City of Denton

Water and Wastewater Criteria Manual

December 2021

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Section 1 – Introduction

1.1 Purpose

The purpose of this Manual is to provide minimum guidelines for the design and construction of water distribution and wastewater collection systems within the City of Denton, Texas and its extra-territorial jurisdictions. The criteria established in this Manual have been developed from a review of various applicable publications, North Central Texas Council of Government (NCTCOG) Public Works Construction Standards (as amended by the City of Denton), regulatory requirements, and City of Denton offices which oversee the design, construction and maintenance of the water distribution and wastewater collection systems.

These guidelines are to be used by design engineers in the City of Denton Capital Projects Engineering Division, consulting engineers employed by the City, and engineers of subdivision and land development infrastructure projects proposed for construction and acceptance by the City within its Certificate of Convenience and Necessity (CCN) area. The criteria established in this Design Manual provide basic guidance. However, full responsibility and liability for proper design remains with the design engineer. Users of this Manual should be knowledgeable and experienced in the theory and application of water and wastewater engineering. Alternative designs may be submitted for consideration but will require additional time to evaluate, and the Director of Water Utilities must approve any deviations from criteria established in this Manual.

Along with this Manual, the Denton Development Code (DDC) should be consulted for additional criteria. The criteria established in this Manual do not supersede the criteria contained in the DDC. In the case of conflict among this Manual, NCTCOG Public Works Construction Standards as amended by the City of Denton, City of Denton Standard Details, or other cited regulations and standards, the more stringent requirement shall apply.

Section 3 – Water Design Guidelines

3.1 General

It is the responsibility of the design engineer to ensure the final design of a water main is in conformance with the most recent versions of the following documents:

A. Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) – Rules, Ch. 290, "Public Drinking Water"
B. Denton Development Code (DDC)
C. This Manual and the City's Standard Details
D. North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction ("COG Specs."), as amended by the City of Denton
E. City of Denton Water Master Plan
F. Appendix B of the 2012 International Fire Code
G. American Water Works Association (AWWA) Standards

3.2 Water Main Separation from Wastewater Mains

Water mains shall be separated from wastewater mains as set forth in Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) Rules - 30 TAC §290.44.e. Location of waterlines or as mostly recently amended.

3.3 Size of Water Distribution Mains

Water mains shall be sized to meet the calculated water demand, fire flow protection requirements, and to conform to the City of Denton's Water Distribution System Master Plan (Master Water Plan). All residential, commercial, industrial, and any other development connecting to the City's water distribution system shall use the following guidelines:

A. The design engineer shall obtain the record drawing water maps from the Capital Projects Engineering Division and use the following criteria, based on the City's Master Water Plan, for sizing the water lines.
   - Average daily demand in gallons per capita per day = 170 GPCD
     Maximum daily demand / Average daily demand = 2.0
     Peak hour demand / Maximum daily demand = 1.5
   - For Single-Family Residential – Use 3.2 people/unit
   - For Multi-Family Residential – Use 2.5 people/unit

B. Water systems shall be provided with a sufficient number of connections to the City's existing water system and shall be of sufficient size to furnish adequate water supply to furnish fire protection to all lots and conform to the City Master Water Plan. Every new water system shall include two or more connections to the existing City water system, when feasible, to ensure an adequate and reliable water supply in the event of a water main break or routine system maintenance. The City may require two or more meter connections, particularly for larger developments. Good engineering judgement is required to ensure reliability is considered in design of all proposed water systems.

C. The City's standardized water service line sizes are:

Table 3.3-1

Service Size	Meter Size
1 in.	5/8 in. x 3/4 in., full 3/4 in., and 1 in.
2 in.	1-1/2 in. and 2 in.
4 in.	3 in. and 4 in.
6 in.	6 in.
8 in.	8 in.

Non-standard sized water services are not allowed. Refer to the water service connection drawings on the City Standard Details.

D. Sites that require an irrigation meter shall have two separate service line connections onto the main; one for the domestic meter, the other for the irrigation meter.

E. Water pipe shall be a minimum of 8 inches in diameter. The standard pipe sizes that shall be used for water main lines are 8", 12", 16", 20", 24", 30", 36" and 42". Pipe sizes of 6", 10", 14", 18", 21", and 33" are considered non-standard by the City and shall not be used for water main lines. Six (6) in. pipe may be used for fire hydrant connections and, with approval of the Director of Water Utilities, for short dead-end mains with a limited number of service connections.

F. Every development shall provide adequate water capacity for fire protection purposes. Fire flow capacity requirements are in addition to daily demand requirements. The procedure for determining fire flow requirements for buildings or portions of buildings shall be in accordance with version of the International Fire Code adopted in the City. For any platted lot where the end use is not defined, the standards in Table 3.3-2 shall apply.

G. If a development requires a dedicated fire line, the fire line connection shall have a backflow prevention device placed in a vault at the right-of-way or easement line. If the building is located within 50 feet of the right-of-way or easement, the backflow preventer may be placed within the building. A flanged fire line valve shall be required to connect to the tee located on the main line and a fire line valve shall be required outside the downstream side of the vault or ROW line whichever applies.

Table 3.3-2

Area	GPM
One and two family dwellings less than 3,600 SF	1,000
Buildings other than one and two family dwellings less than 3,600 SF	1,500
Medium-intensity commercial and light industrial	3,000
High-intensity commercial and industrial	4,000

All fire flows to be calculated with twenty (20) pounds residual pressures.

In addition to the fire flow requirements specified above, all developments shall provide adequate water capacity to satisfy the greater of (1) Peak Hour demand for the Peak Day or (2) Average Hour demand plus fire flow for the Peak Day.

Mains are to be sized to ensure less than 1 foot of head loss per 1,000 feet of water main at Hazen Williams coefficients of C = 100, except for fire flow demands within the subdivision internal distribution system.

Special exceptions to the above standards may be made by the Director of Water Utilities for unique situations.

3.3.1 Public Fire Hydrants

Fire flow requirements shall be in accordance with Ch. 29 of the City of Denton Code of Ordinances and Appendix B of the 2012 International Fire Code.

3.3.2 Private Fire Mains

In addition to the requirements of 3.3.1, private fire protection water mains shall be installed in accordance with NFPA 24 and 2012 International Fire Code requirements. Private fire protection mains shall be permitted by the Fire Marshall's Office.

3.3.3 Fire Flow Tests

Fire flow tests are normally requested by the design engineer, the MEP engineer, and other engineers to determine available water system capacity at or near the point of interest. If a fire flow test on the existing water system is necessary, contact the Water Utilities Department directly.

3.4 Depth of Cover for Water Mains

The following guidelines shall govern depth of cover for water main installations:

Table 3.4-1
Water Main under unpaved areas

Pipe Size	Minimum Depth of cover to top of pipe
12” and smaller	5’
16” and larger	6’

Table 3.4-2
Water Main under proposed or existing pavement

Pipe Size	Minimum Depth of cover to top of pipe
12” and smaller	42”
16”	5’
20” and larger	6’

Additional depth of cover shall be required for low lying areas where future drainage improvements are anticipated.

3.5 Pipe and Fittings

Specifying the appropriate pipe material is the responsibility of the design engineer, based on the analysis of specific site and loading conditions and pressure requirements. The minimum requirements in this Section are based on pipe size only and in no way relieve the design engineer of the responsibility of specifying the pipe material applicable to the specific project. Pipe gasket material shall be that recommended by the manufacturer for the specified pipe. Special attention shall be given by the design engineer for unique pipe fitting and pipe assembly situations.

See Table 3.5-1 for the City’s minimum pipe materials, fittings, polywrap, thrust restraint, and embedment requirements, as a function of pipe size.

All fittings for pipe sizes less than 30 inches in diameter, including vertical and horizontal bends, shall have concrete thrust blocking. See Drawings W700, W701, W702A, W702B, W702C, and W703 on Sheet 3 of the City Standard Details.

For all water line sizes, all fittings, including vertical and horizontal bends, shall have restrained joints, designed independently of concrete thrust blocking. For water lines greater than 12 inches in diameter additional restrained joints may need to be installed beyond the fitting (i.e., may need to be installed on several pipe joints on each side of the

fitting), depending on the required restrained length calculated. Restrained length calculations shall be included in the lay schedule in the material submittal package and shall use approved methods of joint restraint. See City Standard Details, specific product listings and Table 3.5-1.

Table 3.5-1
Minimum Requirements for Pipe and Fittings

Pipe Size	Pipe Material	Ductile Iron Fittings	Polywrap (Pipe & Fittings)	Thrust Restraint (IN ADDITION TO AND DESIGNED INDEPENDENTLY OF THRUST BLOCKING)	Embedment
8 in. - 12 in.	PVC (AWWA C900, DR-14)	Mechanical joint; Compact or Full-Body	8-mil V-Bio Enhanced Polywrap (fitting only)	Wedge-action mechanical joint restraint glands, at fittings.	See drawings U201, U202, U203A, U203C in City Standard Details
16 in. - 20 in.	Ductile Iron, AWWA C151, Special Thickness Class 52, push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	See drawings U201, U202, U203A, U203C in City Standard Details
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint	Contact Water Utilities Dept.
24 in.	Ductile Iron, AWWA C151, Special Thickness Class 52, push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	Crushed Stone
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint.	Contact Water Utilities Dept.
30 in. and larger	Ductile Iron, Pressure Class 350; push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	Crushed Stone
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint.	Contact Water Utilities Dept.

3.6 Meters and Meter Cans/Vaults

The City allows the following water meters, depending on the volume and nature of the customer flow demands:

Table 3.6-1

Meter Size	Type	Manufacturer
5/8” x 3/4”	Positive Displacement	Neptune/Badger
3/4” x 3/4”	Positive Displacement	Neptune/Badger
1”	Positive Displacement	Neptune/Badger
1-1/2”	Positive Displacement	Neptune/Badger
2”	Positive Displacement	Neptune/Badger
3” Tru/Flo	Compound	Neptune/Badger
4” Tru/Flo	Compound	Neptune Badger
6” Tru/Flo	Compound	Neptune/Badger
6” Protectus III Fire Service (Shall be used for combination of domestic and fire service)	Compound	Neptune/Badger
8” Protectus III Fire Service (Shall be used for combination of domestic and fire service)	Compound	Neptune/Badger

Turbine meters shall be allowed for irrigation meters; not for domestic meters.

Venturi meters shall be allowed when recommended by City Water Utilities based on Single Family Equivalent calculations.

Vaults are required for all meters greater than 2 in.

See Section 3.6.4 for Furnishing and Installing meters.

3.6.1 Number of Meters

The standard policy is that only one meter for domestic use will be furnished to each lot. Submetering by the property owner shall be done at the owner’s expense with privately purchased and maintained meters. Exceptions to that policy are:

1) Commercial, industrial or institutional sites shall have a separate irrigation meter from the domestic meter.
2) Multi-family developments with greater than 200 units shall be required to have two meters for redundancy and reliability of water service where each meter is located on a different water main or separated by an inline valve.
3) Multi-building sites where the configuration or size of the site makes a single meter location impractical or infeasible.
4) Duplex, Triplex or Quadplex buildings may have a separately furnished meter for each unit. A single service line tap off of the main shall be made for these building types with a branch service line for each meter.

3.6.2 Sizing

In commercial and industrial projects, the design engineer shall consult with the owner or the Mechanical, Electrical and Plumbing (MEP) engineer to identify proposed sizes and locations for domestic water meters, fire sprinkler connections and irrigation meters.

During Building Permit review, the City evaluates adequacy of meter size using Table E201.1, "Minimum Size of Water Meters, Mains and Distribution Piping Based on Water Supply Fixture Unit Values (w.s.f.u.)" of the version of the International Plumbing Code as adopted by the City (copy included herein as Table 3.6.2-1). The City's Building Permit Plans Review uses the version of the International Residential Code as adopted by the City, Table P2903.6, "Water-Supply Fixture-Unit Values for Various Plumbing Fixture and Fixture Groups" (see Table 3.6.2-2) to estimate water supply fixture units (w.s.f.u.). To facilitate review of the proposed meter size, the design engineer shall submit a tabulation of water supply fixture units (w.s.f.u.); a sample tabulation is provided herein in Table 3.6.2-3.

Contact the Water Utilities Dept. regarding criteria for sizing fire-rated master meters.

When sizing water meters, the design engineer should be aware that, per City Code, water and wastewater Impact Fees are based on water meter size, with the following exceptions:

A. For multifamily developments of 8 or more units, Impact Fees are based on bedroom count.

B. For fire-rated master meters, Impact Fees are based on the equivalent meter size the City would require for domestic demands (except for multifamily developments of 8 or more units, in which case Impact Fees are based on bedroom counts).

C. For institutional developments like hospitals, dormitories, nursing homes or assisted living facilities the Water Department will need to be consulted as to the appropriate methodology for sizing the meter.

Refer to Table 3.6.2-4, "Land Use and Service Unit/SFE Equivalencies." Impact Fees are based on Single Family Equivalents (SFE's). For example, Impact Fees for a 1-1/2" meter would be twice those for a 1" meter.

TABLE 3.6.2-1

2018 International Plumbing Code - TABLE E201.1
MINIMUM SIZE OF WATER METERS, MAINS AND DISTRIBUTION PIPING BASED ON WATER SUPPLY FIXTURE UNIT VALUES (w.s.f.u.)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 30 to 39 psi		40	60	80	100	150	200	250	300	400	500
3/4	1/2a	2.5	2	1.5	1.5	1	1	0.5	0.5	0	0
3/4	3/4	9.5	7.5	6	5.5	4	3.5	3	2.5	2	1.5
3/4	1	32	25	20	16.5	11	9	7.8	6.5	5.5	4.5
1	1	32	32	27	21	13.5	10	8	7	5.5	5
3/4	1-1/4	32	32	32	32	30	24	20	17	13	10.5
1	1-1/4	80	80	70	61	45	34	27	22	16	12
1-1/2	1-1/4	80	80	80	75	54	40	31	25	17.5	13
1	1-1/2	87	87	87	87	84	73	64	56	45	36
1-1/2	1-1/2	151	151	151	151	117	92	79	69	54	43
2	1-1/2	151	151	151	151	128	99	83	72	56	45
1	2	87	87	87	87	87	87	87	87	87	86
1-1/2	2	275	275	275	275	258	223	196	174	144	122
2	2	365	365	365	365	318	266	229	201	160	134
2	2-1/2	533	533	533	533	533	495	448	409	353	311

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.2-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 40 to 49 psi		**40**	**60**	**80**	**100**	**150**	**200**	**250**	**300**	**400**	**500**
3/4	1/2a	3	2.5	2	1.5	1.5	1	1	0.5	0.5	0.5
3/4	3/4	9.5	9.5	8.5	7	5.5	4.5	3.5	3	2.5	2
3/4	1	32	32	32	26	18	13.5	10.5	9	7.5	6
1	1	32	32	32	32	21	15	11.5	9.5	7.5	6.5
3/4	1-1/4	32	32	32	32	32	32	32	27	21	16.5
1	1-1/4	80	80	80	80	65	52	42	35	26	20
1-1/2	1-1/4	80	80	80	80	75	59	48	39	28	21
1	1-1/2	87	87	87	87	87	87	87	78	65	55
1-1/2	1-1/2	151	151	151	151	151	130	109	93	75	63
2	1-1/2	151	151	151	151	151	139	115	98	77	64
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	264	238	198	169
2	2	365	365	365	365	365	349	304	270	220	185
2	2-1/2	533	533	533	533	533	533	533	528	456	403

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.2-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range 50 to 60 psi		40	60	80	100	150	200	250	300	400	500
3/4	1/2a	3	3	2.5	2	1.5	1	1	1	0.5	0.5
3/4	3/4	9.5	9.5	9.5	8.5	6.5	5	4.5	4	3	2.5
3/4	1	32	32	32	32	25	18.5	14.5	12	9.5	8
1	1	32	32	32	32	30	22	16.5	13	10	8
3/4	1-1/4	32	32	32	32	32	32	32	32	29	24
1	1-1/4	80	80	80	80	80	68	57	48	35	28
1-1/2	1-1/4	80	80	80	80	80	75	63	53	39	29
1	1-1/2	87	87	87	87	87	87	87	87	82	70
1-1/2	1-1/2	151	151	151	151	151	151	139	120	94	79
2	1-1/2	151	151	151	151	151	151	146	126	97	81
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	275	275	247	213
2	2	365	365	365	365	365	365	365	329	272	232
2	2-1/2	533	533	533	533	533	533	533	533	533	486

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.2-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
Pressure Range Over 60		40	60	80	100	150	200	250	300	400	500
3/4	1/2a	3	3	3	2.5	2	1.5	1.5	1	1	0.5
3/4	3/4	9.5	9.5	9.5	9.5	7.5	6	5	4.5	3.5	3
3/4	1	32	32	32	32	32	24	19.5	15.5	11.5	9.5
1	1	32	32	32	32	32	28	28	17	12	9.5
3/4	1-1/4	32	32	32	32	32	32	32	32	32	30
1	1-1/4	80	80	80	80	80	80	69	60	46	36
1-1/2	1-1/4	80	80	80	80	80	80	76	65	50	38
1	1-1/2	87	87	87	87	87	87	87	87	87	84
1-1/2	1-1/2	151	151	151	151	151	151	151	144	114	94
2	1-1/2	151	151	151	151	151	151	151	151	118	97
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	275	275	275	252
2	2	365	368	368	368	368	368	368	368	318	273
2	2-1/2	533	533	533	533	533	533	533	533	533	533

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.2-2

2018 International Residential Code

P2903.6 Determining Water-Supply Fixture Units
Supply loads in the building water-distribution system shall be determined by total load on the pipe being sized, in terms of water-supply fixture units (w.s.f.u.), as shown in Table P2903.6, and gallon per minute (gpm) flow rates [see Table P2903.6(1)]. For fixtures not listed, choose a w.s.f.u. value of a fixture with similar flow characteristics.

TABLE P2903.6
WATER-SUPPLY FIXTURE-UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS

TYPE OF FIXTURES OR GROUP OF FIXTURES	WATER-SUPPLY FIXTURE-UNIT VALUE (w.s.f.u.)		
	Hot	Cold	Combined
Bathtub (with/without overhead shower head)	1.0	1.0	1.4
Clothes washer	1.0	1.0	1.4
Dishwasher	1.4	—	1.4
Full-bath group with bathtub (with/without shower head) or shower stall	1.5	2.7	3.6
Half-bath group (water closet and lavatory)	0.5	2.5	2.6
Hose bibb (sillcock)[a]	—	2.5	2.5
Kitchen group (dishwasher and sink with/without garbage grinder)	1.9	1.0	2.5
Kitchen sink	1.0	1.0	1.4
Laundry group (clothes washer standpipe and laundry tub)	1.8	1.8	2.5
Laundry tub	1.0	1.0	1.4
Lavatory	0.5	0.5	0.7
Shower stall	1.0	1.0	1.4
Water closet (tank type)	—	2.2	2.2

For SI: 1 gallon per minute = 3.785 L/m.

a. The fixture unit value 2.5 assumes a flow demand of 2.5 gpm, such as for an individual lawn sprinkler device. If a hose bibb/sill cock will be required to furnish a greater flow, the equivalent fixture-unit value may be obtained from this table or Table P2903.6(1).

Table 3.6.2-3

SAMPLE W.S.F.U. TABULATION			
Quantity	**Fixture**	**Load Values, in Total Water Supply Fixture Units (Each)**	**Total Fixture Units**
9	Water Closet (Public; Flush Valve)	10.0	90
3	Water Closet (Public; Flush Tank)	5.0	15
5	Urinal (Public; 3/4-inch Flush Valve)	5.0	25
10	Lavatory (Public)	2.0	20
2	Kitchen Sink (Hotel, Restaurant)	4.0	8
1	Service Sink	3.0	3
1	Shower Head (Private)	1.4	1.4
		Total	**162.4**

Table 3.6.2-4

EXHIBIT F LAND USE AND SERVICE UNIT/SFE EQUIVALENCIES WATER AND WASTEWATER FACILITIES From Section 26-218 of City of Denton Code of Ordinances			
Meter Type	**Meter Size**	**Typical Land Use**	**Single Family Equivalents (SFEs)**
Positive Displacement	5/8" X 3/4"	Residential - Single Family (Building less than 1,300 sq. ft./ lot size less than 6,000 sq. ft.)	0.5
Positive Displacement	5/8" X 3/4"	Residential - Single Family	1.0
Positive Displacement	3/4" X 3/4"	Residential / Commercial	1.5
Positive Displacement	1"	Residential / Commercial	2.5
Positive Displacement	1-1/2"	Commercial	5.0
Positive Displacement	2"	Commercial	8.0
Compound	3"	Commercial / Industrial	22.5
Compound	4"	Commercial / Industrial	50.0

Source: City of Denton Approved Meter Manufacturer's Specifications

NOTE: The total service units for multi-family apartment projects with eight or more units shall be determined by multiplying the total number of bedrooms in the multi-family apartment project by 0.26 Single Family Equivalents (SFEs).

3.6.3 Location

Water meters and meter cans and vaults shall be placed within a City Right-of-Way, Public Utility Easement or Public Water Easement. Placement shall also satisfy the following requirements:

A. Located as close as possible to the public water main.

B. Easily accessible to City of Denton employees.

C. Located in an unpaved area that does not conflict with vehicular or pedestrian traffic.

3.6.4 Furnishing and Installing

All meters 2" and smaller shall be furnished and installed by City Water Utilities for fees per the current Fee Schedule. All meter assemblies 3" and larger and their associated vaults shall be furnished and installed by Contractor at their expense and inspected by Public Works Inspection or City Water Utilities.

3.6.5 Details

Details of the meter can assemblies for meter sizes 2" and smaller are shown in Drawings W501A, W501B, W501C, and W502 on Sheet 2 of the City Standard Details.

Details of the meter vault assemblies for meter sizes 3" and larger are shown in Drawings W100, W101, W102, and W103 on Sheet 1 of the City Standard Details.

3.7 Water Main Horizontal and Vertical Alignment

The following guidelines should be followed by the design engineer in placement of water lines:

A. In existing streets, water lines shall be placed in the pavement 2 feet inside of the curb and gutter line intersection. For new residential development, water lines shall be placed on the north and east sides of the streets, where possible, 2 feet inside of the curb and gutter line intersection. See Drawing U101 on Sheet 7 of the City Standard Details.

B. All water lines shall be laid as straight as possible. Avoid excessive number of high points and low points between cross street connections, as they trap air pockets. See Section 3.15.2 for placement of air release valves.

C. Minimum radius of curve and maximum deflection angle of pipe joints will be restricted to the manufacturer's recommendation, after which the use of horizontal or vertical bends will be required. Deflection of pipe shall only be permitted through joint deflection; no bending of pipe is allowed.

D. Vertical bends shall be no greater than 45 degrees.

E. Except for pipe crossings, no other utility shall be installed over, under or within 5 ft. horizontally of a water line.

F. Provide at least 2 feet of vertical separation between a water line and any utility or storm drain crossing it.

3.8 Highway Crossings

Crossings of State or County controlled roads shall require the review and approval of the appropriate regulatory agency. Crossings shall meet the requirements made by the controlling agency and by City of Denton Standards. In the event of different requirement levels for the same item, the more stringent standard shall apply.

3.9 Railroad Crossings

The design engineer shall, prior to the design of any railroad crossing, contact the appropriate railroad company and regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent than those of the Railroad Company or regulatory agency, the City's standards shall apply. See Section 6.4.A for processing of railroad permits.

3.10 Creek Crossings

Where water mains are laid under any flowing stream or semi-permanent body of water, such as a marsh or pond, the water main shall be installed in a separate watertight encasement pipe, with valves on each side of the crossing to allow the isolation and testing of that portion of the water main to determine if there are any leaks and to facilitate future repairs.

A primary consideration in the design of creek crossings is the prevention of soil erosion in the areas of trench backfill. The design engineer shall determine the need and limits of any special embedment and determine and specify the limits for specialized backfills.

3.11 Tunneling, Boring, Jacking and Casing

Tunneling, boring, jacking and Casing are methods used for water line placement under restrictive conditions when open-cut construction is not allowed. Only straight pipe alignments for both horizontal and vertical alignment are allowed.

Design engineers should consider the location, size and depth of boring and receiving pits when choosing the beginning and ending stations for boring. A typical bore pit is between 35 and 40 feet in length to accommodate the boring machine and one joint of pipe. Width of the bore pit can vary depending on the depth and size of pipe, with the narrowest width being approximately 15 ft. The preferred location for the bore pit is the lower elevation end of the bore; allowing any groundwater and/or boring slurry to drain from the tunnel into the bore pit. The water can then be removed by pumping.

Steel casing pipe, where required for open-cut or other than open cut installation, shall have an inside diameter (ID) large enough to accommodate a carrier pipe of at least two

(2) standard sizes above the pipe being installed and shall meet the minimum ID listed in Table 3.11-1. The casing pipe wall thickness design shall be based on the requirements of the agency whose facility is being crossed and shall conform to the minimum criteria listed in Table 3.11-1. Casing pipe shall be provided with interior and exterior coal-tar protective coating in accordance with AWWA C203. Field welds shall be coated with an equivalent coating.

Table 3.11-1

Nominal Carrier Pipe Size	Minimum Casing Pipe ID	Minimum Casing Pipe Wall Thickness
8 in.	12 in.	3/8 in.
12 in.	20 in.	1/2 in.
16 in.	24 in.	1/2 in.
20 in.	30 in.	1/2 in.
24 in.	36 in.	5/8 in.
30 in.	42 in.	5/8 in.
>30 in.	a	b

a. Consult with Water Utilities Department
b. Project specific design, sealed and signed by a Professional Engineer licensed by the State of Texas

Carrier pipes may be PVC with external harness restrained joints (requires larger casing than for pipe alone) or ductile iron with restrained joints. All carrier pipes shall be installed in accordance with the pipe manufacturer's recommendations, properly restrained and supported with approved spacers and casing end seals. Pipe joint restraint shall be achieved using only City approved pipe manufacturer externally restrained joint systems. Refer to Standard Detail U208A and the current City approved Materials Submittal List.

3.12 Elevated Crossings

Elevated crossings are not permitted for water mains except for special cases approved by the Director of Water Utilities. Design requirements for approved elevated crossings shall be tailored to the specific project characteristics.

3.13 Underground Utility Crossings

Where water mains are laid under or over another buried utility line or underground facility (i.e., storm drain, culvert boxes, franchise utilities, etc.), special requirements may be necessary for the protection of the water main. Table 3.13-1 gives a breakdown of the provisions required for different crossing situations.

Table 3.13-1
Utility Crossing Requirements

Crossing	Utility Line Size (in)	Separation (ft)	Special Requirement
Under	less than 24	>= 2	None
Under	less than 24	< 2	Concrete encasement
Under	24 to 42	>= 2	None
Under	24 to 42	< 2	Cased in steel pipe
Under	Greater than 42	>= 2	Cased in PVC pipe
Under	Greater than 42	< 2	Cased in steel pipe
Under	10 feet or greater	Any	Cased in steel pipe
Over	less than 24	>= 2	None
Over	less than 24	< 2	Concrete encasement
Over	24 or greater	>= 2	None
Over	24 or greater	< 2	Cased in steel pipe

Encasement shall be extended a minimum of 3 feet beyond the edge of the utility or facility to be crossed. Water mains that cross utility lines in private easements must adhere to the requirements of the easement owner as well as those listed above.

3.14 Fence or Wall Crossings

Where water mains cross under a fence, wall or some other border structure, special provisions may be required for the protection and maintenance of the water main. Water mains crossing under privacy fencing (wood or chain-link) shall not require any special protection. Water mains crossing under a screening or border wall will require steel casing pipe to allow for removal of the pipe from either side of the wall. A water main crossing under a retaining wall or some other structure serving a soil retention purpose shall be encased in steel encasement that extends a minimum of 5 feet beyond the footing for the wall or structure.

3.15 Existing Water Main Replacement

Whenever an existing main is to be replaced by a new main use the following guidelines for alignment and design:

1) The new line should be located as near as possible to the existing line while allowing the existing line to remain in service until the new line is ready to be put into service.
2) If the existing line is in or next to a roadway, the new line should be placed under existing pavement, not behind the curb in the parkway area.
3) The new line should be designed to utilize the existing metering locations where possible.

The size of the new line should match the size of the existing line. If the existing line is a non-standard size (i.e., 6” or 10”) than the new line should be sized for the next larger standard size. The design engineer shall perform field investigations to determine pavement condition over the existing main. The pavement may have been patched due to breaks in the existing main over the years. Based on field investigations, the design engineer shall include additional quantities for pavement replacement, if necessary.

3.16 Methods of Connection

3.16.1 Pressure Zones

The City of Denton's Water Distribution System is divided into several water pressure zones to ensure even water pressure gradients. Prior to the design of connection points between a proposed main and any existing main, the design engineer shall investigate and determine if the proposed water main crosses the boundary between different pressure zones.

Even though physical connections of water pipes exist between pressure zones, they are designed with valves which are closed at the boundary points so that each pressure zone is isolated. Proposed mains that approach pressure zone boundaries shall be designed to loop within their designated pressure zones and with no or minimum lengths of dead-end mains.

Connections between pressure zones must be approved by the City of Denton, and may require pressure reducing valve stations. The design engineer can determine the pressure zone boundaries by consulting the record drawing water maps which show the designated closed valves between pressure zones and by contacting the Capital Projects Engineering Division. See Figure 3.16.1-1 for a Pressure Zone Map.

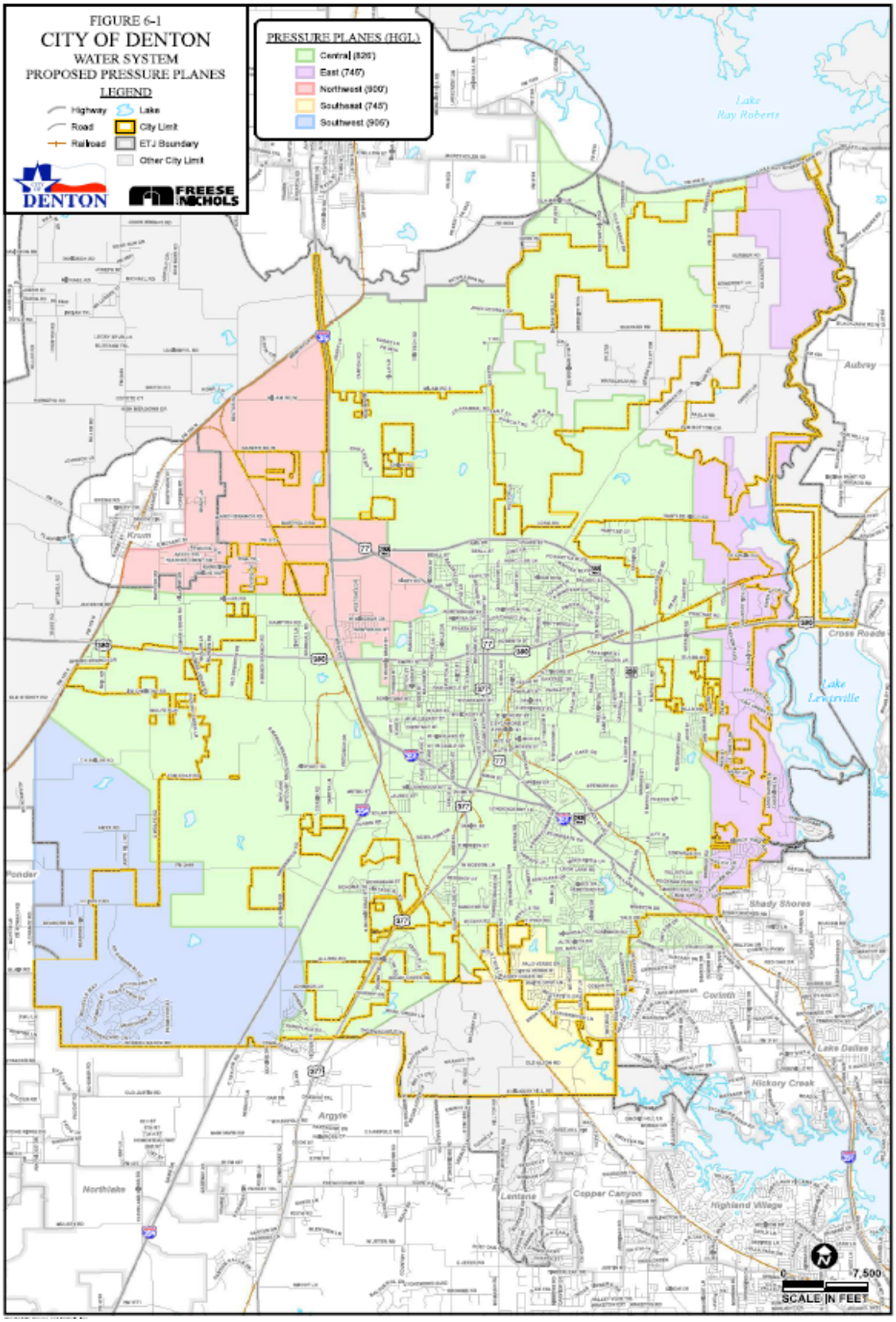

Figure 3.16.1-1 Pressure Zone Map

3.16.2 Tapping Sleeve and Valve

Tapping sleeves with tapping valves shall be used whenever possible for connections to existing mains to avoid interruption of water services. See Figure 3.1 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.

A. Size on size taps are allowed up to 12."
(Example: 12" X 12")

B. Taps on 16" and larger pipes must be approved in writing in advance by the Director of Water Utilities, and at least one standard pipe size smaller than the pipe being tapped. See Figure 3.2 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.
(Example: 16" X 12", 16" X 8" and 16" X 6" taps are allowed).

3.16.3 Type "D" Connection

When two mains 12" and larger are designed such that they cross each other, they should be connected by means of a Type "D" connection, instead of the installation of a cross. See Figure 3.3 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.

3.16.4 Cut-In Connection

On occasions when connecting to an existing main, it may be desirable to have an additional valve on the existing main. In this situation, the design engineer should consider using a cut-in connection with a tee and valve being cut into the existing main. See Figure 3.4 in Drawing PIAZ14 on Sheet 2 of the City Standard Details.

3.16.5 Main Extensions

It is recommended and good practice, though not required, that a new valve be installed at the point of connection for water main extensions. This will facilitate the testing and chlorination of the new main prior to its placement into service. See Figure 3.5 in Drawing PIAZ14 on Sheet 2 of the City Standard Details.

3.17 Valves

3.17.1 Isolation Valves

3.17.1.1 Location

Isolation valves shall be provided to allow for the proper operation and maintenance of the water distribution system, and to ensure water quality can be maintained to each individual water customer connected to the system.

The location of valves needs to properly address the ability of the Department of Water Utilities to remove a water line from service to perform necessary repairs, while minimizing the interruption of service to the least number of customers and to fire protection. Isolation of any given section of water line should generally be able to be accomplished by closure of the least number of valves, as would generally be expected under good engineering design practices and utility engineering standards. The Department of Water Utilities reserves the right to require changes to proposed designs to satisfy these objectives.

The design engineer shall place valves on proposed water mains so they may be easily located in the future by operations and maintenance crews.

The following guidelines should be used by the design engineer in placement of isolation valves on proposed water mains:

A. Two valves are to be installed at every tee location, one flanged to the branch of the tee and the other a mechanical joint connection on one of the two runs of the tee. See Figure 3.6 in Drawing PIAZ15 on Sheet 2 of the City Standard Details. Three valves are to be installed at every cross location, each a mechanical joint connection.

B. Valves for line sizes 12" in diameter or less should not be spaced any farther apart than 1,000 feet. For city blocks that are longer than 1,000 feet between street intersections, placement of a valve will be required between street intersections.

C. Valves should be generally located so that no more than four (4) valves are required to isolate a section of main. See Figure 3.7 in Drawing PIAZ15 on Sheet 2 of the City Standard Details. For mains larger than 12" in diameter, valve spacing and placement shall be subject to alternate criteria approved by the Director of Water Utilities.

D. All fire hydrant leads are to be designed with a valve that is flanged to the main line.

3.17.1.2 Specifications

Refer to Table 3.17.1.2-1.

Table 3.17.1.2-1
Isolation Valve Requirements

Size	4 in. - 12 in.	16 in. - 20 in.	24 in.	30 in.	36 in. or larger
Type	Gate Valve (AWWA C509 resilient-seat)	Gate Valve (AWWA C515 resilient-seat)	Gate Valve (AWWA C515 resilient-seat)	Gate Valve (AWWA C515 resilient seat)	Gate Valve (AWWA C515 resilient-seat) or butterfly, to be determined by City on a case-by-case basis
Orientation	Vertical	Vertical	Vertical	Vertical or horizontal; to be determined by City on a case-by-case basis	Vertical or horizontal; to be determined by City on a case-by-case basis
Gear Operator Required	No	No	Yes	Yes	Yes
Vault Required	No	No	Yes	Yes	Yes
Bypass Required	No	No	No	Yes	Yes

3.17.1.3 Details

Refer to Drawings W104, W105, W106A, W106B, and W601 on Sheets 1 and 2 of the City Standard Details.

3.17.2 Air Release Valves and Air / Vacuum-Air Release Valves

For water mains less than 16" diameter in certain situations where the topography, remoteness, or some other hydraulic factor necessitates it, air release valves are required at local high points to facilitate automatic release of accumulated air.

For 16" and larger mains, the City requires air / vacuum air release valves at local high points to facilitate automatic release of accumulated air and to facilitate automatic prevention of vacuum conditions within the line. See Drawings W801 and W802 on Sheet 3 of the City Standard Details.

3.17.3 Pressure Regulators

In areas where pressures may exceed 80 psi, builders and plumbers should be advised that in such locations pressure reducing devices should be installed in accordance with the current Plumbing Code adopted by the City of Denton. Pressure reducing valves will not be installed in the public water system.

3.18 Dead-end Mains

Dead-end main situations should be avoided whenever possible. These situations create a stagnant water condition that can cause taste and odor problems as well as low chlorine residuals. These mains create maintenance problems, because they must be routinely flushed. In addition, dead end mains result in a waste of water resources due to required flushing to ensure water quality.

In lieu of dead-end mains, the design should loop through public right-of-way or a dedicated public utility easement (with adequate assurance of access and fencing prohibited) to another nearby water main using the same size pipe.

If a dead-end main situation is unavoidable, it shall be designed so that it may be periodically flushed of stagnant water by locating a fire hydrant or other flushing device near the main's end and past the last service connection.

It is recommended that a dead-end main should have no more than one fire hydrant connected to it. If the length of the dead-end main is such that a fire hydrant is required along it, then the design engineer should consider if any additional fire hydrants need to be placed on the cross feed mains. See Figure 3.8 in Drawing PIAZ16 on Sheet 2 of the City Standard Details.

3.19 Fire Hydrant Locations and Coverage

The design engineer should locate fire hydrants as close as possible to street intersections, but outside of the curb radius. This positioning of fire hydrants provides coverage along several streets. When spacing requirements necessitate the installation of fire hydrants between street intersections, they should be placed at the projection of lot lines between property owners. For main replacement projects in established neighborhoods, fire hydrants should be designed as close as possible to the old fire

hydrant location, provided coverage is adequate. Neighborhood residents are familiar with the fire hydrant being at that location and normally expect a replacement fire hydrant to be placed at the same location. Fire hydrants are not to be installed closer than nine (9) feet to any wastewater main or any wastewater appurtenance.

As a general guideline, fire hydrants shall be placed at a maximum of 600 feet apart in residential areas and a maximum of 300 feet apart in commercial (including apartments) and industrial areas.

3.20 Requirements for Abandoning Water Mains

The design engineer should note the limits and appropriate conditions for the abandoning of existing water mains which are to be replaced by the construction of any proposed water mains.

The design engineer should also make allowances in the design to provide for the existing and proposed mains to be in service simultaneously until all customer services are transferred from the old main to the new main with minimum interruption of service. If the construction of a proposed main necessitates the abandoning of the existing main prior to the new main's placement into service, then provisions for a temporary water main with services must be addressed by the design.

Typically, abandoned lines may be left in place with only the ends being plugged or capped. However, the City may require special abandonment actions including, but not limited to, filling the abandoned water main with grout, removal and proper disposal of all above ground appurtenances, and removal and proper disposal of the abandoned pipe.

3.20.1 Replacement Mains

On mains being abandoned, the design engineer shall note and locate points of cut and plug as close as possible to the main that remains in service. (See Figure 3.9 in Drawing PIAZ16 on Sheet 2 of the City Standard Details).

3.20.2 Extension Mains

If a design requires an existing main to be cut by a connection with a proposed main, then a cut and plug is to be specified behind the connection point. (See Figure 3.10 in Drawing PIAZ16 on Sheet 2 of the City Standard Details).

3.20.3 Fire Hydrants

Fire hydrants located on mains being abandoned shall be removed and delivered to the City of Denton Water Utilities Department.

3.21 Flushing and Disinfection

Prior to making permanent connections to the distribution system, water distribution mains, valves and appurtenances shall be adequately flushed and disinfected in accordance with the most current revision to AWWA C651, and bacteriological testing shall be completed to meet the standards established by the Water Utilities Department and Chapter 290 of the Texas Administrative Code (30 TAC §290). Additionally, heavily chlorinated water shall be flushed from all segments of the newly constructed mains before final connections are made.

Before commencement of construction of water distribution infrastructure, the Contractor or engineer shall submit a flushing and disinfection plan to the Department of Water Utilities for review. Ata minimum the plan shall describe:

A. Flushing procedures
B. Hydraulic calculations to demonstrate adequate flushing velocities, or demonstrate conformance with the conditions outlined in AWWA C651 Table 3.
C. The method of chlorination
D. Bacteriological sampling plan
E. Dechlorinating procedures (Ref. AWWA C655)
F. Disposal of chlorinated water

Section 4 – Wastewater Design Guidelines

4.1 General

It is the responsibility of the design engineer to ensure the final design of a sewer main is in conformance with the following:

A. Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) – Rules, Ch. 217, "Design Criteria for Domestic Wastewater Systems"
B. Denton Development Code (DDC)
C. This Manual and the City's Standard Detail Drawings
D. North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction ("COG Specs."), as amended by the City of Denton
E. City of Denton Wastewater Master Plan

4.2 Estimated Wastewater Flows

A. For sewers in new developments, sewer lines and lift stations shall be designed to accommodate the projected buildout flows from all residential, commercial, industrial, or institutional sources upstream of the proposed sewer improvement. Figure: 30 TAC §217.32(a)(3) Table B.1. - Design Organic Loadings and Flows for a New Wastewater Treatment Facility (see excerpted information in Table 4.2-1) shall be used as a guide to generate wastewater flows. However, minimum flow capacity for sizing of sewers for peak flow condition shall not be less than the results of the following calculation procedures:
    1. Delineate the wastewater drainage area that will drain into the sewer main or lift station. Include all upstream offsite areas.
    2. For the development site, use the following design parameters:
        a. Table 4.2-1 to generate the wastewater loading by type of use.
        b. 3.2 capita per lot for single family.
        c. 2.5 capita per unit for multifamily.
        d. Apply a 4.0 multiplier to the average daily flow to determine the peak flow.
    3. For undeveloped upstream areas, use the following design parameters:
        a. 4 lots per acre.
        b. 3.2 capita per lot.
        c. Average daily flow of 100 gal/capita/day.
        d. Apply a 4.0 multiplier to the average daily flow to determine the peak flow.
    4. For developed residential upstream areas, use the following design parameters:
        a. Count number of single family lots.
        b. Obtain number of multifamily units (available through DCAD)
        c. 3.2 capita per lot for single family.
        d. 2.5 capita per unit for multifamily.
        e. Average daily flow of 100 gal/capita/day.
        f. Apply a 4.0 multiplier to the average daily flow to determine the peak flow
    5. For developed non-residential upstream areas, use the following design parameters:
        a. Average daily flow of 1500 gpd/acre.
        b. Apply a 4.0 multiplier to the average daily flow to determine the peak flow

For replacement of existing sewers and construction of parallel sewers for additional capacity, wastewater flow data will be provided by the City from data generated by City sewer shed computer models.

TABLE 4.2-1

Excerpt of Table B.1 - Design Flows for a New Wastewater Treatment Facility (reproduced from TCEQ Rules - 30 TAC §217.32(a)(3), Table B.1)		
Source	**Remarks**	**Daily Wastewater Flow (Gal. Per Person)***
Municipality	Residential	75-100
Subdivision	Residential	75-100
Trailer Park (Transient)	2½ Persons per Trailer	50-60
Mobile Home Park	3 Persons per Trailer	50-75
School	Cafeteria & Showers Cafeteria/ No Showers	20 15
Recreational Parks	Overnight User Day User	30 5
Office Building or Factory	A facility must be designed for the largest shift	20
Hotel/Motel	Per Bed	50-75
Restaurant	Per Meal	7-10
Restaurant with bar or cocktail lounge	Per Meal	9-12
Hospital	Per Bed	200
Nursing Home	Per Bed	75-100
Alternative Collection Systems e.g., septic tanks	Per Capita	75

*** City of Denton requires usage of the highest number of the TCEQ ranges.**

4.3 Separation Distances between Wastewater Collection System Pipes and Manholes and Public Water Supply Pipes

Wastewater mains and manholes shall be separated from water mains as set forth in Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) Rules - 30 TAC §217.53.d Separation Distances.

4.4 Size and Slope of Sewers

After the design engineer has determined the wastewater flows per Section 4.2, the sewer size can be determined using the following criteria. However, no sewer, other than service laterals and force mains, shall be less than 8 inches in diameter.

The size and grade of the proposed sewer shall be evaluated by Manning's Equation.

$$V = \frac{1.49}{n} (R)^{0.67} (S)^{0.50}$$

Where:

V = velocity (feet per second)
n = Manning's coefficient of roughness; minimum 0.013
R = hydraulic radius (feet)
S = slope of energy grade line (feet per foot)

Proposed sewers shall be designed with slopes sufficient for 3.0 feet per second (fps) velocity, with a minimum velocity required of 2.0 (fps). The minimum acceptable Manning's "n" factor for design shall be 0.013, which takes into consideration the slime, grit and grease layers that will affect hydraulics or hinder flow as the pipe matures. The sewer pipe grades shown in Table 4.4-1 are based on an "n" value of 0.013 and are the minimum acceptable slope for sewer lines.

Table 4.4-1
Minimum and Maximum Pipe Slopes

Size of Pipe in Inches I.D.	Minimum Slope In Percent	Maximum Slope in Percent	Capacity Flowing Full at Min. Slope (MGD)
8	0.335	8.40	0.45
10	0.25	6.23	0.71
12	0.20	4.88	1.03
15	0.15	3.62	1.62
18	0.115	2.83	2.25
21	0.095	2.30	3.07
24	0.08	1.93	4.14
27	0.07	1.65	4.91
30	0.06	1.43	6.23
33	0.055	1.26	7.66
36	0.045	1.12	9.17

The capacity of the sewer pipe flowing full shall be computed by the following equation:

$$C = \frac{0.299}{n} (D)^{2.67} (S)^{0.50}$$

Where C = capacity (million gallons per day)
n = Manning's coefficient of roughness; minimum 0.013
D = inside diameter (feet)
S = slope of the energy grade line (feet per foot)

4.4.1 High Velocity Protection

Where velocities greater than 10 fps will occur when a pipe flows full, based on Manning's Equation and an "n" value of 0.013, restrained joint pipe or external restraint systems must be utilized.

4.5 Sewer Main Depth

Minimum depth for the design of sewer mains shall be determined by providing a two percent grade for the lateral from the center of the house or building to the center of the proposed main and including an additional two foot drop. Therefore, for a house 100 feet from the proposed sewer main, the designed depth of the main shall be at least 4.0 feet below the finished floor elevation of the house since:

2 feet + (2% of 100 feet) = 4.0 feet

The lateral also must have at least two (2) feet of cover at its shallowest point. The design engineer is responsible for ensuring sufficient depth and grade is maintained to serve all building sites in the sewer shed.

4.6 Recommended Cover

Recommended cover for all sewer mains is four (4) feet to six (6) feet. Minimum cover shall be 3.5 feet. Any main approved to have less than minimum cover shall be encased in Class "G" embedment. See Drawing U204 on Sheet 7 of the City Standard Details.

When establishing depth for proposed wastewater mains, design engineers shall consider the impact of proposed water and drainage improvements especially on service laterals that cross those improvements to connect to the wastewater main.

4.7 Sewer Alignment

Design engineers shall be guided by the following in the alignment of wastewater lines:

A. For new construction in areas not served, sewer mains shall be laid straight between manholes. No horizontal or vertical bends are allowed between manholes.
B. Avoid shifting mains from one side of the ROW to the other side of the ROW between street intersections.
C. Where the bypass of existing flows is feasible, it is recommended that replacement mains be constructed horizontally in the same trench.

4.8 Sewer Laterals

Minimum lateral sizes from the sewer main to the public cleanout are:

A. 4” minimum for single family
B. 6" minimum for residential duplex, triplex, and quadplex
C. 6” minimum for local retail, light commercial, apartment, manufacturing and industrial

Single-way clean-outs shall be provided on laterals at the public easement or Right-of-Way line. Double-way cleanouts are not allowed. See Drawings S403 and S404 of Sheet 5 of the City Standard Details.

Manholes shall be provided for lateral connections when the lateral pipe diameter is equal to the main sewer pipe diameter or the lateral is 8-inch diameter or larger.

Laterals shall be constructed to the property line and shall be located at a point five (5) feet downstream from the center of the lot on unimproved property. For improved property, design engineers should use technical judgement in lateral placement.

Preferred grade for lateral construction is 2%. Laterals shall not be designed with less than 1% grade.

4.9 Gravity and Force Main Sewer Pipe Material

Gravity and Force Main sewer pipe shall meet the following criteria unless special circumstances require an alternative and is approved by the Director of Wastewater Utilities.

Table 4.9-1

Size	Application	Pipe Material
8 in. through 12 in.	Gravity	PVC – ASTM D3034, SDR 35 (for pipe depths 15 ft. or greater, use SDR-26 pipe) HDPE – ASTM D3350, DR-17
15 in.	Gravity	PVC – ASTM D3034, SDR 35 (for pipe depths 15 ft. or greater, use SDR-26 pipe)
18 in. through 24 in.	Gravity	PVC – ASTM F 679, PS46 or PS115 Fiberglass Reinforced Plastic – ASTM D3262
6 in. through 60 in.	Force Main	HDPE – ASTM D3350, DR-13.5 DIP – AWWA C150/C151, CL52 or PC 350, epoxy interior lining

For gravity sewer pipe sizes over 24” in diameter, design calculations and pipe selection shall be submitted by the development design engineer for review; approvals will be provided on a project specific basis.

Force main sewer pipe shall be designed to meet the working and surge pressure requirements of the specific application. Design calculations and pipe selection shall be submitted by the development design engineer for review.

Different pipe materials shall not be mixed between manholes. If it is anticipated that a mixing of materials will occur, the design engineer shall design a manhole at the point of transition of pipe materials. For previously placed stub-out of a material other than PVC pipe, design engineer shall add a note to the plans calling for removal of the stub out or change the material of the proposed pipe for that section of pipe between manholes.

4.10 Sewer Pipe Embedment

The types of embedment and backfill for sewer mains are shown in Drawings U201, U202, U203A and U203C of Sheet 7 of the City Standard Details. Embedment requirements shall be based on sewer mains under proposed pavement, unpaved areas and existing pavement.

Embedment and backfill up to six (6) in. above the top of the pipe will be based on materials as specified by North Central Texas Council of Governments (NCTCOG) Standard 504.2.2.1(a). Crushed stone embedment – Aggregate Grade 4.

Table 4.10-1

Standard Crushed Rock Aggregate Grade 4	Percent
Retained on 1 - ½ inch sieve	0 %
Retained on 1 inch sieve	0 – 5 %
Retained on ½ inch sieve	40 – 75 %
Retained on No. 4 sieve	90 – 100 %
Retained on No. 8 sieve	95 – 100 %

4.11 Manholes

Manholes constructed on existing or proposed sewer lines shall be sized as follows:

Table 4.11-1

Pipe Diameter	Manhole Diameter
8” through 12”	4.0 ft. (For depths greater than 12 ft., use 5.0 ft.)
15” through 27”	5.0 ft.
30” through 36”	6.0 ft.

Special manholes shall be designed for mains larger than 36” diameter pipe.

The types of manholes allowed by the City are shown in Drawings S101, S102, S103 and S107B of Sheet 4 of the City Standard Details.

Generally, manholes shall be stationed on the main run, and where known, the stations of the side mains should also be indicated. When connecting a proposed main to an existing main at a manhole, the connection shall have the top inside elevation of the outfall main level with the top inside elevation of the proposed main.

4.11.1 Manhole Locations

Manholes shall be provided at the following locations to facilitate maintenance, cleaning, and inspection:

A. At the location of lateral connections that are 8” in diameter or larger.
B. At 500 feet intervals on sewer mains 15” diameter or smaller; at 800 feet internals on mains 18” diameter through 30” diameter; at 1,000 feet intervals on mains 36” diameter through 48” diameter; and at 2,000 feet for 54” diameter and larger.
C. At all locations where pipe diameter or pipe material changes.
D. At all locations where the horizontal or vertical alignment of the sewer main changes.
E. At the ends of all mains with service connections. Two ends of a main may not be combined in one manhole.
F. If the main line is less than 150 ft. long and does not contain any service connections, then a Sanitary Sewer Mainline Cleanout may be used. See Drawing S402 on Sheet 5 of the City Standard Details.
G. At the end of any pipe segment at least 150 feet long.
H. Sewer service laterals are to be connected to the sewer main line and not into a manhole unless it is a size on size connection.
I. Manholes shall not be placed in sidewalks, pedestrian ramps, driveway approaches, or in the bottom or on the slopes of a drainage channel or drainage structure.
J. Manholes shall be kept a minimum of 30 feet from any railroad track.

4.12 Highway Crossings

Crossings of State or County controlled roads shall require the review and approval of the appropriate regulatory agency. Crossings shall meet the requirements made by the controlling agency and by City of Denton Standards. In the event of different requirement levels for the same item, the more stringent standard shall apply.

4.13 Railroad Crossings

The design engineer shall, prior to the design of any railroad crossing, contact the appropriate railroad company and regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent than those of the Railroad Company or regulatory agency, the City’s standards shall apply. See Section 6.4.A for processing of railroad permits.

4.14 Tunneling, Boring, Jacking and Casing

Tunneling, boring, jacking and casing are methods used for sewer line placement under restrictive conditions when open cut construction is not allowed. Only straight pipe alignments for both horizontal and vertical alignments are allowed.

Design engineers should consider the location, size and depth of boring and receiving pits when choosing the beginning and ending stations for boring. A typical bore pit is between 35 and 40 ft. in length to accommodate the boring machine and one joint of pipe. Width of the bore pit can vary depending on the depth and size of pipe, with the narrowest width being approximately 15 ft. The preferred location for the bore pit is the lower elevation end of the bore; allowing any groundwater and/or boring slurry to drain from the tunnel into the bore pit. The water can then be removed by pumping.

Steel casing pipe, where required for open-cut or other than open cut installation, shall have an inside diameter (ID) large enough to accommodate a carrier pipe of at least two (2) standard sizes above the pipe being installed and shall meet the minimum ID listed in Table 4.14-1. The casing pipe wall thickness design shall be based on the requirements of the agency whose facility is being crossed and shall conform to the minimum criteria listed in Table 4.14-1. Casing pipe shall be provided with interior and exterior coal-tar protective coating in accordance with AWWA C203. Field welds shall be coated with an equivalent coating.

Table 4.14-1

Nominal Carrier Pipe Size [a]	Minimum Casing Pipe ID	Minimum Casing Pipe Wall Thickness
8 in.	12 in.	3/8 in.
12 in.	20 in.	1/2 in.
16 in.	24 in.	1/2 in.
20 in.	30 in.	1/2 in.
24 in.	36 in.	5/8 in.
30 in.	42 in.	5/8 in.
>30 in.	b	c

a. Minimum depth of bore shall be 42 inches.
b. Consult with the Department of Water Utilities
c. Project specific design must be sealed and signed by a Professional Engineer licensed by the State of Texas

Force mains through casings shall follow the same requirements as are laid out for water mains in section 3.11 of this manual.

4.15 Underground Utility Crossings

The requirements of Section 3.13 of this manual shall govern the crossing of underground utility lines by wastewater mains.

4.16 Fence or Wall Crossings

The requirements of Section 3.14 of this manual shall govern the crossing of fences or walls by wastewater mains.

4.17 Creek Crossings

When a sewer main crosses a creek or channel, the design engineer must evaluate the condition of the creek bed and ensure erosion control is provided. Backfill material and minimum construction criteria are shown in Low Water Channel Crossing Drawings S701 and S702 on Sheet 6 of the City Standard Details. These criteria include creek bed soil and condition, as well as presence of exposed rock.

4.18 Siphons

For creek or channel crossings where a Low Water Channel Crossing is not feasible, design of an inverted siphon crossing is permissible when approved by the Director of Water Utilities. Inverted siphons shall not have less than two (2) barrels, with a minimum pipe size of eight (8) in., and shall be provided with necessary appurtenances for convenient flushing and maintenance. Access structures are required at each end of the siphon with adequate clearance for maintenance and cleaning purposes. Bank and channel stabilization may be required to protect the crossing lines and casing of the carrier pipe may be required to meet environmental or other restrictions.

4.19 Abandonment of Sewer Mains

The design engineer should note the limits and appropriate conditions for the abandoning of existing wastewater mains which are to be replaced by the construction of any proposed wastewater mains.

The design engineer should also make allowances in the design to provide for the existing and proposed mains to be in service simultaneously until all customer services are transferred from the old main to the new main with minimum interruption of service. If the construction of a proposed main necessitates the abandoning of the existing main prior to the new main's placement into service, then provisions for a temporary wastewater main with services must be addressed by the design.

Typically, abandoned lines may be left in place with only the ends being plugged or capped. However, the City may require special abandonment actions including, but not limited to, filling the abandoned wastewater main with grout, removal and proper disposal of all above ground appurtenances, and removal and proper disposal of the abandoned pipe. In situations where a manhole is being left in service even though one or more lines into the manhole are being abandoned, the abandoned line shall be cut and plugged outside of the manhole. However, if the City determines that the pavement is in good condition the City may allow the abandoned line to be plugged from inside of the manhole.

4.20 Abandonment of Manholes

If a manhole as well as the sewer main is to be abandoned, the method described is Section 4.18 above, along with the minimum guidelines shown in Drawing S105 on Sheet 4 of the City Standard Details, shall be used.

4.21 Lift Stations

The need to construct a lift station should be determined only after a thorough analysis of the physical and economic factors involved. A Preliminary Engineering Report is required, which lists all factors and adheres to current state regulations. The City reserves the right to review each proposal and determine whether there is enough merit to justify a lift station.

4.21.1 Preliminary Design Submittal

A preliminary design submittal is required for each lift station proposed. The submittal shall include a written report and a map prepared by a Professional Engineer licensed by the State of Texas.

A. The plans submitted shall contain the following information, as a minimum:
   1. Be to scale, with the scale indicated.
   2. A north arrow.
   3. A location map.
   4. Delineation of the boundary of the proposed development.
   5. Delineation of the boundary of the sewer shed in which the development lies.
   6. The area in acres of the development.
   7. The area in acres of the sewer shed contributing to the Lift Station.
   8. The proposed land use or uses for the development.
   9. The proposed land use or uses for the sewer basin.
   10. The proposed lift station site.
   11. The proposed force main routing and size.
   12. Delineation of the one-hundred-year flood plain and Environmentally Sensitive Areas (ESAs).
   13. Location and size of the existing collection system at the tie-in point.
   14. Contour lines (2-foot intervals).
   15. Show how storm drainage is taken off site.
   16. Property lines.

B. The written report shall include the following information:
   1. A general narrative about the proposed development and the circumstances that warrant a lift station.
   2. Influent hydraulic calculations showing:
      a. Area in acres of the sewer basin and the development.
      b. The area of each proposed land use for the development and for the projected land use(s) for the basin.
      c. The design flow for the basin and the development.
      d. The maximum flow for the basin and the development.
      e. Elevation of the proposed lift station site.
      f. The elevation of the proposed discharge point of the force main.
   3. Preliminary wet well volume calculations.
   4. Preliminary force main size.

5. Cost estimates for proposed lift station(s) and force main(s), and cost estimates for a gravity line in lieu of the lift station if possible.
6. Ground water levels in proposed site areas.

4.21.2 Site Layout

A. Station Siting. The following are the minimum criteria for station sites.

1. The station shall be protected from the 100-year flood and shall be accessible during a 25-year flood.

2. The station should be located as remotely as possible from populated areas. The entire station site shall be completely enclosed with an eight (8) ft. high, opaque concrete or masonry wall, with an opaque sliding gate, minimum of sixteen (16) ft. on track flush with the ground. All shall be of an architectural style and colors blending with the development architecture, as approved by the city.

3. The station will include an approved odor control system.

4. The station site and its access shall be dedicated to the City as City property.

5. The station site shall be located so it may serve as much of the entire sewer basin as possible. This may require the station to be located off-site of the development. When it is required the station serve a larger area than the proposed development, the developer may enter into a pro-rata contract with the City to be reimbursed the cost of excess capacity as other developments tie to the system.

B. Wet Well/Dry Well Arrangement

1. Orientation shall consider the routing of incoming sewers and force main.

2. Orientation shall allow a two-ton vehicle to directly access the wet well or the dry well, forwards and backwards.

3. Wet wells and dry wells shall be separated by at least a water and gas tight wall with separate entrances.

4. Wet wells shall have sloped bottoms to avoid excess sludge deposits.

5. The wet well shall have a lockable aluminum door with an aluminum frame and safety grating. The minimum opening size shall be 4’ x 6’ with two doors large enough to adequately maintain the wet well. Door and frame shall be Bilco Type K, KD or an approved equal.

6. The dry well or valve vault shall have a lockable aluminum door with an aluminum frame and safety grating. The minimum opening size shall be 2’x 3’ or large enough to adequately maintain the dry well or meter vault. Door and frame shall be Bilco Type K, KD or an approved equal.

7. The wet well, dry well, valve vault and meter vault, including decks, shall all be cast in-place concrete only. No other materials are acceptable.

8. The coating for the wet well exterior and interior walls shall be coated as specified in 4.21.2.C and D below, respectively.

9. The wet well shall be hydrostatically tested to the top of the wet well for 48-hours prior to placing the lift station into service. Only losses due to evaporation will be acceptable.

10. Provisions shall be made to remove water from the dry well, valve vault or meter vault without allowing gas or water from the wet well into these structures.

C. Exterior Walls (below grade, to be backfilled)

Table 4.21-1

Surface Preparation	Coating System
Clean and Dry	Tnemec Series 46H-413 Polyamide Epoxy - Coal Tar 8 - 10 mils in two coats for a total of 16.0 to 20.0 dry mils

D. Interior Walls (Thick Film System)

Table 4.21-2

Surface Preparation	Coating System	
	Primer	Finish
Brush-off Blast Cleaning	Tnemec Series 218 Mortarclad 0.25 in.	Tnemec Series 436 Perma-Shield 100 - 125 dry mils

In addition to this coating system, the lining products listed in Drawing S101 of the City Wastewater Standard Details are acceptable.

E. Site Access

1. Access will be provided by an all-weather surface of flex-base or better from a public street to the station site.

2. Access shall be functional during a 25-year flood. The road surface shall be above the water level caused by a 25-year return period storm.

3. Every station more than 100 feet from a public street requires a turn-around adjacent to the lift station, sized large enough to accommodate a City service truck with generator.

F. The equipment rack shall not obstruct vehicle access to the wet well or the dry well; the location must be approved during the review process. It shall be placed at an easily accessible elevation and include a canopy.

G. Site inside the fence shall be an all-weather surface, such as ¾ in. crushed rock or flex-base.

H. Passive ventilation shall be screened to prevent insect access to the wet well. Minimum air vent shall be 4-inch diameter. Vent outlet shall be at least 1 foot above the 100-year flood elevation.

4.21.3 Hydraulic Design

A. Influent Flow

The preliminary design report shall include the design flow and the maximum flow for the development and the sewer basin. The design flow shall be calculated in accordance with TCEQ rules. Refer to Section 4.2 Estimated Wastewater Flows herein for maximum flow calculations.

B. Pump Capacity

1. Definition
   Firm pumping capacity is the pumping capacity of the station with the largest pump out of service.

2. The firm pumping capacity shall be greater than the maximum flow for the entire sewer basin. If the sewer basin is significantly larger than the proposed development and it is not feasible to design for this flow, the firm pumping capacity may be designed to handle a portion of the basin with approval from the Director of Water Utilities.

3. The pump curves shall be selected so the pumps will run near the best efficiency point during normal operating conditions. The selected curves shall also be such that the pumps do not approach shut-off head when they are running simultaneously.

   System head curves, pump curves and head calculations shall be submitted. Calculations and pump curves at both minimum (all pumps off) and maximum (last normal operating pump on) static heads, for a C value of both 100 and 140, must be provided for each pump and for the combination of pumps with modified pump curves.

C. Wet Well Volume

1. Wet well volume for a submersible pump station is the volume contained above the top of the motor, or as specified by the pump manufacturer, to the bottom of the influent pipe. TCEQ Rule §217.60(b)(4) (d) A gravity pipe discharging to a

wet well must be located so that the invert elevation is above the liquid level of a pump's "on" setting.

2. Wet well volume for all other non-submersible pump stations is the volume contained in an area from a minimum of two (2) feet above or distance at which vortexing does not occur above the top of the intake of the pump.

3. High level alarm elevation shall be a minimum of 48 inches below the top of the wet well or 48 inches below the flow line elevation of the lowest influent pipe, whichever elevation is lower. Wet well volume shall be calculated by the following method:

$$T = \frac{V}{D-Q} + \frac{V}{Q} .$$

Where:
T = Total time between successive pump starts in minutes (operating cycle)
D = Rated pump capacity in GPM
V = Storage volume between lead pump on and pump off elevations in gallons
Q = Inflow to wet well in GPM
The operation cycle 'T' shall not be less than 10 minutes for Average Flow and not more than 60 minutes for Minimum Flow conditions.

4. Per TCEQ Rules, 30 TAC § 217.63:

(g) Systems for preventing the discharge of wastewater must operate for a duration at least equal to the longest power outage on record for the past 60 months, or at least 20 minutes, whichever is longer. The design must be based on peak flows, inflow, and infiltration. If the longest power outage on record for the past 60 consecutive months is greater than 48 hours and generators will be used to provide backup power, then the owner must have a contract in place that guarantees fuel supply during an emergency. The owner must also have sufficient storage capacity at the wastewater treatment facility for the fuel for the duration of the emergency.

(h) For calculation purposes, the owner must assume that the lift station wet well is full to the pump activation level when the power outage period begins.

D. Force Main Capacity

Force main capacity shall be sized to meet the capacity of the entire sewer basin. The force main may be designed to handle a portion of the basin with approval from the Director of Water Utilities. The minimum force main size shall be four (4) inches in diameter, except for Grinder Pump lift stations. The minimum recommended velocity is 3 feet per second (3 fps), and the velocity shall not be less than 2 feet per second (2 fps) when only the smallest pump is in operation.

4.21.4 Pumps

Acceptable pumps are listed in the City of Denton Approved Products and Materials List.

4.21.5 Mechanical

A. Force Main

1. Force main pipe material shall be in accordance with Table 4.9-1. Force mains smaller than 6-inches may be approved with proper design justification, by the Director of Wastewater Utilities.

2. All fittings shall be ductile iron meeting AWWA C-110 or C-153. Interior of the pipe and fittings shall be lined with American Polybond Plus, which consists of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyethylene, or approved equal.

3. Force mains shall be laid to Denton Standard Construction Specifications.

4. Plans shall include plan and profile for the force main, including valves every 2000 feet per TCEQ 217 rules.

5. All force main contractors shall furnish and install non-metallic pipe detection tape. The pipe tape shall be green, 6-inch wide, 4 mils thick with 3-inch black continuous lettering “Caution Sewer Line Buried Below.” The pipe tape shall be per TCEQ requirements:
   i. A detectable underground warning tape must be laid in the same trench as a force main pipe. The detectable underground warning tape must be located above and parallel to the force main.
   ii. The detectable underground warning tape must bear the label "PRESSURIZED WASTEWATER" continuously repeated in at least 1.5 inch tall letters.

B. Lift Station Interior Piping

1. Piping inside the lift station shall be ductile iron meeting AWWA C-150 and C-151. All fittings shall be ductile iron meeting AWWA C-110 or C-150. Interior of the pipe and fittings shall be lined with American Polybond Plus, which consists of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyethylene, or approved equal.

2. All nut and bolt assemblies inside the wet well shall be ASTM 316 stainless steel, unless otherwise allowed.

C. Isolation Valves

1. Each pump shall have one isolation valve downstream of the pump.

2. Isolation valves shall be resilient seat gate valves or plug valves from the approved materials list, meeting the City of Denton Standard Construction Specification.

3. Isolation valves shall be located in the building for self-priming stations, and in a separate vault for submersible stations, and not inside the wet well.

D. Check Valves

1. Check valves shall be controlled closing swing check valves with a lever arm or a ball check. There must be at least 15 feet of vertical head downstream in order to use a ball check valve.

2. A check valve shall be located upstream of the isolation valve.

3. If the station is submersible, then a check valve shall be located with the isolation valve in a separate vault. For self-priming stations, a check valve shall be located in the building. Under no circumstance shall the check valve be allowed in the wet well.

4. All nuts and bolts shall be stainless steel.

E. Air Release/Vacuum Valves

1. Air release valves of a type suitable for wastewater service shall be installed along the force main where the force main would be prone to trapped air.

2. The type of valve shall be air release or a combination of air release and vacuum breaker (see Drawing S803 on Sheet 6 of the City Standard Details). The design engineer shall determine the type and location, subject to approval of the Director of Wastewater Utilities.

3. Calculations for valve type and valve sizing shall be provided to the City.
4. Locations of the air release/vacuum valves shall be shown on the plan and profile sheets for the force main.

5. Isolation valves for 3 inches and smaller air release valves shall be all bronze or brass. Isolation valves 4 inches and larger shall meet City of Denton Standard Construction Specification for resilient seat gate valve. The first fitting placed into the force main shall be a brass corporate valve (male corporate fitting).

6. Air release valves shall be fitted with blow off valves, quick disconnect coupling and hose to permit back flushing after installation without dismantling the valve.

7. Air release valves must be located in a vault as shown in Standard Details.

4.21.6 Electrical, Instrumentation and Supervisory Control and Data Acquisition (SCADA) Requirements

The City of Denton Water Reclamation department performs the build and install of SCADA and telemetry packages. Developers should request the packet and COD will provide a bill of materials for this service.

4.22 Low Pressure Collection Systems

Low pressure collection systems may be allowed with specific approval by the Director of Wastewater Utilities.

4.23 On-Site Sewage Facilities

4.23.1 General

Planning, design and operation of on-site sewage facilities within the City of Denton must comply with the current Texas Administrative Code (TAC) Title 30, Part 1 TCEQ Rules, Ch. 285 for On-Site Sewage Facilities, as amended by the City of Denton. The property owner proposing to use an on-site sewage facility shall comply with the criteria listed in this Section, and Sections 35.11 and 35.12 of the City of Denton Development Code.

4.23.2 Permits Required

Any owner of a residential, commercial or institutional building who utilizes an on-site sewage facility is required to secure a permit from the City of Denton to construct, alter, repair or extend an on-site sewage facility regardless of the size of the lot or tract of land. Contact the Environmental Services Division at the Pecan Creek Water Reclamation Plant for details on permit fees and maintenance requirements.

4.23.3 Site Evaluations

A professional engineer or a professional sanitarian, licensed by the State of Texas, must perform site evaluations.

4.23.4 Planning Requirements

A professional engineer or a professional sanitarian, licensed by the State of Texas, must prepare on-site sewage facility plans.

4.23.5 On-Site Sewage Facility Land Use Requirements

Lots or tracts of land where an on-site sewage facility is proposed must have the following minimum area size.

- A minimum of 1 acre when a public water system serves the tract or lot.
- A minimum of 2 acres when a private water well is located on the tract or lot.

Section 5 – Construction Plans

5.1 General

Before any public works construction relative to a development may begin, City staff will verify the construction plans have been approved. Construction may not begin until the construction plans have been approved, all fees (including review and inspection fees) have been paid, all necessary agreements and bonds have been provided, and a Pre-Construction Conference has been held by the City.

5.2 Responsibility

The sealing engineer is responsible for the accuracy, completeness, and conformance of the submitted plans to City standards. The purpose of the City review is to ensure conformance to City policies and standards. The City review is limited to facts as presented on the plans submitted. The City has no project engineering design or quality control review responsibility. The engineer certifying the plans is responsible for the accuracy and completeness of the plan documents. The City reserves the right to require plan corrections to fit actual field conditions or meet City standards requirements, which are found to be contrary to or omitted from the plans.

5.3 Format

Construction plans shall be digitally drawn on 24 in. by 36 in. size sheets; with borders of 22 in. x 34 in. so half-size reproduced plans will be to half-scale fitting 11 in. x 17 in. sheets. Each sheet shall be legible when reduced to half-size.

5.4 Plan Requirements

Construction Plans must contain, as a minimum, information listed in the following sections before they can be approved:

5.4.1 General

North arrow, scale, date and mean sea level elevations of all improvements, based on North America Vertical Datum 1988 (NAVD 88). Only NAVD 88 shall be used for plan elevations; no assumed or NGVD 29 elevations. Plans shall be drawn with a horizontal scale of one (1) inch equals forty (40) feet as a minimum, and appropriate corresponding vertical scale. The plans shall provide a reference to the elevation benchmark or monument used in the development of the plans. Show all crossings of existing and proposed underground utilities. The construction plans shall be signed and sealed by a professional engineer, licensed by the State of Texas, prior to bidding the project for construction.

5.4.2 Water Systems

Plan sheets must show the horizontal alignment of the proposed water system within street rights-of-way and easements, with horizontal control points for location of the rights-of-way and easements and for location of the water system within the rights-of-way and easements. Sizing of pipe, valves, fittings and appurtenances must be shown on the plan

view. All valves, fittings, fire hydrants, and other appurtenances must be stationed and given GPS coordinates based on the City of Denton's grid coordinate system. Profile views of water mains 12 inches or larger must be provided showing proposed grade, pipe material, casing pipe size and thickness (if any), and the location, elevation and size of any underground conduit or facility to be crossed. Approved variances (if any) from City Standard Details must be provided. Show all service lines up to and including the meter can/vault. Service lines do not need to be stationed or have GPS coordinates. Adequate detail of other planned and existing improvements shall be shown to indicate planned crossings of utilities, storm drains, and stormwater facilities and potential conflict points.

5.4.3 Sanitary Sewer Systems

Plan sheets must show the horizontal alignment of the proposed sanitary sewer system within street rights-of-way and easements, with horizontal control points for location of the rights-of-way and easements and for location of the sanitary sewer system within the rights-of-way and easements. Sizing of pipe, manholes, fittings and appurtenances must be shown on the plan view. Manhole rim elevations, and pipe "in" and "out" elevations must be shown. All manholes, fittings, and other appurtenances must be stationed and given GPS coordinates based on the City of Denton's grid coordinate system. Every sanitary sewer line shall be profiled. Profile views shall show proposed grade, pipe material, casing pipe size and thickness (if any), manhole information, and the location, elevation and size of any underground conduit or facility to be crossed. Approved variances (if any) from City Standard Details must be provided. The plan view shall include arrows indicating direction of flow in pipe. Show all service lines to and including the public cleanout. Service lines do not need to be stationed or have GPS coordinates. Adequate detail of other planned and existing improvements shall be shown to indicate planned crossings of utilities, storm drains, and stormwater facilities and potential conflict points.

5.4.4 Grading

For situations involving proposed grading over existing water or sanitary sewer systems, provide a grading plan and profile showing the existing and proposed topography in two-foot contours. The grading plan shall consist of contours and spot elevations with water directional arrows to define the flow patterns.