ARTICLE II
WATER AND SEWER SPECIFICATIONS

FEB 26 2015

Section 25-20. Excavation and Trenching.

A. SCOPE: This section covers excavation and trenching work and shall include the necessary clearing, grubbing, and preparation of the site: removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

B. GENERAL REQUIREMENTS: Excavation work shall be performed in a safe and proper manner with appropriate precautions taken against all hazards. Excavations shall provide adequate work space and clearances for the work to be performed therein and for the installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of any loose material when concrete is placed thereon.

Excavations for manholes and similar structures constructed of masonry units shall have horizontal dimensions with at least a 6-inch clearance provided for outside plastering.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the City or City's Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill or embankment.

C. BLASTING: The Contractor shall comply with all laws, ordinances, applicable safety codes, requirements, and regulations relative to the handling, storage, and use of explosives and the protection of life and property. The Contractor shall be responsible for all damage caused by any blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.

The Contractor shall avoid excessive overbreak or damage to adjacent structures, equipment, utilities or buried pipeline. Blasting near utilities shall be subject to approval of the utility owner or City.

Before delivery of any explosives at the job site, the Contractor shall have blasting endorsement on his public liability and property damage insurance policy.

All rock which cannot be handled and compacted, as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials

except as specified or directed.

D. UNAUTHORIZED EXCAVATION: Except where otherwise authorized, shown, or specified, all material excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the Contractor, with concrete placed at the same time and monolithic with the concrete above.

E. DEWATERING: The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed, therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches, which extend down to or below groundwater, shall be dewatered by lowering and keeping the ground water level beneath such excavations, 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which is used for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

F. SHEETING AND SHORING: Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, and shored, as necessary to prevent caving or sliding, for protection of workmen, work, existing structures and facilities. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances.

Trench sheeting shall not be pulled before backfilling unless pipe strength is sufficient, in the opinion of the City or City's Engineer, to carry trench loads based on trench width to the back of sheeting; nor shall sheeting be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner, which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

G. STABILIZATION: Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms, which are otherwise solid but which

become mucky on top due to construction operations, shall be reinforced with one or more layers of crushed rock or gravel. No more than 1/2 inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding materials are placed thereon. The finished elevation of stabilized subgrades for concrete structures shall not be above subgrade elevations shown on the drawings.

All stabilization work shall be performed by and at the expense of the Contractor.

H. TRENCH EXCAVATION: The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench on any line under construction.

Except where tunneling is shown on the drawings, is specified, or is permitted by the Engineer, all trench excavation shall be open cut from the surface.

1. Alignment, Grade, and Minimum Cover: The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of Section 25-21 Installation of Mains.

   Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of 42-inch backfill cover over the top of the pipe. Greater pipe cover depths may be necessary on vertical curves or to provide necessary clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation.

2. Limiting Trench Widths: Trenches shall be excavated to a width, which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. Unless otherwise shown on the drawings, the maximum trench widths, below an elevation of 6 inches above the top of the installed pipe, shall be no more than 24 inches greater than the outside diameter of the pipe. The minimum permissible clearances between the installed pipe and either trench wall shall be 6 inches.

   Stipulated minimum clearances are not minimum average clearances, but are minimum clear distances that will be required.

   Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes, not to extend lower than one foot above the top of the pipe.

3. Unauthorized Trench Widths: Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted, either pipe of

adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.

4. Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand-excavating methods shall be used. Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalks are obtained at least from an elevation one foot (1') above the top of the installed pipe to the bottom of the trench, and that trench alignment is such that pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sidewalks of the trench. Undercutting the trench sidewalk to obtain clearance will not be permitted.

5. Cutting Concrete and Asphalt Surface Construction: No cutting of concrete/asphalt surfaces shall be allowed unless City approval is obtained in writing. Cuts in concrete or asphalt pavement and base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clear groove at least 1 1/2 inch deep along each side of the trench and along the perimeter of cuts for structures.

   Concrete and asphalt pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than the top width; no undercutting will be permitted.

   Pavement cuts shall be made to and between straight or accurately marked curved lines, which unless required, shall be parallel to the centerline of the trench. Pavement removed for connection to existing lines or structures shall not be of greater extent than necessary for the installation as determined by the City or City's Engineer.

   Where the trench parallels the length of concrete walks and trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and replaced between existing joints or between saw cuts.

6. Excavation Below Pipe Subgrades: Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, to provide for the installation of either 3/4 inch crushed limestone embedment pipe foundation material or sand if in accordance with the material manufactures design specifications. (#1578 4/09)

7. Artificial Foundations in Trenches: Whenever so ordered by the City or City's Engineer, the Contractor shall excavate to such depth below grade as directed and the trench bottom shall be brought to grade with such material as the City or City's Engineer may order installed.

8. Bell Holes: Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

Section 25-21. Installation of Mains.

A. STANDARDS: Specifications shall incorporate the provisions of the AWWA standards and/or manufacturer's recommendations and Missouri Department of Natural Resources "Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013.

B. BEDDING: A continuous and uniform bedding shall be provided in the trench for all buried pipe; Backfill material shall be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported, stabilized and protected. Rocks and hard objects larger than one inch diameter found in the trench shall be removed for a depth of at least six inches below the bottom of the pipe.

C. MATERIAL: Material for bedding shall be 3/4 inch clean crushed limestone or sand in accordance with the material manufactures design specifications. (#1578 4/09)

REFERS TO WATER

D. TRENCH BACKFILL: All trench backfill above pipe bedding shall conform to the following requirements.

1. Compacted Crushed Stone Backfill: Compacted backfill above the bedding shall consist of 3/4 inches clean crushed limestone and will be required for the full depth in the following locations:

   a. Beneath pavements, surfacing, driveways, curbs, gutters, walks, or other surface construction or structures.

   b. In the street, road, or on highway shoulders or any paved roadways.

2. Other Backfill: A continuous and uniform material shall be provided in the trench for all buried pipe above the bedding and shall be free of brush, roots more than 2 inches in diameter, debris, and refuse, but may contain rubble and detritus from rock excavations and stones smaller than 2": Compaction of trench backfill above pipe bedding in locations other than those specified will not be required except to the extent necessary to prevent future settlement.

Uncompacted backfill material above bedding may be placed by any method, acceptable to the City or City's Engineer, which will not impose excessive

principle backflow preventer. Where chemical additive or antifreeze is added to only a portion of an automatic fire sprinkler or standpipe system, the reduced pressure principle backflow preventer shall be permitted to be located so as to isolate that portion of the system.

3. Subject to Back Pressure: Where a potable water connection is made to a non-potable line, fixture, tank, vat, pump or other equipment subject to backflow pressure, the potable water connection shall be protected by a reduced pressure principle backflow preventer.

REFER TO WATER

4. Lawn Irrigation Systems: The potable water supply to lawn irrigation systems shall be protected against backflow by a double check valve back flow preventer or a reduced pressure principle backflow preventer. Where chemicals are introduced into the system, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer.

Section 25-30. Sewer Pipe.

A. PVC SEWER PIPE:

1. Scope: This section covers Polyvinyl Chloride Piping (PVC). PVC pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances. All sewer line construction shall be in accordance with 10CSR 20-8.120, effective January 30, 2012.

2. Materials: In depth less than 10 feet SDR-35 gasket-bell type pipe shall be used. All sewer pipe with a depth of 10 feet or greater shall be SDR-21 gasket-bell type pipe. PVC pipe and fittings 4 inches through 15 inches shall meet or exceed the requirements of the latest revision of ASTM D-3034 and shall be cell classification of 12454-B, 12454-C or 13364-B as defined in ASTM D-1784. Pipe and fittings 18 inches through 27 inches shall meet ASTM F-679 and shall be cell classification of 12364-C or 12454-C. (#1578 4/09)

   Minimum pipe stiffness (F/Y) at 5ø deflection shall be 46 for all sizes when tested in accordance with ASTM D2412.

   All joints of pipe and fittings shall have elastomeric gaskets and shall show no signs of leakage when tested in accordance with D 3212. Solvent weld joints will not be permitted below grade.

SIZES	O.D. DIMENSIONS	WALL THICKNESS
4"	4.215	.125 inches
6"	6.275	.180 niches
8"	8.400	.240 inches

10"	10.500	.300 inches
12"	12.500	.360 inches
15"	15.300	.414 inches
18" (T-1)	18.700	.536 inches
21" (T-1)	22.047	.632 inches
24" (T-1)	24.803	.711 inches

3. Location of Services: All SCH40 and SDR-21 PVC wyes or tee fittings will be located in the center of each lot for ease of location on future hookups.

4. Lateral Lines: All service lateral lines shall be schedule 40 meeting the requirements of ASTM D2665 or D2441.

5. Connection to existing: Any adaptation from SDR-35 to SDR-21 shall be completed with a solvent weld coupling.

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

7. Cutting Pipe: 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 with a file to remove all roughness and sharp corners.

8. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all contact surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

   Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

9. Inspection: Pipe fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

10. Alignment: Pipelines or runs intended to be straight shall be laid straight.

11. Laying Pipe: Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

12. Push-On-Joints: All instructions and recommendations of the pipe manufacturer relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

13. Relation to Water Mains:

    a. Horizontal Separation: Sewer mains shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured from edge to edge. In cases where it is not practical to maintain a 10-foot separation, the City Superintendent may allow deviation on a case-by-case basis if supported by data from the design engineer. Such deviations may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.

    b. Crossings: Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches (46 cm) between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

    c. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling.

14. Street Crossing: No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with 3/4 inch crushed limestone to the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed.

15. Marking: Each pipe and fitting shall have plainly and permanently marked thereon:

    a. Manufacturer's name or trademark.
    b. Nominal pipe size.
    c. ASTM Designation D3034 and Class Number
    d. SDR number.
    e. Material designation.

16. Acceptance Tests: Each reach of sewer shall meet the requirements of *SECTION 25-32. Sewerline Acceptance Testing*

B. BUILDING SEWER:

1. General: It shall be the responsibility of the property owner to construct and maintain the sewer lines from the building to the sewer main. The property owner assumes all ownership of the line from the building to the main tap or "Y" on the City main.

2. Materials: All sewer service connection lines shall be a minimum of 4 inches diameter, Sch 40 PVC.

3. Laying of Pipe: All sewer lines shall have a minimum of 3 feet of cover over the top of the pipe with a fall of 1/4 inch per foot. At no time shall 90-degree turns be acceptable. It shall be acceptable to use 45-degree bends providing there is a minimum of 1 foot of pipe between each bend.

4. Service Hookup: The City shall be notified to provide assistance in locating building sewer extensions at the sewer main. No unauthorized connection to the sewer main at locations other than building sewer extensions shall be allowed. No split services will be allowed; all buildings will have a separate sewer service.

C. PVC FORCE MAIN:

1. Scope: This section covers bell and spigot rubber gasket PVC pressure pipe. Pipe shall be completely furnished with all fittings, jointing material, anchors, blocking, encasement, and other necessary appurtenances. All force main construction shall be in accordance with 10CSR 20-8.130, effective January 30, 2012.

2. Materials: All materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM D 1784, Type 1, Grade 1, Class 200. All pipe and fittings shall have integral bells and conform to the following.

Pipe Dimensions.	ASTM D2241, SDR 21
Fittings:	Rated to exceed pipe with MJ type fittings
Rubber Joint Rings:	ASTM D1869

3. Handling: Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Extra care shall be used in handling during cold weather.

Pipe and fittings, which have been scratched during handling or installation, shall be

replaced by and at the expense of the Contractor. Pipe repairs will not be permitted.

4. Storage: All pipe shall be stored on a flat surface so as to support the barrel evenly with the bell ends overhanging and not stacked in piles higher than 5 feet. Bells shall be inverted in alternate rows.

   Pipes stored for an extended period (several months) shall be covered with an opaque material to protect the pipe from the sun's rays.

   Rubber gaskets shall be stored away from grease, oil, ozone-producing electric motors, and excessive heat and in a cool dark place.

5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed. All joint contact surfaces shall be kept clean until the jointing is completed.

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

6. Cutting Pipe: Cutting shall be done with a fine-toothed saw and miter box or tubing cutter approved for PVC pipe. Remove all burrs from inside the cut end with a file or knife. The cut end shall be beveled with a milled curve-tooth flat file or beveling tool designed for PVC pipe.

7. Joints: All instructions and recommendations of the pipe manufacturer relative to gasket installation and other jointing operations shall be followed by the Contractor.

8. Alignment: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall be as shown on the drawings.

   Either shorter pipe or fittings shall be installed if the alignment or grade requires them. Pipe shall not be bent.

9. Laying Pipe: Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

   Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is authorized by the City or City's Engineer.

   A copper tracer wire (insulated #12 wire) shall be laid in the bedding within 1' above the top of the pipe. Tracer connections shall be placed in areas not to exceed 500'. Tracer connections shall be supplied at all air relief valves.

10. Street Crossing: No cutting of concrete/asphalt surfaces shall be allowed unless prior

City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with 3/4 inch crushed limestone to the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed.

Where pressure lines cross State maintained roadways, the PVC pipe shall conform to ASTM D-2241-76, or latest revision thereof, within the State right-of-way.

11. Pressure Test: Pressure testing is required and is covered under *SECTION 25-32. Sewerline Acceptance Testing.*

12. Marking: Each pipe and fitting shall have plainly and permanently marked thereon:

    a. Manufacturer's name or trademark.
    b. Nominal pipe size.
    c. ASTM Designation D2241.
    d. SDR Number.

D. VITRIFIED CLAY SEWER PIPE:

Vitrified Clay Sewer Pipe is not allowed.

E. DUCTILE IRON PIPING:

1. Scope: This section covers ductile iron piping. Ductile iron pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances.

   Piping, furnished complete with all joint gaskets, bolts, and nuts, is required for installation.

2. Materials: Unless otherwise required by the drawings or specified herein, joints in ductile iron piping shall be mechanical or push-on type.

Ductile	ANSI A21.51; AWWA C151, ASMT A536, Grade 60-42-10; thickness Class 50.
Fittings	ANSI A21.10, AWWA C110, except shorter laying lengths will be acceptable.
12" and Under Over 12"	250 psi pressure rating. 150 psi pressure rating.
Mechanical Joints	ANSI A21.11, AWWA C111
Locked Joints	American "Loc-Fastite", U.S. Pipe "Lok-Tyton", or Clow

"Super-Lock".

Push-On Joints	ANSI A21.11, except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.
Flexible Couplings	Elastomeric polyvinyl chloride or resin impregnated fabric provided with stainless steel tightening bands. Assemblies shall be capable of connecting pipe of different size and material with a flexible leak-proof joint.

Shop Coating and Lining

• Cement Lining	ANSI A21.4
• Bituminous Coating	Manufacturer's Standard.
• Field Coating	Heavy coal tar epoxy, MIL-C-18480; Koppers "50 Bitumastic", Tnemec "476 Super"

3. Handling: Pipe fittings and accessories shall be handled in a manner that will insure installation in sound, undamaged condition.

   Equipment, tools, and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipes shall have broad, well-padded contact surfaces.

   Pipe fittings, in which the cement lining has been broken or loosened, shall be replaced by and at the expense of the Contractor.

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

   Ends of ductile iron pipe shall be cut with a saw, abrasive wheel, or oxyacetylene torch. Field cutting of holes for saddles shall be done by mechanical cutters; oxyacetylene cutting will not be permitted.

5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

   Every precaution shall be taken to prevent foreign matter from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

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

6. Inspection: Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

7. Laying Pipe: The pipe shall be protected from lateral displacement by placing the specified embedment material. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

   Pipe shall be laid with the bell ends facing the direction of the laying except when reverse laying is specifically authorized by the City or City's Engineer

8. Mechanical Joints: Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Over tightening of bolts to compensate for poor installation practice will not be permitted.

9. Push-on Joints: All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

   Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot shall be suitably beveled to facilitate assembly.

10. Couplings: Dresser couplings shall be carefully installed in accordance with the manufacturer's recommendations.

    Flexible couplings shall be installed at joints between ductile iron pipe and pipe of unlike material. Flexible couplings shall be concrete encased.

11. Shop Coating and Lining: The interior surfaces of all pipe for gravity sewers, drain lines and dewatering lines shall be provided with the standard cement lining. The exterior surfaces of all pipe and fittings shall be shop coated with a bituminous coating.

12. Concrete Encasement: Concrete encasement shall be installed where and as shown on the drawings. Concrete and reinforcing steel shall be in accordance with the cast-in-place concrete section. All pipe to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.

13. Leakage: All joints shall be watertight and free from leaks. Each leak, which is

discovered within one year after final acceptance of work by the City, shall be repaired by and at the expense of the Contractor.

14. Marking: Each pipe or fitting shall be plainly and permanently marked thereon:
    a. Pipe Class
    b. Manufacturer's Name or Trademark.
    c. Nominal Pipe Size.
    d. Weight.
    e. Date of Manufacture.
    f. Sampling Period.

Section 25-31. Manholes.

A. GENERAL: This section covers standard, drop, and wet well manholes. Manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details shown on the drawings.

At the option of the Contractor, manholes shall be constructed of precast concrete sections or cast-in-place concrete.

Only manholes, which are required to have inside pipe and fittings for dropping sewage into the lower line, will be designated as drop manholes. All drop manholes shall have a minimum inside diameter of 5 feet.

B. MATERIALS:

1. Portland Cement:	ASTM C150, Type II.
2. Concrete:	ASTM C94 with compressive strength of 3000 psi at 28 days. Curing and protection shall be in accordance with "Cast-In-Place Concrete ".
3. Brick:	ASTM C32, Grade MS or ASTM C62, Grade SW.
4. Granular Backfill:	See bedding requirements, *Section 25-20 Excavation and Trenching and Section 25-31 Manholes.*

5. Precast Sections:

a. Standard and Drop Manhole:	Circular precast concrete; ASTMC478 Manhole except as modified.
b. Wetwell Manhole:	Reinforced concrete pipe; ASTM C76, Class II, Wall B.
c. Minimum Thickness:	As indicated on drawings.

d. Openings:	Circular shaped boxout for each connecting pipewith A-Lock locking-type gaskets installed by manhole manufacturer.
e. Hydrated Lime:	ASTM C207, Type S.
f. Sand:	Concrete sand, fine aggregate, sieved through 8-mesh screen.
g. Shrinkage-Correcting:	Master Builders "Embeco" Sida"Kemox",or Sonneborn Aggregate "Ferrolith G-DS".
h. Mortar:	One part Portland cement, 1/2 part hydrated lime, three parts sand.
i. Nonshrinking Mortar:	Premixed or job mixed; job mixed shall be one part shrinkage-correcting aggregate, one part Portland cement, and one part sand.

6. Gaskets:

a. Mastic:	Fed Spec SS-S-210; K.T. Snyder "Ram-Nek."
b. Rubber:	Neoprene or other synthetic, 40 plus or minus five hardness when measured by ASTM D2240, Type A durometer.
c. Rubber Joint Filler:	Natural or synthetic.
d. Hardness:	40 plus or minus five when measured by ASTM D2240, Type A durometer.
e. Tensile Strength:	1200 psi minimum.

7. Manhole Steps:

a. Cast Iron:	ASTM A48, with asphalt varnish coating applied at the foundry.
b. Composition:	Plastic ASTM 2146 Type II, Grade 16906. Steel reinforcing bar ASTM A615.
c. Manhole Frame:	ASTM A48, with coating applied at the foundry. Frame and cover shall be equal to a Neenah R-1642, Deeter 1247, or EJ 1045

Frame with 1040 AGS Cover imprinted with "City of Nixa Sanitary Sewer".

C. DELIVERY: Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained strength of at least 80 percent of the specified minimum.

D. INSPECTION: Precast concrete sections and brick shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

E. CONSTRUCTION: All mortar shall be used within 40 minutes after mixing. Mortar, which has begun to take on initial set, shall be discarded and not mixed with additional cement or new mortar. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large radius of curve as practicable. All inverts shall be troweled to a smooth clean surface.

Circular precast sections shall be provided with a rubber or mastic gasket to seal joints between sections. The space between connecting pipes and the wall of precast sections shall be equipped with A-Lock Locking-type gaskets or equal to be installed at the factory.

F. WATERPROOFING: Manholes shall be waterproofed by application of heavy-duty coal tar coating applied over entire exterior surface to attain a dry film thickness of not less than 15 mils. Surface to receive coating shall be thoroughly dry.

G. FRAMES AND COVERS: Frames shall be set so that the top of the cover is flush with finished pavement or 2 inches higher than finish grade in unpaved areas except where noted otherwise on the drawings.

H. PIPE CONNECTIONS: Pipe connections shall be such that differential settlement between pipe and manholes is permitted and shall be made using water stops, A-Lok gaskets, standard O-ring gaskets, special manhole couplings, or other methods as approved.

I. STUBS: Future connections shall be provided in manholes at the locations shown on the drawings. Stubs shall be not less than 3 feet and shall terminate in a bell plug. Final length shall be determined by City for future anticipated connection.

J. HOLES: Core holes and handling holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the Engineer.

K. PAINTING: If castings arrive on the job without a foundry coating, one coat of coal tar paint shall be applied. Before painting, all castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the paint is dry and hard.

Section 25-32. Sewer Acceptance Testing.

A. SCOPE: This section covers the performance testing of the installed sewer, force main, and manholes.

B. GENERAL: The Contractor shall provide at his expense all necessary pumping equipment, testing water, means of conveying test water to the testing site to include piping connections between the piping and the nearest available source of test water, pressure gauges, and other equipment, materials and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints and other materials that are found to be defective shall be removed immediately and replaced with new and acceptable material by and at the expense of the Contractor.

C. SEWER PERFORMANCE TESTING: Each reach of sewer shall be performance tested. It shall be the responsibility of the contractor to notify the City of Nixa personnel at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the Engineer and the City of Nixa. (#1578 4/09)

1. Lamping: Each straight section of sewer between manholes shall be straight and uniformly graded. Each such section will be lamped by the Contractor in the presence of the City Inspector. (#1578 4/09)

2. Exfiltration: The Contractor shall conduct an exfiltration test on each reach of sewer between manholes. Exfiltration tests shall be conducted by blocking off all manhole openings except those connecting with the reach being tested, filling the line and measuring the water required to maintain a constant level in the manholes. Each manhole shall be subjected to at least one exfiltration test. During the exfiltration test, the water level shall be maintained at the top of the frame and cover on each manhole to locate all leaks.

   The total exfiltration shall not exceed 200 gallons per inch of nominal diameter per mile of pipe per day for each reach tested. For purposes of determining maximum allowable leakage, manholes shall be considered sections of 48 inch pipe. The exfiltration tests shall be maintained on each reach for at least 2 hours and as much longer as necessary, in the opinion of the City Inspector, to locate all leaks. (#1578 4/09)

   The Contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests.
   If the leakage in any reach exceeds the allowable minimum, it shall be re-tested after the leaks are repaired.

In lieu of water testing of manholes, vacuum testing will be allowed. A vacuum of 5 psi for a period of 5 minutes is required or as much longer as necessary, in the opinion of the City Inspector, to locate all leaks. (#1578 4/09)

Air testing will be in accordance with ASTM F1417-92 "Installation Acceptance of Plastic Gravity Sewer Pipe Using Low Pressure Air." A minimum pressure of 4 psi for 4 minutes or longer, as necessary in the opinion of the City Inspector, shall be maintained through each reach of sewer. (#1578 4/09)

3. Vacuum Test for Manhole: A vacuum test for manholes can be used in place of exfiltration. Ten inches of mercury is needed for 2 minutes if the manhole is less than 10 feet deep. Ten inches of mercury for 2.5 minutes is needed if the manhole depth is 10 to 15 feet deep. Ten inches of mercury for 3 minutes is needed if the manhole depth is from 15 to 25 feet deep. A loss of 1 inch of mercury per test is all that is allowed.

4. Infiltration: Infiltration shall also be tested by maintaining a minimum test pressure of 2 feet above the maximum groundwater elevation above the top of the pipe. If at any time prior to the expiration of the guarantee period infiltration exceeds 200 gallons per inch of nominal diameter per mile of sewer per day, the Contractor shall locate the leaks and make repairs as necessary to control in the infiltration.

5. Vertical Deflection: Initial installed vertical deflection for flexible pipe (PVC sewer pipe) shall not exceed 5 percent. The Contractor shall test the initial installed vertical deflection by pulling a mandrel or other device through all reaches of sewer to demonstrate that the 5 percent deflection limitation has not been exceeded. The deflection testing shall not be performed until a minimum of 30 days after backfilling of pipe. The method of test shall be acceptable to the Engineer and done in the presence of the City Inspector. The City Inspector shall submit all deflection test results to the Engineer. (#1578 4/09)

D. FORCE MAIN PERFORMANCE TESTING: The force main shall be subjected to hydrostatic pressure testing and leakage testing as specified herein.

All testing work shall be done in the presence of the City Inspector. The Contractor shall notify the City Inspector at least three days in advance of the times and places at which testing work is to be done. (#1578 4/09)

1. Pressure Testing: 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 for the tests.

The test pressure at any point in the pipeline shall be equal to 100 psi. The test pressure shall be maintained for at least 30 minutes and for whatever longer period is necessary for the City Inspector to inspect the pipeline. (#1578 4/09)

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

2. Leakage Test: After the specified pressure test is completed and all pipeline repairs have been made and retested to the satisfaction of the Engineer, the line being tested shall be subjected to a leakage test. The hydrostatic pressure during leakage testing may be any predetermined pressure selected by the Contractor, provided that it does not exceed and is at least 75 percent of the pressure specified for pressure testing. The selected pressure shall be maintained constant (within a maximum variation of plus or minus 5 percent) during the entire time that line leakage measurements are being made.

   Leakage measurements shall not be started until a constant test pressure is established; compression of air trapped in unvented pipes or fittings will give false leakage readings under changing pressure conditions. After the selected test pressure is stabilized, the line leakage shall be measured by means of a suitable water meter installed in the pressure supply piping on the line side of the force pump. The water meter shall be furnished and installed by the Contractor.

   Line leakage shall be the total amount of water introduced into the line as measured by the meter during the leakage test.

   Each leakage test shall have a duration of 2 hours plus whatever additional period is necessary to accurately determine leakage in the opinion of the Engineer.

   The pipeline will not be accepted if the leakage indicated by the test is in excess of that determined by the following formula:

   where: $Q = 0.015\ DxLxN$

   Q = Allowable leakage in gallons per hour
   D = Nominal diameter of pipe in inches
   L = Length of section tested in thousand feet
   N = Square root of average test pressure in psi

3. Defects: It is the intent of these specifications that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

   The specified leakage test is to be made after the pipeline has been backfilled and the

joints covered. If such test shows a leakage rate in excess of the permissible maximum the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line for a sufficient time to provide adequate soil saturation for locating leaks by this method.

Sections 25-33 thru 25-39 Reserved