

SECTION 2500 – SANITARY SEWER

2501 SCOPE

This division governs all work, materials and testing required for installation of gravity and pressure pipelines of **8" to 18"** as 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.

2502 GENERAL

A. Description

Sanitary sewer construction shall consist of furnishing all labor, materials and equipment for the complete installation of sewers and appurtenances in accordance with the contract documents, standard drawings, approved shop drawings, General Provisions and these specifications.

B. Specification Modifications

It is understood that throughout this section these Specifications may be modified by appropriate items in the Project Specifications, or by 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 Project Specifications. The City may, at its option, update and revise these specifications periodically in response to changing technology and construction methodologies.

D. Pipe Sizes

These standards shall apply to gravity sewers eight (8) inches to eighteen (18) inches, and force mains four (4) inches to six (6) inches.

E. 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 and 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 2500 – Sanitary Sewer (8” to 18” Mains), current edition.

F. 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 sanitary sewer 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.

2503 MATERIALS

A. General

This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the Plans and/or as provided for in the 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

Equipment and methods shall be adequate to protect the pipe, joint elements and prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or watertightness will be rejected.

B. Pipe, Fittings, Joints, Coatings and Linings

1. General

Furnish pipe and fittings of materials, joint types, sizes, strength classes, coatings and linings as indicated and specified.

2. Ductile-Iron Pipe and Fittings

Pipe and fittings shall conform to ANSI A21.51, except as otherwise specified herein.

a. General

Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.

b. Design

All ductile iron pipe shall meet the requirements of ANSI A21.50 and ANSI A21.51 and shall be of the thickness class specified therein or shown on the drawings. All ductile iron pipe shall have coatings and linings per these specifications.

c. Joints

Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI A21.11. Flanged joints for ductile iron pipe and fittings shall conform to the requirements of A21.10. Gaskets shall be neoprene or other synthetic rubber material. Natural rubber gaskets will not be acceptable. Restrained joints shall be Griffin Snap-Lok or approved equal

d. Fittings

Fittings shall be in accordance with ANSI/AWWA C 153 and shall have a pressure rating of not less than that specified for the pipe. Fittings used with ductile iron pipe shall be ductile iron. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall have mechanical

joints. All fittings shall be provided with stainless steel grade 304 or better bolts, washers, and nuts.

e. Stainless Bolts

Bolts shall conform to the following:

1. Mechanical joint bolts and nuts shall be stainless steel conforming to ASTM F593 for bolts and ASTM F594 for nuts. All T-Bolts & 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 ANSI/AWWA C111/A21.11-95. Nuts shall be finished with fluoropolymer coating system to minimize galling and ensure proper torque. Anti-seize 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.
2. 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. Anti-seize compound shall not be utilized with the fluoropolymer coated nuts. Identification on the head of the bolts shall be B8."

f. Coatings

Coatings shall conform to the following:

1. 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."

2. 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

g. Linings

Pipe and fitting linings shall conform to the following:

1. Interior lining of pipe shall be Induron "Protecto 401 Ceramic Epoxy".

h. Polyethylene Encasement

Polyethylene encasement shall conform to the following:

1. Requirements

All ductile iron pipe sewer mains shall be polyethylene encased and shall meet all the requirements for ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems.

2. Polyethylene Film

Polyethylene film shall consist of three layers of coextruded 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.

3. 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 674-05.

4. 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.

5. 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.

6. Backfill

Prevent damage to film by assuring that backfill material is free from cinders, refuse, boulders, rocks, stones, or other material that could damage the film. Follow AWWA C600 for backfilling.

7. 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.

3. Polyvinyl chloride (PVC) Pressure Rated Plastic Pipe and Fittings

Pipe and fittings shall conform to ASTM D 2241, except as otherwise specified herein.

a. General

Furnish maximum pipe lengths normally produced by the manufacturer, except for fittings, closures and specials. Pipe shall be used only for pressure flow systems.

b. Materials

PVC Pressure Rated Pipe shall meet the requirements of ASTM D1784, cell classification 12454, for PVC compounds and shall be purple in color. Fusible PVC shall only be utilized if the application has been approved by the Engineer.

c. Design

Pressure flow systems, i.e., force mains, shall have the wall thickness as shown on the plans, with a minimum wall thickness conforming to DR 18 with a minimum burst pressure not less than 400 psi conforming to pipe materials designation codes PVC 1120, PVC 1220, or PVC 2120.

d. Service Lines

Sanitary sewer service lines shall be constructed using schedule 40 PVC pipe with solvent welded joints or SDR 26 PVC pipe as specified in section 2503B.4.

e. Joints

Pressure flow systems shall be joined in accordance with ASTM D 3139 with particular attention given to Section 5.3. Restrained joints, when specified, shall be Certa-Lok C900 RJ (Coupled) or C900 RJIB (Integral Bell) or approved equal. Joints for fusible PVC 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. Fusible PVC pipe joints shall be assembled in the field with butt-fused joints. All fusion joints shall be completed in accordance with the pipe suppliers specifications and procedures. Fittings: Fittings shall be in accordance with ANSI/AWWA C 153 and shall have a pressure rating of not less than that specified for the pipe. Fittings used with polyvinyl chloride (PVC) pipe shall be ductile iron complying with Section 2503B of these specifications. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall have mechanical joints. Fittings used with fusible polyvinyl chloride pipe shall be ductile iron complying with section 2503B of these specifications.

4. Type PSM polyvinyl chloride (PVC) Sewer Pipe and Fittings

8 through 18 inch diameter pipe and fittings shall conform to ASTM D 3034 or ASTM F679, as applicable.

a. General

Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.

b. Materials

Type PSM polyvinyl chloride (PVC) pipe shall meet the requirements of ASTM D1784, cell classification 12454, for PVC compounds and shall be green in color.

c. Design

Pipe shall have an integral bell and spigot joint. Wall thickness shall be SDR 26 or SDR 21 as shown on plans. All pipe between any two (2) manholes shall be of the same SDR.

d. Joints

Joint tightness shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F477. Natural rubber gaskets will not be accepted. Restrained joint pipe, when specified, shall be CertaFlo Greenline or approved equal.

e. Fittings

Fittings defined as a tee (T) or wye connections, suitable for assembly to four (4) inch or six (6) inch building service lines, shall be heavy wall sewer fittings (SDR 26). A special design is required for service connections 8 inches and larger. Couplings for transition from restrained joint pipe (IPS) to type PSM PVC, when required, shall be gasket x gasket fittings with a minimum wall thickness conforming to SDR26. To connect existing PVC pipe to PVC Composite (truss) pipe or vitrified clay pipe (VCP) with a different outer diameter, fernco fittings or an approved equal shall be used.

5. Service Saddles

Service saddles, tee or wye connections, shall be molded PVC conforming to ASTM D1784. All service saddles shall be adhered to the receiving gravity sanitary sewer pipe utilizing an adhesive compatible with the service saddle and receiving gravity sanitary sewer pipe type as recommended by the manufacturer (solvent weld, epoxy, polyurethane, silicone, etc.), All service saddles shall be provided with stainless steel straps, bolts, and nuts, and shall be compatible with the outside diameter (OD) of the existing sanitary sewer main.

C. Tunnel Liner

Steel tunnel liner plates shall be galvanized in accordance with ASTM A123. The design and shape of the liner plates shall be such that assembly can take place entirely from within the tunnel liner. Liner Plates shall be capable of

withstanding the ring thrust load and transmitting this from plate to plate. The minimum outside diameter shall be four (4) feet and the minimum wall thickness shall be United States Standard Gauge 12 (0.2046 inches). Sufficient sections shall be provided with one and one-half (1-½) inch or larger grouting holes located near the centers so that when the plates are installed there will be one line of holes on either side of the tunnel and one at the crown; the lower line of holes on each side shall not be more than eighteen (18) inches above the invert. The holes in each line shall not be more than five (5) feet apart and unless otherwise approved, shall be staggered. Bolts and nuts shall conform to ASTM A 153, A 307, A 325 and A 449 as applicable. Steel liner plates shall have bolted joints in both longitudinal joints in adjacent rings when assembling.

D. Casing Pipe

Casings pipe for bored, jacked, horizontal directional drill, 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 14 and under	Nominal Wall Thickness – Inches	
	Under Railroads	All other Uses
	0.312	0.188
16	0.312	0.188
18	0.312	0.250
20	0.375	0.250
22	0.375	0.250
24	0.406	0.281
26	0.438	0.281
28	0.469	0.312
30	0.469	0.312
32	0.500	0.312
34	0.500	0.312
36	0.500	0.344

2. Steel

Shall be Grade A on all uses 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 Advance Products & Systems (APS) model AW, CCI model ESW, or approved equal.

6. Annular Space

Shall not be filled between lining and sewer pipe.

7. Carrier Pipe

Shall be installed in casing pipe and shall be restrained joint pipe in accordance with Section 2503B of these specifications.

E. Manholes and Special Structures

1. Scope

This section governs the furnishing of all labor, equipment, tools, and materials, and the performance of all work incidental to the construction of manholes, drop manholes and special sewer structures complete with covers, fittings, and appurtenances as required in accordance with the Plans and Special Project Specifications.

2. General

As used herein special structures refers to manholes on large sewers, special junction structures, metering stations and similar structures constructed on the pipeline.

Manholes and special structures may be constructed of precast concrete sections or cast-in-place concrete.

3. Manhole Materials

a. Mortar and Plaster Coating

Mortar and plaster coatings for masonry manhole units shall conform to ASTM C 270. The mix shall consist of two (2) parts portland cement to one (1) part masonry cement to six (6) parts standard plaster sand. No mortar or plaster mixed more than thirty (30) minutes shall be incorporated in the work.

b. Non-Shrink Grout

Non-Shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C 827 and shall develop compressive strength not less than three

thousand (3,000) pounds per square inch with a trowelable mix within twenty-four (24) hours per ASTM C 109. The placement time shall be not less than forty-five (45) minutes based on initial set per ASTM C 191.

Non shrink grout for use on inverts for pre-cast manholes shall have compressive strength of 4,000 pounds per square inch with minimum of 752 lbs. of Portland cement and 100% sand (8-sack grout).

c. Epoxy System

Where specified, interior surfaces shall be coated using a two part, 100% solid, epoxy material spray applied on the job site. Approved systems are Raven 400, 404, 405, and 470. Interior surfaces shall be cleaned and prepared for spray applications in accordance with manufacturer's recommendations. Epoxy systems shall only be applied after manhole installation is complete and must be hand sprayed; spun application will not be permitted. All epoxy systems shall be holiday or spark tested per manufacturers' recommendations.

d. Polyurethane System

Where specified interior surfaces shall be coated using a 100% solids polyurethane. Approved systems are Zebron 386 and Sherwin Williams SherFlex. Interior surfaces shall be cleaned and prepared for spray applications in accordance with manufacturer's recommendations. Polyurethane systems shall only be applied after manhole installation is complete and must be hand sprayed; spun application will not be permitted. All polyurethane systems shall be holiday or spark tested per manufacturers' recommendations.

e. Precast Concrete

Precast concrete manholes shall conform to ASTM C 478 with the following modifications.

- i) Wall thickness not less than one-twelfth (1/12) of inside diameter or four (4) inches, whichever is greater, shall be used when the manhole depth is less than sixteen (16) feet; one-twelfth (1/12) of inside diameter plus one (1) inch or five (5) inches, whichever is greater, shall be used when manhole depth is sixteen (16) feet or greater.

- ii) Cement, Fine Aggregate, Coarse Aggregate and Water used in the manufacture of precast manholes shall be as specified in Section 2503E.3.
- iii) Developed bases shall be used where practical. The diameter of the base pad shall be eight (8) inches greater than outside diameter of the manhole.
- iv) Pipe openings shall be circular or horseshoe shaped with surfaces grooved or textured to improve mortar bond. Flexible gaskets shall be used with developed base manholes and must be cast into the manhole base. Flexible gaskets shall be A-Lok X-Cel, or approved equal.
- v) When tying into an existing manhole, the pipe opening shall be core drilled and a modular or flexible gasket installed, such as Link Seal, A-Lok Z-Lok, PSX Direct Drive, or approved equal. If an existing manhole lining is damaged during construction, the lining must be repaired per manufacturers' recommendations.
- vi) The minimum distance from the bottom of the downstream pipe to the top surface of the base shall be three (3) inches.
- vii) Manhole steps shall not be provided.
- viii) Joints between manhole sections, adjustment rings, and below the ring and cover shall be sealed with preformed bitumastic sealants, Kent-Seal, Ram-Nek, E-Z Stick or approved equal. The minimum bead dimension shall be one inch.

f. Manhole Joint Sealants

i) Cold Applied

Joints on the manholes shall be wrapped with a Butyl Joint Wraparound Sleeve: The butyl component of the wrap shall consist of 50 percent minimum butyl rubber and shall contain 2 percent or less of volatile matter, and shall be 9" wide by 0.03" inch thick. The backing component shall be EPDM or Intra-Curing Halogenated Based Rubber that is a minimum of 0.03" thick. A release paper may be used. The butyl rubber-based wrap shall be EZ-Wrap Rubber as supplied by Press-Seal Gasket

Corporation, Gator Wrap as manufactured by Sealing Systems, Inc. or approved equal.

ii) Heat Applied

Heat Shrinkable Wraparound Sleeves: The wrap system shall consist of a two-piece sleeve (backing and adhesive) with a closure system and a G-type primer. It shall consist of an irradiated cross-linked polyefin sheeting, pre-coated with a layer of anti-corrosion adhesive. The backing shall have a minimum recovery of 22 percent. The wrap shall have a mastic type adhesive, specially formulated to become fluid at temperatures achieved during installation and maintain flexibility in cold climates with installation temperatures down to -40° F. Upon cooling the adhesive shall form a tough, elastomeric protective layer. The wrap shall employ a closure seal to allow sealing of the overlap area. The overall thickness of an applied sleeve shall nominally measure 0.01 inch. The heat shrinkable wraparound sleeves shall be Wrapid Seal as manufactured by Canusa or approved equal.

g. Chimney Seals

An external flexible rubber frame seal and where necessary, extension or extensions to seal entire chimney of all sanitary sewer manholes. The seal and extensions shall seal all joints from the base flange of the frame down to the top of the cone. The seal shall be a continuous seamless band made of high quality EPDM rubber with a minimum thickness of 65 mils or a heat-shrinkable sleeve. The top section of the seal shall extend 3" attaching to the casting base/flange with the side section covering over the entire grade adjustment ring area and onto the cone section a minimum of 2". Installation of Chimney Seals shall be per the manufacturer's recommendations and these instructions shall be supplied to the inspector on each project. The seal shall be: Infi-Shield by Sealing Systems Inc., Cretex Classic External Seal or Wrapid Seal as manufactured by Canusa.

h. Manhole and Special Concrete

Manhole and special concrete shall conform to Section 2000 of the City of Lawrence Technical Specifications or as provided herein.

1. Standard Concrete

Standard concrete used for concrete encasements thrust blocks, pipe anchors, pipe collars, etc. shall be 4000 psi, 28-day strength, unless otherwise specified.

2. Structural Concrete

Structural concrete used for aerial crossing piers, wetwell walls, manhole walls, bases, inverts, and flat slabs, etc. shall be 4000 psi, 28- day strength, unless otherwise specified.

3. Reinforcement steel

Reinforcement steel shall conform with the following minimum requirements.

i. Design

Reinforcing steel shall conform to one of the following.

1. Welded Wire Fabric – ASTM A 185.
2. Reinforcing Bars – ASTM A615, Grade 60.
3. Fabricated Steel Bar and Rod Mats – ASTM A 184, Grade 40, or Grade 60.

j. Fabricating Tolerances

Tolerances for concrete reinforcement shall conform to the following requirements.

1. Sheared length = +/- 1 inch.
2. Stirrups, ties, and spiral = +/- 2 inches.
3. All other bends = +/- 1 inch.

k. Iron Castings

Casting shall conform to the requirements of ASTM A 48, Class 30. Castings shall be clean and without surface defects that will impair serviceability. Plugging or filling of holes or other defects will not be permitted. Parting fins and pouring gates shall be removed.

1. Rings and Covers

- i) Rings and covers shall meet the following minimum requirements.

- ii) Bearing surfaces between the ring and cover shall be machine finished or ground to assure interchangeability and a nonrocking fit in any position.
- iii) Provision shall be made for opening, such as concealed pick hole(s).
- iv) Manhole Rings and Lids shall be Deeter Foundry model 1048, or approved equal with casing inside diameter of twenty-four (24) inches, lid outside diameter of twenty-five and one-quarter (25.25) inches, and lid seating thickness of one and one-half (1.5) inch plus/minus one-eighth (0.125) of an inch.
- v) Bolt-down type manhole rings shall be anchored to the manhole walls with not less than four (4) five-eighths (5/8) inch diameter steel bolts embedded a minimum of four (4) inches, except where the entire ring is embedded in a concrete top slab.
- vi) Rings and bolt-down covers shall be provided with machined surfaces, O-ring gaskets and one-half (1/2) inch hex head stainless steel cover bolts and washers. Cover bolt heads shall fit flush or below the top of the cover. The O-ring rubber gasket shall be neoprene or other synthetic, sixty (60) plus or minus five (5) hardness when measured by ASTM D 2240 type durometer.
- vii) Rings and bolt down covers shall be Deeter Foundry model 1048-B or approved equal.

F. Air Release Valves

Combination air release and vacuum relief valve assemblies shall be installed in the locations as indicated on the drawings. Each valve assembly shall be installed complete with appurtenant piping and valves as shown on the standard drawings.

Combination air release and vacuum relief valves shall be A.R.I. Model D 025. All working parts shall be stainless steel and the valve body shall be reinforced nylon.

Combination air release and vacuum relief valves shall be housed in a precast concrete vault as detailed on the standard drawings.

2504 INSTALLATION

A. General

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

B. Sanitary Sewer Installation

1. Scope

This section governs construction methods and procedures for the installation of gravity and pressure sanitary sewer pipelines and appurtenances.

2. Service Connections

Service connections shall be installed as shown on the Plans or as specified herein. Building service connections shall be tee or wye connections.

1. Service connections shall be installed at forty-five (45) degrees with pipe springline for pipe sizes 8 through 12 inch diameter. Service connections shall not be installed in pipe sizes greater than or equal to eight (8) inch diameter unless approved by the Engineer.
2. Services shall be schedule 40 PVC with solvent welded joints or SDR 26 PVC. 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.
3. The Contractor shall maintain an accurate record for submittal to the Engineer of location, size and direction of each service connection. Locations shall use the pipeline stationing as shown on the Plans or the distance from the first downstream manhole. In the event such records are not kept or are lost before final acceptance of the work, the required information shall be redetermined by the Contractor at their own expense.

3. Gravity Sewers

All gravity sewers shall be installed to the alignment, elevation, and slope, and shall include pipe embedment as specified and/or shown on the Plans.

Joint deflection shall not exceed the maximum allowable deflection per joint according to ASTM C 425 and AWWA C 600.

4. Pressure Sewers (Force Main)

All pressure sewers shall be installed with required pipe embedment to depths shown on the Plans and to a continuous slope when not shown. 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, unless otherwise shown in the plans. Approved air relief valves shall be installed at all locations shown on the Plans or where required by the Engineer.

The Contractor shall block and anchor the pipeline to accommodate thrust and testing forces at pipe deflections, bends, tees, and plugs in accordance with the Contract Documents. All damage caused by the Contractor's failure to provide adequate thrust supports shall be corrected by the Contractor at no additional cost to the project.

5. Location Wire

Location wire shall be buried above all pressure sewers in accordance with the following:

1. Location wire shall be installed to enable the detection of all pressure sewer pipe. Location wire shall be 12 AWG copper clad steel (CCS), minimum break load of 280 lbs. with purple 30mil HDPE jacket for open trench installations or 12 AWG copper clad steel (CCS), minimum break load of 1,100 lbs. with purple 45 mil HDPE jacket for directional drill installation.
2. The location wire shall be placed no further than 6 inches to the side or above the sanitary sewer. For directional drill installation, location wire shall be taped every 8-10 feet.
3. The location wire shall be accessible at test stations at least every 1,500 feet.
4. Test stations shall be Copperhead Industries LLC SnakePit Magnetized Tracer Box.
5. Splicing of location wire shall be accomplished by the use of Copperhead Industries LLC Locking SnakeBite Wire Connector,

Copperhead Industries SCB01SR direct bury splice kit, Copperhead Industries LLC 3WB-01 DryConn Threeway 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.

6. Anodes shall be a minimum of one pound bare magnesium or zinc drive-in grounding anode and shall be driven –into the ground at the same elevation as the sewer line. Anodes shall be placed at the beginning and end of the sewer line and at every test station or at least every 1,500 feet.

6. Anchors

Pipelines shall be anchored in accordance with the table below:

Pipeline Anchors	
Percent of Grade	Center to Center Maximum Spacing (feet)
15-35	36
35-50	24
>50	16

The anchor shall be of concrete or other material approved by the Engineer. Concrete anchors shall have a minimum thickness of twelve (12) inches. The anchor shall extend not less than one (1) foot into undisturbed earth on the sides and bottom and one (1) foot above top of pipe. In incompressible material, the above dimensions may be six (6) inches each side and bottom. The anchor shall support a joint fitting.

7. Pipe Laying

All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

1. The grade alignment of all sewer lines shall be determined, maintained, and installed through the use of a laser. Other methods for determining the proper grade alignment must be approved by the Engineer.
2. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Engineer for approval an alternate appropriate bedding for the pipe or pipe of sufficient strength to provide safe supporting strength.

3. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.
4. Rejected pipe and fittings shall be marked and removed from the Project Site at no cost to the project. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench, and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.
5. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.
6. Pipe laying normally shall begin at the lowest point.
7. Unless otherwise required, lay all pipe straight between manholes. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.
8. Pipe connecting to a drop structure shall be supported with Flowable Mortar, outside the structure excavation, as shown on standard details.
9. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of stormwater or other foreign matter.
10. When a sanitary sewer line crosses an existing pipeline and the clearance is less than two (2) feet, special embedment may be required.

8. Manhole Installation

Manhole installation shall be governed by this Section and Section 2504. It shall be performed by the Contractor on a schedule that will provide an orderly progression of the work.

a. Bases

- Precast developed bases shall be reinforced in accordance with ASTM C 478.
- If preferred developed bases are not used, poured concrete bases shall be used. Developed bases shall be installed on a maximum of 4 inches of crushed rock. Depths exceeding this amount shall be filled with mass concrete.

- Poured-in-place bases shall have a minimum thickness of eight (8) inches. When poured-in-place bases are used, the invert shall be poured monolithically with the base using 4000 psi KCM MB concrete per 2510.3.6. The bottom wall sections shall be embedded in the base section a minimum of three (3) inches. The bottom precast wall section shall not be set upon a previously poured base. Solid concrete blocks shall be used for supporting and leveling the wall section prior to pouring the base.

b. Inside Dimensions

The minimum inside diameter of standard manholes shall be four feet. Drop manholes shall have a minimum five foot diameter.

c. Precast

1. Delivery

Written documentation (eg. Letter of Certification) must accompany manholes being delivered to the site and given to the Inspector. The documentation should state that either:

- The manholes being delivered have reached 80% of the required 4,000 psi 28- day design strength (ie. 3200 psi) prior to leaving the plant, or
- Prior to leaving the plant, the manholes being delivered have cured at least as long and under the same conditions, and are of the same design mix and lot, as a test cylinder that has reached 3200 psi.

2. Inspection

Precast concrete components shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C478.

- Wall thickness shall conform to the requirements of Section 2503.E.3.e.
- Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal each joint (including adjustment rings and castings) with a double bead of preformed bitumastic joint sealant. Lift holes shall be patched with non-shrink grout after

testing. Each joint, including adjustment rings and castings, shall be sealed with approved heat or cold-applied sealant conforming to Section 2503.E.3.f or 2503.E.3.g of these specifications.

d. Inverts

Inverts shall be structural concrete or 4000 psi non-shrink grout per 2510.3.2 and steel-troweled to produce a dense, brushed finish. The invert channel shall be “U” shaped in cross section and extend upward one-half of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation and bends. The invert bench shall be sloped to drain. A minimum drop of 0.2 feet shall be required across all manholes unless otherwise approved by the Municipal Services and Operations Department.

e. Top Elevation

The finished top elevation of manhole castings shall conform to the following unless otherwise shown on the plans or directed by the Engineer.

1. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.
2. In non-pavement areas, the top of the casting shall be not more than six (6) inches above the surrounding ground. The final elevation shall be at a point where water will not pond over the manhole cover.

f. Manhole Adjustment

All new manholes will be provided with adjustment ring(s) underneath the casting as shown on Plans. The joints shall be sealed with preformed bitumastic sealant. The maximum allowable adjustment distance between the top of the cone and the bottom of the casting shall be 12” total, including extender and adjustment rings. If the top of an existing manhole is required to be raised to an elevation that will exceed the maximum adjustment distance or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole. Adjustment rings shall be sealed with an approved cold-applied sealant conforming to Section 2503.E.3.f of these specifications. Adjustment rings shall be sealed with an approved heat-applied sealant

conforming to Section 2503.E.3.g if manhole location is governed by Section 2504.B.8.h.2, of these specifications.

g. Castings

Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed bitumastic sealer. Bolt-down castings shall be held in place as shown on the Plans and shall comply with Section 2503.E.3.k.1 of these specifications.

h. Floodplain

1. Manholes in the 100 year floodplain shall be installed with bolt down gasketed lids conforming to the provisions of Section 2503.E.3.k.1 of these specifications.
2. Manholes in the 100 year floodplain shall have all joints sealed with a heat-applied sealant conforming to Section 2503.E.3.g of these specifications.

i. Excavation

1. Depth of excavation shall be to that required for proper installation of the manhole or structure. Over-depth excavation may be required by the Engineer if the subgrade is unstable. Over-depth excavation due to unstable subgrade shall be backfilled as required by the Engineer. Over-depth excavation occurring through an oversight by the Contractor shall be backfilled as required by the Engineer at no additional cost to the project.
2. Side clearances outside the manhole and/or structures shall be no greater than to allow for forming, connection of piping, proper application of special coatings, if required, and to permit inspection. When concrete is to be placed directly against excavated faces, excavation shall be sufficiently outside of the manhole or structure to provide not less than three (3) inches of concrete cover over the steel reinforcements.

9. Detailed Installation Requirements

All pipes shall be installed in accordance with the following standards:

1. ASTM D-2321 – PVC Solid Wall.
2. ANSI/AWWA C 600 – Ductile Iron Pipe.

10. Tunneling, Boring, and Jacking

a. Scope

This item establishes the requirements to be followed for pipeline excavation performed by tunneling, boring and jacking methods.

b. General

Tunneling, boring and jacking includes all underground horizontal excavations necessary to install the pipeline. The contractor shall submit to the Engineer, prior to actual work, a written description of their proposed tunneling, boring or jacking operations. It shall include the types and locations of shafts, methods to provide safe support strength for the pipeline when the shafts or bore pits exceed maximum allowable trench widths and other features that would affect the pipeline.

c. Tunnel, Bored, or Jacked Cross Section

Cross sections shall be circular and of the size specified for all tunneling, boring or jacking operations. Alternate size and shape may be submitted for consideration by the Engineer.

d. Construction

1. General

All tunneling, boring or jacking excavation shall provide an excavation conforming to outside diameter of the casing and/or carrier conduit. The excavation shall be to an alignment and grade which will allow the carrier conduit to be installed to proper line and grade as shown on the Plans and as established in Section 2504 – Installation.

2. Excavation

Conduct excavation in a manner to prevent disturbing overlying and adjacent material. Perform dewatering and chemical soil stabilization or grouting, if necessary, due to existing field conditions.

11. 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. 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).

- i) 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 2503B of these specifications.

e. Casing Spacers

Casing spacer type shall conform to section 2503D.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 2503D.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.

i. Carrier Conduit Installed Without Casing

Carrier conduits installed without casing shall be assembled at the entrance to the auger hole and carefully pushed or jacked through the opening using a method designed to prevent disturbing the assembled joints. Auger holes shall be sized to accommodate the carrier conduit with a minimum of annular space around the conduit. When finally in place, carrier conduit shall be true to the line and grade required on the Plans. Carrier conduit installed without casing shall be restrained joint pipe in accordance with Section 2503B of these specifications.

2505 TESTING

A. Scope

This section governs the furnishing of all labor, equipment, tools and materials, and the performance of any or all acceptance tests.

B. General:

The Contractor shall furnish all labor, equipment, materials and reports for the required acceptance tests. All pipelines, including building service connections, shall undergo and pass all required tests to determine soundness and workmanship. Pipelines that do not conform to the project requirements shall be repaired and/or replaced and shall be retested until the pipelines meet the project requirements. No testing shall be performed before backfill and compaction operation has been completed. All testing shall conform to the most recent version of KDHE's *Minimum Standards of Design for Water Pollution Control Facilities*.

Alignment, grade and visible defects shall be checked as follows:

C. Television Inspection

Sewer lines and casing pipe installed under this project shall be inspected by closed circuit television. Video inspection shall be performed by the City of Lawrence Municipal Services & Operations Department.

Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.

D. Pipe Testing Procedures

1. Air Test

The Contractor shall perform a low pressure air test. The section of pipe between successive manholes shall be sealed with suitable plugs. One of the plugs shall have an orifice through which to pass air into the section of pipe being tested. The air supply line shall have a positive on-off valve and suitable means for readily disconnecting it at the control panel. A second orifice in the plug shall be used for constantly reading the internal pressure of the pipe. This orifice shall be continuously connected to a pressure gauge having a range from 0 to 10 psi. The gauge shall have minimum divisions of 0.10 psi and shall have an accuracy of 0.04 psi. The line under test shall be pressurized to approximately 4 psi. The air supply will then be shut off, and the pressure will be allowed to stabilize for a minimum of 2 minutes. If, during this period, the pressure has dropped below 3.5 psi, more air shall be introduced to raise the pressure to a minimum of 3.5 psi. After

this stabilization period, the air supply line shall be disconnected and timing will begin. The time of the test, in minutes, will be equivalent to one-half of the nominal diameter of the pipe being tested. As an example, for an 8-inch pipe, the time period will be 4 minutes; for a 10inch pipe, 5 minutes; etc. The maximum allowable pressure drop during the specified time period will be 1.0 psi.

Each sewer main tested shall be allowed two low pressure air 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.

2. Hydrostatic Testing for Pressure Systems

a. Conformance Procedure

All testing shall conform to AWWA C 600 or AWWA C605 procedures and KDHE's *Minimum Standards of Design for Water Pollution Control Facilities* as applicable and as modified herein. Tests shall apply to all pressure sewers.

b. Sectionalizing

Test in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Contractor shall furnish and install test plugs at no additional cost to the project, including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs. Contractor shall be responsible for any damage to public or private property caused by failure of plugs. Limit fill rate of line to available venting capacity.

c. Pressure Test

All pressurized sewer systems shall be pressure tested as follows:

1. The pipeline shall be filled with water and all air expelled from the pipeline. Vents shall be provided where necessary and suitable plugs shall be provided for tapped vents.
2. The Contractor shall provide all necessary pumping equipment, piping connections, pressure gauges, anchored or blocked test plugs, and all other equipment, materials, and facilities necessary to complete the pressure testing.

3. The test pressure at any point in the pipeline shall be 2.5 times the operating pressure not to exceed 200 psi.
4. The test pressure shall be maintained for a minimum of 30 minutes or whatever period is necessary for the Inspector to inspect the pipeline. Under no circumstance shall the Inspector be permitted to leave the project site during pressure testing activities.
5. Any drop in pressure across the tested section of the pipeline shall constitute failure of the pressure test.
6. 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.
7. Pressure testing shall be repeated until the line and all parts thereof withstand the test pressure in a satisfactory manner.
8. Each sewer main tested shall be allowed two pressure 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.

3. Deflection Test

d. General

After all sewer pipe has been laid and backfilled, the Engineer or authorized representative shall require a deflection test. The maximum allowable deflection shall not exceed 5.0% of the pipe's internal diameter. The deflection test shall consist of guiding a mandrel of the appropriate size through the pipe to accurately measure any deflection in the pipe. Attention should be given to the fact that the pipe's nominal diameter is greater than the actual internal diameter of the pipe. Lamping will not be approved for deflection testing. The mandrel shall conform to ASTM D-2680 or ASTM D-3034, whichever applies.

E. Manhole Testing Procedures

Vacuum testing shall be performed in the following manner:

1. Each manhole shall be vacuum tested. Testing shall be completed prior to the application of any specified lining material.

2. All lift holes, removed step holes, core drill setup holes, or other imperfections inside the manhole shall be filled with an approved non-shrink grout prior to testing.
3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.
4. The test head shall be placed at the inside of the top of the casting and the seal inflated in accordance with the manufacturer's recommendations.
5. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for 48" diameter, and 75 seconds for 60".

F. Soil Density Tests

1. General

Compaction tests shall be performed as specified on the Plans. All compaction tests shall be performed by a testing laboratory approved by the Engineer. The Engineer may require additional density tests if needed.

2506 SEPARATION REQUIREMENTS

A. Potable Waterline Separation Requirements

1. 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 sanitary sewer main, service line, or manhole and potable waterline.
- b. Under no circumstance shall potable waterline and sanitary sewer be placed in the same trench.
- c. Sanitary sewers shall meet the minimum separation requirements from public water supply wells or other water supply sources and resources as set forth by the appropriate reviewing agency.

2. 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 gravity sanitary sewer lines shall be located below potable waterlines.
- c. Sanitary sewer force mains shall always cross below potable waterlines and shall maintain a minimum of two (2) feet of vertical separation, as measured from the outside walls of the pipe.

3. Protective Measures

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

- a. Construction of the sanitary sewer line using one of the following materials:
 - i) 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.
 - ii) 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.
 - iii) 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.

- b. Provide concrete encasement of the sanitary sewer line, a minimum of six (6) inches in thickness, for a minimum distance of ten (10) feet on each side of the pipeline crossing.
- c. Pipe joints shall be located a minimum of ten (10) feet on each side of the pipeline crossing.

B. General Utility Separation Requirements:

1. Horizontal Separation

A minimum of five (5) feet of horizontal separation, as measured from outside walls of the pipe, shall be required between all utilities,

excluding potable waterlines, and sanitary sewer main, forcemain, service line or manhole.

2. Vertical Separation

A minimum of two (2) foot of vertical separation, as measured from the outside walls of the pipe, shall be required between all utilities and sanitary sewer main, forcemain or service line.

2507 ABANDONMENTS

A. Scope

This section governs construction methods and procedures for the abandonment of gravity and pressure pipelines, service lines, and appurtenances.

All sanitary sewer abandonments shall conform to the following requirements:

B. Gravity and Pressure Pipeline

Gravity and pressure pipeline shall be plugged and filled with flowable fill or cement mortar.

C. Manholes

Manhole cones or the top four (4) feet shall be removed, penetrations shall be plugged and grouted, and the manhole shall be filled with flowable fill if under pavement or sidewalk, otherwise the manhole shall be filled with sand.

D. Manhole Connections

Manhole connections shall be cut, plugged and grouted within two (2) feet of the manhole.

E. Service Lines

Service lines shall be cut and plugged within eighteen (18) inches of the sanitary sewer main and the cap shall be encased in concrete.