

800 WATER SUPPLY & DISTRIBUTION

ITEM 801 FURNISHING AND LAYING PIPE AND FITTINGS

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801.01 Description. The work in this section consists of all work for the furnishing and laying of the various sizes of water mains. This work comprises excavating the trench, furnishing and laying pipe in the trench and jointing it, placement of concrete thrust blocks, back-filling the trench, repairing or replacing head walls, drains, sewer, gas, electric and water connections, and any other structures or facilities disturbed or damaged by the Contractor's operations; disposing of surplus excavation; testing; and any work needed to assist the City's effort in chlorinating the water line; and all other work required for the furnishing and laying of the pipe lines and connections complete and ready for service as shown on the plans and covered in the specifications. Provide and install of all required fittings including bends, reducers, polyethylene encasement, bitumastic paint, petrolatum-based tape coating, wax tape coating, blow-offs, tees, sleeves, chlorination taps, small diameter branch connections; connections at the ends of mains to other lines or fittings, and special castings required for the installation of the valves, all as called for on the drawings.

Contractor Qualifications. The City will only allow Contractors holding either a City of Columbus Water Contractor's License or a Combined Water/Sewer Contractor's License in accordance with Columbus City Code 1103.02 and 1103.06 to perform work on City of Columbus water lines, including water service lines and taps,.

801.02 Design Criteria. Provide pipe designed to meet the following:

1. Reference Standards.

- A. Ductile Iron – AWWA C150, Manual M41
- B. Concrete – AWWA C301, Manual M9

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C. Steel – AWWA C200, C206, Manual M11

2. **Manufacturer's Qualifications:**

- A. No less than five (5) years successful experience manufacturing proposed pipe material, pipe diameter, and pipe joint with an ISO 9007:2000 or other equivalent nationally recognized, certified quality assurance program.
- B. Use only one type of pipe material where the City allows material alternates. When adjoining proposed water main to existing water main of different pipe material and/or coating, provide approved connection with necessary adapters. Ensure that type of pipe selected and resulting methods and means complies with requirements and limitations set forth herein and on Drawings.

3. **External Loads.**

- A. Dead Loads: 8 feet of cover or 2.5 feet of cover whichever produces greatest load in conjunction with live load.
- B. Live Loads: AASHTO HS-20 truck, AREMA E-80 loads for railroad crossings. Use 1.5 Impact Factor.
- C. Soil Unit Weight: minimum 120 pcf.
- D. Design pipes with Marston's earth loads for transition width trench for all heights of cover.
- E. Exclude structural benefits associated with primary liner in design of pipe in tunnel installations.

4. **Internal Pressure.**

- A. 150 psi normal operating pressure
- B. 100 psi surge allowance (water hammer)
- C. 150 psi test pressure.
- D. Minimum pressure: full vacuum

5. **Laying Condition.**

- A. For 16" diameter pipe and under: Flat-Bottom trench with bell holes.
- B. For 20" diameter pipe and greater: 6" bedding
- C. No blocks
- D. Tamped backfill
- E. 1.2 Load factor for Concrete pipe

6. **Thrust Restraint Lengths:**

- A. For pipe diameters 20-inch and greater, obtain calculations performed by the pipe manufacturer to determine adequate thrust restraint lengths in accordance with referenced standards. Do not include passive resistance of soil. In all cases, establish minimum restrained joint lengths based on AWWA M11, latest edition. When anticipating a high water table or submerged conditions, include buoyancy conditions for soil unit weight.

Submit calculations sealed by a registered Professional Engineer for review by Project Manager. Adjustments in deflections or use of other pipe material may result in reduction or increase of thrust lengths. Adjustments in restrained length will result in no additional cost to City.

7. Factory Hydrostatic Test

- A. Ductile Iron Pipe: AWWA C 151, Section 5.2.1; Concrete Pipe: AWWA C 301, Section 4.6.4.3; Steel Pipe: AWWA C 200, Section 5.2; at point of manufacture. The City will either reject pipe revealing leaks or cracks or require repairs.

8. Design Plans:

- A. Pipe diameter shown on Drawings refers to the inside diameter of the pipe after lining. Unless otherwise noted, the Drawings detail ductile iron pipe. If the Drawings show concrete or steel pipe, furnish equivalent fittings or a combination of fittings to match those specified or shown. Submit methods for tying pipe joints, anchorage and special backing to Engineer for approval before installation.
- B. The City may not necessarily call out bevel pipe, outlet connections on straight pipe, closure pipe assemblies and other accessories required for steel or concrete pipe on the drawings. , Furnish as required to satisfactorily install the new water main as shown on Drawings. Include payment for these piping items in the unit price bid for Item 801.
- C. , Prior to start of work, provide the Engineer 4 copies of a laying schedule, including laying dimensions and pipe calculations for 20" and greater diameter pipe.. The Engineer may require a pictorial layout. Provide a complete and accurate laying schedule conforming to Drawings. For Concrete Pipe, stock additional bevel adapters and short lengths of pipe at the job site to permit field adjustment of the alignment. The unit price bid of Item 801 includes payment for these items..

9. Pipe Identification:

- A. Stamp, mark, or identify all water main materials with following: name of manufacturer, date of manufacture, operating design pressure, and manufacturer's part number. Provide markings on the outside of the pipe.

10. Corrosion Protection:

- A. For all exposed portions of nuts and bolts, such as flanged or mechanical joints, coat with bitumastic paint, petrolatum-based tape coating system, or wax-tape coating system as approved in the current Division of Power and Water Approved Material List.
- B. For 20" diameter and greater pipe, bond gasketed and flanged joints with bonding clips or wires to provide electrical continuity along entire pipeline. Provide bonding clips for Concrete Pipe. Provide bonding wires for Ductile Iron Pipe. Provide either bonding clips or wires for steel pipe.
 1. Electrical Bond Wires: Use electrical a minimum No. 2 AWG, seven strand, copper cable with THWN insulation for bond wires . Remove

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one inch of THWN insulation from each end of the bond wire. Provide a minimum of two bond wires. Attach wires to pipe by thermite welding.

Furnish weld caps of high density plastic, 10 mils (minimum) thickness as included in the current Approved Materials List. Provide caps that incorporate a dome for the weld, a tunnel to contain the lead wire from the weld connection, and a base plate to cover the prepared pipe surface. Provide weld caps prefilled with mastic/adhesive with an integral primer for adhesion to the pipe or structure. Size weld caps for the thermite connection. Coat any damaged area of the pipe exposed after application of the weld cap with bitumastic paint.

- 2. Electrical Bond Clip: Weld three (3) ASTM 366 steel bonding clips, each approximately 0.13 inches thick, 2.5 inches long, and 1.25 inches wide, with 1/8-inch fillet welds to the bell and spigot of adjacent concrete or steel pipe with rubber gasketed joints. Manufacture clips to maintain continuity regardless of small deflections of finished joints.
- C. For 20" diameter and greater, provide flange isolation kits at valves for steel or concrete mains, connections to existing pipe, connections between dissimilar pipe materials, or where shown on Drawings.
- D. For 20" diameter and greater, provide flush-mounted test stations at the following locations: All manhole locations, all major sources of stray electrical current (such as underground pipeline crossings), all cased crossings and tunnels (both ends), all underground isolation flanges, and at galvanic anode locations. Ensure maximum spacing between test stations of 1,500 ft.

Test all test stations within each valved section of water main or at least at every other test station. Include a continuity verification of the water main, a base line native state pipe-to-soil potentials at all test stations, permanent reference cells, and electrical isolation devices in the testing. Submit a report with the results of the tests, along with an O&M manual for the test stations. Perform a walk-through inspection with the Engineer to verify installation of all corrosion control components in accordance with project drawings and the submittal.

801.03 Ductile Iron Pipe. Provide pipe manufactured in accordance with AWWA C151 except as herein modified:

Corrosion Allowance: .08 inches minimum

Wall Thickness and Class as follows:

Size	Wall Thickness	Thickness/Pressure Class
3 Inches	0.31	53
4 Inches	0.29	52
6 Inches	0.31	52
8 Inches	0.33	52
10 Inches	0.35	52
12 Inches	0.37	52

16 Inches	0.40	52
20 Inches	0.33	250
24 Inches	0.37	250
30 Inches	0.42	250
36 Inches	0.47	250
42 Inches	0.52	250
48 Inches	0.58	250
54 Inches	0.65	250
60 Inches	0.68	250
64 Inches	0.72	250

Provide pipe with a bituminous coated cement lining complying with AWWA C104 Specifications and an outside coating of bitumastic enamel or approved equal.

Provide ductile iron pipe cast, cleaned, cement lined, coated, tested, and certified at a single manufacturing facility with all manufacturing units contiguous to one another.

Gauge full from the end of the spigot to two feet from the flare of the bell ten (10) percent of the ductile iron pipe supplied to the project..

The City will not allow field welding on ductile iron pipe or fittings, except for the bonding of joints, or outlets welded on in the factory unless otherwise approved by Engineer.

Restrain the water main joints using an approved restrained joint for all cased crossings greater than 60 linear feet in length,.

Polyethylene Encasement: Wrap all ductile iron pipe with tube style 8-mil linear low density polyethylene (LLDPE) film made from virgin material (no recycle material) in accordance with AWWA C 105/A21.5 for all open cut installations. Provide black film with nominal 2% carbon black UV inhibitor and printed per the C105 Standard. Adhere to the following Physical Properties:

- a. Tensile Strength: 3,600 psi minimum in machine and transverse direction (ASTM D882)
- b. Elongation: 800% minimum in machine and transverse direction (ASTM D882) as measured using rubber lined grips.
- c. Dielectric Strength: 800 Volts/Mil thickness, minimum (ASTM D149)
- d. Impact Resistance: 600 grams, minimum (ASTM D1709 Method B)
- e. Propagation Tear Resistance: 2,500 grams force, minimum in machine and transverse direction (ASTM D1922)

Testing: Virgin Polyethylene Encasement Film as delivered may undergo third party specification compliance testing by the City. The City will require the Contractor to reimburse the City for the cost of such test if the testing reveals non-virgin polyethylene encasement material and the material fails to meet the specifications. Additionally, the City will require the Contractor to immediately remove the non-compliant film from the site. Remove and replace pipe installed with non-compliant polyethylene encasement film at no additional cost to the City.

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Installation: Deliver film to the jobsite contained in a sound sacrificial sleeve of UV Protected Polyethylene to protect contents during storage prior to installation.

Install the polyethylene encasement per Method A of ANSI/AWWA C105/A21.5. Remove all lumps of clay, mud, cinders, etc. from the pipe surface before encasing the pipe. Keep soil, or bedding material, from becoming trapped between the pipe and the polyethylene sleeve. When lifting polyethylene-encased pipe use a fabric type sling or padded cable to protect the polyethylene. Overlap joints (double coverage) and tape. Fold excess slack over the top of the pipe and tape in place every three feet. Carefully backfill the pipe according to Item 801.11 and 801.12. To avoid damage during backfilling allow adequate slack in the film tube at joints. Use backfill material of cinders, rocks, boulders, nails, sticks or other material that could damage the polyethylene sleeve.

Appurtenances:

- a. Cover Pipe Shaped appurtenances in the same manner as the pipe.
- b. For odd-Shaped appurtenances, pass a split length of sleeve under the appurtenance and then over the appurtenance. Bring together around the body and securely tape into place. Make seams by folding edges over twice and taping.
- c. Bolted Joints and Valves: Overlap joints as for pipe installation. Tape film securely around valve stems and other penetrations. Use care to prevent penetration of the film by bolts and other Protrusions.
- d. Branches, Blow-offs, Air Valves, Service Taps: Wrap a minimum of three layers of tape completely around the polyethylene encased pipe to cover area where tapping machine will contact the pipe. Install the corporation stop directly through the tape and polyethylene. Repair any damage after the installation with tape or an additional wrap of polyethylene film. Wrap copper service at least three feet back from the installation with tape or additional polyethylene film to prevent electrolysis.

Tape: Provide 1- 1/2" minimum width, 6mil nominal thickness PVC Tape, Use to fit, anchor, or repair the encasement film.

801.04 Fittings For Use With Ductile Iron Pipe. Provide Class 250 fittings, manufactured in accordance with AWWA C110 or C153. For pipes 24-inches and larger, provide AWWA C153 Compact Ductile Iron Fittings. Provide fittings with ends made in accordance with AWWA C111. Coat all fittings inside and outside with a bituminous coating complying with AWWA C110 or C153. Provide factory-coated carbon steel bolts for mechanical joint fittings, and coat with bitumastic paint, wax-tape coating system, or petrolatum-based tape coating system as approved in the current Division of Power and Water Approved Material List.

801.05 Concrete Pipe and Fittings. The Contractor may use prestressed concrete cylinder pipe and fittings in sizes 20 inches or larger in diameter. Manufacture in accordance with AWWA C301.

Provide steel cylinder for fittings designed in conformance to AWWA Steel Pipe Manual, M11, (latest revision) so that allowable deflection of the pipe under combined

dead and live loads does not exceed 2 percent of the internal diameter of the steel cylinder.

Design Criteria:

- a. Use 90-degree Olander coefficients for earth and live loads and water weight contained in pipe along with 15-degree Olander coefficients for pipe weight.
- b. Tunnel and Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and stress anticipated during handling and installation.

Butt straps for closure piece: minimum 12-inch wide split butt-strap; minimum plate thickness equal to thinnest joined member; fabricated from material equal in physical and chemical properties of thinnest joined member. Provide minimum lap of 4 inches between joined member and edge of butt strap, welded both inside and outside. Provide minimum 6-inch welded outlet for inspecting each closure section. The City will not require a welded outlet for inspection when a closure section contains an access manway within 40 feet of the closure section.

Visible cracks: The City will not accept visible cracks longer than 6 inches, within 15 degrees of a line parallel to pipe longitudinal axis except:

- a. In surface laitance of centrifugally cast concrete,
- b. In sections of pipe with steel reinforcing collars or wrappers, or
- c. Within 12 inches of pipe ends.

Repair interior lining cracks that exceed 1/16-inch (0.0625 inches) wide. The City will reject pipe with exterior coating cracks that exceed 0.01 inches wide. When pipe has irreparable cracks exceeding limitations, immediately remove pipe from site.

Field repair procedures for coatings/linings:

- a. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with non-shrink grout. Use only manual chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with non-shrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off non-shrink grout flush with surrounding surface after the patch stiffens sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.
- b. Do not use pipe with defective coating areas greater than 6 inches in diameter. Immediately remove pipe from project.
- c. The City will reject pipe with a steel cylinder dented while making field repair. Immediately remove pipe from project.

801.06 Steel Pipe and Fittings.

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Use steel for steel pipe and fittings in sizes 20 inches or larger in diameter that satisfies the minimums of ASTM A 36, ASTM A 570 Grade 36, ASTM A 53 Grade B, ASTM A 135 Grade B, or ASTM A 139 Grade B.

Provide pipe sections in length of no less than 10 feet except as required for special fittings and closure sections. Provide closure sections and short sections of steel pipe not less than 4 feet in length unless indicated on Drawings or specifically permitted by Engineer.

Design Criteria:

- a. Maximum deflection from specified diameter: 3 percent for mortar lined and flexible coated pipe.
- b. Modulus of soil reaction (E’): based on laying conditions in accordance with Table 6-1 of AWWA M 11, but no greater than 2,000 psi.
- c. Deflection lag factor: (D1) = 1.2.
- d. Bedding constant: (K) = 0.1.
- e. Minimum diameter (D) over thickness (t) ratio = 230

Nominal Allowable Steel Wall Thickness: Provide pipe with a wall thickness not less than following table for depths of cover up to 16 feet. Provide pipe with a net internal diameter (including internal linings) less than net internal diameter listed. Provide pipe design calculations to confirm adequate wall thickness.

Net Inside Diameter (Inches)	Minimum Wall Thickness (Inches)
20, 24, and 30	0.149
36	0.178
42	0.207
48	0.235
54	0.271
60	0.301
66	0.333
72	0.362
78	0.393
84	0.423
90	0.454
96	0.484

The City will require a Cathodic Protection System in accordance with the Supplemental Specification for Cathodic Protection System Design and Installation.

Linings and Coatings: Provide shop-coated and shop-lined steel pipe with minimum of one coat of shop-applied primer approved for use in potable water on all exposed steel surfaces. Use primer with no less than 5 percent solids for field-applied coatings on tape-coated steel pipe. . Provide primer compatible with coating system and in accordance with coating manufacturer’s recommendations.

Shop-applied Cement-mortar Lining: AWWA C205; except as specified herein: 1/2 inch minimum thickness for pipe diameters 42 inches and larger; 3/8-inch minimum thickness for pipe diameters 36 inches and smaller. Cut back lining from joint ends to facilitate joining and welding of pipe. Apply cement-mortar lining to inside of pipe by

centrifugally spinning. For special sections (shape of which precludes application by spinning method) accomplish by mechanical placement or pneumatic placement and finish to produce smooth, dense surface comparable to centrifugally spinning. Use galvanized wire mesh in accordance with AWWA C205 when not applying shop-applied mortar by machine. Do not extend wire mesh across welded portion of mitered fittings. Crimp mesh to provide integral "chair" so wire does not fully rest against steel cylinder. Make repairs of cement-mortar lining for widths exceeding 6 inches by bonding to steel and adjacent faces of lining with bonding agent conforming to ASTM C 881, Type II. Repair cracks 1/16 inch and larger to satisfaction of Engineer and according to AWWA C205.

External coating system for steel pipe installed above ground and in vaults (exposed):

- A. Provide approved 3-coat epoxy/polyurethane coating system as designated below. Provide materials from same manufacturer.
 - 1. Surface Preparation: SSPC SP 10, Near White Blast Clean, 2.0 to 3.0 mils surface profile.
 - 2. Prime Coat: 4.0 to 4.0 mils DFT, Inhibitive Epoxy Primer, or approved equal.
 - 3. Intermediate Coat: 4.0 to 6.0 mils DFT. Chemical Resistant Epoxy, or approved equal.
 - 4. Finish Coat: 1.5 to 2.5 mils DFT Aliphatic Polyurethane, or approved equal
 - 5. Total Allowable Dry Film Thickness for System: Minimum: 9.5 mils, Maximum: 12.5 mils.
- B. Perform adhesion test on pipe in accordance with ASTM D 4541. Minimum field adhesion: 1,000 psi. Perform test on pipe for project at frequency of one for every 1000 square feet of coating. Perform cure test in accordance with ASTM D 4752 (solvent rub test) and ASTM D 3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

External Coating Systems for Buried Steel Pipe: Supply pipe with one of the following coatings specified.

- A. Tape Coating: Provide approved tape for external tape coating, applied in pipe manufacturer's facility. Apply in accordance with AWWA C214 and manufacturer's requirements; 80-mil. Components: Primer, one 20-mil layer of inner-layer tape for corrosion protection and two 30-mil layers of outer-layer tape for mechanical protection. Where using couplings, bond coupling to adjacent pipes with bonding cables as shown on Drawings or recommended by manufacturer. Use approved filler putty type insulating putty to fill in gap and create smooth sloped transition between top of reinforcing plate and pipe, before applying tape coating. Primer: Compatible with tape coating, supplied by coating-system manufacturer. Provide pipe with shop coatings cut back in accordance with manufacturer's recommendations to facilitate joining and welding of pipe. Do not expose tape coating to direct sunlight for more than 90 days. Discard (remove) and

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replace outer layer of tape coating when exposure exceeds 90 days at no additional cost to the City.

- B. Polyurethane Coating: AWWA C222; shop-applied, polyurethane coating except as modified in this Section; Minimum DFT of 25 mils (0.025 inch). Coating thickness on sealing areas of spigot end of pipe exterior: minimum 8 mils (0.008 inch), maximum of 10 mils (0.010 inch). The City will allow the Contractor to exceed the 10 mils maximum in spigot end provided the spigot diameter, , does not exceed the maximum specified by pipe manufacturer. Perform adhesion test on pipe in accordance with ASTM D 4541. Minimum field adhesion: 1,000 psi. Perform test on pipe for project at frequency of one for every 1,000 square feet of coating. Perform cure test in accordance with ASTM D 4752 (solvent rub test) and ASTM D 3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

External Coating System for Steel Pipe in Tunnel, Casing: For water lines in tunnel where using annular grout, shop prime external surfaces of steel pipe with 4.0 to 6.0 mils DFT of approved Inhibited Epoxy Primer.

Inspection and testing of coatings (factory): Perform electrical inspection on inner layer of tape before applying intermediate layer of tape, and in accordance with NACE Standard RP-02-74. Perform electrical holiday test with 60-cycle current audio detector, in accordance with AWWA C214.

Repair detected holidays immediately before applying outer layer of tape. Clear holiday area of material and reprime if necessary. Recoat area with inner wrap tape. Overlap inner wrap tape onto surrounding inner wrap coating by at least 2 inches. Perform electrical retest at repaired area after repairing holiday, and before continuing outer wrap.

Inspection and testing of coatings (field): Perform “spot check” of external coatings, and repair per manufacturer’s recommendations. Shrink Wrap: Perform “spot-check” electrical inspection on shrink wrap to check for holidays, as directed by Engineer in field. Perform peel tests over heat affected zone. Minimum acceptable result: 15 lbs-ft/in.

Field repair procedures and special fittings application for cement mortar lining:

- a. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in mortar surfaces with non-shrink grout. Repair defects by cutting out unsatisfactory material and replacing with non-shrink grout, securely bonded to existing mortar. Finish to make junctures between patches and existing mortar as inconspicuous as possible. After each patch sufficiently stiffens allowing for greatest portion of shrinkage, strike off grout flush with surrounding surface.
- b. Areas greater than 6 inches in diameter: Remove defective lining down to bare steel by chipping, taking sure care to prevent further lining damage. Leave the ends of lining where removing defective lining, square and uniform, not feathered. Clean bare steel with wire brush to remove loose or other foreign matter. Remove existing wire reinforcement and replace. Overlap new reinforcement to existing reinforcement by 1/2 inch. Secure

reinforcement, against wall of pipe, at frequent intervals, by tack welding to pipe. Prepare cement mortar mixture. Mixture to compose of Portland Type II cement, sand, and water. Proportions of sand to cement not to exceed 3 parts sand to 1 part cement, by weight. Use only enough water to obtain proper placement characteristics. Discard mixture when Set-up time exceeds 1/2 hour. The Contractor may also use non-shrink grout. Do not use combination of cement mortar and non-shrink grout within same repair. Apply an approved concrete bonding agent; refer to the Division of Power and Water Approved Material List, to bare steel and interface of existing lining. After applying bonding agent to steel and lining, apply new mix within 10 minutes. Apply cement mortar to repair area 1/2 inch thick, then hand trowel to achieve smooth dense finish, making sure not to leave exposed wire. To ensure proper thickness while placing new mortar, check thickness with 1/2-inch-long wire gauge. Curing: Place plastic sheeting over repair area; use tape to adhere plastic to area surrounding repair area. Let cure for 4 days, and then remove plastic sheeting.

801.07 Joints for Ductile Iron Pipe. Provide ductile iron pipe and ductile iron fittings with either mechanical joint ends or push-on joint ends unless otherwise shown on Drawings. Provide joints in accordance with AWWA C111.

Provide restrained joints in accordance with those listed in the Division of Power and Water Approved Materials list for 20-inch and larger diameters at all bends, tees and dead ends unless otherwise approved by the Engineer. Provide mechanical joint restraint glands with gripping wedges only when approved by the Engineer.

801.08 Joints for Steel and Concrete Pipe. Conform to AWWA C301 for concrete pipe and AWWA C 200 and C206 for steel pipe.

Use a restrained joining system at all bends, tees and dead ends. Provide welded joints for restrained joints in steel pipe. Provide concrete pipe restrained joints in accordance with those approved in the Division of Power and Water Approved Material List.

Submit design and installation details for approval when providing special joints..

Rubber-Gasketed Joints:

Concrete Pipe: Single weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell-and-spigot onto steel cylinder.

Steel Pipe:

- a. Bells: Formed by either expansion of pipe end over a die, or by segmental expander which stretches steel past its elastic limit, or by attaching sized weld-on bell rings. Attach weld-on bell rings with full-thickness fillet welds, welded inside and out (double-welded). Ensure that the minimum thickness of completed weld-on bell ring equals the thickness of pipe wall in barrel of pipe between joint ends. The City will not allow use of an expanded bell with a Carnegie spigot.
- b. Spigots: Size prior to rolling gasket groove. For Carnegie spigots, use only with attached weld-on bells. Attach with full-thickness fillet welds, welded inside and out (double-welded).

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Welded Joints: Employ independent certified testing laboratory, approved by Engineer, to perform weld acceptance tests on welded joints. Include cost of such testing in contract unit price bid for Item 801. Furnish copies of all test reports to Engineer for review. Test by magnetic particle test method for lap welds and fillet welds or by X-ray method for butt-welds, for 100 percent of all joint welds. Engineer has final decision to suitability of welds tested.

Weld Acceptance Criteria: Conduct in accordance with ASTM E165 – Standard Test Method for Liquid Penetrant Examination and ASTM E709 – Standard Guide for Magnetic Particle Examination. Use X-ray methods for butt welds, for 100% of joint welds. Examine weld surfaces for the following defects:

- a. Cracking
- b. Lack of fusion/penetration
- c. Slag which exceeds $1/3$ (t) where t = material thickness
- d. Porosity/relevant rounded indications greater than $3/16$ inch; rounded indication defined as one of circular or elliptical shape with length equal to or less than three times its width.
- e. Four or more relevant $1/16$ -inch rounded indications in line separated by $1/16$ inch or less edge to edge.

Welder Qualifications: Ensure that all welders engaged to join pipe, fittings, etc. and/or pipe repair have and maintain qualifications under provisions of AWS B2.1, and successfully pass welding testing in accordance with AWWA C206.

Present written welder certification documents to the Engineer for approval prior to any individual performing welding work on any pipeline joints, repairs, fittings or associated work. Provide welder certification appropriate to the work.

Flanged Joints: Provide flanged joints where shown on Drawings in accordance with AWWA C207, standard steel ring Class D, red rubber gaskets, $1/8$ -inch thick, full-face. Bolts and nuts: ANSI B18.2.1 and ANSI B18.2.2, respectively.

Joint Linings and Coatings:

Internal Joints: Provide non-shrink joint grout for internal joints on steel and prestressed concrete pipe. Prepare grout in small batches to prevent stiffening before use. Discard set grout. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material inside joint with wire brush or hammer. Remove rust and foreign materials from metal surfaces. Allow grouted exterior joints to cure at least 1 hour before compacting backfill. For pipe diameters less than 30 inches, the joint can be “buttered” as described in AWWA C205.

Exterior Joints:

- a. Concrete pipe in tunnels: provide zinc coating for joint rings.
- b. Joint Wrapper for concrete pipe: Minimum width of 9 inches for 30-inch diameter and smaller; minimum width of 12 inches for diameters greater than 30-inch, hemmed at edge to allow threading with minimum $5/8$ -inch-wide steel strap. Provide minimum 6-inch-wide polyethylene foam strip sized, positioned, and sewn $1\ 1/2$ -inches from the outer edge of the wrapper’s two

circumferential edges of the polyethylene foam.. Grouting exterior joint space: Pour grout down one side of the pipe until it rises to the other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 5 minutes. Add more grout if necessary. Proceed with placement of bedding and backfill when grout mechanically stiffens.

- c. Heat Shrink Joint Sleeves for steel pipe: Provide in accordance with AWWA C216. Pipe manufacturer to hold back coating at joints in accordance with shrink sleeve manufacturer's recommendations. Apply manufacturer-approved insulating putty at bell step-offs. For welded joints, apply heat-resistant protective sleeve prior to internal welding. Surface preparation and sleeve application: in accordance with manufacturer's instructions. Do not expose joint sleeves to sunlight for more than 90 days. Discard (remove) and replace when exposure exceeds 90 days. Provide a technical representative from the shrink sleeve manufacturer on site at beginning of pipe laying operations to advise Contractor and Project Manager regarding installation, repairs, and general construction methods. Include the cost for these items in unit price bid of Item 801.

801.09 Water Mains Appurtenances. Furnish and install, prior to testing, all fittings, blow offs, air vents and water service taps in the number of and sizes shown on the plans, or at locations selected by the Engineer. The plans show connection outlets designed for attaching valves and other appurtenances furnished and installed by the Contractor under other items. Provide factory-coated carbon steel nuts and bolts as included in the current Approved Materials List. Coat exposed portions of nuts and bolts with approved bitumastic paint, petrolatum-based tape coating system, or wax tape coating system as identified in the Division of Power and Water Approved Material List.

Furnish and install all valves, for laying the water main, as shown or as directed by the Engineer. The City will pay for furnishing and installing valves under other items. Provide valves with mechanical joint ends for 48-inch diameter and smaller, unless otherwise shown or approved by the Engineer. For larger than 48-inch diameter, provide flanged joints. Furnish and lay, under this item, any special casting necessary to make the valve installation as shown on the plans. Furnish and lay all closure pieces, special bends and fittings necessary for the constructing of the pipe line, along the route as shown on the plans.

801.10 Excavation and Pipe Laying. Lay all pipe as per the manufacturer's specifications. Lay the pipe according to the proposed horizontal and vertical locations as shown on the plans. Make connections to the existing pipe lines at the locations shown on the plans. If, during the course of the work, unforeseen conditions arise, the Contractor may change the horizontal or vertical alignment of the pipe line or location of the connection to the existing pipe as directed by the Engineer. For 16 inch diameter and smaller, install the water line with the greater cover of either 4 feet (1.2 m) from the existing ground or the top of the existing or proposed curb grade to the top of the water line, if the plans do not show the water line grade, , For 20 inch diameter and larger, provide minimum 6 feet of cover.

If a need arises that requires changing the waterline grade, lower the line unless the Engineer gives specific approval to raise the line. When installing the water line in an

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embankment area, place and compact the embankment as required by Section 203.05 prior to excavating the water line trench.

Include the cutting and removal of pavement, curbs, and sidewalk in the bid item for replacement of these items. Excavate and prepare of the trench and lay the pipe in conformance with the applicable parts of the Standard Specifications for Installing Ductile Iron Pipe AWWA C600, or the latest revision thereof, except as herein modified.

The City will pay for restoration of pavement, sidewalks, curb and gutter, temporary pavement and all maintenance of surfaces under other items of the Contract.

Trench Excavation and Foundation:

Keep pipe trenches free of water. Determine trench excavation widths using following schedule as related to pipe inside diameter (I.D.).

Nominal Pipe Size, Inches	Minimum Trench Width, Inches	Bedding Depth, Inches
16" and less, ≤ 10' cover	I.D. + 24	0
16" and less, ≥ 10' cover	I.D. + 24	6
20" to 30"	I.D. + 24	6
36" and Greater	I.D. + 48	6

For 20 inch diameter and greater, provide Crushed Carbonate Stone (CCS) Size No. 57 as specified in Item No. 703 – Aggregate for bedding material beneath pipe. Uniformly place and spade full depth to eliminate bridging. Grade trench to provide uniform support along bottom of pipe. Excavate for bell holes after grading the bottom and in advance of placing pipe.

For 16 inch diameter and smaller, the Contractor may use a flat-bottom trench for up to 10 foot depth of cover. For depth of cover exceeding 10 feet, provide 6 inches bedding in accordance with requirements listed above. In areas of rock excavation, provide 6 inches bedding in accordance with requirements listed above. Comply with the requirements of Item 903 for rock excavation.

Pipe Laying and Initial Backfill:

Use a fabric type sling or padded cable when handling pipe. Do not use chains or unpadded cables. Use backfill material free of large rocks or stones, or other materials which could damage coatings.

Pipe Haunching (for 20 inch inch diameter and greater): Provide Crushed Carbonate Stone (CCS) Size No. 57 as specified in 703 – Aggregate. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. Extend the depth of haunching extend from the trench bottom up to 1/2 times the pipe diameter. If the pipe requires adjustment after placement, remove and re-lay as new pipe. Prevent damage to coating when placing backfill. Place haunching material manually around pipe and spade full depth of lift to prevent bridging and provide uniform bearing and side support.

Initial Backfill: Provide granular material meeting the requirements of Section 304.02 or Section 703.11 for 16" diameter and smaller, and above pipe haunching for 20 inch diameter and greater. Moisture content not to exceed less than minus 4 percent of

optimum moisture prior to the spreading operation. Shovel in-place and compact material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Do not exceed 8 inches compacted thickness for a single layer of backfill material. . See Section 801.12 for compaction requirements. Do not water tamp. Extend initial backfill a minimum of 12 inches above top of pipe.

Thrust Restraints:

Provide concrete blocking, supports and/or buttresses on all water mains 16" diameter and smaller and at connections to existing pipes, regardless of diameter, as required. Also provide concrete blocking at all tees, bends, dead ends and at any other locations shown on the plans or directed by the Engineer. Build these concrete structures to the lines, grades and dimensions shown on the Standard Detail Drawings, L-6310, L-6311, L-6312, or as ordered by the Engineer, and construct with Class "C" concrete as per Item 499. Include the cost of temporary timber backers and the cost of excavating to line and grade shown for the supports in the unit price bid for Item 801.

On all water mains 20 inch diameter and larger, provide adequate restrained joint lengths. Provide joint restraint for each tee, bends, or dead end with limits designed by an engineer in accordance with manufactures suggested recommendations unless otherwise shown on the drawings. Prior to ordering the pipe and commencing with construction, submit a pipe laying schedule showing the proposed designed restraining system for the entire water main improvement for approval by the City of Columbus Division of Power and Water.

Include the cost of the restrained joints, blocking, supports and/or buttresses or design thereof in the unit price bid for Item 801.

Rubber Gasketed Joints:

During any construction, keep rubber gaskets and lubricants in an area heated to at least 40°F when the outside temperature falls below 40°F.. Place gaskets or use lubricant in the bell or on the spigot of the pipe no later than 5 minutes after removal from the heated area.. Lubricate all joints according to the manufacturer's recommendations.

Steel Pipe Installation:

Install pipe stulls (cross bracing) prior to placement of pipe, bends, and fittings to prevent deflection during installation. Stulls to remain in place, horizontally and vertically positioned until completion of welding. Remove stulls no sooner than 24 hours after completing placement of backfill to natural ground level or to pavement subgrade level.

Immediately replace damaged plastic end-caps. Do not leave uncapped for more than 4 hours.

Pipe deflection: After backfill completion, test pipe for excessive deflection by measuring actual inside vertical diameter. For maximum allowable deflection, see section 801.06. The Engineer may measure deflection along the pipe. The City will not accept arithmetic averages of deflection. If deflection exceeds that specified, perform one of the following:

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- a. Remove backfill and side support. Reround the pipe and properly replace compacted backfill and side support. Examine cement mortar lining to verify no damage occurred. Replace damaged mortar lining.
- b. Remove entire portion of deflected pipe section and install new pipe as directed by Engineer, at no additional cost to the City.

Installation shall comply with manufacturer's instructions and with AWWA Manual M11.

- a. Ensure that the pipe manufacturer furnishes the services of a factory trained, qualified, job experienced technician to advise the Contractor and City personnel as necessary in pipe laying and pipe jointing applications. Provide the technician for a minimum of 15 days and 2 trips to the job site. Provide the technician for a minimum of 10 days prior to and during the laying of the first sections of pipe for the technician's first trip. The City will request the remainder of the technical service days in coordination with the Contractor.
- b. Ensure that the pipe manufacturer provides the services of the pipe exterior coating manufacturer for a minimum of 5 days divided into 2 trips for tape or polyurethane coatings. Provide a technician capable of advising the Contractor and City personnel as necessary regarding the inspection and repair of the coating. Provide the technician for a minimum of 3 days for the first trip to observe unloading of the pipe from the factory, inspect the pipe exterior coating, and to observe pipe handling and laying by the Contractor. If no exterior coating requires repair during the first trip, obtain coating repair instructions on pipe samples provided by the pipe manufacturer. The Contractor may use the remainder of the technical service days as needed, with approval by the City, during periods when the Contractor makes coating repairs. Obtain documentation from the technical service representative that provides assurance that the Contractor's repairs meet requirements. Submit this documentation to the City prior to the technical service representative leaving the job site.

801.11 Backfill Within The Influence of Pavement. This section discusses backfilling above the initial backfill up to ground surface or beneath pavement subgrade within the influence of pavement as defined by Standard Drawing L-6309E.

Unless otherwise shown, specified, or ordered, provide granular backfill material meeting the requirements of Section 304.02 or Section 703.11. The City will allow use of flowable Control Density Fill, Type II complying with the requirements of Item 613 as an alternate to compacted granular material.

Ensure that the moisture content does not exceed less than minus 4 percent of optimum moisture prior to spreading. Shovel in-place and compact material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Do not exceed 8 inches for a single layer of compacted thickness. See Section 801.12 for compaction requirements. Extend the compacted backfill to the top of the pavement subgrade for trenches within traveled areas, and to within 6 inches of the existing ground in all other areas.

Comply with the requirements of Item 801.12 for the backfill of a water main parallel to the centerline and within proposed or dedicated rights-of-way, but outside the influence line for support of pavement, shall.

Backfill the remaining depth of trench within traveled areas with material specified for pavement replacement. Place and compact base and pavement materials as specified under the applicable repaving item. Strike off the pavement base at the proper depth to accommodate the specified thickness of temporary or permanent pavement.

Backfill the remaining depth of trench outside traveled areas as specified under the seeding or sodding items.

Uniformly wet or dry the backfill as to obtain the specified density. Provide backfill free of sod, debris, frozen earth, foreign objects, metal objects, or large rocks or stones. Include the cost of hauling away and disposing of the excavated material in the unit price bid for furnishing and installing the various sizes of valves, water mains and constructing the structures.

801.12 Backfill Outside The Influence of Pavement. Backfill in conformance with the requirements of Section 801.11 above, outside the influence of pavement, as defined by Standard Detail L-6309E, except as herein modified..

Provide suitable backfill material native to the project , or granular backfill material conforming to the requirements of Section 304.02 or Section 703.11. Dispose of excavated material unsuitable for compacting at no additional cost to the City. Provide granular backfill material from somewhere else. Spread material in successive layers not exceeding a depth of 8 inches. Compact from above the initial backfill to within 6 inches of the existing ground. The following requirements apply to granular material conforming to Section 304.02, Section 703.11, and to native material:

Max. Lab. Dry Wt. Lbs./cu. Ft.	Min. Compaction Requirements % Lab. Max.
90-104.9	102%
105-119.9	100%
120 and more	98%

Backfill the remaining 6 inches of excavation with approved material without mounding of fill. Maintain trenches in good and safe condition up to the time of acceptance of the work.

Backfill traveled areas in accordance with Section 801.11.

801.13 Water Main Cleaning and Flushing. Before applying a hydrostatic test to any newly constructed water main, flush the main or clean and flush as herein prescribed. Use care during the construction operations to ensure maintenance of the interior surfaces of all pipe and fittings in a sanitary condition. Make every effort to keep loose foreign material out of all pipe and fittings. Temporarily block or cap exposed open ends of pipe during construction. Take particular care to protect the main during temporary work interruptions.

Flush all main sizes 8 inches and smaller through available fire hydrants as directed and witnessed by a designated Division of Power and Water representative. Valving operations may be required to ensure a thorough cleaning of all sections of the main. Ensure flow rates for adequate flushing velocities of 1000 gallons per minute for 6 inch

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mains and 1600 gallons per minute for 8 inch mains or maximum available flows from the system. Clean sections of main not capable of flushing by valving and hydrant operations as directed by the Engineer.

Clean all mains 12 inches and larger by passing a new properly sized poly pig through the pipe. The City will not allow use of used poly pigs. Use a poly pig with a minimum density of 5 pounds per cubic foot, coated with a double spiral wrap without wire brushes or scrapping tools. Provide acceptable poly pigs in accordance with those listed in the Division of Power and Water Approved Materials list. As an alternative to poly pig, the City will allow actual manned entry inspection of pipes 36" and larger, as approved by Engineer. Remove all debris encountered during the inspection by a method approved by the City.

Prepare the main for the insertion and removal of the poly pig at points identified by the Engineer as insertion ports, if required, and exit ports. Provide all material, equipment and labor to insert the poly pig and construct a sanitary exit port. Where practical, insert the poly pig into the first length of pipe during the initial installation. At the exit port prevent the backflow of purged water into the main by the temporary installation of mechanical joint bends and pipe joints to provide a riser out of the trench. On larger pipe, the Contractor may excavate additional trench to serve the same purpose as riser.

Line the excavation with polyethylene when using the trench method.. Provide pumps and/or ditches to prevent contaminated water from reentering the main. After cleaning the main to the satisfaction of the Division of Power and Water representative, remove all temporary constructions and complete all work necessary to secure the system prior to backfilling insertion and exit sites. The Engineer may require additional poly pig runs when water purged from the main indicates the presence of excessive dirt or debris.

Route all discharged water through an approved erosion control device. Follow stormwater best management practices at all times.

801.14 Hydrostatic Tests. Apply a hydrostatic test to the mains and fire hydrant leads as required in Section 5 of the Standard AWWA Specification C600 for Ductile Iron Pipe, Section 4 of AWWA Specification C604 and M11 for Steel Pipe or AWWA M9 for Concrete Pipe. Test all new services to the curb stop. Test each valved section of water main independently of one another unless otherwise approved by the Engineer. Conduct pressure test with all watch valves open and hydrant foot valves closed. Maintain 150 psi of pressure in any tested section.. Test for at least two hours, except when the test indicates zero leakage after the first hour. The City may approve termination of the pressure test after one hour with zero leakage., Furnish all materials, make all taps required and furnish a pump, metering equipment, piping, other equipment and all necessary assistance for conducting the tests.

Fill steel and Concrete pipe with water prior to testing and allow to stand in the pipe for at least 24 hours to permit absorption of water into the cement mortar lining. Add water to replace the water absorbed prior to testing.

Before applying the specified test pressure, expel all air from the pipe at air release valves and/or hydrants. Allow the pipeline to stabilize at the test pressure before conducting the hydrostatic test. Do not allow the test pressure to vary by more than 5 psi +/- for the duration of the test. Maintain test pressure within this tolerance by adding

makeup water through the pressure test pump into the pipeline. Measure the amount of makeup water by suitable methods. The City will not accept a pipe installation that exceeds leakage specified per Standard Detail Drawing L-6640 (evaluated on a pressure basis of 150 psi).

Locate leaks revealed by this pressure test at no additional cost to the City. Remove and replace cracked or defective pipes, fittings, valves, joints, or other appurtenances, discovered during the pressure test at no additional cost to the City. Repeat the test repeated until satisfactory to the Engineer.

Test against existing valves at the Contractor's risk and in strict compliance with the requirements of the Engineer. If unable to achieve the required test, disconnect from the existing valve, plug and re-test until obtaining satisfactory results. Repair damage caused to existing facilities at no additional cost to the City.

801.15 Chlorination of Completed Pipe Line. After satisfactory hydrostatic testing, the City will chlorinate the completed pipe in accordance with AWWA C651. The City will furnish the chlorine, pumping equipment necessary to introduce the chlorine into the chlorination tap and one man. Furnish and pay for all other labor, material and equipment including chlorination taps and blow-off taps. Provide taps with tapping valves, sufficient tubing or pipe to extend outside the trench and an operable valve above ground. Provide blow-offs with sufficient tubing to extend to an approved drainage facility. Provide blow-offs with adequate protection from pedestrian and vehicular traffic. Install blow-offs of the sizes and at the locations shown on the drawings or as directed by the Engineer. Do not reuse corporation Stops, 2-inch and under, used in the chlorination process as part of a water service, air release, or any other permanent feature of the water main. The Division of Power and Water will approve the time and the section of line for chlorination. . The Division of Power and Water will notify the Contractor when to remove the temporary blow-offs and corporation stops. Plug the blow off hole with an approved plug as identified in the Division of Power and Water Approved Materials List.

Hand swab all pipes and fittings not otherwise disinfected. The Division of Power and Water will determine amount of chlorine used during hand swabbing operations.

801.16 Main Shuts. Prior to the start of proposed water main improvement, submit a plan and an accompanying schedule identifying the location and estimated dates for water main shuts to the Division of Power and Water for approval.

Only Division of Power and Water personnel will operate valves. Operation of existing valves by the Contractor or their representative may result in penalties as identified in Chapter 1113 of the City Code.

Notify Division of Power and Water personnel at least 72 hours in advance to the actual water main shut. Notify and coordinate water main shuts with all affected customers. City personnel will work with the Contractor in identifying affected customers and will provide a sample notification letter. The City will approve the final notification letter. The Division of Power and Water personnel may re-schedule the main shut at its discretion if the Contractor appears unprepared to perform the work scheduled during the shut.. The City will not pay for costs associated with lost time due to lack of preparation by the Contractor. At a minimum, notify critical users (large

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businesses, hospitals, medical centers, industries, etc.) of non-shuts due to rescheduling or delays in the work.

To minimize impacts to customers, the City may require the Contractor to make shuts at night. Include costs incurred to perform contract work after regularly scheduled hours due to main shuts and all cost associated with coordinating shuts with the City in Item 801.

801.17 Certification. Furnish a sworn statement from the material manufacturer certifying that the Contractor performed all the required tests and that the pipe and fittings comply with the requirements specified.

801.18 Method of Measurement. The City will pay for furnishing and laying pipe based on plan view dimensions (footages along the centerline of the horizontal alignment).

The City will adjust compensation for ductile iron fitting changes ordered by the Engineer to reflect an increase or decrease in payment equal to the weight difference between the fitting shown on the drawings and the fitting actually installed for ductile iron pipe. The City will include the weight of glands required to install fittings in the fitting weight.

The City will compute number of cubic yards of concrete blocking, supports or buttresses from dimensions shown on the standard drawings therefore or as measured in the field if the Engineer ordered special blocking. The City will make no allowance for blocking poured larger than the dimensions shown on the standard drawings unless the Engineer gave advance approval.

The City will adjust compensation for any blocking changes ordered by the Engineer to reflect an increase or decrease in payment equal to the cubic yard difference between the volume of blocking shown on the standard drawings and that ordered by the Engineer.

For water lines 20" in diameter and greater, the City will pay for corrosion protection on a lump sum basis. Lump sum payment includes labor, materials and equipment necessary to install required corrosion protection devices as required in Section 801.02. The City will make no separate payment for corrosion protection on 16" diameter and smaller water lines.

Include costs in the lump sum item 'Cathodic Protection System Design and Installation' for all labor, equipment, materials and supervision for the design and installation of the cathodic protection system, complete in place, will. Do not include costs in this pay item for work covered under 'Corrosion Protection (20" diameter and greater)', which includes work for corrosion protection devices listed in Paragraph 801.02.

The City will base payment for concrete or steel pipe, when directed by the Engineer to install extra fittings as required to avoid unforeseen obstacles, based on the following:

- a. The City will pay for each extra fitting requested by the Engineer and delivered to jobsite according to unit price for "Extra Fittings, Concrete or Steel, Complete in Place."

- b. The City payment will include full compensation for items necessary for installation and operation of water line.

801.19 Basis of Payment. The City will pay for all work done under these items at the unit price specified. The City payment will include full compensation for all labor, material and equipment required to furnish and lay the pipe and appurtenances as herein specified.

The City will make payment at the contract price for:

Item	Unit	Description
801	Linear Foot	_____ Inch Water Pipe and Fittings
801	Lump Sum	Corrosion Protection (20" diameter and greater)
801	Cubic Yard	Concrete Blocking Class C, Increase or Decrease
801	Pound	Ductile Iron Fittings, Increase or Decrease
801	Each	Extra Fittings, PCCP Concrete or Steel, Complete in Place
801	Lump Sum	Cathodic Protection System Design and Installation – Steel Pipe