EXHIBIT 3

City of Denton

Water and Wastewater Criteria Manual

~~February 20, 2002~~

July XX 2017

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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 extraterritorial jurisdictions. The criteria established in this Manual have been developed from a review of various applicable publications, North Central Texas Council of Government Public Works Construction Standards (NCTCOG) (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 the City and within its extra-territorial jurisdictions. 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. The Director of Water Utilities or the Director of Wastewater Utilities, as applicable, must approve any deviations from criteria established in this Manual.

Along with this Design Manual, the Denton Development Code (DDC) shall be consulted for additional criteria. The criteria established in this manual do not supersede the criteria contained in the DDC. Any revisions to the DDC supersede the criteria in this Manual.

Section 2 – Preliminary Design (Applicable Only to City Projects)

NOTE: This Section of this Manual is applicable only to design for City administered projects; not development projects. However, this Section includes information development design engineers may find useful to ensure appropriate coordination for their development projects.

2.1 General

The success of any project can be attributed to the thoroughness of the initial investigations undertaken by the design engineer. This section describes the general steps that are essential when beginning a project to develop the vision required for preparing the final engineering plans and specifications.

2.2 Project Folder

The design engineers shall ~~keep~~ create and maintain an electronic project folder and appropriate subfolders in the current electronic document system for each project. The folder and subfolders shall contain all pertinent correspondence including, but not limited to the following items:

A. Assignment memo for the project, if applicable.

B. Copies of memos from other City Offices.

C. Correspondence to and from the private sector, e.g., consulting engineers, developers, etc.

D. Correspondence to and from other utilities, e.g., gas, electric, cable, telephone, etc.

E. Engineering calculations used to determine the size of pipe, alignment, cost, etc. of the project.

F. Notes to file concerning conversations with citizens, consultants, etc.

2.3 Internal Coordination

Internal coordination among departments within the City is necessary to prevent duplication of efforts, avoid conflicts and to inform other sections of activity in the project area. ~~A form memo shall be used for t~~The internal coordination process shall be accomplished and documented via email.~~(see Figure 2.1).~~

~~This form is to be completed by t~~The ~~designer~~ design engineer shall contact~~and forwarded to~~ the following:

- ~~Engineering & Capital Projects Administrator~~Director of Capital Projects

- ~~Engineering Administrator, Electric Utility~~Executive Manager of Energy Delivery, DME
- Director of Water Utilities
- Director of Wastewater Utilities
- Director, Parks and Recreation
- City Engineer
- Manager of Streets and Traffic
- Manager of Drainage
- Engineering Development Review

And, indicate that a water or wastewater project is planned for a specific area and request they identify, within 7 calendar days, any activities currently underway or planned by their Operation that might conflict with the proposed project; negative responses are to be requested to ensure proper coordination.

Figure 2.1

Date:

To: Engineering & Capital Projects Administrator,
Engineering Administrator, Electric Utility
Director, Parks and Recreation

From:

Subject:

Water/Wastewater designs (Circle one) are being proposed for the subject project. Please note any relevant activity within your division and return the completed copy to me.

Paving Design:

_____

_____

_____

_____

_____

Signed

Drainage Design:

_____

_____

_____

_____

_____

Signed

Water/Sewer Design:

_____

_____

_____

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_____

Signed

Parks and Recreation: _____

_____

_____

_____

_____

Signed

The email communication ~~form, shown in Figure 2.1,~~shall include ~~contains~~ a Concept Plan Fact Sheet with:

- Brief description of the project,
- Planned schedule,
- Approximate cost,~~size of pipe and the designer's name, and should be accompanied by~~
- Map highlighting the general area or location of the project, and
- General layout of the project with pipe sizes. ~~After review each designer signs the form and returns to the designer who initiated the process.~~

2.4 Record Research

A thorough search for and review of existing ~~design~~ records is required for all design projects. These include water and wastewater construction plans, ~~K-map books and~~ as-built information and online GIS interactive utility maps. Verification of main location and/or depth may be obtained by field trips by the design engineer and/or a qualified Subsurface Utility Engineering (SUE) firm. The design engineer should visit all sites of proposed construction prior to and during design.

2.5 Utility Coordination

A. The design engineer shall initiate the utility coordination process prior to survey or design. Subsurface Utility Engineering (SUE) firms should be considered for all projects. Level "A" SUE locations may be required by the City depending on the nature of the project and the magnitude of existing utility congestion along the project route.

B. The design engineer will furnish for submittal to the utilities a description of the proposed project and the project location maps ~~(water, sewer, or Mapsco)~~, highlighting in ~~pink or~~ blue (for water) and green (for wastewater) the proposed route or location of the project. The following utility companies will be contacted:

1. ~~General Telephone Company~~AT&T
2. ~~Texas Utilities (TXU)~~Atmos Energy
3. ~~Marcus Cable~~Charter Communications
4. CoServ Gas & Electric
5. ~~Dig Tess~~Frontier Communications
6. Grande Communications
7. Oncor Electric

~~5.~~8. Texas 811

The Public Works Inspection ROW Permit Coordinator should also be contacted to determine if other utilities should be contacted and if the City has any pending permits for work in the area of the planned project.

C. If the design engineer is in need of a specific location of a facility, a field determination shall be coordinated with the specific utility company. The requesting

party shall be responsible for any excavation required to locate existing facilities, unless the owner of the existing facility desires to make the excavation, or as governed by the existing franchise law. In any case, the owner of the utility shall be contacted prior to excavation and shall be afforded the opportunity to have a representative on site to ensure protection of the owner's interests.

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
~~A.~~D. North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction ("COG Specs.")
~~B. COG Standard Drawings for Public Works Construction~~
~~C.~~E. City of Denton ~~a~~Addendum to COG ~~s~~Specs.~~ifications and Standard drawings~~
~~D. Denton City Code, and Subdivisions and Land Development Regulations~~
~~E. Rules and Regulations for public water systems established by the Texas Natural Resources Conservation Commission (TNRCC).~~
F. City of Denton Water Master Plan
~~F.~~G. Appendix B of the 2012 International Fire Code

3.2 Water Main Separation From Wastewater Mains

Water mains shall be separated ~~by a minimum of nine feet~~ 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 and amended herein by the City of Denton (see also Section 4.3 of this Manual, where those requirements are listed).~~the TNRCC Article 317 & 290 guidelines. When the nine feet separation is unattainable and the wastewater main is in poor condition, or constructed with non-pressure joints, the replacement of the wastewater main shall be considered. Refer to Section 4.3 "Separation and Spacing of Sewer Mains from Water Mains".~~

3.3 Size of Water Distribution Mains

Water mains shall be sized according to the City of Denton's Water Distribution System Master Plan. Design engineers shall contact the City of Denton Water Utility to obtain the latest version of the water distribution system model and determine the size of water main required. For all residential, commercial, industrial and developments of any other kind connecting to the City's water distribution system, the following guidelines shall be used:

A. The design engineer shall obtain the as-built water maps from the Capital Projects Engineering Division and use the following criteria for sizing the water lines.
    1. Average daily demand per capita per day = 180 GPCD
    2. Maximum daily demand / Average daily demand = 2.2 GPCD
    3. Peak hour demand / Maximum daily demand =1.7 GPCD
    4. For Single-Family Residential – Use 3.2 people/unit

5. For Multi-Family Residential – Use 2.5 people/unit

B. Water systems shall be provided with a sufficient number of ~~outlets~~connections to the City's existing water system and shall be of sufficient size t=o 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 connections for larger developments. Good engineering judgement is required to ensure reliability is considered in design of all proposed water systems.

The City has standardized water service line sizes as follows:

- One (1) in. services are used for 5/8" x 3/4", full 3/4" and 1" water meters
- Two (2) in. services are used for 1-1/2" and 2" water meters
- Four (4) in. services are used for 3" and 4" water meters
- Six (6) in. services are used for 6" water meters
- Eight (8) in. services are fused for 8" water meters.

Non-standard sized water services are not allowed. Please refer to the water service connection Drawings on the City Standard Details.

~~B.~~C. Water pipe shall be a minimum of ~~6~~8 in. diameter. The standard pipe sizes that shall be used for water main lines are ~~6",~~ 8", 12", 16", 20", 24", 30", 36" and 42". ~~The~~ 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 short dead-end mains with limited service connections.

~~C.~~D. Every development shall provide adequate water capacity for fire protection purposes. The procedure for determining fire flow requirements for building or portions of buildings shall be in accordance with Appendix ~~III-A of the Uniform~~B of the 2012 International Fire Code. For any platted lot where the end use is not defined, the following standards shall apply:

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, the development shall provide adequate water capacity to satisfy the following demand conditions:
Peak day – Peak hour demand
Peak day – Average demand plus fire flow.

~~The water system shall be designed in accordance with the City's Water Distribution System Master Plan and the design standards specified in the City's Water and Sanitary Sewer Design Criteria Manual.~~
Mains are to be sized to ensure less than 1 foot of head loss per 1000 feet of water main at Hazen Williams coefficients of C = 100 except for fire flows demands within the subdivision internal distribution system.

Special and unique exceptions to the above standards may be made by the ~~Planning and Zoning Commission after recommendation from the Public Utilities Board~~Director of Water Utilities.

~~3.3.1 Fire Hydrant Spacing~~

~~Fire hydrants shall be maximum of six hundred (600) feet apart in residential areas and three hundred (300) feet apart in commercial / industrial areas.~~

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. ~~Fire flow requirements for Buildings shall be in accordance with Chapter 29 of the City of Denton Code of Ordinance and Appendix IV of the current Uniform Fire Code. Private fire protection water mains shall be installed in accordance with N.F.P.A. 24 and Uniform Fire Code requirements. Private fire protection mains shall be permitted by the Fire Marshall Office.~~

3.3.3 ~~Public Fire Mains~~ Fire Flow Tests

~~Fire Flow requirements for Buildings shall be in accordance with Chapter 29 of the City of Denton Code of Ordinance and Appendix IV of the current Uniform Fire Code.~~
~~Public fire protection water mains shall be installed according to the City of Denton Water Utilities Design Criteria.~~ 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 apply to water main installations in public rights-of-way, easements, or unimproved areas without permanent paving surfaces with base (such as asphalt streets without permanent base, gravel or unimproved streets, or streets without curb and gutters):

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

For water main installation in proposed or existing permanent pavement (such as improved streets with curb and gutter), the following guidelines apply:

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

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

3.5 Pipe ~~Material~~ and Fittings

~~The specification of pipe material is the responsibility of the designer based on the analysis of specific site and loading conditions, and pressure requirements. The following guidelines are based on pipe size only and in no way relieve the designer of the responsibility of pipe material specifications applicable to the particular job:~~

~~Pipe Size~~	~~Pipe Material~~
~~6” through 12”~~	~~PVC AWWA C-900, minimum DR 18 (150 Pressure Class). Ductile Iron AWWA C-150 Special Thickness Class 51 (cement mortar lined polyethylene encased).~~
~~16” through 20”~~	~~Ductile Iron AWWA C-150, Special Thickness Class 51 (cement mortar lined, polyethylene encased). Bar Wrapped Concrete Steel Cylinder, AWWA C-303, working pressure of 150 psi with 100 psi surge pressure. Cement Mortar Interior and Exterior Lined Steel Pipe, AWWA C-200, working pressure of 150 psi working pressure and 100 psi surge~~

	pressure.
24" and larger	Ductile Iron AWWA C-150, Special Thickness Class 51 (cement mortar lined, polyethylene encased). Bar Wrapped Concrete Steel Cylinder, AWWA C-303, working pressure of 150 psi with 100 psi surge pressure. Cement Mortar Interior and Exterior Lined Steel Pipe, AWWA C-200, working pressure of 150 psi working pressure and 100 psi surge pressure.

The designer shall also specify pipe material based on restrictions due to special construction methods, such as follows:

A. No PVC pipe for elevated crossings

Specifying the appropriate pipe/gasket 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/gasket material applicable to the particular project.

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, including vertical and horizontal bends, shall have concrete thrust blocking. See Drawings W700N, W701, W702A, W702B, W702C, and W703 on Sheet 3 of the City Standard Details.

Additionally, all fittings, including vertical and horizontal bends, shall have restrained joints, designed independently of concrete thrust blocking. For each particular fitting, the 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.

3.6 Meters and Meter Cans/Vaults

All meters supplied by the City of Denton will be at contractor's expense. For larger meters, the type of meter, whether compound or turbine will be at the City of Denton's discretion. Meter vaults for meter sizes up to 2" are to be provided by the contractor. For meter sizes above 2", the City of Denton will provide and install the meter vaults at contractor's expense. Details of the meter vault and meter installation for meter sizes 3 inch and larger are shown in Drawings W101 and W102 in Appendix -A.

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 only.	See U201, U202, U203A, U203C in Water/ W/W 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 legnth calculated.	See U201, U202, U203A, U203C in Water/ W/W 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 legnth 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 legnth 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.

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

Size	Type	Manufacturer
5/8” x 3/4"	Positive Displacement	Neptune
3/4” x 3/4”	Positive Displacement	Neptune
1”	Positive Displacement	Neptune
1-1/2”	Positive Displacement	Neptune
2”	Positive Displacement	Neptune
Spectrum 175 (3”)	Venturi Inlet (Single Jet)	Metron-Farnier
Spectrum 500D (3”or 4”)	Venturi Inlet (Single Jet)	Metron-Farnier
3” Tru/Flo	Compound	Neptune
4” Tru/Flo	Compound	Neptune
6” Tru/Flo	Compound	Neptune
6” Protectus III Fire Service	Compound	Neptune
8” Protectus III Fire Service	Compound	Neptune

Turbine meters are only allowed for irrigation meters; not for domestic meters.

Venturi meters are only allowed on a case-by-case basis, when recommended by Water Utilities.

Vaults are required for all meters greater than 2 in.

3.6.1 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 2012 International Plumbing Code (copy included herein as Table 3.6.1-1). To facilitate that review, the design engineer shall submit a tabulation of water supply fixture units (w.s.f.u.); a sample tabulation is provided herein in Table 3.6.1-2.

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

When sizing water meters, the design engineer should keep in mind 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).

Refer to Table 3.6.1-3, "Land Use and Service Unit/SFE Equivalencyies." Impact Fees are based on SFE's. For example, Impact Fees for a 1-1/2" meter would be twice those for a 1" meter.

3.6.2 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.

3.6.3 Installation

All meters 2" and smaller shall be furnished and installed by City for fees per current Fee Schedule. All meter assemblies 3" and larger and their associated vaults shall be furnished and installed by Contractor at their expense.

3.6.4 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 from the curb and gutter line intersection. For new development, water lines shall be placed on the north and east side, where possible, 2 feet inside from 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 and will require air release valves.

C. Minimum radius of curve and maximum deflection angle of pipe joints will be restricted to 80% of manufacturer's recommendation, after which the use of horizontal or vertical bends will be required.

TABLE 3.6.1-1

2012 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

TABLE 3.6.1-2 SAMPLE WSFU 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 3.6.1-3

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
Single Jet	3" Metron Spectrum 175	Commercial / Industrial	17.5
Compound	3"	Commercial / Industrial	22.5
Single Jet	3" or 4" Metron Spectrum 500D	Commercial / Industrial	35.0
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).

TABLE 3.6.1-1 (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

TABLE 3.6.1-1 (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

TABLE 3.6.1-1 (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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

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

D. ~~All vertical and horizontal bends shall be restrained joints. When multiple vertical bends are required for utility clearances, all fittings are to be designed with restrained joints in addition to concrete thrust blocking.~~Vertical bends shall be no greater than 45 degrees.

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

F. Provide at least two feet of vertical separation between a water line and any utility or stormdrain crossing it.

3.8 ~~Water Pipe Embedment~~Highway Crossings

~~The type of embedment for water mains shall be shown in Drawings W201 and W203 in Appendix A.~~

~~3.8.1 Highway Crossings~~

The design engineer shall, prior to the design of any highway crossing, contact the appropriate regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent that those of any applicable agency, the City's standards shall apply.

3.8.1~~2~~ State Highway Alignment Criteria

Refer to Section 4.12.1. ~~"Wastewater Design Guidelines."~~

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 that those of the railroad company or regulatory agency, the City's standards shall apply.

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 embedments and determine and specify the limits for specialized backfills.

3.11 Tunneling, Boring and Jacking

Tunneling, jacking and boring 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 bore pit is over 20 feet in length to accommodate 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 5 feet. 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.

The casing pipe thickness design shall be based on the following criteria:

- Pipe diameter <16-inch – casing thickness 3/8 inch (minimum)
- Pipe diameter ≥16-inch – casing thickness 1/2 inch (minimum)

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.

3.12 Elevated Crossings

Two acceptable methods of elevated crossings for consideration by the design engineer are 1) hanging the water main on a roadway bridge or 2) designing a specific utility bridge for the support of the water main crossing. The following basic criteria must be addressed by the design engineer for all elevated crossings:

A. Provisions for thrust restraints at the points of transition from a buried conduit to an elevated conduit and for all elevated changes of alignments and fittings.

B. Increased loading effects on the bridge created by a full main and its supports.

C. Access to main for maintenance purposes.

D. Coatings or methods of corrosion control for elevated pipe sections and pipe supports.

E. P.V.C. pipe is not to be used for any exposed sections of elevated crossing, due to deterioration caused by the ultraviolet rays present in direct sunlight.

F. Evaluate and address the freeze potential of small diameter or low flow mains.

G. Each joint of pipe is to have two support straps, to ensure positive restraint in all directions. Spacing of pipe supports is to be in accordance with the length of pipe

joints specified and one of the supports should be placed near the bell end of the pipe.

H. Air relief provisions are required where high points are created in the main. See Section 3.15.2.

I. A minimum of one expansion joint fitting is recommended for a water main crossing on a roadway bridge. Placement of the expansion joints should coincide with the expansion joints of the road way bridge.

J. Valves on each side of the crossing to facilitate pressure testing of the crossing and future repairs.

3.12.1 Specific Utility Bridge

In addition to the guidelines for all elevated crossings, the following criteria must be addressed for the designs of specific utility bridges for elevated crossings:

A. Height required for specific crossing types (Example: 2 feet above 100 year flood elevation for creeks).

B. Required length of spans and spacing of bridge piers to clear desired physical crossing.

C. Soil conditions pertaining to design of the piers.

D. Lateral loadings created by winds or open bodies of flowing water.

E. Potential hazards of facility to the general public, both pedestrian and vehicular.

3.13 Existing Water Main Replacement

To replace an existing main, the new main should be designed parallel to, and two (2) to three (3) feet away from the main being replaced and at least five (5) feet away from existing curbing to avoid damaging the curbing during installation of the proposed main, where appropriate and feasible. 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

3.14 Methods of Connection

3.14.1 Pressure Zones

The City of Denton's 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 there are physical continuations of water pipes between pressure zones, they are designed with valves that are closed at the boundary points so that each pressure zone is isolated. Proposed mains that approach pressure zone boundaries should be designed to loop within their designated pressure zones and with a minimum length of dead-end mains. Connections between pressure zones may require pressure reducing valve stations. The design engineer can determine the pressure zone boundaries by consulting the as-built water maps which show the designated closed valves between pressure zones and by contacting the Capital Projects Engineering Division.

3.14.~~1~~2 Tapping Sleeve and Valve

Tapping sleeves with tapping valves should be used whenever possible for connections to existing mains in order to avoid interruption of water services. See Figure 3.1 in Drawing PIAZ16 on Sheet 2 of the City Standard Details.

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

B. ~~Size, less one standard pipe size taps, are the largest allowed~~Taps on 16" and larger ~~connections~~pipes must be at least one standard pipe size smaller than the pipe being tapped. See Figure 3.2 in Drawing PIAZ16 on Sheet 2 of the City Standard Details.
(Example: 16" X 12", 16" X 8" and 16" X 6" taps are allowed).

3.14.~~2~~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 PIAZ16 on Sheet 2 of the City Standard Details.

3.14.~~3~~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 Water/Wastewater Standard Details.

3.14.~~4~~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.

3.15 ~~Valving~~Valves

~~The designer should place valves on proposed water mains so that they may be easily be located in the future by the valve operating crews. Valves should also be placed in~~

~~such a manner so that the isolation of sections of main will not unduly impact water customers or reduce fire coverage. All isolation valves shall be gate valves.~~

3.15.1 Isolation Valves

3.15.1.1 Location

Valves shall be provided to allow for the proper operation and maintenance of the water distribution system, and 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 Water Utilities Dept. 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 Water Utilities Department reserves the right to modify proposed designs to satisfy these objectives.

The design engineer shall place valves on proposed water mains such that 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 valves on proposed water mains:

A. Valves are to be located at street intersections at the projection of property lines, except when the main connection is by the tapping sleeve and valve method. This specific type of construction requires the placement of the valve at the point of connection. See Figure 3.6 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.

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 PIAZ13 on Sheet 2 of the City Standard Details. For mains larger than 12” in diameter, valves 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 positively anchored to the main line.

3.15.1.2 Specifications

Refer to Table 3.15.1.2.

3.15.1.3 Details

Refer to Drawings W104, W105, W106, W107 and W601 on Sheets 1 and 2 of the City Standard Details.

Table 3.15.1.2-1
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

3.15.2 Air Release Valves and Air / Vacuum-Air Release Valves

For 12" mains, City may require air release valves at local high points to facilitate automatic release of accumulated air.

For 16" and larger mains, 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.

3.16 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 have to be flushed. In addition, dead end mains result in a waste of water resources due to required flushing to ensure water quality.

If a dead-end main situation is unavoidable, it should be designed so that it may be periodically flushed of stagnant water by locating . ~~The following two design methods are considered acceptable for the provisions of flush points.~~

~~A.~~ ~~Locate A~~a fire hydrant near the main's end.

~~B. Install a 2" valve assembly to serve as a flush point at the main's end.~~

It is recommended that a dead-end main should have no more than one blow-off 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 PIA Z15 on Sheet 2 of the City Standard Details.

3.17 Fire Hydrant ~~Installation~~ 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 and industrial areas.

3.18 Requirements for Abandoning Water Mains

The design engineer is to 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.

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.

3.18.1 Replacement Mains

On mains being abandoned, the design engineer should 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 PIAZ15 on Sheet 2 of the City Standard Details).

3.18.2 Extension Mains

If a design requires an existing main to be cut by a connection with a proposed main, then no cut and plug is to be specified. (See Figure 3.10 in Drawing PIAZ15 on Sheet 2 of the City Standard Details).

3.18.3 Fire Hydrants

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

3.18.4 Valves

Sixteen (16) in. and larger valves located on mains being abandoned shall be removed and delivered to the City of Denton Water Utilities Department.

NOTE: The Water drawings have been removed from this update, since they are contained in the City Standard Details. This Manual now references the applicable Standard Detail Sheet for those Drawings.

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.")
E. City of Denton Addendum to COG Specs.
F. City of Denton Wastewater Master Plan
~~A. North Central Texas Standard Specifications for Public Works Construction (COG Specs)~~
~~B. COG Standard Drawings for Public Works Construction~~
~~C. City of Denton addendum to COG specs and drawings~~
~~D. Denton City Code, and Subdivisions and Land Development Regulations~~
~~Rules and Regulations for public water systems established by the Texas Natural Resources Conservation Commission~~

4.2 Estimated Wastewater Flows

A. For sewers in new developments, sewer lines and lift stations shall be designed for the estimated future population to be served, plus adequate allowance for institutional and commercial flows. ~~TNRCC Table 4.1 on page 21 –~~Figure: 30 TAC §217.32(a)(3) Table B.1. - Design Organic Loadings and Flows for a New Wastewater Treatment Facility (see excerpted information below in Table 4.2) 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:
   ~~B.~~1. Delineate the proposed development that will drain into the sewer main and lift station. Add drainage areas from up-~~-~~stream sub-~~-~~basins.
   ~~C.~~2. To calculate sewer flows, use the following design parameters:
      ~~1.~~a. Use 4 houses per acre for off-site area and add the number of proposed lots for the development to establish total number of lots.
      ~~2.~~b. Use 3.2 capita per lot
      c. Use average daily flow of 100 gal/capita/day.
      ~~3.~~d. Apply a 4.0 multiplier to the average daily flow to determine the peak flow.
      ~~4. Peak 2-hour flow factors are as follows:~~
      ~~a. For flow less than 0.5 MGD use 5 peaking factor~~
      ~~b. For flow above 0.5 MGD use 4 peaking factor~~

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 4.1 - Design Flows per TNRCC Criteria

Source	Remarks	Daily Wastewater Flow (Gallons Per Person)	Duration of Flow (Hours)
Municipality	Residential	100	24
Subdivision	Residential	100	24
Trailer Park (Transient)	2½ Persons per Trailer	50	16
Mobile Home Park	3 Persons per Trailer	75	24
School with Cafeteria	With Showers Without Showers	20 15	8 - 12 8 - 12
Recreational Parks	Overnight User Day User	30 5	16 16
Office Building or Factory	—	20	Length of Shift NOTE: The Facility shall be Designed for largest shift.
Motel	—	50	12
Restaurant	Per Meal	5	12
Hospital	Per Bed	200	12 - 24
Nursing Home	Per Bed	100	12 - 24
Alternative Collection Systems (Subchapter D)	Per Capita	75	24

TABLE 4.2

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	Per Capita	75

~~*4.3 Separation and Spacing of Sewer Mains From Water Mains*~~

~~A. When water mains and sanitary sewers are installed, they shall be installed no closer to each other than nine feet in all directions and parallel lines must be installed in separate trenches. Where the nine-foot separation distance cannot be achieved, the guidelines in this section shall apply. The guidelines also are listed in tabular form in Table 4.2 below.~~

~~1. Where a sanitary sewer parallels a water line, the sewer shall be constructed of cast iron, ductile iron or PVC meeting ASTM specifications with a minimum pressure rating for both the pipe and joints of 150 psi. The vertical separation shall be a minimum of two feet between outside diameters and the horizontal separation shall be a minimum of four feet between outside diameters. The sewer shall be located below the water line.~~

~~2. Where a sanitary sewer crosses a water line and the sewer is constructed of cast iron, ductile iron or PVC with a minimum pressure rating of 150 psi, an absolute minimum distance of six inches between outside diameters shall be maintained. In addition the sewer shall be located below the water line where possible, and one length of the sewer pipe must be centered on the water line.~~

3. Where a sewer crosses under a water line and the sewer is constructed of ABS truss pipe, similar semi-rigid plastic composite pipe, clay pipe or concrete pipe with gasketed joints, a minimum two foot separation distance shall be maintained. The initial backfill shall be cement stabilized (two or more bags of cement per cubic yard of sand) for all sections of sewer within nine feet of the water line. The initial backfill shall be from one-quarter diameter below the center line of the pipe to one pipe diameter (but not less than 12 inches) above the top of the pipe.

4. Where a sewer crosses over a water line, all portions of the sewer within nine feet of the water line shall be constructed of cast iron, ductile iron or PVC pipe with a minimum pressure rating of 150 psi using appropriate adapters. In lieu of this procedure, the new conveyance may be encased in a joint of 150 psi minimum pressure class pipe at least 18 feet long and two nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five feet intervals with spacers or be filled to the spring line with washed sand. The encasement pipe should be centered on the crossing, and both ends sealed with cement grout or manufactured seal.

5. The sewer need not be disturbed where a new water line is to be installed parallel to an existing sewer that shows no evidence of leakage, and the water line is installed above the sewer a minimum of two feet vertically and four feet horizontally. Should excavation for the sewer line produce evidence that the sewer is leaking, the sewer must be repaired or replaced as described in sub-paragraphs 1 or 4 above.

6. The sewer need not be disturbed where a new water line is to cross over (by two feet or more) an existing sewer showing no evidence of leakage. Should excavation for the sewer line produce evidence that the sewer is leaking, then the sewer must be repaired or replaced as described in subparagraphs 1 or 4 of this paragraph.

B. Unless sanitary sewer manholes and the connecting sewer can be made watertight and be tested for no leakage, they must be installed so as to provide a minimum of nine feet of horizontal clearance from an existing or proposed water line. Where the nine-foot separation distance cannot be achieved, an encasement pipe as described in paragraph A.4 of this subsection may be used for the water line.

C. Fire hydrants shall not be installed within nine feet vertically or horizontally of any sanitary sewer, regardless of construction.

D. No physical connection shall be made between a drinking water supply (public or private) and a sewer. Any appurtenances shall be designed and constructed to prevent any possibility of sewage entering the drinking water system.

E. No sewer carrying domestic or industrial wastes shall cross water mains to connect to pumping equipment. Water mains shall not be installed closer than ten feet to

~~septic tank drain fields. No raw water lines shall be installed within five feet of any tile or concrete sanitary sewer.~~

4.3 Separation Distances Between Wastewater Collection System Pipes and Manholes and Public Water Supply Pipes (excerpted from TCEQ Rules - 30 TAC §217.53.d and amended for City of Denton Standards)

NOTE: The City of Denton does not allow the use of cast iron for water or wastewater piping.

~~F.~~A. Wastewater collection system pipes must be installed in trenches separate from water supply pipe trenches.

~~G.~~B. Wherever possible, a wastewater collection system pipe must be located below a water supply pipe. If a collection system pipe cannot be located below a water supply pipe, the design engineer must justify in the engineering report why it is not possible to locate the collection system pipe below the public water supply pipe.

~~H.~~C. Wherever possible, wastewater collection system pipes and manholes must be located at least nine (9) feet from all water supply pipes. If a collection system pipe or manhole cannot be located at least nine (9) feet away from a water supply pipe, the design engineer must justify in the engineering report why it is not possible to provide at least nine (9) feet of separation. Table C.1. in Figure: 30 TAC §217.53(d)(3) provides a reference to paragraphs in this subsection that apply if a collection system pipe or manhole cannot be located at least nine (9) feet away from a water supply pipe.

~~I.~~D. If a wastewater collection system pipe is located above a water supply pipe and runs parallel to the water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must be encased. The casing pipe must be constructed of at least 150 pounds per square inch (psi) pressure class pipe that:

~~J.~~ 1. encases the entire length of wastewater collection system pipe that is within nine (9) feet of the water supply pipe;

~~K.~~ 2. is sealed at both ends with cement grout or a manufactured seal;

~~L.~~ 3. is at least two nominal sizes larger than the wastewater collection pipe; and

~~M.~~ 4. is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

~~N.~~E. If a wastewater collection system pipe crosses above a water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be encased in a casing pipe according to subparagraph E.1 of this paragraph, or must be constructed using at least 150 psi pressure class pipe according to subparagraph E.2 of this paragraph.

1. A casing pipe for a wastewater collection system pipe that crosses above a water supply pipe must be constructed of at least 150 psi pressure class pipe that:
(a) is sealed at both ends with cement grout or a manufactured seal;
(b) is at least two nominal sizes larger than the wastewater collection pipe;
(c) is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals; and

~~O.~~ 2. A wastewater collection system pipe that crosses above a water supply pipe must be constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe and must use manufacturer-approved adapters. Gasketed joints, compression joints, and other non-bonded joints must be designed to seal at atmospheric pressure.

~~P.~~F. If a wastewater collection system pipe is located below a water supply pipe and runs parallel to the water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be constructed using at least 150 psi pressure class pipe according to subparagraph F.1 of this paragraph, or must be encased in a casing pipe according to subparagraph F.2 of this paragraph.

1. A wastewater collection system pipe that runs parallel to and below a water supply pipe must be constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe that:
(a) is located at least two (2) vertical feet below the water supply pipe;
(b) is located at least four (4) horizontal feet away from the water supply pipe; and
~~Q.~~ (c) includes joints that are designed to seal at atmospheric pressure.

2. A casing pipe for a wastewater collection system pipe that runs parallel to and below a water supply pipe must be constructed of at least 150 psi pressure class pipe that:
(a) is sealed at both ends with cement grout or a manufactured seal;
(b) is at least two nominal sizes larger than the wastewater collection pipe; and
~~R.~~ (c) is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

~~S.~~G. If a wastewater collection system pipe crosses below a water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be constructed using at least 150 psi pressure class pipe according to subparagraph G.1 of this paragraph, or must be encased in cement-stabilized sand according to subparagraph G.2 of this paragraph, or must be encased in a casing pipe according to subparagraph G.3 of this paragraph.

1. A wastewater collection system pipe that crosses below a water supply pipe and is constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe must:
(a) have at least six (6) inches of separation between the outsides of the pipes;
(b) be centered on the crossing;
(c) be at least 18 feet long; and

~~T.~~ (d) terminate at joints that are designed to seal at atmospheric pressure.

2. A wastewater collection system pipe that crosses below a water supply pipe and is constructed of any material other than at least 150 psi pressure class, corrosion-resistant, non-brittle pipe must:

(a) have at least two feet of separation between the outsides of the pipes; and

~~U.~~ (b) be encased in cement-stabilized sand backfill that meets the requirements of subparagraph G.4 of this paragraph.

3. A casing pipe for a wastewater collection system pipe that crosses below a water supply pipe must be constructed of at least 150 psi pressure class pipe that is:

(a) sealed at both ends with cement grout or a manufactured seal;

(b) at least two nominal sizes larger than the wastewater collection pipe; and

~~V.~~ (c) supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

4. Cement-stabilized sand for encasing wastewater collection system pipes must:

(a) include at least 160 pounds of cement for every cubic yard of sand;

(b) be installed beginning one-quarter pipe diameter below the centerline of the collection system pipe;

~~W.~~ (c) be installed ending one full pipe diameter above the top of the collection system pipe, or 12 inches above the top of the collection system pipe, whichever is greater.

~~X.~~H. If a nine-foot separation distance between a manhole and a water supply pipe cannot be achieved, the manhole must either:

~~Y.~~ 1. have no measurable leakage during a leakage test conducted according to the requirements in 30 TAC §217.58 of the TECQ Rules (relating to Testing Requirements for Manholes); or

2. have all portions of the manhole within nine (9) feet of a water supply pipe encased in at least one foot of cement stabilized sand that meets the requirements of paragraph G.4.(a) and (b) of this subsection.

4.4 Size and Slope of Sewer

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)

Table 4.3
Separation Distance Between Wastewater Pipes and Water Supply Pipes

Figure: 30 TAC §217.53(d)(3)

Table C.1.

Case	Protection Requirement
Parallel pipes within nine feet, where the collection system pipe is above the water supply pipe	Encased in a casing pipe according to paragraph (4) of this subsection
Crossing pipes within nine feet, where the collection system pipe is above the water supply pipe	Encased in a casing pipe according to paragraph (5)(A) of this subsection **-or-** Constructed using 150 per square inch (psi) pressure class pipe according to paragraph (5)(B) of this subsection
Parallel pipes within nine feet, where the collection system pipe is below the water supply pipe	Constructed using 150 psi pressure class pipe according to paragraph (6)(A) of this subsection **-or-** Encased in a casing pipe according to paragraph (6)(B) of this subsection
Crossing pipes within nine feet, where the collection system pipe is below the water supply pipe	Constructed using 150 psi pressure class pipe according to paragraph (7)(A) of this subsection **-or-** Encased in cement-stabilized sand according to paragraph (7)(B) of this subsection **-or-** Encased in a casing pipe according to paragraph (7)(C) of this subsection
Manhole within nine feet of a water supply pipe	No measurable leakage according to paragraph (8)(A) of this subsection **-or-** Encased in cement-stabilized sand according to paragraph (8)(B) of this subsection

Proposed sewers shall be designed with slopes sufficient to provide a minimum velocity of 2.0 feet per second (fps). It is desirable to design for 3.0 fps velocity in the sewer. The minimum acceptable Manning's "n" factor for design shall be 0.013. This "n" value 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 below are based on an "n" value of 0.013 and are the minimum acceptable slope for sewer lines.

Table 4.4 - 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)
6	~~0.60~~0.50	12.35	~~0.28~~0.26
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	~~0.06~~0.07	1.65	4.91
30	~~0.055~~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)

~~Table 4.2 - Separation of Water and Sewer Lines~~

~~Condition~~	~~Location~~		~~Material Water or Sewer~~	~~Minimum Separation~~		~~Comments~~
				~~Vert~~	~~Horiz~~	
~~Sewer Force Main and Gravity Sanitary Sewer Parallel to Water~~	~~Water Above Sewer~~	~~Std.~~	~~CI, DI, or PVC 150 PSI~~	~~2 ft.~~	~~4 ft.~~	~~Separate trenches~~

Main						
Gravity Sanitary Sewer Crossing Water Main	Water above Sewer	Std.	CI, DI, or PVC 150 PSI	6 in.	NA	Center one 18-20 ft. joint of sewer pipe on water main.
Gravity Sewer Crossing Water Main	Water above Sewer	Std.	ABS, Clay, Concrete, or Composite	2 ft.	NA	Cement stabilize sand backfill initial backfill zone of sewer 9 ft. each side of crossing. Center one joint of sewer pipe on water main.
NEW WATER AND EXISTING SANITARY SEWER						
New Water Parallel To Existing Sewer	Water Above Sewer	Std.	Clay, Concrete, ABS, CI, DI or PVC	2 ft.	4 ft.	If sewer shows no sign of leakage, then leave sewer alone. If sewer shows signs of leakage, then repair or replace.
New Water Crossing Existing Sewer	Water Above Sewer	Std.	ABS, Clay, Concrete, or Composite	2 ft.	NA	If sewer shows no sign of leakage, then leave sewer alone. If sewer shows sign of leakage, then repair or replace.
New Water Crossing Existing Sewer	Sewer Above Water	Std.	ABS, Clay, Concrete, or Composite	2 ft.	NA	Replace existing sewer with one joint CI DI or PVC 150 PSI, centered ing over water line.
New Water Parallel to Existing Sewer	Sewer Above Water	Std.	ABS, Clay, Concrete. or Composite	2 ft.	4 ft.	Replace existing sewer with CI, DI, or PVC 150 PSI or cement stabilized sand backfill in initial backfill zone of sewer where parallel closer than 9', or encase water in 150 PSI Pipe two nominal sizes larger.

Table 4.2 – Existing Water and New Sanitary Sewer

Condition	Location	Material Water, Sewer	Minimum Separation		Comments
			Vert	Horiz	
New Sewer parallel Existing Water	Water Above Sewer or Sewer Above Water	Std.	CI, DI, or PVC 150 PSI	2 ft.	4 ft.	Separate trenches
New Sewer Crossing Existing Water	Water Above Sewer or Sewer Above	Std.	CI, DI, or PVC 150 PSI	6 in.	NA	Center one joint of sewer pipe in water line

	Water					
New Sewer Crossing Existing Water	Water above Sewer	Std.	ABS or Clay	2 ft.	NA	Cement stabilize sand backfill initial zone of sewer for 9 ft each side of crossing. Center one joint of sewer pipe on water main.
New Gravity Sewer Crossing Water Main	Sewer Above	Std.	CI, DI, or PVC 150 PSI	9 ft.	NA	Encase sewer main in a joint of 150 PSI pressure class pipe at least 18 feet long and two nominal size diameter larger than the new sewer pipe diameter.

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, 0.25 depth of the pipe is flowing full at slopes greater than those listed in Section 4.4 above, designer will make special provisions must be made to protect the pipe due toagainst pipe and bedding displacement of the bedding by erosion and/or shock.

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 insuring that 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 with less than minimum cover shall be encased in Class "G" embedment. See Drawing SU204 in Appendix B.on Sheet 7 of the City Standard Details.

When establishing depth for proposed wastewater mains, design engineers should be aware of proposed street grades in unimproved areas. This information can be obtained from the Engineering Capital Projects Engineering DivisionDepartment. Design engineers should also anticipate the size of proposed storm sewers that will be installed in unimproved streets. To do this, calculate the cross-sectional area of both drainage ditches and convert that area into a circular area of equivalent storm sewer pipe, thus

determining the anticipated size of the future storm sewer. Future storm sewers should be at least 2.5 feet below the top of the curb. The top of the proposed sewer main should be at least two (2) feet below the bottom of the future storm sewer.

4.7 Sewer Alignment

Design engineers should 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 at the center of the pavement. 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. When existing flow permits, it is recommended that 8 and 10 inch replacement mains be constructed horizontally in the same trench.

4.8 Sewer Laterals

Minimum lateral sizes are:

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

Clean-outs shall be provided on laterals at the easement or Right-of-Way line. See Drawings S403 and S404 of Sheet 5 of the City Standard Details.
~~The minimum size of a sanitary sewer lateral within a dedicated easement on R.O.W. shall be 6- inches in diameter. Clean-outs shall be provided on laterals. See Drawing S402 in Appendix-B.~~

Manholes shall be provided for lateral connections when the lateral pipe diameter is equal to the main sewer pipe~~greater than 6-inch in~~ diameter or the lateral is 8-inch diameter or larger.

Laterals shall be constructed ~~up~~ 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%. It is recommended that laterals not be designed with less than 1% grade. ~~Minimum size for laterals is as follows:~~
~~A. 4” minimum for single family~~
~~A. 6” minimum for local retail, light commercial and apartment~~
~~B. 8” minimum for manufacturing and industrial~~

4.9 Gravity and Force Main Sewer Pipe Material

Gravity sewer pipe shall ~~be PVC and~~ meet the following criteria, unless special circumstances require an alternative and the alternative is approved by the Director of wastewater Utilities.

Size	Pipe Material
6 in. through 15 in.	PVC – ASTM D3034, SDR 35 (for pipe depths 15 ft. or greater, use SDR-36 pipe)
18 in. through 24 in.	PVC – ASTM F 679, PS46 or PS115 Fiberglass Reinforced Plastic – ASTM D3262

For gravity sewer pipe sizes over 24" in diameter, design calculations and pipe selection shall be submitted by the development design engineer to Engineering Development Review for review; approvals will be provided on a project specific basis.
~~Design calculations and pipe selection for shall be submitted to the Engineering Department. For pipe sizes over 24" diameter, pipe material shall be approved on a project by project basis.~~

Force main sewer pipe shall be designed to meet the working and surge pressure requirements of the particular application. Design calculations and pipe selection shall be submitted by the development design engineer to ~~the~~ Engineering Development Review~~Department~~.

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 ~~Appendix B~~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 6 inches above the top of the pipe will be based on materials as specified by North Central Texas Council of Governments (NCTCOG) Standard~~s~~ 504.2.2.1(a).~~2.1.8 (a~~) crushed stone embedment - Aggregate Grade 4.

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

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. ~~and for mains greater than 12 feet deep.~~

The types of manholes ~~currently used~~ allowed by the City are shown in ~~Appendix B~~Drawings S101, S102, S103 and S107A of Sheet 4 of the City Standard Details and ~~as~~ are listed below:

A. Cast-in-place
~~A. Pre-cast~~
B. Pre-cast with pre-cast base with lining as noted in Drawing S101 on Sheet 4 of the City Wastewater Standard Details
C. ~~Cast in place~~Fiberglass
D. Drop connection

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 preferred connection should 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. If the main line is less than 150 ft. long, then a Sanitary Sewer Mainline Cleanout may be used. See Drawing S402 on Sheet 5 of the City Standard Details.
F. At the end of a sewer line projected for extension in the near future, where a manhole and stub-out shall be provided at the end of the sewer line.

4.12 Highway Crossings

The design engineer shall, prior to the design of any highway crossing, contact the appropriate regulatory agency and determine if there are any special requirements.

4.12.1 State Highway Alignment Criteria

Some of the design parameters that affect water and sewer line construction and that have been established by TxDOT are listed below.

A. **Utility Accommodation Zone**

On most state highways the Utility Accommodation Zone is within 10 feet of the ~~R.O.W.~~ROW line, with the outside 3 feet being reserved for overhead utilities. ~~The Highway Department~~TxDOT does not permit its pavement to be cut. ~~On projects paralleling and within state highway R.O.W.s, all water and sewer construction must take place within this10-foot zone. On some projects where there is a water and sewer main on the same side of the R.O.W., it will not be feasible to maintain the 9-foot separation between water and sewer lines.~~The City of Denton requires that all of its water and sewer lines be constructed in an easement outside of the TxDOT ROW, unless provision is made with TxDOT to accommodate the water or sewer line within its highway utility accommodation zone.

B. **Control of Access Zone**

On all interstate highways there is a control of access zone. On interstate highways without service roads, the control of access zone extends from ROW line to ROW line. This means no construction, except by other than open-cut, may take place within the ROW lines. On interstate highways with service roads, the control of access is from back of service road to back of service road. This means no construction, except by other than open-cut, may take place between the service roads. The design engineer is responsible for determining control of access.

Variances to the control of access regulations can sometimes be granted. However, a variance usually entails approval from the Dallas District office, the State Office and FHWA. Additionally, a variance would require the four tests below be met.

1. The accommodation will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway.

2. The accommodation will not be constructed and/or serviced by direct access from the through traffic roadways or connecting ramps.

3. The accommodation will not interfere with or impair the present use or future expansion of the freeway.

4. Any alternative location would be contrary to the public interest. This determination would include an evaluation of direct and indirect environmental and economic effects that would result from the disapproval of the use of such right-of-way for the accommodation of such utility.

4.13 Railroad Crossings

The design engineer shall, prior to the design of any railroad crossing, contact the appropriate regulatory agency and determine if there are any special requirements.

4.14 Tunneling, Jacking, and Boring

Tunneling, jacking and boring 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 over 20 feet in length to accommodate one joint of pipe. Width of the bore pit can vary depending on the depth and size of pipe, with the narrowest width about 5 feet. The preferred location for the bore pit is at the lower elevation end of the bore. This allows any groundwater and/or boring slurry to drain from the tunnel into the bore pit, for removal by pumping.

The casing pipe thickness design shall be based on the following criteria:

Pipe Diameter	Casting Pipe thickness
<16”	3/8”
≥ 16”	1/2”

All encased carrying pipe shall be ~~ductile iron~~PVC. Minimum depth of bore shall be 42”.

4.15 Creek Crossings

When a sewer main crosses a creek or channel, the design engineer must evaluate the condition of the creek bed. Backfill material and minimum construction criteria are shown in Drawings S701 and S702 on Sheet 6 of the City Standard Details ~~S301 in~~

~~Appendix B~~. These criteria include ~~construction of~~ creek bed soil and condition, ~~material of soil~~ as well as presence of exposed rock.

4.16 Siphons

For creek or channel crossings and under special design conditions, design of inverted siphons should be undertaken only as a last resort, when all other alternatives have been evaluated and rejected. Inverted siphons shall not have less than 2 barrels, with a minimum pipe size of 8 inches, and shall be provided with necessary appurtenances for convenient flushing and maintenance. Manholes are required at each end of the siphon with adequate clearance for rodding.

4.17 Abandonment of Sewer Mains

When an existing sewer line is replaced with a new sewer line, often it is necessary to abandon the old line, especially if the replacement is not in the same ditch. The design engineer shall ensure the laterals tying into the existing sewer line are transferred to the new main, so that a live sewer main is not abandoned. If a manhole on the sewer main being abandoned is to remain in service because other sewer mains are entering this manhole, the sewer main to be abandoned shall be plugged inside the manhole. A note is required on the plans, showing which sewer main is to be plugged inside the manhole. "Cut and plug" method resulting in excavation outside the manhole and a cut in the main with attendant excessive costs shall be avoided. Design engineer shall use the minimum guidelines shown _____ ~~in Appendix A~~ for abandonment of an existing sewer line.

4.18 Abandonment of Manholes

If a manhole as well as the sewer main is to be abandoned, the method described is Section 4.17 above, along with the minimum guidelines shown in ~~Appendix B~~Drawing S105 on Sheet 4 of the City Standard Details, shall be used.

4.19 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.

4.19.1 Preliminary Design Submittal

A preliminary design submittal will be 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 plan or plans submitted shall contain the following information:
   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. Property lines.

B. The written report shall include the following information:
   1. The 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.

4.19.2 Site Layout

A. Station Sitting. 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 station shall be a minimum of 100 feet from a potential residential use.

   3. The station site and its access shall be dedicated to the City.

4. 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. 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. 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 shall be cast in place concrete or pre-cast with watertight joint meeting ASTMC478-90. Steel, fiberglass, HDPE and RCP are not acceptable materials. The tops may be pre-cast with the doors built-in. The coating for the wet well exterior and interior walls shall be as specified in 4.19.2.C and D below, respectively.

8. 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.

9. 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)

Surface Preparation	Coating System Primer
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

Surface Preparation	Coating System	
	Primer	Finish
Brush-off Blast Cleaning	Tnemec Series 66-1255 H.B. Epoxoline 4.0 - 6.0 dry mils	Tnemec Series 262 Elasto-Shield 50 - 75 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. If the station is greater than 100 feet from a public street, a turn-around shall be provided on the station site.

F. Fencing

Fence shall be seven (7) feet above grade, using six (6) feet high chain link fabric surmounted by three strands of barbed wire. ~~See detail #1 for fence and gate configuration.~~

G. Electrical and Instrumentation Panels

Panels shall generally be located where they do not obstruct vehicle access to the wet well or the dry well. The panels shall be place at an elevation to be easily accessible.

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

I. 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.

4.19.3 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 low 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 Wastewater 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.

4. 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.

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 Wastewater Utilities~~Engineering Administrator~~. The minimum force main size shall be four 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.

4.19.4 Pumps

Pump criteria is included in the City of Denton Standard Construction Specifications.

4.19.5 Mechanical

A. Force Main

1. Force mains 6-inch through 12-inch shall be polyvinyl chloride (PVC) meeting AWWA C-900 with a minimum working pressure of 150 psi and a minimum thickness of DR 18. Pipe larger than 12-inch diameter shall meet AWWA C-905 and minimum thickness of DR 18, 235 psi pressure class.

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 fushion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyehtylene, or approved equal.

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

4. Plans shall include plan and profile for the force main.

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 1-inch black continuous lettering “Caution Sewer Line Buried Below.” The pipe tape shall be terra tape, extra stretch, or approved equal, and shall be installed on top of the sewer pipe embedment along the centerline of the pipe line.

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 fushion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyehtylene, 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 meeting the City of Denton Standard Construction Specification.

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

D. Check Valve

1. Check valve shall be a controlled closing swing check valve 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. The check valve shall be located upstream of the isolation valve.

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

4. All external 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.

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.

4.19.6 ~~Electrical Requirements for New Lift Stations~~Electrical, Instrumentation and Supervisory Control and Data Acquisition (SCADA) Requirements

Due to rapid advances in technology and equipment in this area, contact the Director of Wastewater Utilities for the latest requirements.

~~1. Electrical services to be 240 volt 3 phase or 480 volt 3 phase.~~

2. Allow a minimum of 3 feet in front of all enclosures to wet well openings for workmen standing space. Observe NEC Article 110 rules for working clearances around the electrical panels.

3. Install a manual transfer switch between electrical service and electrical equipment along with an emergency generator receptacle (Appleton# ADJA 1033-150).

4. Install a weatherproof 20 amp rated 120-volt convenience receptacle outside of the electrical control panel wired to a 20-amp circuit breaker.

5. Where a single phase power transformer is required, install a minimum 3 KVA transformer, fused on both the primary and secondary side.

6. Install a power phase monitor capable of protecting against phase loss, phase reversal, low voltage, and high voltage.

7. Power phase monitor shall have two sets of control or alarm contacts. One set used to disable the pump control circuit, the second set used to alarm the RTU of a power failure.

8. Install current transformer between the service discount and the rest of the electrical equipment to provide a means to monitor the complete station load. Terminate secondary leads on a terminal strip for connection to a future power usage monitor.

9. Install potential transformer to provide a 120-volt secondary voltage on all three phases. Terminate the secondary leads on a terminal strip for connection to a future power usage monitor.

10. A spare conduit shall be installed between the pump control panel and the RTU enclosure for power usage monitor wiring (1" minimum).

11. All electrical power circuits to be protected by circuit breakers (versus fuses) where applicable. Use the following as a guide for single-phase circuits; RTU-15 amp, Flow meter/record-15 amp, pump control circuit-15 amp, convenience outlet/flood light-20 amp.

12. Thermal protection and moisture sending devices in submersible pumps are to be wired to disable pumps and/or control circuits.

13. Hand position on H-O-A switch is to be capable of operating pump in the event of a complete failure of the Miltronics level controller.

14. The required remote start/stop capability is to be provided by using RTU control module. Install interface relay between RTU contacts pump control circuit. RTU contact operating may be momentary action only.

15. Motor starters shall have a normally open auxiliary contact to be used for a pump run contact connected to the RTU.

16. All control relays are to be octal 8 pin or 11 pin plug-in type where feasible.

17. Three laminated control drawings are to be provided.

18. Mercury float switch is to be installed and wired as a low level emergency shut off in the event of a continuous pump run due to a level controller failure, pump control switch left in Hand position, etc.

19. Where submersible pump cords are to be installed in conduits, the conduits should be sized and installed to facilitate removal and re-installation of the pump cords.

20. A switch-operated floodlight shall be installed to illuminate control panel area at night.

4.19.7 Electronic Requirements for New Lift Stations

A. Scada System (Motorola)

1. Communications
   a. Antenna – 7db Yagi
   b. Tx/Rx Freq – 173.39625 MHz
   c. Field Radio – 20 W Max Trac, or equivalent

2. RTU and Modules
   a. RTU requires a cabinet 30" H x 24" W x 12" D with backplate
   b. RTU is rack mount, 8 slot (Moscad)
   c. One CPU, Series 300 module
   d. One mixed I/O module
   e. One AC Analyzer module, PN L-1986A, or equivalent. The equivalent must communicate with MODBUS.

3. A 120V, 15A convenience outlet shall be provided in the RTU cabinet.

B. Flow and Flow Recording

1. Flow recorder – Chessell 392, 10" circular recorder, 4-20mA input, single channel (pen), no totalizer, 7 day charts. No other options

2. Flow meter

   a. Polysonics DCT 1088 with 4-20mA output, optional display, 120VAC power
   b. Flow meter transducer vault
      i. May be standard manhole (24" access)

~~ii. Force main material through vault must be PVC, Cast Iron, or ductile iron. No Concrete.~~
~~iii. Force main shall have ten (10) straight pipe diameters~~
~~iv. upstream and ten (10) straight pipe diameters downstream of transducer location.~~
~~v. d. There shall be a minimum clearance of 12" between the vault floor and the bottom on the force main.~~

~~3. DCT 1088 analog output shall go to recorder and RTU, AI #2~~

~~4. A 120 Volt, 15 A convenience outlet should be provided in Flowmeter / Recorder Cabinet~~

~~C. Level I analog inputs~~

~~1. Level meter – Milltronics Hydroranger, 115 VAC. Unit comes with Isolated 4-20mA output, built in temperature compensator and 5 relays.~~
~~a. Relays #1 and #2 to be used for pumps control and alternation~~
~~b. Relays #3, #4, and #5 shall go to terminal strip for use as RTU discrete imputs: #3 – wet well low level; #4 – Wet well high level; #5 – Loss of echo.~~

~~2. Transducer (level meter) shall be XPS – 15 with submergence shield. Transducer beam shall have clear path to wet well bottom, and it shall be accessible from outside the wet well access hatch.~~

~~3. The hydroranger analog output shall go to a RTU analog input, AI#1.~~

~~4. Do not purchase hydroranger programmer.~~
~~**Contact Water Reclamation Plant Electronics Office at (940) 349-7523 for programmer.**~~

~~D. General~~

~~1. All leads shall be landed on terminal blocks:~~

~~2. No wire nuts or butt splices blocks:~~

~~3. Separate Voltages in conduits; 120 VAC SHALL NOT be run with 4-20 mA DC Signal Loops.~~

~~4. RTU shall be in dedicated enclosure.~~

~~5. Flowmeter Recorder shall be in dedicated enclosure.~~
~~**Contact Water Reclamation Plant Electronics Office at (940) 349-7523 for programmer.**~~

~~E. General~~

~~1. All leads shall be landed on terminal blocks:~~

~~2. No wire nuts or butt splices blocks:~~

~~3. Separate Voltages in conduits; 120 VAC SHALL NOT be run with 4-20 mA DC Signal Loops.~~

~~4. RTU shall be in dedicated enclosure.~~

~~5. Flowmeter Recorder shall be in dedicated enclosure.~~

Section 5 – Right-of-Way and Easements

5.1 Right-of-Way ~~Approvals and~~ Requests and Approvals prior to Contract/Work Order

Prior to release of any project for construction contract or work order, right-of-way (ROW) must be cleared. This means all ~~highway,~~ highway, railroad, Park Department approvals, easements, releases, agreements, covenants, etc. required for the project must be properly executed. ~~and/or notarized, and~~ executed documents provided to the appropriate City Office and recorded with the County Clerk's office (if applicable).

5.2 Within Existing ~~Public~~ City ROW and Easements

When planning to utilize an easement for utility extensions, the design engineer should review the rights provided by that easement to ensure the easement can be used for the planned utility, e.g., some easements may grant permission for an underground water line, but not include permission for placement of wastewater lines.

If the project falls entirely within an existing ~~public~~ City ROW or water, wastewater or utility easement, the design engineer must request and ~~ROW~~obtain approval of a Permit to Construct Within City ROW from the ~~ROW~~ Public Works Inspection Division. This request ~~should~~ must be made on the ~~proper ROW request form (see figure 5.1)~~permit application form available from Public Works Inspection.

If the easement is a Denton Municipal Electric (DME) easement, and the design engineer wishes to cross a section of that easement, a letter or permission from DME will be required in addition to an easement from the property owner.

5.3 City Easement and ROW Acquisition

For a City project, the design engineer is to involve the Real Estate Division in the project from the planning stage to assist in selecting routings which will alleviate ROW costs to the lowest practical level. Real Estate will perform all ROW duties under the direction of the design engineer.

If ~~there~~ easements, rights-of-way or railroad~~, highway~~ approvals~~, etc.,~~ must be acquired for a development project, the development design engineer must submit a request ~~using the ROW request form (see figure 5.1)~~to the Real Estate Division, using the appropriate forms available from Real Estate. ~~Many of these a~~Acquisitions can be time consuming~~:~~, often requiring 6 - 12 months. The development design engineer should ~~recognize~~ plan for this activity and duration and ~~make~~ submit the appropriate forms and permit applications ~~request to ROW~~ Real Estate as early as possible.

The procedures for easement acquisition for development projects ~~City contracts or work orders~~ are as follows:

A. The design engineer ~~shall~~ requests a sample easement document form from the ~~Right-of-Way~~ Real Estate Division ~~to obtain a sample form~~ for preparation of the easement documents applicable to the development ~~P~~project ~~at hand~~.

B. Upon receipt of the sample easement document form from ~~the ROW Division~~Real Estate, the design engineer prepares ~~an~~ easement documents for permanent and temporary construction easements. The easement documents shall include the following, prepared by a licensed land surveyor and in the format approved by the ~~ROW~~ Real Estate Division:
   1. ~~A~~ Metes and bounds legal descriptions of the proposed easements ~~by using solely a perimeter description (see Figure 5.2)~~.
   2. The square footage and acreage of the proposed easements.~~, both temporary and permanent:~~
   3. A survey plat ~~prepared by a licensed land surveyor~~ drawing fully ~~describing~~ depicting the proposed easements and ~~its~~ their relationship to the parent tract.

C. Design engineer submits unsigned easement document package to Real Estate for review and approval.

D. Upon Real Estate's approval, documents will be released for execution by affected parties. The design engineer is responsible for obtaining the required signatures.

E. Upon execution, the design engineer shall return the original, fully executed easement documents to the ~~ROW~~ Real Estate Division, along with a check made payable to the "Denton County Clerk" for the required County Clerk filing fees. Real Estate will file the documents with the County Clerk's Office.

F. Upon ~~recording~~ receiving the recorded documents ~~at~~from the County Clerk's office, ~~and return from the courthouse,~~ Real Estate will provide a file-stamped copy of the easement documents ~~will be relayed~~ to the design engineer ~~along~~ with the~~ir~~ receipt for filing fees.

5.~~3.14~~ ~~Approvals~~Non-City ROW Permits and Approvals

A. Railroad ~~Approvals~~ Permits

Railroad permit approvals ~~are invariably time consuming~~ require considerable time~~,~~ ~~t~~Therefore, the design engineer should ~~make his~~coordinate and submit railroad permit requests to the ~~ROW~~ Real Estate Division as early as possible. In some instances, it may be desirable to ~~make~~ perform the railroad crossing under a separate contract or work order. When making a request, the request form ~~should~~ shall be accompanied by four (4) sets of prints with the railroad crossing highlighted. ~~ROW~~ Real Estate will notify the design engineer when ~~"ROW is clear" via the original request form.~~the railroad permit approval has been received and provide a copy of the approved permit.

~~Figure 5.1~~

Date:

To: Engineering & Capital Projects Administrator,

From:

Subject: ROW Request

Project Name:_____ Job No.:_____

Description:_____
_____
_____
_____

Plan No: _____ Sheet (s) _____ Prints _____

TYPE OF REQUEST:

[ ] Public Utility Easement
[ ] Easement Abandonment Request ..... [ ] City of Denton – Electric Prints
[ ] Water Main Easement .....4 [ ] Texas Highway Approval..... 4
[ ] Sanitary Sewer Main Easement.....4 [ ] Lone Star Gas 3
[ ] Water and Sanitary Sewer Main Easement .4 [ ] Railroad 4
[ ] Covenant Agreement – Copy Plat (2).....2 [ ] Ownership/Deed Information
[ ] R.O.W. Approval.....1 [ ] Survey..... 2
[ ] Other [ ] Temporary Const Easement 4
[ ] Fee Purchase..... 3

Advertisement Date: _____
Comments:_____
_____
_____
_____

Contact _____for additional information.
Return request form and documents to the undersigned

_____
_____
Requestor

To Be Completed by R.O.W. Division

R.O.W. Status: [ ] Acquired [ ] Approved [ ] Returned
Comments:_____
_____
_____

_____ _____
Right-of-way Agent

B. ~~State~~ Texas Department of Transportation (TxDOT) ~~Highway~~ Utility Permit Approvals~~.~~

~~Obtaining Highway approval is usually not as difficult or time consuming as railroad approvals. However, there are some design parameters that could have a bearing on State Highway approvals.~~All water and wastewater utility work within TxDOT rights-of-way require TxDOT Utility Permit approval. TxDOT's requirements and procedures for Utility Permits are included in TxDOT's "Use of Right-of-Way by Others Manual," which can be found online at http://onlinemanuals.txdot.gov/txdotmanuals/use/use.pdf .

Development design engineers should coordinate with and submit their TxDOT Utility Permit applications through Engineering Development Review for any City utility work associated with land development. TxDOT requires the utility owner to submit the permit for any utilities within their ROW.

City design engineers will process TxDOT Utility Permits as part of their project work.

~~1. Utility Accommodation Zone (see 4.12.1).~~

~~2. Control of Access Zone (see 4.12.1). When making a request, the form should be accompanied by the number of prints specified on the form. The ROW Division will notify the design engineer when "ROW is clear," via the original request form. The design engineer then has a highway approval note added to the plans stating the approval date and date of expiration.~~

~~3.~~ In addition to the proposed utility construction plans, a traffic control plan ~~shall~~ must be submitted with the TxDOT Utility Permit application by the design engineer. The traffic control plan ~~shall~~ must conform to the latest version of the "Texas Manual of Uniform Traffic Control Devices~~,~~," ~~Texas Department of Transportation.~~

C. ~~Water and/or Wastewater Mains Crossing Other Utilities in Their Own Easements~~Private and Non-City Utility Easement Use Approval

When a proposed water or wastewater main crosses a non-City utility that has its own easement, a letter of permission from the affected utility is required in addition to an easement from the affected property owner.

An example of this would be a wastewater main crossing an ARCO oil pipeline in an ARCO easement. In this case, a wastewater easement should be ~~written all the way across~~obtained from the property owner for the entire width of the ARCO easement, and a separate letter of permission obtained from ARCO (the utility owner) for the ~~pipeline~~ wastewater main crossing.

Section 6 – Addenda, Plan Revisions and Change Orders

6.1 General

This section provides direction to the design engineer to ensure plan modifications are properly incorporated into the project. Occasionally, Aafter the design engineer has submitted the submitted and received approval of the final plans and specifications to the Purchasing Department and eitherand bid advertising has begun or a work order has been initiated, occasionally, despite the best efforts of the design engineers, the design must be altered due to receipt of additional information requiring a design modification. This section is devoted to the procedures the design engineer must undertake to see that modifications are properly incorporated into the project. The importance of the time factor for performing any required modification cannot be over-emphasized. The design engineer must make the modifications quickly and coordinate those changes with the Engineering Department.appropriate parties (the approving and bidding authorities).

6.1.1 Development Projects

The development design engineer must submit any proposed design changes to Engineering Development Review for review and approval as soon as practically possible.

6.1.2 City Projects

The City's design engineer is not to attempt to contact contractors at any time concerning addenda, plan revisions or change orders. All contact must be through the Engineering Capital Projects Engineering Department for issuance of addenda prior to bid opening or through Water and Sewer ConstructionPublic Works Inspection for plan revisions and change orders after bid award.

6.2 Addenda

An addendum is required when there is briefly defined as a change in plans or specifications during advertisement, but prior to the receiptption of bids. The change specifications may be initiated from within Engineering Division or may be initiated from the "outside."by the design engineer or by an external party.

6.2.1 Development Projects

After the development design engineer has received approval from Engineering Development Review for a design change, he is responsible for preparing and issuing the appropriate addendum to the affected parties.

6.2.2 City Projects

After the City's design engineer has been notified which designs must be modifiedidentified the required design changes, he is responsible for immediately notifying the Engineering DepartmentCity's Project Manager. After approval of the design changes by the Project Manager and consultation with the Purchasing Department and to determine if the advertising schedule permits an addendum, the required changes in plans and specifications and resulting addendum must be made

prepared quickly by the design engineer. All revisions by addendum must be submitted ~~to the Engineering~~ by Capital Projects Engineering~~Department~~ to Purchasing no later than 10 calendar days prior to the bid opening date~~. This will~~in order to allow ~~the~~ Purchasing ~~Department time~~ to adequately notify all plan holders ~~by certified mail~~ of any contract modifications prior to receipt of bids.

6.3 Plan Revisions

A plan revision is a modification in design after award of the contract. ~~This type of modification~~A plan revision is usually a minor change in alignment horizontally or vertically where little or no quantity change or additional bid item is involved. This type of modification may also b~~ey~~ initiated by the design engineer or by an external party~~from inside Engineering or outside~~, during ~~actual~~ construction of the project. ~~Here, too, t~~Timely modifications and communications must also be made in this situation ~~so as~~ to ~~assure~~ ensure ~~that the~~ construction is not delayed.

6.4 Change Orders

A change order is required when there is a modification in the plans or specifications that involves a quantity change~~, or~~ an additional bid item not previously bid by the contractor, or any other change which involves a change (increase or decrease) in the contract dollar amount.

6.4.1 Development Projects

After approval of the design changes by Engineering Development Review, change orders will be handled by the development design engineer, with appropriate notification to Engineering Development Review and Public Works Inspection. Change orders increasing the cost of public infrastructure items require an increase in the maintenance bond and may require an increase in the performance and payment bonds. The increase in costs will also require additional City inspection fees.

6.4.2 City Projects

All change order negotiations will be conducted by Capital Projects Engineering. Change ~~Orders~~ orders that ~~involve less than~~ are $~~15~~50,000.00 or less may be approved by "Administrative Action" and do not require City Council approval. ~~Conversely, any c~~Change orders greater than $~~15~~50,000 over the original contract dollar amount require Public Utilities Board (PUB) approval recommendation (in the case of utilities) and City Council approval. In all cases, a change order increase cannot exceed 25% of the original contract award amount~~ of the contract~~. Change order decreases that exceed 25% of the original contract award amount must have the consent of the contractor and require Administrative, or PUB and Council approval. Additionally, the design engineer is responsible for providing written justification and notification to ~~the Engineering/ Transportation~~Capital Projects Engineering~~Department~~ on all ongoing change orders.

6.5 Method of Plan Modification

The design engineer is responsible for making all required modifications to the plans. Several changes may be made under a single addendum, plan revision, or change order. Regardless of which type of change is being implemented, each plan modification made as a "group" under these processes is to be designated with a number within a triangle, and this designation is to be placed by each note, or other item being changed. Subsequent modifications to the design should be designated sequentially, e.g., 1, 2, 3, etc. The original design is not to be erased; it must be crossed out or otherwise indicated as void.

The design engineer is to furnish Public Works Inspection with at least six (6) sets of prints of the modified plan sheets. More prints may be required if an addendum is being processed. Public Works Inspection will determine the exact number of prints required of the design engineer.

6.6 Distribution of Modified Plans or Specifications for City Projects

~~Engineering~~ The Capital Projects Engineering Division~~Department~~ is responsible for distributing the modified plans or specifications to all ~~involved~~ affected parties and ~~establishing~~ initiating City Council ~~hearing dates~~agenda items, if required.

Section 7 – Submittals

7.1 General

If a specialized project requires unique construction methods or materials, control of the quality of those methods or materials must be assured. A contractor has a multitude of options that can be employed on any project and still fall within the guidelines outlined in the specifications of that project, yet the end result may not be exactly what the design engineer desired. Some control of the quality methods or materials can be obtained by requiring the contractor to furnish submittals for approval by the design engineer prior to construction.

7.2 ~~Submission of~~ Material and Shop Drawing Submittals

A material submittal is a proposal by a manufacturer through the contractor to the City of Denton ~~Engineering Department~~Public Works Inspection Division for an item or material or an approved equal to the item or material that is acceptable to the City of Denton and ~~a design engineer~~that has been specified by the design engineer. A shop drawing is a drawing, diagram, schedule or other data specially prepared by the contractor or subcontractor, manufacturer, supplier or distributor to illustrate some portion of the work. A ~~submittal~~ shop drawing may ~~also~~ be required of a contractor when specific construction phases, methods or procedures require analysis to determine their conformance to approved performance, quality or safety,~~. (The recently initiated~~ e.g., Trench Safety~~ submittal~~, a structural fabrication or assembly, or mechanical and electrical/electronic assemblages~~ is an example of this)~~.

Submittals on specific items usually consist of the manufacturer's technical specifications which state materials, components, performance tests as noted by an approved laboratory, dimensions, finishes, and limitations or operational ranges of items. Submittals on specialized construction methods should state steps, procedures and construction sequences that the contractor proposes to follow. These items can be submitted as "catalog cut sheets", letters of certification by the manufacturer or notarized letters by the contractor. These items can be submitted for review either as a package or separately.

~~At least five~~One (1) set~~s~~ of submittals (preferably in digital format) ~~are~~ is required of the contractor. All submittals are to ~~go through Engineering Department Construction~~be submitted to Public Works Inspection prior to review by the design engineer for City construction contracts. For development contracts, the submittals are to be provided to the development design engineer for review, who is to submit the approved submittals to Public Works Inspection. Two submittals, accompanied by a transmittal letter written by the ~~Engineering Department~~City, ~~should~~ are to be returned to the contractor through ~~Engineering Construction~~Public Works Inspection ~~Inspection Division~~.

7.3 Standards for Pipe

Pipe and related fittings should conform to or have a designation of certification by the American Water Works Association (AWWA) or the American National Standards Institute (ANSI). Other materials should conform to American Society for Testing and Materials (ASTM).

7.4 Submittal Review

The design engineer shall review the submittals for conformance to the item specified, including kind, type, size, operational limits, component materials, etc. ~~The Engineering Department~~Public Works Inspection will~~should~~ also review the materials submittals and carefully check for conformance to the North Central Texas Council of Governments Standard Specifications for Public Works Construction, City of Denton addendum to those specifications and the contract specifications. After review and approval by the development design engineer, Engineering Development Review will review and approve shop drawings for development projects; the design engineer will review and approve shop drawings for City construction contracts.

7.5 Nonconformance of Submittal

After review, if the submittal does not conform, the ~~Engineering Department~~appropriate reviewing authority will stamp~~s~~ the submittal accordingly and return~~s~~ them to the contractor, with ~~. A~~a letter stating which item~~ ~~(s) were not acceptable and why.~~did not conform shall accompany the submittal.~~

7.6 Submittal Acceptable with Minor Exceptions

If the submittal is acceptable with minor exceptions, the plans are to be stamped accordingly and the minor exceptions noted in the submittal. A letter from the appropriate reviewing party stating the minor exceptions ~~shall~~ will accompany the return of the submittal to the contractor.

7.7 Acceptable Submittal

If the submittal is acceptable without exception, the plans are to be stamped accordingly, and a letter by the appropriate reviewing authority stating the acceptance ~~shall~~ will be returned to the contractor with the submittal.

7.8 Submittal Records

The design engineer and Public Works Inspector are ~~is~~ to keep ~~a~~ copies~~y~~ of all submittals whether approved or disapproved in the project file.

NOTE: "Section 8 – Addenda, Plan Revision and Change Orders" and "Section 9 – Submittals" were duplications of Sections 6 and 7 of the "Old" Manual and have been deleted, with Sections 6 and 7 retained, in this Draft of Proposed Changes.

NOTE: The Wastewater ~~d~~rawings have been removed from this update, since they are contained in the City Standard Details. This Manual now references the applicable Standard Detail Sheet for those Drawings.

Section ~~10~~ 8 – On-Site Sewage Facilities

~~10~~8.1 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 ~~o~~On-~~s~~Site ~~s~~Sewage ~~f~~Facilities,~~y construction standards and administrative rules adopted by the Texas Natural Resource Conservation Commission or any other successor agency, and~~ 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 ~~Division 5 "On-Site Sewage Disposal" containing Sections 26-210 through 26-230~~Sections 35.11 and 35.12 of the City of Denton Development Code.

~~10~~8.2 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.

~~10~~8.3 Site Evaluations

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

~~10~~8.4 Planning Requirements

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

~~10~~8.5 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 2 acres when a private water well is located on the tract or lot.
- A minimum of 1 acre when a public water system serves the tract or lot.