

City of Lawrence
Construction and Material Specifications
Section 2500 – Sanitary Sewer (8” to 18” Mains)



Revised: January 2018

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SECTION 2501 SCOPE

This division governs all work, materials and testing required for installation of gravity and pressure pipelines 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.

SECTION 2502 GENERAL

2502.1 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.

2502.2 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.

2502.3 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.

2502.4 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.

2502.5 Definitions: “Engineer” shall mean the Utilities Engineer or the Department of Utilities 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 Utilities 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.

2502.6 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.

SECTION 2503 MATERIALS

2503.1 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.

2503.2 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. 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. 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 2503.2 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 2503.2 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) with schedule 40 hub outlets. 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.

5. PVC Composite (Truss) Pipe, meeting the requirements of ASTM D2680, will be allowed only for connection to existing truss pipe or existing vitrified clay pipe (VCP).
6. 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.

2503.3 Pipe Embedment Materials.

1. Scope: Pipe embedment materials shall be furnished and installed to complete the work shown on the Plans or as called for in the Contract Documents.
2. Bedding Aggregate: All materials used for crushed stone pipe bedding shall conform to KDOT specifications for SCA-3 or CM-H.
3. Concrete for encasement:
 - a. Concrete shall test not less than a twenty-eight (28) day compressive strength of 4000 psi and shall otherwise conform to Section 2510.3.6.
 - b. Reinforcing steel when required shall be placed as shown on the Plans and shall conform to Section 2510.3.7.

2503.4 Backfill Materials:

1. Scope: Backfill materials shall be as required and/or permitted to complete the work shown on the Plans or called for in the Contract Documents.
2. Select Earth Backfill Material: Select earth backfill shall be finely divided job excavated material free from debris, organic matter, rocks larger than one (1) inch and/or frozen materials.
3. Other Earth Backfill: Other backfill may be job excavated material free from debris and organic matter. No rock greater than six inches in its longest axis, shall be placed in any trench excavation as backfill.
4. Flowable Mortar, conforming to Section 2507.3, shall be used in areas as defined in Section 2507.3 and as indicated on the plans.

2503.5 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.

2503.6 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.

a. 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	0.312	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

b. Steel shall be Grade A on all uses unless a higher standard is required by the responsible agency.

c. Steel pipe shall have welded joints in accordance with AWWA C 206.

d. Casing Spacers shall be CCI stainless steel, CCI polyethylene or approved equal.

e. The end seals shall be Advance Products & Systems (APS) model AW, CCI model ESW, or approved equal.

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

g. Carrier pipe installed in casing pipe shall be restrained joint pipe in accordance with Section 2503.2 of these specifications.

SECTION 2504 SITE PREPARATION:

2504.1 Scope: This section governs normal project site preparation for construction.

2504.2 General:

1. Contractor shall do all clearing necessary for performance of his work and shall confine his operations to that area provided through easements, licenses, agreements and rights-of-way. The Contractor's entrance upon any lands outside of that area provided by easements, licenses, agreements or public rights-of-way, shall be strictly prohibited without the express written consent of the affected property owner. The Contractor shall be required to provide copies of all permissions and agreements to the Inspector.
2. The Contractor shall not occupy any portion of the Project Site prior to the date established in the Notice to Proceed without prior approval of the Engineer.

2504.3 Obstructions:

1. General: Natural obstructions, existing facilities and improvements encountered during site preparation shall be removed, relocated, reconstructed or worked around as herein specified. Care shall be used while performing site preparation work adjacent to any facilities intended to remain in place. Except as otherwise specified, the Contractor shall be responsible for any damage to existing facilities and improvements and any repairs required shall be promptly made at the Contractor's expense. Waste materials shall be disposed of in a satisfactory manner off the work site. Existing utilities damaged by the Contractor shall be restored as directed by the utility company at no additional cost to the project. Unless identified as a specific bid item, no separate or additional payment will be made for any work in connection with removal, relocation or restoration of obstructions and existing facilities.
2. Surface Obstructions:
 - a. Sidewalks, curb and gutter, drainage structures and similar obstructions shall be tunneled under if tunneling is best suited. Otherwise the obstruction shall be cut in straight lines or removed to the nearest construction joint if located within five feet of the center-line of the trench. In no case shall the joint or line of cut be less than one foot outside the edge of the trench. Surface obstructions removed to permit construction shall be reconstructed as specified and to the dimensions, lines and grades of original construction. Backfill of tunneled sections shall be performed in accordance with Section 2507. All restoration shall be in accordance with Section 2508.
 - b. Mailboxes shall be maintained in the manner that the Postal Service requires to prevent interruption of mail delivery.
 - c. Site preparation shall include, where necessary and permitted, the removal of trees, shrubs, brush, crops, and other vegetation within the limits of the easements (rightof-way) or as may be provided for in licenses, permits and agreements. The following procedures for protection of existing greenery are required.
 1. Trees: All reasonable effort shall be made to save as many trees as possible. Trees are defined as two inches in diameter and greater when measured at a

point three feet above the ground surface. If trees can be saved by trimming, this shall be done in accordance with acceptable pruning practices.

All trees within easements or right-of-way provided, which are specifically to be removed or saved, have been marked on the plans with the following notations:

- (a) Trees marked "S" shall be saved.
- (b) Trees marked "X" shall be removed.
- (c) Trees marked "R" shall be removed and replaced.

Trees to be removed shall be completely removed, including stump and large roots, unless such removal may result in damage to existing pipelines. In that event, trees shall be sawn off not more than four (4) inches above the ground and the stump shall be removed to twelve (12) inches below finish grade. Any tree replaced shall be outside the permanent utility easement and shall be a like species of nursery stock. (Generally, 2 to 2 ½ inch caliper).

- 2. Small Plants and Flowers: At least two weeks prior to the start of construction, property owners shall be notified by the contractor of the proposed starting date. The purpose of this notification is so that the property owners can remove any small plants or flowers that they, the property owners, desire to save.
- d. Fences. Fences interfering with construction, and located within public rights-of-way or utility easements or as may be allowed for in permits or agreements, may be removed by the Contractor only if the opening is provided with a temporary gate that will be maintained in a closed position except to permit passage of equipment and vehicles. Fences within temporary construction easements may be removed by the Contractor provided that temporary fencing is installed in such a manner as to serve the purpose of the fencing removed. The contractor shall locate and record all fence corners prior to removal. All fencing removed shall be restored by the Contractor to the pre-construction condition unless otherwise specified in the Special Project Specifications. The Contractor is and shall be solely liable for the straying of any animals protected or corralled or other damage caused by any fence so removed.
- e. Property Pins: The Contractor shall preserve all property corners, pins or markers. In the event any property corners, pins, or markers are removed by the Contractor, such property points shall be replaced at the Contractor's expense and shall be reset by competent surveyors properly licensed to do such work. In the event such points are section corners or Federal land corners, they shall be referenced and filed with the appropriate authority.
- f. Sodded and Landscaped Areas: Sodded and/or landscaped areas on or adjacent to improved property shall be disturbed only to the extent required to permit construction. Such areas shall not be used as storage sites for construction supplies and shall be kept free from stockpiles or excavated materials.

3. Subsurface Obstruction:

- a. Where existing utilities and service lines are to be encountered, the owner thereof shall be notified by the Contractor at least 48 hours (not including weekends and/or holidays) in advance of performing any work in the vicinity. All excavation, pipeline installation and backfilling work in the vicinity of such utilities shall be accomplished in the manner required by the respective owner and, if requested, under their direct supervision. The Contractor shall be responsible for any and all damages to a public or private utility that may occur as the result of the construction.
- b. The Contractor shall make every reasonable effort to ascertain the existence of obstructions and shall locate obstructions prior to machine excavation where definite information is not available as to their exact location. Where such facilities are unexpectedly encountered and damaged, responsible officials and other affected parties shall be notified and arrangements made for the prompt repair and restoration of service. All utilities shall be properly supported in the excavation.
- c. Private Sewer Facilities: The Contractor shall make every reasonable effort to protect private sewer facilities not shown on the Plans. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary repairs to the facilities for continuous service prior to the close of the work day at no cost to the owner thereof.

SECTION 2505 EXCAVATION:

2505.1 Scope: This section governs the methods and procedures required for pipeline excavations for open cut and tunneling.

2505.2 General: The terms “excavation” and “trenching” shall mean the removal and subsequent handling of all material required to perform the work.

1. All pipeline excavation work shall be accomplished under supervision of a person experienced with the materials and procedures, which will provide protection to existing improvements, including utilities and the proposed pipeline. A currently certified competent person shall be present during all excavation operations according to OSHA regulations.
2. Contractor shall have a trench safety plan for the trench conditions to be encountered on the project. The trench safety plan shall be available on the job site at all times and shall be designed by a licensed professional engineer should conditions warrant.
3. The alignment, depth, and pipe subgrades of all sewer trenches shall be determined by overhead grade lines parallel to the sewer invert.
4. When pipe is to be installed in embankment or fill, the embankment shall be built up to a plane at least 18 inches above the top of the pipe prior to the excavation of the sewer trench.

5. The Contractor shall not open more trench in advance of pipe laying than is necessary. Four hundred (400) feet will be the maximum length of open trench allowed on any line under construction, unless otherwise approved, in advance, by the Engineer. All open trenches shall be adequately protected and shall conform with OSHA safety standards.
6. In the event hazardous wastes as defined by the Resource Conservation and Recovery Act of 1976 (PL94-580) are encountered, work shall be halted and the Engineer shall be notified. Work shall be resumed only after the Contractor has notified the proper authorities and permission has been given by the governing authority to resume construction activities. Regulation of removal, handling and disposal of hazardous wastes is the responsibility of Federal and State agencies.

2505.3 Unclassified Excavation: Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation.

2505.4 De-Watering: The Contractor shall remove any water that may accumulate or be found in the trenches and other excavations made under the Contract.

The Contractor shall form all dams, flumes or other works necessary to keep the excavation clear of water while the sewers and their foundations, and other foundation works, are being constructed. All water shall be removed from such excavation in a manner that will not damage property.

2505.5 Blasting: When blasting is permitted by Lawrence-Douglas County Fire and Medical Services, the Contractor shall use the utmost care to protect life and property. The Contractor shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage thereto caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by the General Provisions and Covenants and Special Project Specifications before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

2505.6 No Blasting Areas: No blasting of any kind for rock excavations or any other purpose will be allowed if so noted on the Plans.

2505.7 Open-Cut Method (Trenching):

1. Scope: This item establishes the requirements to be followed for pipeline excavation performed by the open-cut method (trenching).
2. General: Excavations for pipelines shall be accomplished by the open-cut method (trenching) except as specified or approved by the Engineer. Trenching shall be with a minimum inconvenience and disturbance to the general public.

The Contractor shall sort and stockpile the excavated material so the proper material is available for backfill.

3. Trench Depths: All trenches shall be excavated to depths required for proper pipe embedment. Overdepth excavation shall be required when the subgrade is unstable. Overdepth excavations shall be backfilled with granular pipe embedment material unless otherwise directed by the Engineer.
4. Trench Walls: Undercutting of trench walls is not permitted.
5. Trench Widths:
 - a. Minimum Widths: Trench widths and pipe clearances shall be not less than that shown in the following table.

**MINIMUM TRENCH WIDTHS AND PIPE CLEARANCES
(INCHES)**

Nominal Pipe Diameter	Trench Width ¹	Pipe Side Clearance ²	Soil/Incompressible
			Pipe Bottom Clearance
4	22	6	6
6	22	6	6
8	22	6	6
10	24	6	6
12	27	6	6
15	30	6	6
18	34	6	6
21	39	7	6
24	43	7	6
27	48	8	6
30	54	8	6

¹ Measured below a horizontal plane six (6) inches above the top of the pipe line.

² Measured from the outside face of pipe barrel to inside face of trench.

- b. Maximum Widths: The maximum allowable trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and six (6) inches above the top of the pipe.

Maximum side clearance shall be twelve (12) inches, measured horizontally from outside face of pipe to trench wall. When the side clearance exceeds twelve inches, for 8” to 18” diameter pipe, it shall be the Contractor’s responsibility, at no additional cost to the project, to provide bedding adequate to develop the required lateral support for the pipe and/or provide a pipe of sufficient strength class to accommodate the loading conditions as approved by the Engineer.

The maximum allowable widths may be exceeded at manholes, bore pits, service connections, and in unstable earth material. Where the maximum trench width is exceeded the Contractor shall provide the appropriate strength class of pipe embedment to provide safe support strength to the pipeline.

- c. Trench Slope: The trench width above a horizontal plane six (6) inches above the top of the pipe may vary and side sloping is permissible unless otherwise specified.
 - d. Trench Shields: When trench shields are utilized by the Contractor, said shields or any part thereof shall not extend lower than six (6) inches above the top of the proposed pipeline nor shall the maximum allowable trench width be exceeded.
6. Maximum Trench Widths for Ductile Iron Pipe: When ductile iron pipe is utilized, the strength class and the maximum allowable trench width as established by the Design Engineer will be shown on the Plans.
 7. Option to Trenching: Contractor may perform excavation by tunneling methods as set forth herein at no additional cost to the project provided prior written approval for each such location is obtained from the Engineer.

2505.8 Tunneling, Boring and Jacking:

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

Tunneling, boring and jacking shall be done with a minimum inconvenience and disturbance to the general public and abutting property owners.

3. 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.
4. Construction:
 - a. 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 2506 – Installation.

- b. 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.

SECTION 2506 INSTALLATION:

2506.1 Scope: This section governs construction methods and procedures for the installation of gravity and pressure pipelines and appurtenances.

2506.2 General: All pipeline installations shall conform to the following requirements:

1. Governmental Requirements: Sanitary sewer line installation shall comply with applicable State and County Health and Environment Departments requirements.
2. Trench Dewatering: Contractor shall maintain a dry and stable trench, obtain necessary permits, and provide for the proper method of discharging such water from the work site at all times until pipeline installation is completed to the extent that hydrostatic pressure flotation or other adverse effects will not result in damage to the pipeline.

Proper dewatering techniques are the Contractor's responsibility. All work performed by the Contractor which is adversely affected by his failure to adequately dewater trenches will be subject to rejection by the Engineer. The Contractor shall repair and/or replace the affected pipeline without additional compensation.

3. Trench Shoring and Bracing: All shoring, bracing or blocking shall be furnished and installed as necessary to preserve and maintain exposed excavation faces, to protect existing improvements, to protect the proposed pipeline and to provide for safety.

Shoring or other methods for support of trench walls is the responsibility of the Contractor and shall be accomplished by methods that will not adversely affect pipeline alignment, grade and/or structural integrity. All excavation shall be in accordance with OSHA CFR 1926-(P).

All bracing, sheeting and/or shoring installed below a horizontal plane six (6) inches above top of proposed pipe shall not be disturbed or removed after pipe and/or pipe embedment has been installed unless otherwise specified. The bottom skids of a trench shield shall not extend lower than six (6) inches above top of proposed pipe.

4. Pipe Embedments: All pipe embedment shall conform to Section 2506.2.6 unless otherwise specified. Installation shall be in strict conformance with instructions for the appropriate embedment being utilized.
5. Bedding Installation:
 - a. The trench subgrade shall be prepared to provide a uniform and continuous pipe support between pipe bells and joints.

- b. Place and densify embedment material by shovel slicing or vibrating and prepare embedment material so that the pipe will be true to line and grade after installation.
 - c. After each pipe has been brought to grade, aligned, and placed in final position, deposit and densify by shovel slicing sufficient bedding material under the pipe haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations. Place bedding material uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
 - d. Place pipe that is to be bedded in Concrete Encasement or Flowable Mortar in proper position on temporary supports consisting of concrete blocks. When necessary, anchor or weight the pipe to prevent flotation when the concrete is placed.
 - e. Place concrete for encasement uniformly on each side of the pipe and deposit at approximately its final position. Do not move concrete more than five (5) feet from its point of placement.
 - f. If unstable subgrade conditions are encountered and it is determined by the Engineer that the bedding specified will not provide suitable support for the pipe, additional excavation to the limits determined by the Engineer will be required. This additional excavation shall be backfilled with material approved by the Engineer.
6. Pipe Embedment Designations and Descriptions:

a. Granular Embedment:

The pipe shall be bedded in granular material, with a minimum thickness below the pipe as specified in Section 2505.7.5.a. The granular material shall be placed to a point six (6) inches above the top of the pipe bell or coupling. Backfill to a level not less than thirty (30) inches above the top of pipe shall be carefully placed select earth backfill compacted to ninety percent (90%) of maximum density at an optimum moisture + or – 2% as defined in AASHTO T99 or ASTM D 698. The select material shall be free from debris, organic matter, frozen material and rocks larger than one (1) inch. Embedment materials shall conform to 2503.3.

b. Concrete Encasement

All Concrete Encasements require a 4000 psi, 28-day strength concrete except as otherwise specified. After initial set of concrete, one (1) foot of backfill material should be placed over the conduit or concrete. The backfill above this point shall not be placed nor sheeting removed until at least forty-eight (48) hours after placement of the concrete. Time requirements may be adjusted by the Engineer to obtain structural integrity.

7. 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.

- a. 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.
 - b. Services shall be schedule 40 PVC with solvent welded joints. 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. 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 his own expense.
8. 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.

9. 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.

10. Location Wire: Location wire shall be buried above all pressure sewers in accordance with the following:
- a. 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.

- b. 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.
- c. The location wire shall be accessible at test stations at least every 1,500 feet.
- d. Test stations shall be Copperhead Industries LLC SnakePit Magnetized Tracer Box.
- e. 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.
- f. 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.

11. 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.

12. Pipe Laying: All pipe shall be installed in accordance with the pipe manufacturer’s recommendations, except as modified herein.
- a. 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.
 - b. 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.

- c. 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.
 - d. 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.
 - e. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.
 - f. Pipe laying normally shall begin at the lowest point.
 - g. 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.
 - h. Pipe connecting to a drop structure shall be supported with Flowable Mortar, outside the structure excavation, as shown on standard details. All other pipe connecting to a structure shall be supported with SCA-3 or CM-H.
 - i. 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.
 - j. When a sanitary sewer line crosses an existing pipeline and the clearance is less than two (2) feet, special embedment may be required.
13. Connection of Pipes of Dissimilar Materials: The connection of pipes of different materials shall be made using approved transition coupling and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.
14. Connection of Pipes to Manholes: Connection to existing manholes shall be core drilled and booted.

2506.3 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.

2506.4 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.

1. Casing Types:

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).

1. 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.

2. **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.

3. **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.

4. **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 2503.2 of these specifications.

5. **Casing Spacers:** Casing spacer type shall conform to section 2503.6.4.d. Casing spacer interval, size and installation method shall be as recommended by the manufacturer for the particular installation.

6. **End Seals:** End seals shall conform to Section 2503.6.4.e. End seal installation shall be as recommended by the manufacturer and shall be constructed after sewer pipe has been installed and approved.

7. The annular space between lining and sewer pipe shall not be filled.
8. 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.
9. 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 2503.2 of these specifications.

SECTION 2507 BACKFILL:

2507.1 Scope: This section governs the furnishing of all labor, equipment, tools and materials to properly backfill trenches and structures.

2507.2 General:

1. All trash and debris shall be removed from the pipeline excavation prior to backfilling.
2. Unless otherwise specified, all sewer trenches and excavation around structures shall be backfilled to the original surface of the ground with suitable earth or earth and rock. When an earth and rock mixture is used, it shall be placed and thoroughly consolidated with sufficient earth to completely fill all voids between the rocks.
3. The backfill material shall be placed in loose lifts not to exceed 8 inches in depth. Each lift shall be compacted to the required density prior to the next lift being placed.
4. Commercial sand backfill shall not be used.
5. In areas designated on the plans, the original topsoil shall be replaced to original elevation and depth. (Minimum depth shall be six (6) inches).
6. Backfill material shall be carefully placed to avoid damage to or displacement of the pipe and other exposed utilities or structures.
7. Backfill shall not be placed when material contains frost, is frozen, or a blanket of snow prevents proper compaction. Contractor shall remove waste material, trees, organic material, rubbish, or other deleterious substances.
8. No rock shall be allowed within thirty six (36) inches of the pipe embedment and no rock greater than six (3) inches in its largest axis shall be placed in any trench excavation as backfill.

2507.3 Backfilling in Street or Alley Right-of-way and Under Pavement. This work shall consist of placing flowable mortar fill material in all sanitary sewer trenches crossing existing or proposed public streets, alleyways or sidewalks to a point two (2) feet beyond the edge of the public pavement, and for all portions of trenches running parallel to and within two (2) feet of the edge of the public pavement.

1. Flowable mortar shall meet the requirements of the City of Lawrence Technical Specifications, Section 1100: Grading.
2. Flowable mortar shall be discharged from the mixer by a reasonable means into the trench area to be filled.

2507.4 Backfilling In Areas Other Than Street or Alley Right-of-way:

1. From the top of the pipe embedment (as defined in Section 2506.2.6) to a point at grade, the backfill material shall be compacted to no less than 90% of maximum density at optimum moisture plus or minus 2% as determined by ASTM 698.

2507.5 Backfill Around Structures:

1. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum strength of 2000 psi and can sufficiently support the loads imposed by the backfill without damage.
2. The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement of the structure. Any damage caused by premature or unbalanced backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.
3. No rock larger than six (6) inches maximum dimension shall be placed within one (1) foot of the exterior surface of any structure.

SECTION 2508 RESTORATION:

2508.1 Scope: This section covers all work required in surface restoration on private and public properties that are disturbed by construction.

2508.2 General: The Contractor shall restore the project site to conditions at least equal to those existing prior to entry unless otherwise specified.

1. Maintain adequate safety signs, barricades and lights until final restoration of work area is completed.
2. Public property shall be restored to the requirements of the public body having jurisdiction.
3. Private property shall be restored to conditions at least equal to those existing prior to the work or as indicated on the plans.

2508.3 Clean-Up: The Contractor, upon completion of installation and backfill operations, shall prepare the area for final grading including but not limited to the following items:

1. Clean-up shall follow the backfilling operations as closely as possible.
2. Excess material shall be removed from the site including material that has washed into the stream beds, storm water facilities, streets, etc., on or off site.
3. Tools, equipment and construction material shall be removed except for in designated storage areas along the pipeline route.
4. Restore surface and sub-surface drainage and provide erosion control measures where they are required and/or necessary.

2508.4 Finished Grading: The Contractor shall finish grade the area to lines and grades shown on the Plans or, if not shown, to those that existed prior to the area being disturbed. Special attention shall be directed to assure surface drainage. The area shall be smoothed by raking or dragging.

2508.5 Seeding and Sodding: Shall comply with the City of Lawrence Technical Specifications, Section 7200: Seeding.

2508.6 Pavement Replacement: This section covers the replacement of asphalt pavement, gravel surfacing, sidewalks, driveways, curbs, and other pavement construction removed or damaged during the progress of the work

1. All pavement replacement work shall comply with applicable sections of the City of Lawrence Technical Specifications, current edition.
2. All pavement replacement work shall be subject to acceptance by the Engineer, and agency having jurisdiction thereof. All materials utilized for pavement replacement work shall be new unless otherwise specified on the Plans, Special Project Specifications, or as approved by the Engineer.

2508.7 Trees, Shrubs and Bushes: Any tree, shrub or bush replaced shall be planted outside the permanent utility easement and shall be of the same species as the removed tree, shrub or bush. Any tree, shrub or bush species that is prohibited by local restrictions shall be substituted with a related species. Replacement planting shall conform to the guidelines ANSI-Z60.1-1980 "American Standard for Nursery Stock" specified by the American Association of Nurserymen. The Contractor shall notify private property owners at least two weeks prior to the start of construction so private property owners can remove small plants and flowers.

SECTION 2509 TESTING:

2509.1 Scope: This section governs the furnishing of all labor, equipment, tools and materials, and the performance of any or all acceptance tests.

2509.2 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.

2509.3 Alignment and Grade: Alignment, grade and visible defects shall be checked as follows:

1. 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 Utility Department.
 - a. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.

2509.4 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 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.

2509.5 Deflection Test:

1. 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.

2509.6 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.

SECTION 2510 MANHOLES AND SPECIAL STRUCTURES:

2510.1 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.

2510.2 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.

2510.3 Manhole Materials:

1. 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.
2. 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).

3. 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.

4. 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.
5. Precast Concrete: Precast concrete manholes shall conform to ASTM C 478 with the following modifications.
 - a. 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.
 - b. Cement, Fine Aggregate, Coarse Aggregate and Water used in the manufacture of precast manholes shall be as specified in Section 2510.3.6.
 - c. 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.
 - d. 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.
 - e. 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.
 - f. The minimum distance from the bottom of the downstream pipe to the top surface of the base shall be three (3) inches.
 - g. Manhole steps shall not be provided.
 - h. 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.
 - i. Manhole Joint Sealants:
 1. 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.

2. 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.
 - j. 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.
6. Manhole and Special Concrete: Manhole and special concrete shall conform to Section 2000 of the City of Lawrence Technical Specifications or as provided herein.
 - a. 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.
 - b. 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.
 7. Reinforcement steel: Reinforcement steel shall conform with the following minimum requirements.
 - a. 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.
- b. 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.
8. 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.
 - a. Rings and Covers: Rings and covers shall meet the following minimum requirements.
 1. Bearing surfaces between the ring and cover shall be machine finished or ground to assure interchangeability and a nonrocking fit in any position.
 2. Provision shall be made for opening, such as concealed pick hole(s).
 3. Manhole Rings and Lids shall be Clay & Bailey model 2032, Neenah model R1736-A, 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.
 4. Bolt-down type manhole rings shall be anchored to the manhole walls with not less than four (4) three-fourths (3/4) inch diameter steel bolts embedded a minimum of four (4) inches, except where the entire ring is embedded in a concrete top slab.
 5. 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.
 6. Rings and bolt down covers shall be Deeter Foundry model 1048-B or approved equal.

2510.4 Manhole Excavation:

1. Excavation: Excavation for manholes and special structures shall be governed by this Section and Section 2505. It shall be achieved in a suitable and orderly manner providing a minimum disturbance to the general public.

2. Depth of Excavation: 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.
3. Side Clearances: 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.

2510.5 Manhole Installation: Manhole installation shall be governed by this Section and Section 2506. It shall be performed by the Contractor on a schedule that will provide an orderly progression of the work.

1. Bases:

- a. Precast developed bases shall be reinforced in accordance with ASTM C 478.
 - b. 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.
 - c. 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.
2. Inside Dimensions: The minimum inside diameter of standard manholes shall be four feet. Drop manholes shall have a minimum five foot diameter.
3. Precast:
- a. 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:
 1. 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
 2. 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.

- b. Inspection: Precast concrete components shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C478.
 - c. Wall Thickness: Wall thickness shall conform to the requirements of Section 2510.3.5.a.
 - d. Construction: 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. Each joint, including adjustment rings and castings, shall be sealed with approved heat or cold-applied sealant conforming to Section 2510.3.5.i or 2510.3.5.j of these specifications.
4. 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 Department of Utilities.
5. 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.
- a. 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.
 - b. 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.
6. 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 2510.3.5.i of these specifications. Adjustment rings shall be sealed with an approved heat-applied sealant conforming to Section 2510.3.5.j if manhole location is governed by Section 2510.5.9, of these specifications.
7. 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. Boltdown castings shall be held in place as shown on the Plans and shall comply with Section 2510.3.8.a of these specifications.

8. Manholes in the 100 year floodplain shall be installed with bolt down gasketed lids conforming to the provisions of Section 2510.3.8.a of these specifications.
9. Manholes in the 100 year floodplain shall have all joints sealed with a heat-applied sealant conforming to Section 2510.3.5.j of these specifications.

2510.6 Manhole Backfilling: Manhole backfilling shall be governed by Section 2507.

2510.7 Restoration: Restoration shall be governed by Section 2508.

2510.8 Manhole Testing: 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".

2510.9 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.

SECTION 2511 SEPARATION REQUIREMENTS:

2511.1 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:
 1. 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.
 2. 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 D3215.
 3. 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 either side of the pipeline crossing.
- c. 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 pipeline crossing.

2511.2 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.

SECTION 2512 ABANDONMENTS:

2512.1 Scope: This section governs construction methods and procedures for the abandonment of gravity and pressure pipelines, service lines, and appurtenances.

2512.2 General: All sanitary sewer abandonments shall conform to the following requirements:

1. Gravity and Pressure Pipeline: Gravity and pressure pipeline shall be plugged and filled with flowable fill or cement mortar.
2. 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.
3. Manhole Connections: Manhole connections shall be cut, plugged and grouted within two (2) feet of the manhole.
4. 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.

SECTION 2513 MEASUREMENT AND PAYMENT:

2513.1 Scope: This section covers the methods of measurement and the basis of payment for the furnishing of all labor, equipment, tools and materials and for the performance of all related work necessary to complete any construction covered in Section 2500.

2513.2 General: The methods of measurement and payment shall be in accordance with City of Lawrence Technical Specifications Section 0010: General Technical Provisions, as specified herein, and as listed in the Proposal.

2513.3 Items not listed in the Proposal: There will be no measurement or separate payment for any items of work not specifically identified and listed in the Proposal and all costs pertaining thereto will be included in the Lump Sum Proposal or Contract Unit Prices for other items listed in the Proposal.

2513.4 Basis of Payment: Payment will be made of the respective unit at the unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

2513.5 Standard Bid Items: The following is a list of standard bid items and quantity units for sanitary sewer projects. Project-specific or special items shall be added to the list where appropriate. Lack of inclusion of a specific item from the Standard Bid Items List will not be justification for non-performance. All work must meet City Standards.

<u>Bid Item</u>	<u>Quantity Unit</u>
Mobilization	LS
__-inch SSP (SDR-__)*	LF
__-inch SSP Service Line	LF
__-inch SSP Service Connection	EA
Standard Manhole (4' Dia., 6' depth)	EA
Standard Drop Manhole (5' Dia., 6' depth)	EA
Extra Depth Manhole (__' Dia.)	VF
Connect to Existing Manhole	EA
Standard Doghouse Manhole	EA
Adjustment of Existing Manhole	EA
Flowable Mortar	CY
Seed, Fertilize, and Mulch	LS
Erosion Control	LS
Construction Staking	LS
Traffic Control	LS
Testing	LS
Demobilization	LS

*For PVC Pipe