

Section C-1 – Pipes and Fittings

C1.00 Work Included

The work under this Division of the Specifications shall include all labor, materials, and equipment necessary to furnish and install all piping, pipelines, connections and appurtenances, valves and accessories, restraint systems, and adaptors, all as specified under this Division and as shown on the Drawings.

C1.01 Schedule of Pipe and Jointing

Pipe and fitting materials, jointing and pipe linings shall be in accordance with the following schedule. This schedule is set forth as a guide to illustrate requirements. The lack of specific mention of any certain pipe line does not relieve the Contractor from the responsibility for furnishing, installing, painting, and testing same as required for a complete job.

<u>Service</u>	<u>Pipe Material</u>	<u>Jointing</u>	<u>Lining</u>
Water Main Piping Underground	Ductile Iron Class 350	Push-on Joint or Mechanical Joint with Retainer Gland as indicated on Drawings	Cement Lined
Water Main Piping Above Ground	Ductile Iron Class 350	Groove Type Coupling	Cement Lined
Pipe Fittings Underground	Cast or Ductile Iron	Mechanical Joint with Retainer Glands	Cement Lined
Service Connection 1/2" to 2"	Copper Type K	Compression Connection	None

C1.02 Ductile Iron Pipe

a) General

Ductile iron pipe shall be centrifugally cast cement-lined and shall conform to ANSI/AWWA C151/A21.51-02, Ductile Iron Pipe Centrifugally Cast for Water, of latest revision. Cement lining shall conform to ANSI/AWWA C104/A21.4-08, Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water, of latest revision, and shall include a bituminous seal coat. Pipe exterior shall receive a standard foundry coal tar dip coating in accordance with ANSI/AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water, of latest revision; product shall meet with EPA approval. Pipe may be furnished in 18 or 20-foot nominal laying lengths.

Where restrained joints are not required, joints shall be of the push-on type with a rubber gasket conforming to ANSI/ANSI C111/A21.11, Rubber Gasket Joints for Cast-Iron and Ductile Iron Pressure Pipe and Fittings, of latest revision. Pipe plain ends shall be suitable beveled to permit easy entry into the bell. Pipe joints shall be “Tyton” as manufactured by United States Pipe Company, “Fastite” as manufactured by American Cast Iron Pipe Company, “Tyton” as manufactured by Water Systems Company, “Tyton Joint” as manufactured by Griffin Pipe Products Company, or approved equal.

In areas where the contract plans call for restrained joints, joints shall be ductile iron mechanical joints utilizing mechanical joint Mega-Lug “retainer glands” as manufactured by EBAA Iron, Inc., or approved equal. Additional restraint will be provided if thrust conditions are created due to horizontal and/or vertical adjustment to the pipeline due to field conditions. Mechanical joints shall conform to ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, of latest revision.

b) Pipe Thickness

Pipe thickness classes for 24” diameter and smaller pipe shall be Class 350 psi unless otherwise noted on the drawings or instructed by the City Engineer.

c) Marking Pipe

Each pipe delivered to the job shall have clearly marked the weight, class designation and sampling period. In addition, each pipe shall have cast on the face of the bell the manufacturer's mark and the year the pipe was produced.

C1.03 Ductile Iron Fittings

Ductile iron fittings shall be cement lined, mechanical joint, conforming to ANSI/AWWA C110/21.10-08, Ductile-Iron and Gray-Iron Fittings for Water, of latest revision. Mechanical joints shall conform to ANSI/AWWA C111/A21.11 for Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings, of latest revision. Hydrant tees shall be mechanical joint tees. Cement lining shall conform to AWWA C104 Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water and shall include a bituminous seal coat. The exterior surface of fittings shall receive a standard foundry coal tar dip coating, product to meet with EPA approval. Fittings up to and including 24-inch size shall be 350 psi pressure rating and fittings over 24-inch shall be cast iron or ductile iron with a pressure rating class of 250 psi. All mechanical joint fittings shall be supplied with ductile iron retainer glands, as manufactured by EBAA Iron, Inc., or approved equal.

C1.04 Mechanical Joint Solid Sleeves

Mechanical joint solid sleeves shall be as manufactured by U.S. Pipe, Clow, or equivalent. Solid sleeves shall be installed with ductile iron retainer glands and shall be installed in accordance with manufacturer’s recommendations. Solid sleeves shall be installed where

shown on the drawings and where necessary to prevent movement of cut out lengths of pipe which are to be rejoined.

C1.05 Flexible Couplings

Flexible couplings shall be Smith-Blair Omni 442 or equal. Couplings shall be installed in accordance with the recommendations of the manufacturer. All flexible couplings are to be adequately harnessed to withstand the test pressures in the lines unless other means are provided to take the thrust.

C1.06 Transition Couplings

Transition couplings shall be Smith-Blair Omni 442 or equal. Couplings shall be installed in accordance with the recommendations of the manufacturer. All transition couplings are to be adequately harnessed to withstand the test pressures in the lines unless other means are provided to take the thrust.

Transition couplings shall be used where new ductile iron mains are to be joined to existing pit cast iron pipes.

C1.07 Water Service Lines

Water service lines smaller than 4-inch in diameter shall be made of Type K soft copper conforming ASTM B88.

All service materials required including corporation stops, service pipe, curb valve, curb box and adaptors shall be furnished by the Contractor.

A standard service "kit" will consist of the following materials:

- a) Type K soft copper tubing conforming to ASTM B88.
- b) Corporation valve Mueller H-15008, compression fitting connection
- c) Curb stop valve for ¾-inch and 1-inch services, Mueller Oriseal III H-1504-2, compression fitting connection, and for 1½ -inch and 2-inch services, Mueller II Oriseal H-15209, with Mueller Pack Joint Connection for CTS.
- d) Curb box Tylor Union Series 6850 or equal, arch style, complete with lid marked "WATER".
- e) Service Saddles shall be Smith Blair 313 with CC taps or equal.

Splicing of copper tubing will not be allowed unless approved by the Engineer for service runs longer than standard available length of tubing.

Mueller adapters shall also be provided by the Contractor to join new Mueller curb valve outlets to existing copper, galvanized or plastic service piping.

When the service line has been installed, prior to backfilling and connecting the customer service, the curb valve shall be closed and the corporation opened. After all air is expelled, a visual leakage test will be conducted. The customer service shall then be connected and the curb valve shall be opened. An additional leakage test shall then be conducted under "system pressure". The City Engineer or his representative shall be present for this testing, and no backfilling will be permitted until the pressure testing is satisfactorily completed.

Tapping of the water mains and all necessary connection work shall be carried out only by personnel experienced in this work using equipment designed for use and the corporation stops specified above. Service saddles shall be provided for all taps larger than 1-inch diameter.

The Contractor shall warranty against defective workmanship for a twelve-month period following the date of tap and corporation stop installation.

C1.08 Inspection of Pipe

All pipe and fittings used in the work may be factory inspected by a recognized inspection agency engaged by the Owner. The Contractor shall inform the Owner and the inspection agency of the name and address of the foundry or other sources of materials to be used in the work and shall coordinate with the manufacturer to assure that the inspection agency has access at the manufacturer's plant and adequate assistance and notice so that each item may be examined. All reports will be made to the Owner and the cost of the services of the inspection agency will be borne by the Owner.

C1.09 Excavation and Backfill in Connection with Pipe Laying Operations

The Contractor shall trim the bottom of all trenches to receive pipe and shall provide finish grade by hand methods. The trench bottom shall be carefully graded to the proper elevation, and the maximum practical solid bearing areas shall be provided throughout its entire length, prior to swinging the pipe into place. No blocking under the pipe will be permitted. Additional excavation shall be made under joints to allow for proper jointing.

The Contractor shall provide a bed of DelDot No. 8 quarry process stone to be installed across the full trench width, from a depth of six inches (6") below the bottom of the pipe to the springline of the pipe.

In pipe trenches, after the pipes have been tested and approved, trenches shall be backfilled with suitable material, carefully deposited and compacted in layers not to exceed eight inches (8") in thickness.

Wherever the existing material is unsuitable in the opinion of the City Engineer, the Contractor shall excavate and remove all unsuitable material and shall backfill and compact the trench to grade using quarry processed stone or bank run sand and gravel, as directed by

the City Engineer. All pipe trenches in paved roadways shall be backfilled with bank run sand and gravel or quarry processed stone compacted in eight-inch (8") layers. Refer to the contract drawings for select fill requirements at various locations.

All material unsuitable for backfill and excess excavation shall be disposed of at an off-site location at the Contractor's expense.

C1.10 Pipe Laying

All pipes shall be carefully examined for defects, and no pipe known to be defective shall be laid. If any pipe is found to be broken or defective after being laid, it shall be removed and replaced by sound pipe without any further payment than is included in the prices bid.

Joint surfaces shall be protected from damage, and shall be carefully examined before jointing. No damaged joints shall be used in the work.

Pipe shall be thoroughly cleaned and ample precautions shall be taken to prevent entrance of dirt and debris into the pipe after laying. Exposed ends of all uncompleted lines shall be provided with plugs or covers at all times when pipe laying is not actually in progress.

All pipes shall be carefully laid to true alignment and grade with bell ends upgrade.

The trench bottom shall be carefully graded to the proper elevation, and the maximum practical solid bearing areas shall be provided throughout its entire length, prior to swinging the pipe into place. Unless otherwise specified, pipe shall be laid on six inches (6") of compacted thickness DeIDot No. 8 process stone beneath pipe and up to the springline of pipe so that pipe will have a firm bearing for its full length.

Care shall be taken not to excavate below grade. Material excavated below adopted grade shall be replaced by material which will meet with the approval of the City Engineer, without any further payment.

Immediately after the pipe is brought to final position, it shall be thoroughly secured and properly bedded, and ample support shall be provided to prevent settlement or disturbances.

Pipe shall be protected during construction against possible flotation due to pouring of concrete or in case the trench becomes flooded prior to placing the backfill, either with water, or a wet mud mixture.

Jointing and laying shall be in strict accordance with recommendations of pipe manufacturer.

C1.11 Jointing of Pipes and Fittings

Jointing shall be done in strict conformance with manufacturer's recommendations. Pipe shall be handled with care to avoid damage to the lining and coating.

Cutting of pipe where required shall be done in a neat and workmanlike manner using an abrasive cutting wheel or other means which will produce a smooth end normal to the pipe axis with the cement lining undamaged. Cut ends shall be beveled to avoid damage to the gasket. Pipe ends shall be thoroughly cleaned prior to jointing and only approved lubricants shall be used.

Jointing of valves and fittings shall be with mechanical joints with ductile iron retainer glands. Materials and methods for jointing valves and fittings shall conform to the following:

The last eight inches (8") of the outside of the spigot piece and inside of the bell of mechanical joint pipe shall be thoroughly cleaned to remove all oil, grit, tar (other than the standard coating) and other foreign materials from the joint, and then painted with a soap solution. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge toward the glands.

The entire section of the pipe shall be pushed forward to seat the spigot end into the bell. The gasket shall then be pressed into place within the bell being careful to have the gasket evenly located around the entire joint. The ductile iron gland shall be mounted along the pipe into position for bolting, all of the bolts inserted and the nuts screwed up "fingertight." All nuts and set screws shall be tightened with a suitable torque limiting wrench. The torque for various sizes of bolts shall be in accordance with Appendix A of ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings, of latest revision, which is as follows:

<u>Bolt Size (Inches)</u>	<u>Range of Torque (Ft.-Lb.)</u>
5/8	45 - 60
3/4	75 - 90
1	100 - 120
1-1/4	120 - 150
Set Screws 5/8	70

Nuts spaced 180° apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland. Suitable torque gauges shall be used for checking the job.

If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation practice will not be permitted.

C1.12 Anchorage of Fittings

All fittings shall be securely anchored by suitable blocking and/or by an approved bolted metal harness and/or approved restrained joints. Refer to plans for specific anchorage requirements.

Reaction or thrust blocking shall be Class C (2500 lbs.) concrete. Blocking shall be placed between solid ground and the fittings with adequate bearing area on the pipe and the ground.

Blocking, clamps, and methods of anchorage shall be such as to permit accessibility for joint repair. Metal harnesses of tie rods and metal clamps of adequate strength to prevent movement or other approved means may be used where concrete blocks cannot be used. Rods and clamps shall be painted with a corrosion resistant asphaltum. Reaction or thrust blocking metal harnesses of tie rods and clamps shall not be used without written authorization from the City Engineer.

Where fittings are anchored by the use of restrained joints, the type of joint must be as specified or approved by the City Engineer and a sufficient number of straight pipe lengths both sides of the fittings must be furnished with restrained joints designed to withstand the thrust due to the internal test pressure. Deflection of the joints shall be in accordance with the manufacturer's recommendations. All mechanical joint fittings shall be supplied with ductile iron retainer glands unless otherwise directed by the City Engineer.

Retainer glands shall be ductile iron and be Underwriters Laboratory approved, as manufactured by EBAA Iron, Inc., or approved equal.

C1.13 Testing

When a section of pipe of a length deemed adequate by the City Engineer is ready for testing, the pipeline shall be completely filled with water at a controlled slow rate, all air expelled and a pressure and leakage test made in accordance with ANSI/AWWA C600 Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances, latest version except as described herein. The work shall include furnishing all labor, materials, and equipment for carrying out these tests.

The general method of testing pipelines shall be as follows:

1. A hydrostatic test pressure shall be maintained in the pipeline for a minimum period of two (2) hours. At the end of the test period, if the test pressure has remained constant, the pipeline shall have passed the test. If the pressure has dropped, it shall be brought back to the test pressure by pumping a known volume of water (from a graduated container) back into the pipeline. The volume of water thus used, representing leakage from the pipeline, shall be recorded. If the leakage is less than the allowable leakage specified below, the pipeline shall have passed the test. If the leakage exceeds the allowable specified, the Contractor shall locate the leak, repair the section of piping where the leak occurred to the satisfaction of the Engineer, and retest the pipeline as specified above. This process shall be repeated until the pipeline has successfully passed the pressure test.
2. Contractor shall make certain that all air is expelled from a pipeline before it is tested. All caps, plugs and fittings shall be adequately braced and anchored to withstand the test pressures. The test pressure specified by the Engineer shall be obtained and measured at the highest elevation in the pipeline under test.

3. Contractor shall take special note of piping configurations as shown on the Drawings, especially where piping begins or terminates with fittings, which will be difficult to seal, plug and anchor. In these cases, it may be necessary to perform the testing after special anchorage systems have been installed.

Unless otherwise required to meet working conditions, all new potable water pipelines shall be tested under a hydrostatic pressure of 150 pounds per square inch on the highest part of the section under test. The duration of each pressure test shall be at least two hours. The City Engineer or his representative shall be present for all hydrostatic pressure and leakage tests.

Under the foregoing conditions the leakage shall not exceed the following:

$$L = SDP^{1/2} / 148,000$$

L = allowable leakage, gallons per hour
S = length of pipe, in feet
P = average test pressure, psi
D = nominal diameter, inches

Push-on Joints or Standard Mechanical Joints	0.0828 gallons per hour per inch of pipe diameter per 1,000 ft length for 150 psi test pressure
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Joints that leak shall be repaired and retested under the same conditions and under the same period of operation. If joints are found to be defective, they shall be replaced until the line passes the required test.

Any cracked or broken pipe, fittings, or valves shall be removed and replaced with sound pieces.

Wherever conditions will permit, in the opinion of the City Engineer, the pipes shall be tested before the trench is backfilled. All joints shall be examined during the open trench test and all visible leaks entirely stopped.

The Contractor shall be required to provide all pipe taps, gauges, and corporation stops, as well as any other materials and equipment necessary to expel all air and test the lines.

C1.14 Disinfection

All new water lines shall be flushed and disinfected upon completion of pressure testing in accordance with the recommendation of Standard for Disinfecting Water Mains (AWWA C651) of the American Water Works Association, except as may be modified herein. The Contractor shall furnish sodium hypochlorite, which shall conform to AWWA B300, and injection equipment as needed to complete the disinfection of all pipelines.

As a result of both the pressure and leakage testing and the pipeline flushing operations, the pipeline will be filled with potable water with a free chlorine residual of less than 0.5 mg/l. The disinfection of the pipeline shall proceed by filling the pipeline with the heavily chlorinated water at one end while the low chlorine residual (<0.5 mg/l) potable water in the pipeline is expelled at the other end. Chlorine residual shall be monitored at regular intervals until the pipeline is filled with chlorinated water not less than 20 mg/L free chlorine.

Sodium hypochlorite shall be fed at constant rate at a point not more than 10 feet downstream from the beginning of the new main such that the water flowing into the pipeline will have not less than 20 mg/l free chlorine. A feed pump designed for feeding chlorine solution shall be used for injecting sodium hypochlorite into the pipeline. Sodium hypochlorite is available in liquid form, and contains approximately 12 1/2 to 16% available chlorine. Table 1 provides sodium hypochlorite required to produce 20 mg/L of free chlorine in 100 ft of pipeline which does not have a chlorine demand.

Table 1: Sodium Hypochlorite Required to Produce 20 mg/l
Free Chlorine in 100 feet of Pipe by Diameter

Pipe Diameter (inches)	16% Available Chlorine (Gal. NaOCL)	15% Available Chlorine (Gal. NaOCL)	12.5% Available Chlorine (Gal. NaOCL)
8	.032	.035	.04
12	.07	.08	.09
16	.13	.14	.17
20	.20	.22	.26
24	.29	.31	.37
30	.46	.49	.59
36	.66	.70	.84
48	1.18	1.25	1.51

The chlorinated water shall be retained in the pipeline for at least 24 hours, during which time shall all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this 24 hour period, the treated water in all portions of the main shall have not less than 20 mg/l free chlorine.

The heavily chlorinated water should not remain in the pipeline for more than 48 hours in order to prevent damage to the pipe lining and valve components. The heavily chlorinated water shall be flushed thoroughly from the pipeline, until the replacement water throughout its length will be equal in quality to permanent source of supply. The chlorinated water shall be neutralized by treating with sodium bisulfite, sodium sulfite, sodium thiosulfate or equal approved chemical before disposal to a sewer system. The proposed disposal site shall be approved by the City Engineer.

C1.15 Bacteriological Testing

After water has stood in the pipeline at least 24 hours following final flushing before the water main is placed in service, water samples will be collected from points along the line by the Department of Public Works Water Quality Laboratory personnel and tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater. The Water Quality Laboratory will collect samples for bacteriological tests during normal working hours on Monday to Wednesday. The Contractor shall provide at least 24 hours prior notice to the City Engineer or to the Water Quality Laboratory Manager for arranging water sampling and testing. The Contractor shall assist the Water Quality Laboratory personnel in obtaining water samples for bacteriological testing. The cost of the laboratory testing shall be borne by the City.

Bacteriological tests must show complete absence of coliforms. If tests show presence of coliform, Contractor shall perform additional flushing and disinfection of the pipeline until such time acceptable tests are obtained.

No newly laid water main shall be placed into service until approval is given by the City Engineer.

After the applicable retention period, heavily chlorinated water should not remain in contact with pipe for more than 48 hours. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the system or is acceptable for domestic use. Contractor shall contact the local sewer department to arrange for disposal of the heavily chlorinated water to the sanitary sewer.

The chlorine residual of water being disposed shall be neutralized by treating with one of the chemicals listed in Table 1. If a sanitary sewer system is unavailable for disposal of the chlorinated water, an alternative disposal site must be selected.

The proposed alternative disposal site to which the chlorinated water is to be discharged shall be inspected and approved by the Engineer. A reducing agent shall be applied to the chlorinated water to be wasted to completely neutralize the chlorine residual remaining in the water. (See Table 1 for neutralizing chemicals). Where necessary, federal, state and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

Table 1

Pounds of chemicals required to neutralize various residual chlorine concentrations in 100,000 gallons of water.

Residual

The City of Wilmington, Delaware
Department of Public Works

Chlorine Concentration <u>mg/l</u>	Sulfur Dioxide <u>(SO₂)</u>	Sodium Bisulfate <u>(NaHSO₃)</u>	Sodium Sulfite <u>(NaSO₃)</u>	Sodium Thiosulfate <u>(Na₂S₂O₃.5H₂O)</u>
1	0.8	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
10	8.3	12.5	14.6	12.0
50	41.7	62.6	73.0	60.0