

SECTION 109  
WATER DISTRIBUTION SYSTEM

109.1 GENERAL

Work in this Section includes all water system piping including all valves, hydrants, fittings, anchors, air vents and other appurtenances or material as indicated on the construction plans

109.1.1 Related requirements specified in other Sections of the Specifications:

- A. Chapter 8 - General Construction Standards
- B. Section 103 - Site Clearing
- C. Section 104 - Trenching & Backfilling
- D. Section 106 - Seeding
- E. Section 107 - Sanitary Sewer System

109.1.2 Reference Specifications are referred to by abbreviation as follows:

- A. American National Standards Institute - ANSI
- B. American Railway Engineering Association - AREA
- C. American Society for Testing and Materials - ASTM
- D. American Water Works Association - AWWA

109.2 EXISTING FACILITIES

109.2.1 Domestic Water Service - It shall be the Contractor's responsibility to maintain water service to residents during the life of this project; however, during different phases of construction, it will be necessary to temporarily disrupt water service. Any disruption of water service shall be to the Owner's approval and the Contractor shall give residents sufficient warning of the disruption.

109.2.2 Abandoned Facilities - The Contractor shall abandon the existing water lines by closing valves, cutting/sleeving lines, removing valve boxes, and plugging the lines as directed by the City or as shown on the plans. The Contractor shall remove abandoned fire hydrants as directed. All salvageable materials will be delivered to the City's storage yard. All work associated with this Article will be considered incidental to the project and will have no separate pay item unless specifically identified on the bid schedule.

### 109.3 PRODUCTS

Submit shop drawings on all products as required by the City. Provide certified test results of pipe testing.

- 109.3.1 Ductile iron pipe shall meet requirements of AWWA C151, Class 350. All pipe shall have a cement mortar lining on the interior and a bituminous coating on the exterior. Unless otherwise noted, all joints shall be slip joints.
- 109.3.2 Copper tubing shall meet requirements of ASTM B88 for Type "L" copper, hard drawn, for above ground and Type "K" hard drawn for below ground.
- 109.3.3 Polyethylene (PE) Pressure Pipe and tubing shall meet requirements of AWWA C904 and NSF/ANSI 61, 1/2 inch (13mm) through 3 inches (76mm) for Water Service. PE tubing shall be minimum pressure class 200, copper tube size, meeting the requirements of AWWA C904. Couplings for use in joining gravity pipe of differing materials and/or sizes shall be push on type.
- 109.3.4 2" thru 3" Water Line - To be galvanized steel pipe, exceeding requirements of ASTM A53, threaded joint, with malleable iron fittings.
- 109.3.5 Steel casing pipe for boring, jacking, or open cutting under highways and railroads shall meet the requirements of ASTM A139, Grade B. Nominal pipe diameter shall be as indicated on the Drawings. Wall thickness shall be a minimum of 0.375": No protective coating or lining will be required.
- 109.3.6 Fittings shall be ductile iron. Ductile iron fittings shall be in accordance with AWWA C110 or C153. Pressure rating shall be 350 psi All fittings shall be mechanical joint, or mechanical joint plain end unless otherwise approved by the Engineer. All fittings shall have a cement mortar lining on the interior and a bituminous coating on the exterior in accordance with AWWA C104.
- 109.3.7 Ductile Iron Fittings - To be ANSI & AWWA Specification, cement line, Class 350 with mechanical joints.
  - A. Mechanical joint retainer glands shall meet requirements of AWWA C111 except that retainer gland shall be modified to accommodate set screws.
  - B. Locked type mechanical joints may be used where restrained joints are required.
- 109.3.8 Push-on joint and rubber gasket shall meet requirements of AWWA C111. Restrained push-on joints may be used where restrained joints are required.
- 109.3.9 Flanged joints for ductile iron pipe shall meet requirements of ANSI B16.1.
- 109.3.10 Flanged joint gaskets shall be full-face, made of rubber, and shall meet requirements of ANSI B16.21.

- 109.3.11 Cement mortar lining with bituminous seal coat for ductile iron pipe and fittings shall meet requirements of AWWA C104. Cement mortar lining shall be standard thickness.
- 109.3.12 Exterior, bituminous coating for ductile iron pipe and fittings and shall meet requirements of AWWA C106 or AWWA C151 as applicable.
- 109.3.13 Metal harness shall be galvanized rods and clamps as detailed on Drawings.
- 109.3.14 Detector Check Valves shall be epoxy coated UL and FM approved, hot dipped galvanized cast iron with brass by-pass meter trim. Valves shall be ITT Grinnell/Kennedy Model 1371G, or 1369G Hersey Model EDC, Mueller #4-2133-6, Viking Model E-1, Ames 3000 DCDA 4"-10", Wilkins 950 DA 2-1/2"-10", Grinnell Model B-2 detector check valves, or approved equal.
- 109.3.15 Gate valves, smaller than 12 inches shall be iron body, non-rising bronze stem and resilient wedge gates meeting the requirements of AWWA C509 or AWWA C515. Valve ends shall be mechanical joint for underground service or flanged for meter vaults and above ground service. Valves shall open counter-clockwise and shall be equipped with a 2-inch square AWWA operating nut. Valves shall be factory tested in accordance with AWWA C509 and upon request the manufacturer shall furnish certified copies of test reports.
- A. Valves shall be American Flow Control, Clow, Dresser, Kennedy, Mueller, A.P. Smith, or approved equal meeting this Specification.
- 109.3.16 Butterfly valves, 12 inches through 24 inches shall be of the rubber-seated tight closing type meeting requirements of AWWA C504, Class 250B.
- A. Valve ends shall be mechanical joint in accordance with AWWA C111. Accessories (bolts, glands, and gaskets) shall be supplied by the valve manufacturer.
- B. Valve operators shall be of the traveling-nut type, sealed, gasketed and lubricated for underground service. Operators shall be capable of withstanding an input torque of 450 ft. lbs. at full open or closed position, without damage to the valve and valve operators.
- C. A rubber seat may be applied to the body or the disc.
- D. Valves shall open counter clockwise and shall be equipped with a 2-inch square AWWA operating nut.
- E. Valves shall be factory tested in accordance with Section 5 AWWA C504 specification; and upon request, the manufacturer shall furnish certified copies of test reports.
- F. Valves shall be American-Darling, Dresser "450", Mueller "Linesal XP", Pratt "HP 250II", or approved equal.

- 109.3.17 “Hot Tap” valves shall be the equivalent of The Romac 7.00 310-0700010 Quickvalve and sleeve. Valves shall open counter clockwise and shall be equipped with a 2” square operating nut.
- 109.3.18 Valve boxes shall be 2-piece adjustable screw type, cast iron, Tyler Model No. 562-S or Capitol Foundry Model No. 562-S-HD.
- 109.3.19 Pressure Reducing Valve.
- A. Valves shall be hydraulically operated and shall generally function to reduce high upstream pressure to a preset lower downstream pressure without shock or hammer.
  - B. The valve body shall be cast iron with 125 lb. flanges. The piston shall be guided above and below the seat. The piston, seat, and guide shall slide on replaceable "leathers." No metal-to-metal sliding contact will be allowed.
  - C. The valve body shall be constructed to allow the removal and servicing of all parts without removing the valve body from the water line. An indicator shall be furnished as an integral part of the valve to show piston position within the body.
  - D. The working pressure (both HIGH PSI and LOW PSI) shall be determined by the Engineer, approved by the City and shown on the Plans. The valve shall be ordered with the PSI specified and the factory shall preset the pilot for the specified pressure.
  - E. The external pilot (although preset to the specified pressure when shipped from the factory) shall be field adjustable between 40 and 100 PSI.
  - F. The valve shall be a Cla-Val or approved equal.
- 109.3.20 Tapping Sleeve and Valves shall be Mueller H-615 tapping sleeve with duck tipped end gasket and H-667 tapping valve open left, or approved equal. The contractor shall provide all material and labor with the exception that the City will use its tapping machine to make the tap. The contractor needs to schedule this service with the City's Utilities Superintendent. An alternate tapping sleeve can be all stainless steel (18-8 type 304) Style FAST as manufactured by Ford Meter Company, or approved equal.
- 109.3.21 Flexible couplings shall be of gasketed, sleeve type. Each coupling shall consist of a steel middle ring, two steel followers, two rubber compounded wedge section gaskets and sufficient galvanized track, head steel bolts to properly compress the gaskets. Couplings shall be of the type to match piping in which installed. Couplings shall be manufactured by Dresser Manufacturing Division of Dresser Industries, Smith-Blair, Ford, or approved equal.

109.3.22 Fire Hydrants shall be Mueller "Centurion" Model A-421 or Kennedy "Guardian" with 6" shoe, mechanical joint, two 2 1/2" hose nozzles, or approved equal, and one 4 1/2" pump connection with National Standard outlet threads, left turn open with 1 1/2" pentagon operating nut. Hydrant bury mark to match ground surface. One cubic foot stone pocket to be installed at Hydrant Drain. Hydrants to be painted according to AWWA standards. All paints currently being used are Pittsburg Paints Interior/Exterior Gloss Oil, other equivalent paints are acceptable. The colors and Pittsburg code follows:

Blaze Orange	6-313
Black	6-253
Safety Yellow	6-330
Brilliant Red	6-306
Ivy Green	#7013

109.3.23 Flanged adapters for joining plain-end pipe to flanged items shall be Style 128 or 127 as manufactured by Dresser Manufacturing Division of Dresser Industries or Smith-Blair Type 912 or 913, or approved equal.

109.3.24 Pressure gauges shall be open front case type with bronze bourdon tube soldered to socket and tip, stainless steel movement, and a 4-1/2-inch white coated dial graduated from 0 to 100 psi. Gauges shall be similar to Ashcroft No. 1279.

109.3.25 Concrete Thrust Blocks - Install concrete thrust blocks at all appurtenances except under valves. Concrete to be Class C1-1500 psi using Type I cement. Contractor may use retainer glands in lieu of concrete thrust blocks for 11 1/4 and 22 1/2 bends. The MEGALUG by EBAA Iron, INC., or approved equal, is an acceptable alternate.

109.3.26 Service Connection

- A. The Type I service connection shall include corporation stop, water main tap, replacement of meter yoke assembly and box (furnished by the City), connection of service line to both sides of yoke assembly, and connection to the existing service line behind the meter with check valve installed.
- B. The Type II connection shall include water main tap, corporation stop, and connection of the service line to the existing service line at its point of connection to the existing water main with a three-part union or compression coupling. All galvanized service lines encountered shall be treated as a Type I service connection.
- C. The Type III Service Connection includes a 1" Corporation Stop, water main tap, splitting the service line with a "Y", placement of two (2) meter yokes assembly and box and connection of service line to both sides of the yoke assembly and connection to the existing service line behind the meter with check valve.

109.4 EXECUTION

109.4.1 Pipe Laying

- A. Take all precautions necessary to ensure that pipe, valves, fittings, and other accessories are not damaged in unloading, handling, and placing in trench. Examine each piece of material just prior to installation to determine that no damage has occurred. Remove any damaged material from the site and replace with undamaged material.
- B. Exercise care to keep foreign material and dirt from entering pipe during storage, handling, and placing in trench. Close ends of in-place pipe at the end of any work period to preclude the entry of animals and foreign material.
- C. Bedding of pipe shall be as specified in Section 104 - Trenching & Backfilling.
- D. Do not lay pipe when the trench bottom is muddy or frozen, or has standing water.
- E. Use only those tools specifically intended for cutting the size, material, and type pipe involved. Make cuts to prevent damage to pipe or lining and to leave a smooth end at right angles to the axis of the pipe.
- F. Lay pipe with bell ends facing the direction of laying. Where grade is 10 percent or greater, lay pipe uphill with bell ends up grade.
- G. Separation of sanitary sewer lines and water lines shall be in accordance with Virginia Department of Health and Regulations.

109.4.2 Joining Mechanical Joint Pipe

- A. Thoroughly clean inside of the bell and 8 inches of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating and other foreign matter. Paint the bell and the spigot with soap solution (half cup granulated soap dissolved in 1-gallon water). Slip cast-iron gland on spigot end with lip extension of gland toward end of pipe. Paint rubber gasket with or dip into the soap solution and place on the spigot end with thick edge toward the gland.
- B. Push the spigot end forward to seat in the bell. Then press the gasket into the bell so that it is located evenly around the joint. Move the gland into position, insert bolts and tighten nuts finger tight. Then tighten all nuts to the torque listed below:

Bolt Size - Inches	Torque Foot-Pounds
5/8	40-60
3/4	60-90
1	70-100
1-1/4	90-120

Tighten nuts on the alternate side of the gland until pressure on the gland is equally distributed.

- C. Join lock-type mechanical joint pipe according to manufacturer's recommendations.
- D. Permissible deflection in mechanical joint pipe shall not be greater than 2/3 of that listed in AWWA C600.
- E. Permissible deflection in lock-type mechanical joint pipe shall be as recommended by manufacturer.

#### 109.4.3 Joining Push-On Joint Pipe

- A. Thoroughly clean inside of the bell and 8 inches of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating, and other foreign matter. Flex the rubber gasket and insert it in the gasket recess of the bell socket. Apply a thin film of gasket lubricant supplied by the pipe manufacturer, to either the gasket or the spigot end of the joining pipe. Start the spigot end of the pipe into the socket with care. Then complete the joint by forcing the plain end of the bottom of the socket with a forked tool or jack-type device. File the end of field cut pipe to match the manufactured spigot end.
- B. Join restrained push-on joints according to the manufacturer's recommendations.
- C. Permissible deflection in push-on joint pipe shall not be greater than 2/3 of that listed in AWWA C600.
- D. Permissible deflection in restrained push-on joint pipe shall be as recommended by the manufacturer.

#### 109.4.4 Setting Valves and Valve Boxes

- A. Install valves with operator stems in the vertical plane through the pipe axis and perpendicular to the pipe axis. Locate valves where shown on Drawings. Thoroughly clean valves before installation. Check valves for satisfactory operation before and after installation.
- B. Equip all underground valves with valve boxes where shown on the Drawings. Set valve boxes in accordance with Standard Drawings. Set the valve box in alignment with the valve stem centered on the valve nut. Set the valve box to prevent transmitting shock or stress to the valve. Set the box cover flush with the finished ground surface or pavement. PVC extensions shall not be permitted.

- 109.4.5 Locate Fire Hydrants as shown on Drawings and in accordance with Standard Drawings. The bottom flange of the fire hydrant shall be at finish grade with an acceptable allowance of up to 6" above finish grade.

- 109.4.6 Provide air and vacuum valves at locations shown on Drawings. Install gate valves between the water main and relief valves. Construct manholes for air and vacuum relief valve as shown on Drawings.
- 109.4.7 Use sleeves where pipes, valve stem extensions or equipment parts pass through concrete or masonry walls or slabs. Sleeves shall be either cast iron or schedule 40 steel of sufficient size to allow sealing around pipes and clearance for valve stems or equipment. Extend vertical sleeves through slabs 1 inch above top surface.
- A. Use cast iron sleeves with intermediate collars to anchor and provide a water stop on outside of sleeves that go through exterior walls below grade.
  - B. Provide "link-seal" pipe to wall closures manufactured by Thunderline Corp., Wayne, Michigan, or approved equal, where shown on Drawings. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to fill annular space between pipe and wall opening to provide water-tight seal between pipe and wall opening.
- 109.4.8 Provide reaction thrust blocks as shown on typical details
- A. Concrete reaction anchors shall bear against undisturbed earth and shall be of the size and shape shown on the typical details.
  - B. Use metal harness restraints as shown on Drawings.
  - C. "Mega-Lug" retainer glands may be used on bends of 22 ½ degrees or less in lieu of a concrete thrust block.
  - D. Where retainer glands are used, extreme care shall be taken so that each set screw is tightened as recommended by the manufacturer before the pipe is backfilled and tested.
- 109.4.9 When specified, encase water pipelines crossing under highways and railways in a larger pipe or conduit called a casing pipe. Joining of steel casing pipe shall meet requirements of AWWA C206. Install by jacking, boring or open cut if permitted. The carrier pipe shall be supported by full diameter, mechanically adjusted spacers, 8' on center. The installation shall meet requirements of AREA Standards for installation of pipelines carrying nonflammable substances under railway tracks. Brick up casing pipe ends to protect against foreign matter, but do not tightly seal. Prior to beginning work, notify the Railroad or Street Department.
- 109.4.10 Installation of Tapping Sleeves and Tapping Valves
- A. All tapping sleeves shall be set to avoid interference with existing pipe joints.

- B. The contractor shall provide and install the tapping sleeve and valve. Unless otherwise noted the City will make the tap for main lines (no service taps will be made by the City). This service must be scheduled with the Department 48 hours in advance of the tap.

109.4.11 Acceptance Tests; Refer to AWWA C600-17.5

- A. When water is available at the site; the owner will supply water at no cost for testing potable water lines only.
- B. After the line has been backfilled and at least seven days after the last concrete reaction anchor has been poured, subject the line or any valved section of the line to a hydrostatic pressure test in accordance with AWWA C600-17.5, except as modified herein. Fill the system with water at a velocity of approximately 1 foot per second while necessary measures are taken to eliminate all air. After the system has been filled, raise the pressure by pump to the target pressure, as follows: The test pressure shall not be less than 1.25 times the stated working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section. Additionally, test pressures shall:
- (1) not exceed thrust restraint pressure,
  - (2) not vary by more than + or - 5 psi,
  - (3) not exceed twice the rated pressure of the valves or hydrants when the test includes closed gate valves and/or hydrants,
  - (4) not exceed rated pressure of valves if resilient-seated butterfly valves are used,
  - (5) be at least 100 psi.

Measure pressure at the low point on the system compensating for gauge elevation. Maintain this pressure for two hours. If the pressure cannot be maintained, determine the cause, make repairs and repeat the test until successful.

- C. A leakage test shall be conducted concurrently with the pressure test. Leakage (L) or Testing Allowance is defined as the quantity of water required to maintain a pressure within 5 psi of the specified test pressure, after air has been expelled and the pipe is filled with water. Allowable Leakage for a passing test result is calculated by the following formula:

In inch-pound units,

$$L = (SD\sqrt{P})/148,000$$

Where:

L = Allowable Leakage (gal/hour)

S = Length of pipe tested (ft)

D = Nominal diameter of the pipe (in.)

P = Average test pressure during the hydrostatic test (psi [gauge])

Allowable Leakage (or “testing allowance”) can also be found in AWWA 600-17 Table 5A for pipe lengths under 1000 linear feet. This formula is based on an Allowable Leakage of 10.49 gallons per day per mile per inch of nominal diameter at a pressure of 150 psi. If leakage exceeds that specified, ensure all air has been expelled, find and repair any leaks, and repeat the test until successful.

D. All visible leaks shall be repaired regardless of the amount of leakage.

109.4.12 Refer to AWWA C651-14. Disinfect, flush and test water mains and accessories in accordance with the procedures listed below. The water used in the disinfecting process shall be potable water from an approved supply. If water is to be transported to the subject site, then the tank on the truck must also be properly disinfected prior to transporting water. Disinfection of the vehicle should also include all appurtenances used such as valves, hoses, etc.

A. Preliminary Flushing: The main shall be flushed prior to disinfection, except when the tablet method is used. Flushing shall be at a velocity of not less than 3.0 feet/second. Adequate provisions shall be made for drainage of flushing water.

B. Form of chlorine for Disinfection:

- (1) Liquid chlorine shall be used only when suitable equipment is available and only under the direct supervision of a person familiar with the physiological, chemical, physical properties of this element, and who is properly trained and equipped to handle any emergency that may arise. Introduction of chlorine-gas directly from the supply cylinder is unsafe and shall not be permitted.
- (2) Calcium hypochlorite contains 70 percent available chlorine by weight. It shall be either granular or in tablet form. The tablets, 6-8 to the ounce, are designed to dissolve slowly in water. A chlorine-water solution shall be prepared by dissolving the granules in water in the proportion requisite for the desired concentration.
- (3) Sodium hypochlorite is supplied in strengths from 5.25 to 16 percent available chlorine. The chlorine-water solution shall be prepared by adding hypochlorite to water. Product deterioration shall be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.
- (4) Application: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically-powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum

pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

C. Methods of Chlorine Application:

- (1) Continuous Feed Method: Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate into the newly-laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 MG/L available chlorine. To assure that this concentration is maintained, the chlorine residual shall be measured at intervals not exceeding 2,000 feet in accordance with the procedures described in the current edition of "Standard methods" and AWWA M12-"simplified procedures for water examination." In the absence of a meter, the rate may be determined either by placing a pilot gauge at the discharge or by measuring the time to fill a container of known volume. Table 1 gives the time to fill a container of known volume, and gives the amount of chlorine required for each 100 feet of pipe of various diameters. Solutions of 1 percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately 1 lb. of calcium hypochlorite in 8.5 gallons of water.

TABLE 1  
CHLORINE REQUIRED TO PRODUCE 50 MG/L CONCENTRATION  
IN 100 FT. OF PIPE – BY DIAMETER

PIPE SIZE	100% CHLORINE	1% CHLORINE SOLUTION
IN.	LB.	GAL.
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
16	0.430	5.12
20	0.675	8.00

During the application of the Chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. The chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least 24 hours, during which time 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 shall contain no less than 25 MG/L chlorine throughout the length of the main.

- (2) Slug Method (use only if authorized by the Utilities Department): Water from the existing distribution system or other approved source of supply shall be made to flow at a constant, measured rate into the newly laid pipeline. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 MG/L. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or “slug” of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 MG/L for at least 3 hours. The application shall be checked at a tap near the upstream end on the line by chlorine residual measurements.

As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated so as to disinfect appurtenances.

- (3) Tablet Method: Use only when scrupulous cleanliness has been exercised, because preliminary flushing cannot be used. Do not use this method if trench water or foreign material has entered the main or if the water is below 41 deg. F (5 deg. C). This method may be used for mains up to 12 inches in diameter and where the total length of the main is less than 2,500 feet. Tablets shall not be used with PVC pipe.

Place tablets in each section of pipe and also in hydrants, hydrant branches, and other appurtenances. Attach tablets using Permatex No. 1 adhesive or other adhesive approved by the engineer, except for the tablets placed in hydrants and in the joints between the pipe sections. Tablets shall be free of adhesive except on the one broad side to be attached. Place all tablets at the top of the main. If the tablets are attached before the pipe section is placed in the trench, mark the position of the tablet in the pipe and assure that the pipe is placed with the tablet at the top.

The following table shows the number of 5 grain HTH tablets necessary per joint of pipe to obtain 50 PPM chlorine:

PIPE SIZE	TABLETS PER 18-20 FEET JOINT
4 IN	1
6 IN	2
8 IN	3
10 IN	4
12 IN	7

When installation is completed, fill the main with water at a velocity of less than 1 foot per second. The water shall remain in the pipe for at least 24 hours. Operate valves so that the strong chlorine solution will not flow back into the line supplying the water.

- D. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration is no higher than that generally prevailing in the system, or less than 1 MG/L. Chlorine residual investigation shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline. Flushing shall be through a fire hydrant. When a fire hydrant is not available for complete flushing, it shall be through a minimum 2” tap to ensure removal of any debris in the pipe.
- E. Bacteriologic Tests:
  - (1) Refer to AWWA C651-14. After final flushing, and before the water main is placed in service, samples shall be collected and tested for bacteriological quality and shall show the absence of coliform organisms. At least two samples shall be collected at least 16 hours apart at intervals not exceeding 1,200 feet and tested by a State Health Department approved laboratory and the results shall be submitted to the engineer.
  - (2) Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. If laboratory results indicate the presence of coliform bacteria, the samples are unsatisfactory and disinfection shall be repeated until the samples are satisfactory. Cleaning, disinfection and testing shall be the responsibility of the contractor. Water for these operations will be furnished by the owner, but the contractor shall include in his bid the cost of loading, hauling, and discharging the water.

(3) A sampling tap consisting of a corporation cock with metal pipe shall be installed within two feet of valves. The corporation stop inlet shall be male, one inch in size, and the outlet shall have one inch I.P. threads and a cap.

F. Testing and disinfection of the completed sections shall not relieve the contractor of his responsibility to repair or replace any cracked or defective pipe. All work necessary to secure a tight line shall be at the contractor's expense.

#### 109.5 MEASUREMENT AND PAYMENT

- 109.5.1 Waterline - Measurement shall be parallel to the pipe including the length occupied by appurtenances. Bid price shall include all excavation bedding and backfill. Payment shall be per linear foot for the size and type specified.
- 109.5.2. Valves - Measurement shall be per each installed. The bid price shall include all incidental materials, including the valve box. Payment shall be per each for the size and type specified.
- 109.5.3 Bends, Plugs, and Reducers - Measurement for ductile iron fittings shall be based on the weight of the fitting only (no miscellaneous hardware). Payment shall be at the bid price per pound. The price shall include all incidental work and thrust blocks.
- 109.5.4 Tees and Crosses - Measurement and payment shall be per each for the size specified. All incidental materials and work shall be included.
- 109.5.5 Tapping Sleeve and Valve – Measurement and payment shall be per each for the size specified. All incidental materials and work shall be included.
- 109.5.6 Fire Hydrant - Measurement and payment shall be per each. The cost of fire hydrant extensions is to be included in the bid price. All other incidental materials and workmanship shall be included. The cost of valves, tees, and water line shall be paid for separately.
- 109.5.7 Service Line - Measurement will be per lineal foot of line installed including all associated work. Payment will be the bid price per lineal foot installed for the size indicated.
- 109.5.8 Air Release Valve - Measurement and payment shall be per each including all incidental materials and workmanship. The bid price shall also include the valve vault. Service line shall be paid for separately.
- 109.5.9 Service Connections - Measurement will be per each type connection made including all miscellaneous materials and associated work. Payment shall be the bid price per each for the appropriate type. Service line shall be paid for separately.
- 109.5.10 Existing Line Abandonment - When specified as a separate item on the Bid Schedule, payment shall be lump sum for all efforts and material to locate the

existing line and performing the directed abandonment. Line abandonment shall be identified as being valve closure or remove and splice.

- 109.5.11 Connection to existing water system – Measurement and payment shall be per each with no regard to size. This work involves connecting the new water system with the existing water lines after line testing and acceptance. Separate payment will be made for all related pay items such as pipe, bends, valves, etc. This pay item is separate from a main line wet tap.
- 109.5.12 Blow Off – Measurement and payment shall be per each and shall include the tee, valve, and pipe, blow off and box.
- 109.5.13 Check Valve – Measurement and payment shall be per each and include installation of the check valve and vault.
- 109.5.14 Concrete Restoration - All concrete sidewalk, curb and gutter disturbed during construction, shall be replaced at the Contractor's expense. Full sections will be replaced. Payment is incidental unless a separate pay item is listed.

END OF WATER DISTRIBUTION SYSTEM