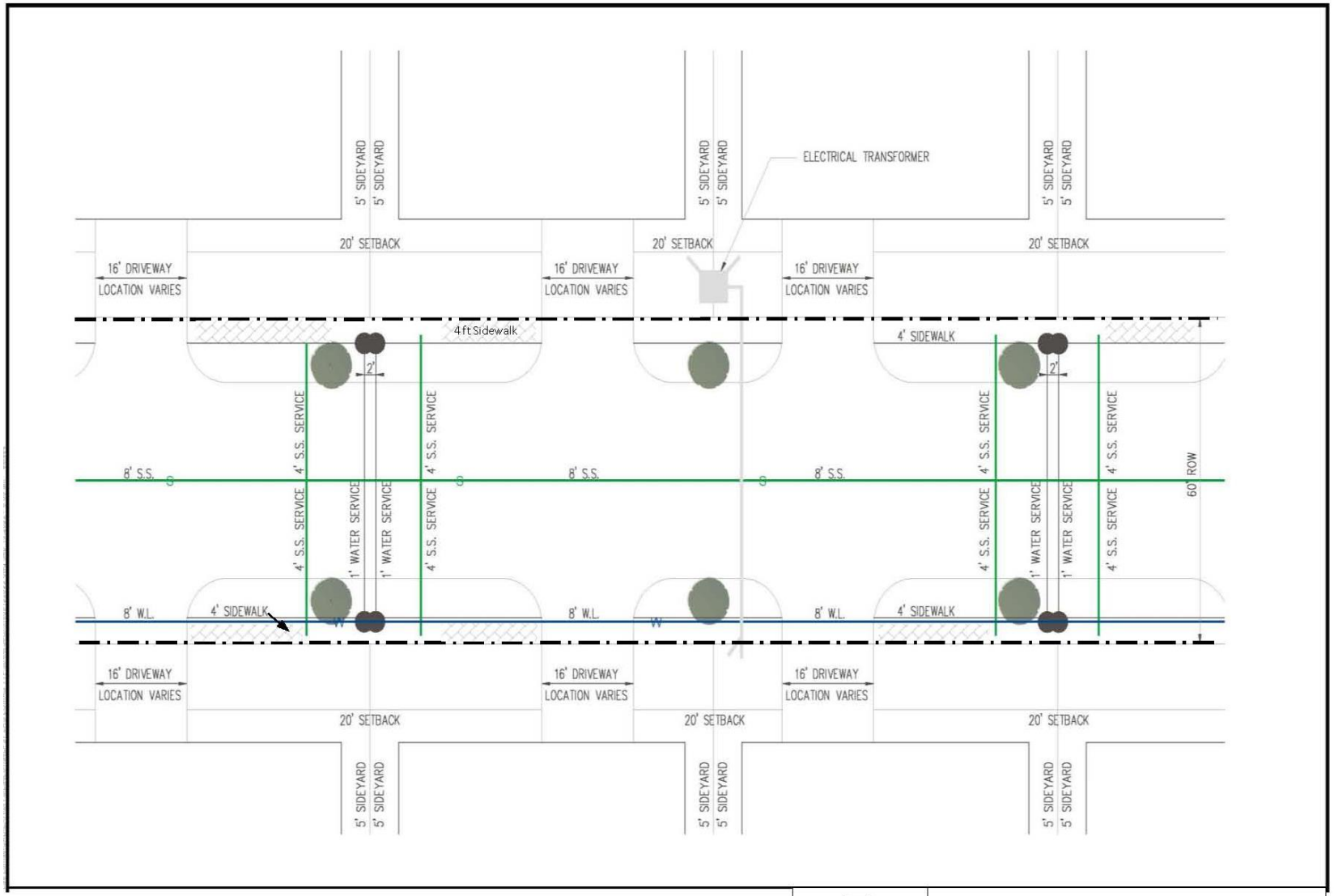
APPENDIX G DESIGN STANDARDS

UTILITY ASSIGNMENTS

CITY OF TERRELL
KAUFMAN COUNTY, TEXAS

APPENDIX H

STANDARD RESIDENTIAL STREET AND LOT LAYOUT



CITY OF TERRELL

Figure H-1

RESIDENTIAL STREET AND LOT LAYOUT