CITY OF LAWRENCE
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2900 – WATERLINES

City *of* Lawrence

2023 EDITION

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SECTION 2900 – WATERLINE

2901 SCOPE

This division governs all work, materials and testing required for installation of waterlines of the respective types and sizes shown on the Plans for the particular location and conforming to the requirements of these specifications. All pipelines shall be constructed to proper line and grade as shown on the Plans and shall result in an unobstructed, smooth and uniform conduit.

2902 GENERAL

A. Description

Waterline construction shall consist of furnishing all labor, materials and equipment for the complete installation of waterlines and appurtenances in accordance with the contract documents, standard drawings, approved shop drawings, General Provisions and these specifications. These specifications govern materials for water mains having a diameter of two inches (50 mm) through 12 inches (300 mm).

B. Specification Modifications

It is understood that throughout this section these Specifications may be modified by appropriate items in the Special Project Specifications or notes on the Contract Drawings.

C. Revisions of Standards

When reference is made to a Standard Specification i.e. ASTM, ANSI, AWWA, MCIB the Specification referred to shall be understood to mean the latest revision of said specification as amended at the time of the Notice to Bidders, except as noted on the Plans or in the Special Project Specifications. The City may, at its option, update and revise these specifications periodically in response to changing technology and construction methodologies.

D. Definitions

“Engineer” shall mean the Utilities Engineer or the Municipal Services & Operations Department authorized representative.

“Design Engineer” shall mean the licensed individual or firm who developed, sealed, and signed the improvement plans.

“Contractor” shall mean any employee, agent or subcontractor of the construction company responsible for completing the work.

"Inspector" shall mean the City of Lawrence Municipal Services & Operations Department inspector assigned to the project or authorized representative thereof.

"Special Project Specifications" shall mean specifications modified due to special or unusual project conditions identified by the Design Engineer that warrant deviation from the City of Lawrence Construction and Material Specifications Section 2900 – Waterlines, current edition.

E. Contractor's Warranty

During a period of one year from the date of final acceptance by the City, the Contractor is responsible for making any necessary repairs arising out of defective workmanship or materials. This includes, but is not limited to, trench settlement of water lines constructed as part of this project. The Contractor is responsible for repairing all trench settlement including removing and replacing sidewalks, streets, driveways, and entrance walks constructed since the project was accepted by the City. Representatives from the City and the Contractor shall conduct an inspection of this project 11 months after the project has been accepted by the City to determine what repairs need to be made.

F. Compliance

Compliance with the Reduction of Lead in Drinking Water Act (2014) is required and all applicable products must meet the lead-free requirements and conform to NSF 372.

2903 MATERIALS

A. General

This section governs materials that may be required to complete waterline construction as shown on the Plans and/or as provided for in the Special Project Specifications.

1. Requirements

   Furnish pipe of materials, joint types, sizes, and strength classes indicated or specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the project.

2. Manufacturer

   The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.

3. Inspection and Testing

Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards. Testing may be witnessed by Design Engineer, Engineer or approved independent testing laboratory. The Contractor shall provide one (1) copy of certified test reports indicating the materials conform to the specifications to the Inspector.

4. Handling

Handling of materials used in waterline construction shall conform with section 2904 of these specifications. Damage to materials that cause reasonable doubt as to their structural strength or water-tightness will cause that material to be rejected.

B. Pipe, Fittings and Anchor Couplings

1. Ductile Iron Pipe, Fittings and Anchor Couplings

Unless indicated otherwise on the plans all ductile iron pipe shall be Class 50 conforming to ANSI A21.51, AWWA C151, ASTM A536, and shall be of Grade 64-42-10.

All ductile iron fittings and anchor couplings shall be mechanical joint fittings, class 350, meeting all applicable requirements of ANSI A21.53 and A21.11 and AWWA C153 and C111. Fittings shall be supplied with all necessary appurtenances to accomplish installation as shown on the plans. All fittings shall be provided with stainless steel grade 304 or better bolts, washers, and nuts; nuts shall be coated to prevent seizing and galling per section 2903E of these specifications

a. Pipe Joints

Unless otherwise specified, shall be of the push-on type conforming to ANSI A21.11/AWWA C111, except gaskets shall be neoprene or synthetic rubber. Natural rubber gaskets will not be acceptable. Mechanical joints shall conform to ANSI A21.11. Restrained joints shall be Griffin SnapLok or approved equal.

b. Lining

All ductile iron pipe shall be cement mortar lined, conforming to ANSI A21.4 and AWWA C104. All ductile iron fittings shall be lined with a fusion bonded epoxy conforming to ANSI 21.16 and AWWA C116. Interior epoxy coating is to be NSF 61 product certified.

c. Pipe Coating

All ductile iron pipe shall be coated with a layer of arc-sprayed zinc per ISO 8179 and bituminous top coated per AWWA C151. The mass of the zinc applied shall be 200 g/m2 of pipe surface area. A finishing layer of topcoat shall be applied to the zinc. The coating system shall conform in every respect to ISO 8179-1 “Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer. Second edition 2004-06-014.”

d. Fitting Coating

All ductile iron fittings shall be shop coated with a fusion bonded epoxy inside and outside conforming to ANSI A21.16 and AWWA C116. Anchor couplings shall be shop coated with a fusion bonded epoxy; asphalt varnish tar coating shall be acceptable when a fusion bonded epoxy coating is not available for the specified anchor coupling.

2. Polyvinyl Chloride Pipe (PVC) and Fittings

PVC shall meet the requirements of ASTM D1784, cell classification 12454-B, for PVC compounds, and AWWA C900 with cast iron pipe O.D., for PVC pipe. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the NSF International. Pipe shall be marked with nominal pipe size, dimension ratio, AWWA pressure class, AWWA standard designation number, NSF 61 product certification seal verifying suitability for potable water service, extrusion production record code, and cell classification. PVC pipe shall be blue in color and pressure rated at 200 psi with a dimension ratio (D.R.) of 14 as defined in AWWA C900.

All fittings shall be ductile iron and anchor couplings shall be mechanical joint fittings, class 350, meeting all applicable requirements of ANSI A21.53 and A21.11 and AWWA C153 and C111. Fittings shall be supplied with all necessary appurtenances to accomplish installation as shown on the plans. All fittings shall be provided with stainless steel grade 304 or better bolts, washers, and nuts; nuts shall be coated to prevent seizing and galling per section 2903E of these specifications.

a. Joints

Joints for PVC pipe shall be slip on type with integral bell and spigot pipe, or pipe with extruded type couplings, meeting the requirements of ASTM D3139, except flexible elastomeric gaskets meeting the requirements of ASTM 477, shall be synthetic rubber. Natural rubber will not be acceptable. Restrained joints shall be Certa-Lok C900 RJ (Coupled) or

C900 RJIB (Integral Bell) or approved equal. Gaskets and lubricants are to be NSF 61 product certified.

b. Lining

All ductile iron fittings shall be lined in conformance with Section 2903.B.1.b of these specifications.

c. Coating

All ductile iron fittings shall be coated in conformance with Section 2903.B.1.d of these specifications.

3. Fusible Polyvinyl Chloride Pipe (FPVC) and Fittings

FPVC shall only be utilized if the application has been approved by the engineer. FPVC shall meet the requirements of ASTM D1784, cell classification 12454, for PVC compounds, AWWA C900, and ASTM D2241for standard dimensions. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the NSF International. Pipe shall be marked with nominal pipe size, dimension ratio, AWWA pressure class, AWWA standard designation number, NSF 61 product certification seal verifying suitability for potable water service, extrusion production record code, and cell classification. Pipe shall be homogenous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible defects. FPVC pipe shall be blue in color and pressure rated at 200 psi with a dimension ratio (D.R.) of 14 as defined in AWWA C900. Fusible polyvinyl chloride pipe shall be as manufactured under the trade name ‘Fusible C-900®’ for Underground Solutions, Inc. Poway, CA, Patent No. 6,982,051, no exceptions.

All fittings shall be ductile iron.

Ductile iron fittings and anchor couplings shall be mechanical joint fittings, class 350, meeting all applicable requirements of ANSI A21.53 and A21.11 and AWWA C153 and C111. Fittings shall be supplied with all necessary appurtenances to accomplish installation as shown on the plans. All ductile iron fittings shall be provided with stainless steel grade 304 or better bolts, washers, and nuts; nuts shall be coated to prevent seizing and galling per section 2903E of these specifications.

a. Joints

Joints for FPVC pipe shall be plain end. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe. Pipe shall be supplied in standard forty (40) foot lengths.

b. Lining

All ductile iron fittings shall be lined in conformance with Section 2903.B.1.b of these specifications.

c. Coating

All ductile iron fittings shall be coated in conformance with Section 2903.B.1.d of these specifications.

4. Copper Pipe

Copper pipe and brass fittings shall be American made Type “K” soft copper, unless rigid is required, and shall be supplied in accordance with ASTM Specification B-88-62.

5. Polyethylene Tubing

Polyethylene Tubing for service connections sizes ½” to 2” shall be of cell classification PE 4710, a minimum of SDR-9 and shall conform to all applicable requirements of AWWA C901.

C. Valves and Valve Boxes

1. Gate Valves

The type, size and location of valves shall be as shown on the Plans. All gate valves 3 inch and larger in pipe lines, except as modified herein, shall be 200 psi, ductile iron body, gate valves with non-rising stems. Gate valves shall be resilient seated conforming with all applicable requirements of AWWA C515. All fittings shall be provided with stainless steel grade 304 or better bolts, washers, and nuts; nuts shall be coated to prevent seizing and galling per section 2903E of these specifications.

2. Butterfly Valves

All butterfly valves 4” and larger shall be Henry Pratt Groundhog Buried Rubber Seated Butterfly Valve or approved equal. All butterfly valves shall conform to AWWA C504 and be rubber seated.

3. Curb Stops

Curb stops shall be brass, ball valve type with a T-head for operation. End connections shall be either iron pipe threads or compression type depending upon application and with the approval of the Engineer or authorized representative. Curb stops shall be Ford Meter Box Company, Inc. or Mueller Co. ball valve curb stop, NL (no lead) option shall be specified.

4. Corporation Stops

   Corporation stops shall be brass construction, tee head type Ford FB-1000 or Mueller P-25008, NL (no lead) option shall be specified. All corporation stops shall be furnished with AWWA taper thread on inlets.

5. Valve Ends

   Valve ends shall be of the mechanical joint type, conforming to ANSI A21.11/AWWA C111 except where flanged ends are required on the plans.

6. Bonnet Thrust Plates

   The bonnet shall have a removable thrust plate to permit the removal and replacement of the valve stem and “O” ring seal while the valve is in service.

7. Tapping Valves

   The size and location of the tapping valves shall be as shown on the plans. The valves shall be 200 psi, ductile iron body, resilient seat gate valves with non-rising stems conforming with all applicable requirements of ANSI/AWWA C515 except that the outlet end shall be standard mechanical joint end conforming to ANSI A21.11/AWWA C111 and the inlet shall have a raised male face, conforming to MSS-SP60, to ensure true alignment of valve and tapping sleeve.

8. Stem Seals and Coatings

   All valves shall be provided with stem seals of the “O” ring type. Two “O” rings shall be used with at least one “O” ring inserted above the thrust collar. The packing plate shall be attached to the valve bonnet by not less than two (2) bolts and one “O” ring below the thrust collar.

   All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated with a fusion bonded epoxy for corrosion protection. The valve manufacturer’s standard epoxy coating will be acceptable.

9. Valve Operation

   All valves shall be equipped with a 2 inch square wrench nut and the direction of rotation to open the valve shall be counterclockwise. Each valve body shall have the word “OPEN” and an arrow indicating the direction to open the valve cast thereon. Wrench nuts shall comply with AWWA C515.

10. Extension Stems

When the distance from the top of the valve cover to the valve operating nut exceeds 3 feet, an extension stem to bring the valve stem to within 3 feet of the top of the valve cover shall be provided.

11. Valve Boxes, Lids and Covers

All valve boxes, lids, and covers shall be coated in bituminous varnish.

a. Valve Boxes

All buried valves shall be provided with valve boxes.

- Valve box shall be cast iron screw type within paved areas.
- Valve box shall be 6" IPS SDR-26 PVC cut to depth required in turf areas.
    - The installation of a concrete pad around a valve box in unpaved areas will not be accepted. If the area is unpaved, the above specification for valve boxes must be followed.
- All valve boxes shall be set plumb and placed directly over the valve it serves.
- Valve Boxes shall be installed per City of Lawrence Standard Valve Adjustment Details.

b. Lids and Covers

- Lid and cover shall be Clay and Bailey #2194 or Star Pipe Products VB0045 or an approved alternative for turf areas.
- All lids shall have "Water" cast in the lid.
- All lids shall be installed flush with finished grade.

c. Valve Box Adapters

- Valve box adapters shall be Clay and Bailey #P-1080 with drop type lid or approved equal.

12. Plans

The type, size and location of valves shall be as shown on the Plans

D. Fire Hydrants

1. General

Fire hydrants shall be open right, dry barrel, standard compression, two-piece standpipe, break-away design conforming to AWWA C502 and shall comply with the following:

a. Fire hydrants shall be supplied with one 4 ½" pumper nozzle, two 2 ½" hose nozzles, 5 ¼" minimum mechanical valve opening with bronze to bronze seating.

b. Hydrant shall be equipped with a 6" mechanical joint shoe connection with all joint accessories furnished.

c. Hydrant shoe shall be fusion bonded epoxy coated internally and externally and all below grade bolts, washers, and nuts shall be stainless steel grade 304 or better; nuts shall be coated to prevent seizing and galling

d. Hydrants shall be Waterous WB-67, U.S or Mueller "Super Centurion".

2. Paint

Fire hydrants shall be painted Federal Safety Yellow to the ground line.

3. Nut Dimensions

Operating stem and nozzle cap nuts shall be 1 ½" point to flat pentagon.

4. Nozzle Threads and Caps

Hydrant nozzles shall meet NFPA standard thread requirements. All hydrant threads shall be oil lubricated by means of an oil reservoir.

E. Stainless Bolts

Mechanical joint bolts and nuts shall be stainless steel conforming to ASTM F593 for bolts and ASTM F594 for nuts. All T-Bolts and nuts shall be threaded in accordance with ANSI/ASME B1.1, Class 2A fit, with coarse-thread series. Heavy hex nuts shall be used. Bolt heads shall be in accordance with the dimensions of ASSI/AWWA C111/A21.11-95. Nuts shall be finished with fluoropolymer coating system to minimize galling and ensure proper torque. Antiseize compound shall not be utilized with the fluoropolymer coated nuts. Identification on the head of the bolt shall be T-304, 304, F593C or F593D.

Flange joint bolts and nuts shall be stainless steel conforming to ASTM A193 Grade B8 for bolts and ASTM A194 Grade 8 for nuts. All bolts and nuts shall be threaded in accordance with ANSI/ASME B1.1, Class 2A fit, with coarse-thread series. Bolt heads and nuts shall be heavy hexagonal. Nuts shall be finished with fluoropolymer coating system to minimize galling and ensure

proper torque. Antiseize compound shall not be utilized with the fluoropolymer coated nuts. Identification of the head of the bolts shall be B8.

F. Specials

1. General

   Vaults which, by their special nature, must be cast in place shall conform to the plans and concrete specifications in Section 2000 – Concrete.

2. Pressure Reducing Valves

   Pressure reducing valves shall be designed to provide tight shutoff under conditions of no flow and shall not “hunt” under ordinary flow conditions. Pressure reducing valves shall be installed as shown on the Plans, and selected and sized as recommended by the valve manufacturer. Pressure reducing valves shall be as suitable for operation under the pressure and flow conditions as shown on the Plans.

3. Air Release Valves

   Air release valves shall be installed at the locations indicated on the Plans. Valves shall be designed for a working pressure of 150 psi and shall have floats and all working parts constructed of non-corrosive material. Each valve assembly shall be installed complete with all appurtenant piping as shown on the Standard Drawings and shall be Cla-Va / 33A, ARI D-040 ST, or approved equal. Orifice size shall be determined by the manufacturer with a 3/16” diameter, minimum.

4. Blow-Off Assemblies

   Blow-off assemblies shall be installed at the locations indicated on the Plans. Blow-off assemblies shall be installed with all appurtenant piping, valves, etc. as indicated on the Plans and/or Standard Drawings. All piping shall be 2 inch diameter galvanized steel as indicated on the Standard Drawings.

5. Tapping Saddles

   a. Tapping saddles used on PVC pipe for 2 inch and smaller services shall be solid brass Ford S-90 series no lead, Mueller H-13000 series no lead, or Mueller S-13000 series no lead.

   b. Tapping saddles used on ductile iron pipe for 2 inch and smaller services shall be solid brass Ford 202B no lead double strap series or Mueller BR2B series no lead.

c. All tapping saddles shall be furnished with AWWA threads.

6. Tapping Sleeves

Tapping sleeve body, flange, bolts, and nuts shall be grade 304 stainless steel; nuts shall be coated to prevent seizing and galling per section 2903E of these specifications. Tapping sleeves shall be either mechanical joint or flanged for a true tapping valve per MSS-SP60 and shall be provided with a complete full circle rubber gasket permanently attached to the body.

a. Size on size tapping will not be permitted for mechanical joint tapping sleeves.

b. All tapping sleeves shall have a ¾" NPT test plug for pressure testing and be capable of withstanding a working pressure of 150 psi.

c. Tapping sleeves shall be Ford FTSS, Romac SST series, Powerseal 3480, Powerseal 3480MJ, JCM 432, JCM 439, or Mueller H304SS.

7. Meter Assembly

d. Location

Meter Assembly shall be installed only in turf areas. Meters shall not be installed in the sidewalk unless approved by the Engineer. Meter Assembly shall not be installed in any location where they may come in contact with vehicular traffic.

e. Furnish and Installation

The contractor shall furnish and install meter assembly materials shall be as specified in the table below:

Meter Size	Service Line Size	Meter Setter	Meter Box Size / Acceptable Products	Meter Box Cover Size / Acceptable Products
5/8"	3/4"	Ford VB-81 W-44-33-NL	18" x 30" / ADS 1805AAH OR ADS 18050012H OR ADS N-12 OR Sigma RMP1830-SW-W OR Contech A2000 OR Approved Equal	18" / Ford A32-PR-BR OR 18" / Trumbull 367-5464 & 367-5815
1"	1"	Ford VB-84W-44-44-NL	20" / Sigma RMP2030-W OR Approved Equal	20" / Ford A3PR-BR
1.5"	1.5"	Ford VBH76-18-44-66-NL	36" / ADS N-12 OR Sigma RMP2030-W OR	36" / Ford MC-36-P-BR

2”	2”	Ford VBH77-18-44-77-NL	Contech A2000 PVC OR Approved Equal	
3”	4”	Meters larger than 2” shall require individual vault designs. The Design Engineer shall submit plans for the vault design to the Engineer for review and approval on a case-by-case basis.		
4” +	Match Meter Diam.			
*Public service line diameter. Customer may increase service line diameter beyond the setter.				

Or approved equals.

8. Service Line Fittings

   Service line fittings shall be Ford Meter Box Company, Inc. or Mueller Co. CTS pack joint fittings, NL (no lead) option shall be specified. Insert stiffeners for polyethylene tubing (PE pipe) shall be Ford Meter Box Company, Inc. 50 series.

G. Location Wire and Tape

Location wire and marking tape shall be buried above all waterlines in accordance with the following:

1. Location Wire

   a. Location wire shall be installed to enable the detection of all plastic, ductile iron, and copper pipe. Location wire shall be 12 AWG copper clad steel (CCS), minimum break load of 280 lbs. with blue 30mil HDPE jacket for open trench installations or 12 AWG copper clad steel (CCS), minimum break load of 1,100 lbs. with blue 45 mil HDPE jacket for directional drill installation.

   b. The location wire shall be placed no further than 6 inches to the side or above the waterline. For directional drill installations tracer wire shall be taped every 8-10 feet.

   c. The location wire shall be accessible at valve boxes, fire hydrants, meter tiles, or test stations at least every 1,500 feet. The location wire shall be installed on the outside of the valve box with a 3/16” hole drilled three inches from the top of the valve box for the location wire to pass through. Test stations shall be Copperhead Industries Snake Pit magnetized Tracer Boxes; lite duty XL box for unpaved areas and roadway box for paved areas.

   d. Splicing of location wire shall be accomplished by the use of Copperhead Industries LLC Locking SnakeBite Wire Connector, Copperhead Industries LLC SCB-01SR direct bury splice kit,

Copperhead Industries LLC 3WB-01 DryConn Three-way direct bury Lug Connector, or 3M DBR/Y-6 direct bury splice kit. Copperhead Industries LLC Locking Snake Bite splice kit shall only be used with Copperhead Industries LLC wire.

e. Anodes shall be a minimum of one pound bare magnesium or zinc drive-in grounding anode rod and shall be driven into the ground at the same elevation as the waterline. Anodes shall be placed at the beginning and end of the watermain, at the meter end of every service line, at every valve box or test station, at all dead ends, at the end of service lines where not connected to the wire at the main, and/or at least every fifteen hundred feet (1,500').

2. Marking Tape

a. Underground marker tape shall be installed 18 inches above waterline.

b. The marking tape shall be at least 3 inches in width, blue in color, and shall have black lettering stating "Caution Buried Waterline Below". Lettering shall be printed on the tape at 20 to 30 inch intervals.

H. Casing Pipe

Casing pipe for bored, jacked or open cut construction shall be steel pipe conforming to ASTM A 139 with a minimum diameter as shown on the Plans.

1. Minimum Wall Thickness

Shall be in accordance with the following table:

Diameter of Casing – Inches	Nominal Wall Thickness – Inches	
	Under Railroads	All other Uses
14 and under	0.188	0.188
16	0.281	0.188
18	0.312	0.250
20	0.344	0.250
24	0.375	0.281

2. Steel

Shall be a minimum of Grade A unless a higher standard is required by the responsible agency.

3. Steel Pipe

Shall have welded joints in accordance with AWWA C 206.

4. Casing Spacers

   Shall be CCI stainless steel, CCI polyethylene, or approved equal.

5. End Seals

   Shall be Advanced Products & Systems (APS) model AC, CCI model ESC or approved equal.

6. Annular space

   Shall not be filled between lining and carrier pipe.

7. Carrier Conduit

   Installed in casing pipe, shall be restrained joint pipe in accordance with Section 2903B of these specifications.

8. Cathodic and Corrosion Protection

   Both shall be provided for all casing conduits. One 32 lb sacrificial anode package per 100 feet of casing pipe shall be provided at each end of the casing. Sacrificial, magnesium anodes shall be attached to the encasement pipe by a #12 A.W.G. grounding wire at each end of the casing. For casing pipes less than 100 feet in length sacrificial anodes shall be provided at a rate of 0.50lb/ft of casing with a minimum anode size of 5 lbs. required.

9. Minimum Casing Pipe Size

   Shall be in accordance with the following table:

Diameter of Carrier Pipe (in)	Recommended Casing Pipe Diameter (in)	Minimum Casing Pipe Diameter (in)
8	16	12
12	20	18

2904 INSTALLATION BY OPEN CUT

A. General

For general open cut installation requirements, refer to Section 1100 – Grading and Trenching.

B. Waterline Installation

1. Scope

This section governs construction methods and procedures for the installation of water pipelines and appurtenances.

2. Minimum and Maximum Cover

   Trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of pipe of 42 inches when back of curb, and with a maximum depth of backfill cover over the top of the pipe of 60 inches in paved areas, except where connections to existing waterlines are made, unless otherwise shown in the plans. Depth of cover shall be measured from the top of pipe to the finished grade or pavement surface elevation. Greater depths of cover may be necessary on vertical curves or to provide necessary clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal waterline grades. When greater depths of cover are necessary, measures shall be taken to bring the pipe back to the proper depth as quickly as possible utilizing either allowable pipe deflection or pipe fittings in accordance with Section 2903B of these specifications.

   Unless otherwise specified herein or as shown on the plans, back of curb water mains shall be installed with a minimum cover of forty two (42) inches measured from the top of pipe to the finished grade and water mains installed under pavement shall be installed with a minimum of sixty (60) inches of cover measured from the top of pipe to the top of pavement.

   Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug which will prevent trench water from entering the pipe.

3. Ductile Iron Pipe

   a. Handling

      Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that pipe, pipe coating, and fittings are not damaged. Hooks shall not be used. Under no circumstances shall pipe or accessories be dropped or dumped. Pipe and fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor at their own expense. Where damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.

All pipe coating which has been damaged shall be repaired by the Contractor prior to installing the pipe.

b. Cutting pipe

Ductile iron pipe shall be cut with either a saw or an abrasive wheel. Cutting of existing cast iron pipe shall be done with either a saw or abrasive wheel, or when there is a free end, with mechanical pipe cutters. The cutting of pipe with a torch will not be permitted.

Cutting shall be done in a neat manner without damage to the pipe, or the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

c. Cleaning

The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter prior to installation and shall be kept clean until the work has been accepted. Such surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

d. Inspection

Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective, damage, or unsound pipe and fittings shall be rejected and marked as such and removed from the site of work.

e. Alignment

Waterlines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in AWWA C600.

f. Laying Pipe

Pipe shall be protected from lateral displacement by pipe embedment material installed per section 1100 – Grading and Trenching. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

4. Polyvinyl Chloride Pipe (PVC)

a. Handling

Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Equipment, tools, and methods used in reloading, hauling, and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipe shall have broad, well padded contact surfaces.

b. Cutting Pipe

All pipe shall be cut with a saw or special cutting tool. Cutting shall be done in a neat manner without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed and beveled. Beveling shall be done with a specifically designed beveling tool. Hand beveling will not be allowed. When cutting pipe with couplings, mark the field cut pipe end the same distance in as the mark appeared on the original full length pipe section.

c. Cleaning

The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.

d. Inspection

PVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe manufacturer. It shall be protected from lateral displacement and deflection by pipe embedment material installed per Section 1100 – Grading and Trenching and as shown on the Standard Drawings. No pipe shall be laid under unsuitable trench conditions.

e. Alignment

Waterlines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in AWWA C605.

f. Laying Pipe

Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

5. Fusible Polyvinyl Chloride Pipe (FPVC)

   a. Handling (Pipe)

      Pipe shall be loaded, off-loaded, and otherwise handled in accordance with AWWA M23 and all pipe suppliers' guidelines shall be followed. The use of chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and may be cause for rejection. Damaged areas may be removed by cutting, limits of acceptable length of pipe shall be determined by the owner or engineer.

   b. Handling (Fittings and Accessories)

      Fittings and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, and hauling fittings and accessories shall be such that fittings and accessories are not damaged. Fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor at their own expense. Where damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.

   c. Cutting Pipe

      All pipe shall be cut with facing blades specifically designed for cutting fusible polyvinyl chloride pipe.

   d. Cleaning

      The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.

   e. Inspection

      FPVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe supplier for open cut, horizontal directional drilling (HDD), or pipe bursting installation methods.

   f. Alignment

      Waterlines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the pipe suppliers recommended bending radius guidelines.

g. Laying Pipe

Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

6. Casing and Carrier Conduits

Casing and carrier conduits shall be installed at required locations by methods acceptable to the Engineer. Installation of the carrier conduit shall be completed prior to installation of the adjacent portions of the pipeline to allow for adjustments.

a. Casing Types

1. Steel Casing Pipe

Steel casing pipe is flexible conduit and shall be designed to conform with the following design concept (other methods may be submitted to the Engineer for approval).

The steel casing conduit is considered a permanent installation to protect the carrier conduit and to support all loads, therefore, cathodic and corrosion protection and watertight removable end seals are required for the casing conduit. Care shall be exercised to prevent the carrier conduit from floating and receiving any load transfer from the casing conduit unless it is designed for such loading. The void between casing and carrier conduits shall not be filled. Cathodic and corrosion protection shall be provided for all casing conduits. One 32 lb sacrificial anode package per 100 feet of casing pipe shall be provided at each end of the casing. Sacrificial, magnesium anodes shall be attached to the casing pipe by a #12 A.W.G. grounding wire at each end of the casing.

b. Casing Installation

Installation of casing shall be supervised by a contractor experienced in such work. Casing shall be installed by a combination of horizontal directional drilling, augering and jacking or open cut trenching, where allowed. Alignment and gradient shall be such that the carrier conduit can be installed to line and grade shown on the drawings.

Welding of steel casing pipe, when multiple pipe sections are used, shall be performed by a person experienced with the type of welding necessary. All welds shall conform to AWWA C 206.

c. Liner Plate Installation

Liner plates shall be assembled immediately following the excavation. Advance liner plates or casing continuously with excavation. All voids between liner and surrounding earth shall be filled with a pumpable grout resulting in a minimum set strength of 4000psi in 28 days, forced in under pressure. As the pumping through any hole is completed, it shall be plugged to prevent the back-flow of grout. After lining installation is complete, it shall be cleaned of all debris and all leaks sealed.

d. Carrier Conduit Installation

After completion of the installation of the casing, the carrier conduit shall be carefully pushed or pulled through the casing in a manner that will maintain proper jointing of the pipe joints and provide required gradient and alignment. Carrier conduit installed in casing pipe shall be restrained joint pipe in accordance with Section 2903B of these specifications.

e. Casing Spacers

Casing spacer type shall conform to section 2903H.4. Casing spacer interval, size and installation method shall be as recommended by the manufacturer for the particular installation.

f. End Seals

End seals shall conform to Section 2903H.5. End seal installation shall be as recommended by the manufacturer and shall be constructed after sewer pipe has been installed and approved.

g. Annular Space

The annular space between lining and sewer pipe shall not be filled.

h. Initial Testing

Air pressure and/or exfiltration test shall be required and shall be successfully performed on the carrier conduit prior to the sealing of the ends of the casing conduit.

7. Jointing

a. Push-On Joints:

All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be followed by the Contractor. All joint surfaces shall be lubricated immediately before the joint is completed.

The lubricant and the gaskets shall be as recommended and supplied by the pipe manufacturer. The lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

Field cut pipe and each spigot end shall be suitably beveled to facilitate installation.

b. Mechanical Joints

Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained the joint shall be disassembled, thoroughly cleaned, and reassembled. Under no circumstance will over-tightening of bolts be permitted.

c. Flanged Joints

When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell and Spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform. All fasteners shall be grade 304 stainless steel or better and shall be coated to prevent seizing and galling.

d. Restrained Joints

Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.

e. Fused Joints

Fusible polyvinyl chloride pipe lengths shall be assembled in the field with butt fused joints. Butt fusion shall be completed in strict accordance with the pipe suppliers' written guidelines for this procedure.

1. Butt fusion shall be performed by qualified fusion technicians as documented by the pipe supplier.

2. Fusion joints shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the buttfusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report. Joint reports shall be submitted and approved by the pipe supplier prior to installation of any fusible polyvinyl chloride pipe.

3. Only appropriately sized and outfitted machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:

    a. Heat Plate: Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly, cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused per the pipe suppliers' guidelines.

    b. Carriage: Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.

    c. General Machine: Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

    d. Data Logging Device: An approved data logging device with the current version of the pipe suppliers' recommended and compatible software shall be used. Data logging device operations and maintenance manual shall be with the unit at all

times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

4. Other equipment specifically required for the fusion process shall include the following:

    a. Pipe rollers shall be used for support of pipe to either side of the machine.

    b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.

    c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.

    d. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

8. Connection to Existing Mains

    The Contractor shall furnish and install all fittings necessary to join the existing and new water mains as shown on the plans.

    The Municipal Services & Operations Department shall be given at least 24 hours' notice prior to turning off any water supply mains. The Contractor shall coordinate tie-ins with the Municipal Services & Operations Department to minimize down time.

    Connections shall be made using suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will minimize any disruption in service. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing pipe. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and swabbed with, or dipped in, chlorine solution having a chlorine content of 10,000 ppm.

9. Setting Valves, Fittings, and Hydrants

    a. Valves and Fittings

        All valves, fittings, plugs, and caps shall be set and joined to the pipe in the manner heretofore specified for cleaning, laying and joining pipe, except that large valves may require special

support so that the pipe will not be required to support the valve weight.

Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body, and shall be opened and closed to see that all parts are in a new working condition. Gate valves shall be set vertical in the horizontal waterline. Valves and pipe shall be supported in such a manner as to prevent stress in either with no deflection in the valve/pipe joint.

Valve boxes and lids shall be installed at each valve and shall be supported and maintained centered and plumb over the operating nut of the valve. The valve box shaft shall not transmit shock or stress to the valve. Install valve box covers flush with the surface of the finished grade or as directed by the Engineer.

All bends and tees shall be provided with thrust blocks as specified. All dead ends on new mains shall be closed with plugs or caps suitably restrained to prevent blowing off under test pressure.

b. Hydrants

All new hydrant installations shall be as shown on the Plans or Standard Drawings and shall include all necessary excavation and backfill to make the installation complete.

Each hydrant shall be inspected before installation for direction opening, nozzle size and threading, nozzle caps and chains, operating nut, and cap nut dimensions, tightness of pressure-containing bolting, cleanliness of inlet elbow and weep hole openings, and handling damage and cracks. Defective hydrants shall be corrected or replaced.

All hydrants shall stand plumb. The weep holes of the hydrant shall be kept clear and free to drain and shall be covered with three (3) cubic feet of ¾" wash rock. The areas around each hydrant and hydrant valve shall be thoroughly compacted to prevent settlement of these areas.

Hydrants shall be set to a grade that allows their proper operation. Traffic hydrants with breakaway joint must be set with the joint above the ground line. Hydrants shall be placed with the hydrant centerline a minimum of four (4) feet and a maximum of twelve (12) feet from the back of curb line. Hydrants shall be rotated so as to have the pumper nozzle

facing the street or rotated to face any direction as required by the Engineer.

Hydrants shall be repainted upon completion of installation.

10. Thrust Restraint

    c. Hydrants

    The back of the base elbow of each hydrant shall be braced against a sufficient area of unexcavated earth or rock with a concrete thrust block and be restrained by suitable restrained joints as shown on the Plans or Standard Drawings.

    d. Fittings

    All plugs, caps, tees, bends, and other fittings, unless otherwise specified, shall be provided with reaction blocking and suitable restrained joints as shown on the Plans or Standard Drawings.

    e. Thrust Blocks

    Vertical and Horizontal reaction blocking shall be concrete conforming with Section 2000 – Concrete. Thrust blocks shall be installed between solid ground and the fitting to be restrained. Concrete shall be located to contain the resultant force and permit access to pipe and fitting joints for repairs.

11. Polyethylene Encasements

    a. General

    Polyethylene encasement shall be installed on all ductile iron pipe and fittings.

    b. Polyethylene Encasement

    Polyethylene Encasement for use with ductile iron pipe shall meet all the requirements for ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems.

    c. Polyethylene Film

    Polyethylene film shall consist of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

d. PVC Pipe Wrapping Tape

PVC pipe wrapping tape, minimum 2” width and 10 mil thickness, shall be used to secure all ends, joints, and repairs of polyethylene film. Duct tape shall not be used. Installation shall be as described in detail in ASTM 674.

e. Repairs

Repair any cuts, tears, punctures, or damage to polyethylene film with PVC pipe wrapping tape or short length of polyethylene sheet or cut open tube, wrapped around pipe to cover damaged area, and secured in place.

f. Installation

Polyethylene encasement shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices – Ductile Iron Pipe and Fittings. Specifically, the wrap shall be overlapped one foot in each direction at joints and secured in place around the pipe, and any wrap at tap locations shall be taped tightly prior to tapping and inspected for any needed repairs following the tap.

g. Certification

The installing contractor shall submit an affidavit stating compliance with the requirements and practices of ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, ANSI/AWWA C105/A21.5, AWWA C600 and M41. This certification shall be provided in duplicate to the City Inspector.

12. Directional Boring

The contractor shall have the option of installing proposed piping by means of directional boring throughout the project at no additional expense to the project. All Horizontal Directional Drilling (HDD) shall conform to Section 2905.

The City shall have the option to stop directional boring if surface upheaval problems are experienced. The contractor shall attempt to address the problems which caused the stop in construction activity. In the event that the problems cannot be remedied, the contractor shall finish installation activities by conventional open cut trenching and auger bore installation methods as shown in the construction plans.

a. All pipe installed by directional boring shall be either restrained joint pipe (RJ) or fusible polyvinyl chloride pipe (FPVC). The

pipe material shall be as specified in the plans and shall conform to Section 2903B of these specifications.

2905 INSTALLATION BY HORIZONTAL DIRECTIONAL DRILING (HDD)

A. Scope

This section provides supplemental requirements for pipe installation performed by HDD methods. Shared specifications for waterline installation regardless of installation technique including sections 2904B.2 through 2904B.10 as well as section 1100 remain in full force.

B. General

1. Coordination

a. Contractor shall obtain all necessary permits required to install the pipe using trenchless methods and for the proper disposal of drilling materials (mud, screenings, water, etc.).
b. Contractor shall furnish all labor, materials, and equipment required to install the pipe using the trenchless methods of installation, all in accordance with the requirements of the Contract Documents. The pipe size, type and length shall be as specified herein or as shown on the drawings. Work shall include and not be limited to proper installation, testing, grouting, restoration of underground utilities and environmental protection and restoration.
c. Contractor shall be sufficiently trained and knowledgeable of the construction technique required by the use of these trenchless methods. Contractor shall furnish all directional drilling and boring equipment, qualified laborers and equipment operators necessary to complete the required work in accordance with the project manual and associated drawings.
d. Contractor shall obtain all additional easements or right of way required to perform the trenchless pipe installation.
e. The length of the drill or bore shown on the drawings is the minimum required length of the installation. The Contractor may, at their option and at no expense to the Owner or Engineer, increase the length of the drill or bore during construction with approval from the Engineer.

2. Submittals

a. Submit technical data for equipment, method of installation, and proposed sequence of construction.
b. Include information pertaining to pits, dewatering, method of spoils removal, equipment size and capacity, equipment

capabilities including installing pipe on radius, type of drill bit, drilling fluid, method of monitoring line and grade and detection of surface movement, name plate data for drilling equipment and mobile spoils removal unit.

c. Data supporting the directional drilling Contractor's qualifications and experience.
d. Field quality-control test reports.
e. Record Drawings/Information
    1. Maintain accurate and up to date record documents showing field and Shop Drawing modifications. Record documents for buried piping shall show actual horizontal and vertical location of all piping, existing utilities that are exposed as part of construction activities, and appurtenances at same scale as the Contract Drawings.
    2. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For each horizontal bend, include dimensions to at least three permanent landmarks or structures, when possible. For straight runs of pipe provide offset dimensions as required to document pipe location.
    3. Include profile drawings with buried piping record documents when the Contract Documents include pipe profile drawings.
f. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
g. Show depth and location of abandoned bores.

3. Quality Assurance

All applicable permits and applications must be in place prior to beginning construction.

All trenchless pipe installation operations shall be performed by a qualified Contractor with at least three (3) years of experience involving work of a similar nature to the work required for this project. Contractor shall have completed a minimum of five (5) projects of comparable length and size of pipe.

All work shall be performed in the presence of the Engineer or the Resident Project Representative.

a. Regulatory Requirements:

1. Comply with the requirements for NPDES permitting, including best management practices for storm water discharges from the construction site.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
4. Comply with KDHE requirements for proper disposal of drilling materials (mud, screenings, water, etc.).
5. All applicable permits and applications must be in place prior to beginning construction.
6. All trenchless pipe installation operations shall be performed by a qualified Contractor with at least three (3) years of experience involving work of a similar nature to the work required for this project. Contractor shall have completed a minimum of five (5) projects of comparable length and size of pipe.
7. All work shall be performed in the presence of the Engineer or the Resident Project Representative.

C. Products

1. Performance / Design Criteria

    a. HDD construction methods shall comply with the latest revisions of ASTM F1962-11. Pipe used for HDD construction must meet project specifications and shall include the use of restrained joints or butt-fused joints.
    b. Tracer wire shall meet the requirements of the City of Lawrence Construction and Materials Specifications.

2. Drilling Fluid

    a. Liquid bentonite clay slurry; totally inert with no environmental risk.
    b. Polymers to produce high yield bentonite can be added with approval by the Engineer.

3. Equipment

    a. Drilling Rig: Directional drilling rig shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head. The machine shall be anchored

to the ground to withstand the pulling, pushing and rotating pressure required to complete the installation.

1. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations.
2. Hydraulic system shall be free of leaks.
3. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations.
4. There shall be a system to detect electrical current from drill string and an audible alarm that automatically sounds when an electrical current is detected.

b. Drill Head: The drill head shall be steerable by changing its rotation and shall provide necessary cutting surfaces and drilling fluid jets.

c. Motors: Motors shall be of adequate power to turn the required drilling tools.

4. Drilling Fluid (Mud) System:

b. Mixing System:

A self-contained, closed, drilling fluid mixing system shall be of sufficient size to thoroughly mix and deliver drilling fluid. The drilling fluid reservoir tank shall be a minimum of 1,000 gallons and the mixing system shall continually agitate the drilling fluid during operations.

c. Drilling Fluid:

Drilling fluid shall be composed of potable water, bentonite clay and appropriate additives. Fluid viscosities shall be appropriate for the soil/rock conditions encountered. Contractor shall take appropriate corrective actions should issues develop such as excessive or deleterious inadvertent returns, or borehole collapse. Such actions may include securing the consulting services of a mud engineer. Contractor shall submit a written plan of action to the Engineer outlining the steps to be taken to respond to such issues.

5. Tracking

a. The system shall be capable of tracking at all depths of up to twenty feet in any soil condition, including hard rock and shale.

b. The Contractor shall supply all components and materials to install, operate and maintain the guidance system.

D. Execution

1. Examination

    a. Proper alignment and elevations shall be maintained throughout the directional drilling or boring operation.
    b. Pipe shall be installed to meet or exceed the requirements of ASTM and AWWA approved installation methods.
    c. Testing of the pipe shall be in accordance with the testing requirements as outlined in the City of Lawrence Construction and Material Specifications.

2. Preparation

    a. The entire drill path shall be accurately surveyed by the Contractor with entry and exit pit stakes placed in the appropriate locations within the areas indicated on the drawings.
    b. If using the magnetic guidance system, the drill path shall be surveyed by the Contractor for any surface geomagnetic variations.
    c. Contractor shall locate all utilities before performing Work.
        1. Request underground utilities to be located and marked within and surrounding construction areas.
        2. Locate, identify, and protect utilities indicated to remain from damage.
        3. The contractor shall expose (pothole) all utilities in advance of directional boring activities. Utilities shall remain exposed during drilling activities to prevent damage to existing utilities due to increased soil pressure resulting from construction activities.

3. Dewatering

    a. Intercept and divert surface drainage, precipitation, and groundwater away from excavation through use of dikes, curb walls, ditches, pipes, sumps or other means.
    b. Develop and maintain substantially dry subgrade during drilling and pipe installation.
    c. Comply with all local, state and federal requirements for discharging water to watercourse, preventing stream degradation, and erosion and sediment control.

4. Excavation

    a. Excavate approach trenches and pits as site conditions require. Minimize number of access pits.

b. Restore areas after completion of drilling and carrier pipe installation to conditions as good as or better than original conditions.

5. Directional Drilling

a. Entrance and exit pits shall be located to avoid conflicts with the public utilities, and other agencies.
b. B. Tail ditches shall be sized to a maximum length of 35-feet to facilitate homing pipe within the excavation. Pipe may be homed above grade and lowered into the tail ditch if approved by the resident inspector. The maximum pipe bending radius provided by the pipe manufacturer shall dictate the minimum tail ditch length required for the installation of pipe homed above grade. Pavement removal and replacement for tail ditches in excess of 35-feet in length shall be subsidiary to the pipe installation cost.
   B. Provide sump areas to contain drilling fluids.
c. Pipe sections shall be joined together per the manufacturer's specifications. When required, tracer wire shall be attached to the pulling eye and the crown of the pipe with tape at 24 inch increments along the pipe and a minimum of two full wraps around the pipe. Contractor shall test tracer wire for continuity for each section before acceptance.
d. Guide drill remotely from ground surface to maintain alignment by monitoring signals transmitted from drill bit.
   1. Monitor depth, pitch, and position.
   2. Adjust drill head orientation to maintain correct alignment.
e. Inject drilling fluid into bore to stabilize hole, remove cuttings, and lubricate drill bit and pipe.
      1. The drilling slurry shall be in a homogenous/flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the bore hole.
   2. The volume of bentonite mud required for each pull back shall be calculated based on soil conditions, largest diameter of the pipe system component, capacity of the bentonite mud pump and the speed of pullback as recommended by the bentonite drilling fluid manufacturer.
   3. Bentonite slurry is to be contained at the entry or exit side of the drill pits or in holding tanks.

4. Slurry may be recycled for reuse in the opening operation or shall be hauled by the Contractor to an approved disposal/dump site for proper disposal.
5. The Contractor and Resident Project Representative shall document all drilling fluid products being used, the pumping pressure, rate of pumping and details relative to drilling fluid circulation at the end points of the drill.
6. The right of way and surrounding areas should be examined regularly for inadvertent returns. If inadvertent returns are discovered, they could be contained or cleaned up in accordance with federal, state or local regulations. These areas shall be monitored for continuing problems.

f. Continuously monitor drilling fluid pumping rate, pressure, viscosity, and density while drilling pilot bore, back reaming, and installing pipe to ensure adequate removal of soil cuttings and stabilization of bore.
    1. Provide relief holes when required to relieve excess pressure.
    2. Minimize heaving during pullback.
g. Calibrate and verify the accuracy of the electronic monitor in presence of the Engineer or Resident Project Representative before proceeding with other drilling. When required accuracy is not met, adjust equipment or provide new equipment capable of meeting required accuracy.
h. Readings shall be recorded after advancement of each successive drill pipe (no more than 10 feet). Access to all recorded readings and plan/profile information shall be made available to the Engineer or the Resident Project Representative at all times. At no time shall the deflection radius of the drill pipe exceed the deflection limits of the carrier pipe.
i. Drill pilot hole with vertical and horizontal alignment with no deviations greater than 5% of depth over the length of the drill unless previously agreed to by the Engineer.

1. In the event that the pilot does deviate from the drill path more than 5%, the Contractor shall notify the Engineer. The Contractor may be

required to pull back and re-drill from the location along the drill path before the deviation.

2. In the event of a drilling fluid fracture, inadvertent returns, or returns lost during drilling operations, the Contractor shall cease drilling and wait at least 30 minutes, inject drilling fluid with a viscosity exceeding 120 seconds as measured by a Marsh funnel and wait another 30 minutes. If mud fracture continues, Contractor shall notify the Engineer for alternate methods.

j. The pilot bore shall be approved by the Engineer or Resident Project Representative prior to commencement of the reaming phase. The diameter of the bore hole shall be increased to accommodate the pull-back operation of the required carrier pipe. The Contractor shall select the proper reamer with the final hole opening being a maximum of 1.5 times larger than the outside diameter of the pipe to be installed.

k. Protect and support pipe so it moves freely and is not damaged during installation. Contractor shall provide pipe rollers, slings or other appurtenances to assist in supporting the pipe during installation.

l. When drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.

m. Complete cleanup of drilling fluid at end of each work day.

6. Obstructions and Unexpected Utilities

a. When obstructions or unexpected utilities are encountered during the directional drilling process, the Contractor shall notify the Engineer immediately. Do not proceed around obstruction without Engineer's approval.

b. For conditions requiring more than 2 feet deviation in horizontal or vertical alignment, the Contractor shall submit a proposed alignment to Engineer for approval before resuming work.

7. Line and Grade Tolerances

a. Horizontal Tolerance:

1. Acceptable horizontal tolerance shall be a maximum of 1 foot per 100 feet difference from the line shown on the drawings.

b. Vertical Tolerance:

1. Acceptable vertical tolerance shall be a maximum of 6 inches per 100 feet difference from the grade shown on the drawings unless approved by the Resident Inspector. Modifications of the design profile to avoid conflict with other utilities shall be submitted for review and approval by the Engineer.

8. Disposal of Spoils

a. Remove, transport and legally dispose of drilling spoils and slurries.

1. Do not discharge drilling spoils and slurries in sanitary sewers, storm sewers, or other drainage systems.
2. When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.
3. Spoils and slurries shall be disposed of on sites provided by the Contractor. Disposal sites must be approved by KDHE.
4. Any material dumped in waters of the United States or wetlands is subject to U.S. Corps of Engineers permitting regulations.

9. Cleaning

a. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits. Clean up excess slurry from ground.

b. Restore approach trenches and pits to original condition.

2906 DISINFECTION AND TESTING

A. General

All water mains constructed shall be disinfected and tested as specified herein.

a. All hydrostatic testing shall be done in the presence of the Engineer, Inspector or authorized representative.

b. All water sampling shall be performed by the Engineer, Inspector or authorized representative.

c. Bacteriological testing shall be performed by the City of Lawrence Municipal Services & Operations Department Laboratory.

d. The Contractor shall notify the Engineer 72 hours in advance of the times and places at which testing work is to be done.

e. Temporary discharge piping shall be provided for disposing of test water. Test water shall be disposed of without damage to public or private property.

B. Disinfection

After installation, the entire main shall be flushed and disinfected by chlorination per AWWA C651. The Contractor shall disinfect the main or prepare the main for disinfection by the owning authority when so noted in the Special Project Specifications.

a. Flushing shall be carried out until water free of visual turbidity is obtained from all points along the main.

b. Disinfection may be performed concurrently with pressure testing if acceptable to the Inspector, or after hydrostatic testing is completed.

c. Disinfection of newly constructed waterlines shall be accomplished by the introduction of a chlorinated solution of not less than 25mg/L into the lines. The contact period shall not be less than 24 hours and the free chlorine residual at the end of the contact period shall not be less than 10mg/L. Following chlorination, all chlorinated water shall be flushed from the system. Chlorinated water to be flushed from the system shall be de-chlorinated as environmental conditions warrant per AWWA C655. Type and application of neutralizing chemicals shall conform to AWWA C655.

d. All existing mains which require a section to be removed for connection work shall be disinfected. The interior of all pipe and fittings used in making the connection shall be swabbed with a 5-10% hypochlorite solution immediately prior to their installation in the system. When the assembly is completed, the existing main shall be thoroughly flushed.

e. Two consecutive sets of acceptable samples taken at least 24 hours apart, shall be collected from the new main. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed

and shall be resampled. If second set of samples also fail to produce acceptable results, the main shall be rechlorinated until satisfactory results are obtained—that being two consecutive sets of acceptable samples taken 24 hr apart.

f. Each water main tested shall be allowed two sets of disinfection tests. Should the main fail to produce satisfactory results and additional testing is required, the contractor will be charged a fee of $500 per test for inspection and testing.

C. Hydrostatic Testing

The Contractor shall perform hydrostatic pressure testing in accordance with AWWA C600 or AWWA C605 procedures as applicable. Where practicable, waterlines shall be tested in lengths between line valves or plugs of no more than 1,200 feet in length.

1. General

- All waterlines shall be subjected to hydrostatic testing. All shutoff valves shall be open during pressure testing. Anchored or blocked test plugs shall be placed as necessary to limit testing length as specified above.
- The Contractor shall provide all necessary pumping equipment, piping connections, pressure gauges, calibrated make-up water reservoir, anchored or blocked test plugs, and all other equipment, materials, and facilities for the testing.
- The contractor shall replace materials, repair waterlines, and repeat testing as necessary should the initial testing fail to yield satisfactory results. Testing shall be repeated until satisfactory results are obtained.
- Gauges shall have documentation of calibration.

2. Hydrostatic Pressure and Leakage Testing

- The test pressure at any point in the waterline shall be 2.5 times the operating pressure not to exceed 200 psi.
- The test pressure shall be maintained within 5 psi for a minimum of 2 hours. Additional make-up water shall be added and accurately measured in order to maintain the test pressure. No pipe installation will be accepted if the leakage volume is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

Where:

L = allowable leakage (gallons per hour)
S = length of pipe tested (ft)
D = nominal diameter of the pipe (in)
P = average test pressure during the hydrostatic test (psi)

Common Calculation Results:

1,000 LF of 12” at 200 psi = 0.76 gallons per hour (1.52 gallons per 2-hour test)
1,000 LF of 8” at 200 psi = 1.15 gallons per hour (2.3 gallons per 2-hour test)

- All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed immediately and replaced with new and acceptable material, by and at the expense of the Contractor.
- Hydrostatic testing shall be repeated until the line and all parts thereof withstand the test pressure in a satisfactory manner.

2907 SANITARY SEWER SEPARATION REQUIREMENTS:

A. Horizontal Separation

a. A minimum of ten (10) feet horizontal separation, as measured from the outside edge to outside edge, shall be required between a potable waterline and a sanitary sewer main, force main, service line, or manhole.

b. Under no circumstance shall potable waterline and sanitary sewer be placed in the same trench.

c. Potable waterlines shall meet the minimum separation requirements from all pollution sources as set forth by the appropriate reviewing agency.

d. When waterlines and other utilities are laid parallel to each other the separation distance shall be determined based on geotechnical considerations. A minimum of three (3) feet of undisturbed earth separating the trenches shall be required. Under no circumstance shall waterlines and other utilities be installed in the same trench.

B. Vertical Separation

a. A minimum of two (2) feet vertical separation, as measured from the outside walls of the pipe, shall be required between a sanitary sewer main or service line and potable waterline.

b. In general potable waterlines shall be located above sanitary sewer lines.

c. Potable waterlines shall maintain a minimum of two (2) feet of vertical separation, as measured from the outside walls of the pipe, and shall always cross above any sewer force main.

C. Protective Measures

When potable waterlines and gravity sanitary sewers cross with less than two (2) feet of vertical clearance, and in all cases where the potable waterline is located below the gravity sanitary sewer, additional measures must be employed to protect the potable waterline.

Acceptable measures include:

- Construction of the sanitary sewer line using one of the following materials:
    - Ductile iron pipe conforming to ASTM A536 or ANSI/AWWA C151/A21.52 with a minimum thickness class 50, and gasketed, push-on, or mechanical joints in conformance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C111/A21.11.
    - PVC pipe conforming to ASTM D3034 with minimum wall thickness of SDR41, ASTM F679, or ASTM F794, with gasketed push-on joints in conformance with ASTM D3212.
    - Reinforced concrete pipe conforming to ASTM C76 with gasketed joints in conformance with ASTM C361 or ASTM C443.

    Install a minimum twenty (20) foot length of sanitary sewer pipe on the crossing to maximize the joint spacing to a minimum of ten (10) feet from the crossing.
- Provide concrete encasement of the sanitary sewer line a minimum of six (6) inches in thickness for a minimum distance of ten (10) feet either side of the waterline crossing.
- Sanitary sewer service lines may be constructed using schedule 40 PVC pipe with solvent welded joints. Pipe joints shall be located a minimum of ten (10) feet either side of the waterline crossing.

2908 ABANDONMENTS

A. Waterline

The abandoned waterline shall be disconnected and capped. At the point of disconnection any valve remaining shall be removed and the waterline remaining active shall be capped with a mechanical joint plug and a thrust block shall be installed. Complete removal of appurtenances shall be completed at the City's discretion.

B. Service Line

Water service lines shall be abandoned at the main. The curb stop/corporation stop and non-brass tapping saddle shall be removed, and the main shall be repaired with stainless steel repair clamp. Brass saddles shall be left in place and plugged with a brass plug. If in the opinion of the Municipal Services & Operations Department a repair clamp cannot be properly installed, a section of main may need to be replaced as directed by the Department.

C. Fire Line

Fire lines shall be abandoned at the main. The curb stop, corporation stop, or valve and non-brass tapping saddle or tapping sleeve shall be removed and the main shall be repaired with a stainless steel repair clamp. Brass saddles shall be left in place and plugged with a brass plug. If in the opinion of the Municipal Services & Operations Department a repair clamp cannot be properly installed, a section of main may need to be replaced as directed by the Department.

D. Fire Hydrant

Fire hydrants shall be abandoned at the main. The entire hydrant assembly shall be removed at the tee and the tee shall be plugged and blocked. If a tapping saddle is present the tapping saddle shall be removed the section of the main shall be replaced. A repair clamp shall not be used to replace a tapping sleeve.