

# WATER LINE CONSTRUCTION

## A. General:

1. Except as specifically modified below, water line construction shall meet the requirements of AWWA C600, latest edition standards. Pipe, fittings, valves, hydrants, and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe shall be so handled that any coating or lining is not damaged.

2. The water main shall be laid and maintained to the required lines and grades with fittings, valves, hydrants and accessories set at the required locations as indicated on the approved plans for the project. All valve and hydrant stems shall be set plumb. Whenever obstructions not shown on the plans are encountered during progress of the work and interfere to such an extent that alteration in plans is required, the County, or its authorized representative, shall be advised and their approval given before such alterations are put into effect. Any such alternative design shall be designed or approved by the Engineer of record for the original design.

3. All water shop drawings/cut sheets shall be submitted by the contractor to both the design engineer and the Botetourt County Public Works Department for review and approval prior to construction. Botetourt County will require three (3) complete sets of shop drawings for review.

4. The contractor shall schedule a preconstruction meeting to be attended by the contractor's site superintendent, design engineer, the design engineer's field representative/inspector, representatives from Botetourt County Utility Department and representatives from Botetourt County Engineering Department and any materials suppliers the contractor feels necessary.

5. The contractor shall obtain a copy of the most current edition of Botetourt County Water and Sewer Construction Standards and Specifications and provide proof (a letter) that the contractor has and is familiar with the requirements therein.

6. Record drawings / field red line drawings shall be maintained by the site superintendent.

## B. Excavation, Bedding and Backfill:

1. The trench shall be dug so that the pipe can be laid to the alignment and depth required and it shall be excavated not more than five hundred (500) feet in advance of the completed pipe laying operation. The width of the trench shall be ample to permit the pipe to be placed, backfilled and thoroughly compacted in accordance with the requirements of these specifications. Trenches shall be of such extra widths as will permit the convenient placing of timber supports, sheeting and bracing and handling of special fittings or appurtenances when required.

2. The trench shall be excavated to the depth required so as to provide a uniform and continuous bearing and support for the pipe on solid and undisturbed ground at every point between bell holes; except that it will be permissible to disturb and otherwise damage the finished surface over a maximum length of eighteen (18) inches near the middle of each by the withdrawal of pipe slings or other lifting tackle. The damaged area shall be refinished as near as possible. The part of the bottom of the trench excavated below the specified grade shall be backfilled with approved materials and be thoroughly compacted. The finished subgrade shall be prepared accurately by means of hand tools.

3. Bedding shall be placed as required by the pipe manufacturers written instructions.

4. Where excavation is made in fractured rock, boulders or other unsuitable material, the subgrade shall be made by backfilling with a minimum of four (4) inch compacted depth of gravel or clean selected soil which shall be thoroughly compacted.

5. Bell holes shall be provided at each joint to permit the jointing to be made properly and to permit maximum bedding length.

6. Ledge rock, boulders and large stones shall be removed to provide a clearance of at least six (6) inches below and on each side of the pipe and appurtenances being laid and any part, projection or joint of such rock stone.

7. No pipe shall be laid in water or when, in the opinion of the County or their authorized representative, trench conditions are unsuitable.

8. Backfill shall be placed in 6 inch lifts and mechanically tamped to ninety five (95) percent of the maximum theoretical density as determined by ASTM D698 Standard Proctor Test. Backfill material shall be free of perishable material, frozen clods, sticky masses of clay and other unsuitable matter. Rock pieces larger than two (2) inches shall not be used in the backfill which is within twelve (12) feet of the pipe. Backfill within existing or proposed roads shall meet the requirements established and required by the Virginia Department of Transportation.

## C. Installation of Pipe and Fittings

1. When installing pipe in the trench proper implements, tools, and facilities satisfactory to the County and as recommended by the material manufacturer shall be provided and used by the contractor for the safe and convenient prosecution of the work. All pipe, valves, fittings, hydrants, and accessories shall be carefully lowered into the trench, piece by piece, by means of a derrick, ropes, slings or other suitable tools or equipment in such a manner as to prevent damage to the water main material and any protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench. The pipe and fittings shall be inspected for defects, and while suspended above grade, be rung with a light hammer to detect cracks.

2. All lumps, blisters and excess coal tar coatings shall be removed from the ends of ductile iron pipe and the outside of the spigot and the inside of the bell shall be wiped clean, dry and free from oil and greases before the pipe is laid.

3. Every precaution shall be taken to prevent foreign material including non-potable water from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into, a heavy tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations no debris, tools, clothing, or other materials shall be placed in the pipe. At the end of each day a watertight plug shall be placed in the end of all pipe openings.

4. After placing a length of pipe in the trench, the spigot end shall be centered in the open bell of the pipe line and the pipe pushed home so that the face of the spigot is in close contact with the shoulder of the bell. Water pipe shall be laid with the bell facing the direction of the laying.

5. No stub of any water main shall terminate with a capped or plugged valve. Where a valve is required to be installed near a stub end, one joint of pipe shall be installed after the valve. The pipe shall be plugged and a concrete kick block poured behind it.

6. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe.

7. When machine cutting is not available for cutting metal pipe twenty (20) inches in diameter or larger, the electric-arc cutting method will be permitted using a carbon or steel rod. Only qualified and experienced workmen shall be used for this work. The flame cutting of metal pipe by means of oxyacetylene torch will not be permitted.

8. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or plumb stems, or where long-radius curves are approved, the amount of deflection allowed shall not exceed the minimum required, for satisfactory jointing of the pipe. The maximum deflection permitted per joint shall be in accordance with AWWA C600 Table 4 for push-on joint and Table 5 for mechanical joint pipe.

9. All tees, bends, plugs, caps and fire hydrants shall be substantially braced, blocked and/or strapped to prevent any movements by providing adequate reaction blocking and/or tie rods. Reaction blocking shall be designed and installed as indicated in the standard details.

10. Hydrants shall be set to finished grade as follows:

a. Bottom of the four and one-half (4-1/2) inch nozzle shall be between eighteen (18) inches and twenty-four (24) inches above finish elevation of the edge of the shoulder on streets without curb and gutter and between eighteen (18) inches and twenty-four (24) inches above the elevation of the curb on streets with curb and gutter as indicated on the standard details.

b. The two and one-half (2 1/2) inch hose connections shall have a minimum of six (6) feet clearance on all sides.

c. Surface shall be approximately level within a six (6) foot radius of the hydrant.

## D. Testing

1. All new water mains shall be tested after backfilling to a hydrostatic pressure of not less than 150 psi. Allowable leakage shall be calculated by the following formula:

$$L = \frac{SDP \cdot L}{133,200} \quad \text{Where: } L = \text{allowable leakage in gallons per hour}$$

$$S = \text{length of pipe tested in feet.}$$

$$D = \text{nominal diameter of pipe in inches.}$$

$$P = \text{average test pressure during leakage test in psi}$$

Allowable leakage is shown in columnar form in Table 6.

2. No water line shall be placed in service until the leakage is less than the allowable leakage as indicated above. Testing of water mains shall only be done after installation of all valves, taps and service laterals are complete. All portions of the water system, including hydrants and service lines, shall be subject to the hydrostatic pressure during the leakage test. Testing of water mains shall be observed and documented by the design engineer. All testing shall be coordinated with Botetourt County Department of Public Works.

3. All high points and service lines in the portion of the system under test shall be vented and all air shall be expelled from the system prior to beginning the test. All fittings and hydrants shall be properly braced or blocked before applying pressure. Where concrete thrust blocks are used, they shall have attained their final set prior to testing.

4. After the portion of the system under the test has reached the required pressure as stated herein, said pressure shall be maintained for two (2) hours. At the conclusion of the pressure test, the volume of makeup water required to refill the pipeline shall be determined by measurement with a displacement meter or by pumping from a vessel of known volume.

5. All joints or fittings at which leakage occurs shall be re-worked to insure tightness. All visible leaks shall be repaired regardless of amount of leakage. If the measured amount of leakage exceeds the values for the appropriate size as found in AWWA Specifications C600, Hydrostatic Testing (Table 6), the pipe-line shall be repaired and re-tested until leakage is within the limit set by the referenced specification. Methods of repair prior to re-testing will be done with the County's approval and inspection. Repairs of new construction will be by adjustment or replacement of material only. The use of repair clamps or bell clamps will not be acceptable.

## Waterline Pipe, Fittings, and Accessories

### A. General

1. All pipe for water main construction shall be either ductile cast iron pressure pipe of the push-on joint or mechanical joint variety, conforming to AWWA C151, latest revision. Thickness class 52 for all pipe twelve (12) inches in diameter or less. Water mains larger than twelve (12) inches diameter in size shall have thickness class as determined by thickness design of ductile-iron pipe AWWA C150 or:

2. Moleculary Oriented Polyvinyl Chloride (PVC) pressure pipe conforming to AWWA C909, dimension Ratio (DR) 18, shall be minimum for water pipe. SDR-21 in two (2) inch size only may also be used where approved by County.

### B. Ductile Cast Iron Standard Mechanical Joint Pipe

1. All ductile cast iron standard mechanical joint water pipe shall conform to ANSI Specification A21.51 and shall be lined with cement mortar and have a protective exterior coating. The linings and protective coatings equal to "Enameline" with tar coating in the exterior will be considered as a satisfactory lining for the water pipe, however, any substitution in pipe lining and/or coating from ANSI A21.4 shall be specifically approved by the County. Joints of standard mechanical joint pipe shall conform to ANSI Specifications A21.1.

2. High strength cast iron tee head bolts, hex nuts, caps or ductile iron glands and rubber gaskets shall be as furnished by the pipe manufacturer. All tie bolts and nuts shall be constructed of the same size and type material as head bolts and hex nuts.

3. In making connections of ductile cast iron pipe using the standard mechanical joint the gland followed by the rubber gasket shall be placed over the plain end of the pipe which shall be carefully inserted and aligned into the socket end of the pipe. Gasket shall then be pushed into position so that it is evenly seated in the socket. The gland shall then be moved into position against the face of the gasket, bolts, inserted and made finger tight. Bolts shall then be tightened in accordance with AWWA C600 Table 3 (75-90 ft-lb torque for pipe size 4-12"). All other requirements concerning bedding, alignment, and cleaning of the pipe before making the joint shall be followed.

### C. Ductile Cast Iron Pipe-Push on Joint

1. All push-on or "slip" joint pipe shall conform to the requirements of standard mechanical joint pipe in regard to strength, class, protective coatings, etc.

### D. Moleculary Oriented Polyvinyl Chloride (PVC) pressure pipe

1. PVC pipe meeting the AWWA Specification C909 for DR 18, pressure class 150 may be used for water lines.

a. PVC pipe shall be installed, embedded and backfilled according to the manufacturers written instructions. To facilitate future locating of PVC water pipe, a copper wire, size 10, shall be laid with the pipe and in contact with all fittings and valves as shown on the Water Detail Drawing.

b. All service line connections to PVC pipe shall be made using a service saddle and corporation stop. Service saddle shall be of a type specifically manufactured for PVC pipe and shall be extra wide or double-band type. No direct tap to PVC pipe will be permitted.

c. Only bell and spigot with elastomeric gasket joints shall be used. Solvent-cement joints or pipe requiring couplings shall be used.

d. SDR-21 shall be used for all pipe sized two (2) inch.

e. For lines five (5) foot or deeper, a monument (as shown on the Water Detail Drawing) shall be installed every five-hundred (500) feet of water line installed.

### D. Cast Iron Pipe Fittings

1. Fittings for all water pipes shall be ductile iron or gray cast iron in accordance with AWWA Specification C110, latest revision, with a minimum pressure rating of 250 psi.

### E. Gate Valve

1. All gate valves shall be of superior quality thin-walled, ductile iron valves, manufactured by American Flow Control. The valves shall be resilient seat, epoxy coated bronze mount type. All gate valves shall withstand a working pressure of 200 psi and shall be in strict conformance to all applicable AWWA Standards. Wrench nut shall turn to the left (counterclockwise) to open the valve. Valves shall be so arranged to fit into pipe lines having standardized mechanical joints or slip joints. All gate valves shall be resilient seat type valves meeting AWWA C509, latest revision standards.

2. On valves fourteen (14) inches or larger, butterfly valves conforming to AWWA C504 may be used.

### F. Fire Hydrants

1. All hydrants shall be traffic model, Dry-barrel type, meeting AWWA C502, latest revision standard; American Flow Control B 84 B. Hydrants shall be of the compression type with main valve openings not less than four and one-half (4-1/2) inches in diameter. Hydrants shall have a cast or ductile iron body with flange trim and shall withstand a hydrostatic test pressure of 300 psi. Hydrants shall have a six (6) inch connection base for setting with a minimum of thirty-six (36) inch cover on connection pipe. Hydrants shall be equipped with hose connections as follows:  
Two (2) each, 2-1/2" N.S.T. hose connections  
One (1) each, 4-1/2" N.S.T. pumper connection

2. Hydrant shall be operated by a National Standard one and one-half (1-1/2) inch pentagon shaped operating nut, opening counterclockwise. The direction of opening shall be clearly marked by an arrow cast on the outside of the hydrant. Hydrants shall be connected to the main with a six (6) inch pipe and shall be controlled by an independent six (6) inch gate valve. The six (6) inch gate valve shall be located as near to the service main as practical and connected to the tee with tie rods.

3. All hydrant barrels and caps shall be painted red.

### G. Valve Boxes

1. All valve boxes, base extensions, lid and cover shall be of cast or ductile iron. Valve boxes shall be of the American Flow Control sliding type, round head marked "Water". The shaft diameter shall not be less than five (5) inches. The valve boxes shall have a minimum range of extension to fit two (2) inch to twelve (12) inch valves inclusive, placed on mains at depths of three (3) feet to five (5) feet of cover in order that the cover of the valve box is set as indicated in the Water Detail Drawing. For valves five (5) feet or deeper an American Flow Control Adjustable Trench Adapter shall be used with the cover of the valve box set as indicated in the Water Detail Drawing.

### H. Special Conditions

1. The County may require that special material and/or construction be used where normal water pressure exceeds the pressure rating used in these standards and where the design will not permit reducing these pressures to acceptable levels.

### Disinfection of Water Mains

#### A. General

1. After testing and before final inspection of the completed systems, water mains and service laterals shall be disinfected and flushed in accordance with AWWA Specification C651 latest revisions.

2. Disinfection as described in AWWA C651—"Placing of calcium hypochlorite tablets"—shall be used. Five (5) gram calcium hypochlorite tablets with 3.25 gram available chlorine per tablet shall be attached at the inside top of the pipe by an adhesive such as Permatex No.2 or equal. The following number of tablets for

the given pipe size shall be used for an initial dose of twenty-five (25 mg/l (ppm)) chlorine:

Pipe Diameter	Number of Tablets Per 18-20 Ft. Pipe Section
8"	2
10"	3
12"	4
16"	7

or the number of tablets equal to 0.0012 (d)/2L rounded to the next higher integer, where d is the inside diameter, in inches, and L is the length of the pipe section, in feet. Use of the continuous feed or slug method of disinfecting may only be used to re-chlorinate a water pipe after the initial disinfection or in other specific cases approved by the County.

3. During filling for disinfection, the velocity of the potable water in the main shall be less than 1 foot per second. The disinfection solution shall remain in the pipe line for not less than twenty-four (24) hours, after which time a chlorine residual of 10 ppm at all parts of the line shall be required. All valves and appurtenances shall be operated while the chlorinated water is in the main.

4. Following chlorination piping shall be thoroughly flushed. Flushing velocities should not be less than 2.5 feet per second. Water in the new main shall be proven comparable in quality to the existing public water supply. The Virginia Waterworks Regulations require at least two consecutive satisfactory bacteriological samples from the distribution system taken at least 24 hours apart before the system can be placed in service. Samples must be collected at regular intervals not exceeding 2000 feet throughout the length of the main and must be taken to an approved laboratory for testing and the Developer/Contractor shall pay all costs associated with disinfection and testing of installed facilities and bacteriological samples as required.

### Separation of Water Lines and Sanitary Sewers

#### A. General:

1. The following factors shall be considered in providing adequate separation:  
a. Materials and types of joints for water and sewer pipe  
b. Soil Conditions  
c. Service branch connections into the water line and sewer lines  
d. Compensating variations in the horizontal and vertical separations  
e. Offsetting of pipes around manholes

#### B. Parallel Installation

1. Normal conditions: water lines shall be laid at least ten (10) feet horizontally from a sewer line whenever possible, the distance shall be measured edge-to-edge unless determined by the County to be unusual conditions.

2. Unusual conditions: when local conditions prevent a horizontal separation described above, the following construction shall be used:

a. The bottom (invert) of the water main shall be at least eighteen (18) inches above the top (crown) of the sewer.

b. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfilling. Pressure test shall be 30 psi.

3. The sewer manhole shall be made 100% water-tight construction and tested in place by Standard vacuum test.

#### C. Crossing

1. Normal Conditions: water lines crossing over sewers shall be laid to provide a separation of at least eighteen (18) inches between the bottom of the water line and the top of the sewer whenever possible.

2. Unusual conditions: when local conditions prevent a vertical separation as described above, the following construction shall be used:

a. Sewers passing over or under water lines shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfill. Pressure test will be conducted at 30 psi.

b. Water lines passing under sewers shall, in addition, be protected by providing:

i. A vertical separation of at least eighteen (18) inches between the bottom of the sewer and the top of the water line. Sewer line shall be encased along its length where it is within 1' of the water line.

ii. Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the water line.

iii. The length of the water line be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.

#### D. Sewers or Sewer Manholes

1. No water pipes shall pass through or come in contact with any part of a sewer manhole.

#### E. Other Utilities

1. When other underground utilities (storm drains, gas, electrical, phone, etc.) cross within twelve (12) inches above or below water lines adequate structural support of the utilities shall be addressed.

## Valve, Air Relief, and Blow-Off Chamber

### A. General

1. During construction air and sediment accumulations may be removed through a standard fire hydrant, compressed air and pumping may be used for de-watering mains through hydrants.

2. Chambers or pits containing valves, blow-offs, meters, or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any storm drain or sanitary sewer.

3. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground in areas with sufficiently water table.

4. The design engineer shall indicate the size of the air relief discharge required on the plan sheet.

## INSTALLATION OF DUCTILE-IRON WATER MAINS

TABLE 4

Maximum Joint Deflection\* Full Length Pipe-Push On Type Joint

Nominal Pipe Size (in.)	Deflection Angle (degrees)	Maximum Offset-S (in. (m))		Approx. Radius of Curve-R Produced by Succession of Joints-ft.(m)	
		18 ft. (5.5m)	20 ft. (6.1m)	18 ft. (5.5m) L	20 ft. (6.1m) L
3	5	19(0.48)	21(0.53)	205(62)	230(70)
4	5	19(0.48)	21(0.53)	205(62)	230(70)
6	5	19(0.48)	21(0.53)	205(62)	230(70)
8	5	19(0.48)	21(0.53)	205(62)	230(70)
10	5	19(0.48)	21(0.53)	205(62)	230(70)
12	5	19(0.48)	21(0.53)	205(62)	230(70)
14	3*	11(0.28)	12(0.30)	340(104)	380(116)
16	3*	11(0.28)	12(0.30)	340(104)	380(116)
18	3*	11(0.28)	12(0.30)	340(104)	380(116)
20	3*	11(0.28)	12(0.30)	340(104)	380(116)
24	3*	11(0.28)	12(0.30)	340(104)	380(116)
30	3*	11(0.28)	12(0.30)	340(104)	380(116)
36	3*	11(0.28)	12(0.30)	340(104)	380(116)
42	2*	7 1/2(0.19)	8(0.20)	510(155)	570(174)
48	2*	7 1/2(0.19)	8(0.20)	510(155)	570(174)
54	1 1/2*	5 1/2(0.14)	6(0.15)	680(207)	760(232)

\*For 14-in and larger push-on joints maximum deflection angle may be larger than shown above. Consult manufacturer.

## INSTALLATION OF DUCTILE-IRON WATER MAINS

TABLE 5

Maximum Joint Deflection\* Full Length Pipe-Mechanical Joint Pipe

Nominal Pipe Size (in.)	Deflection Angle (degrees)	Maximum Offset-S (in. (m))		Approx. Radius of Curve-R Produced by Succession of Joints-ft.(m)	
		18 ft. (5.5m)	20 ft. (6.1m)	18 ft. (5.5m) L	20 ft. (6.1m) L
3	8-18	31(0.79)	31(0.89)	125(38)	140(43)
4	8-18	31(0.79)	35(0.89)	125(38)	140(43)
6	7-07	27(0.69)	30(0.76)	145(44)	160(49)
8	5-21	20(0.51)	22(0.56)	195(59)	220(67)
10	5-21	20(0.51)	22(0.56)	195(59)	220(67)
12	5-21	20(0.51)	22(0.56)	195(59)	220(67)
14	3-35	13 1/2(0.34)	15(0.38)	285(87)	320(98)
16	3-35	13 1/2(0.34)	15(0.38)	285(87)	320(98)
18	3-00	11(0.28)	12(0.30)	340(104)	380(116)
20	3-00	11(0.28)	12(0.30)	340(104)	380(116)
24	2-23	8(0.23)	10(0.25)	450(137)	500(152)
30	2-23	8(0.23)	10(0.25)	450(137)	500(152)
36	2-05	8(0.20)	8(0.23)	500(152)	550(167)
42	2-00	7 1/2(0.19)	8(0.20)	510(155)	570(174)
48	2-00	7 1/2(0.19)	8(0.20)	510(155)	570(174)

TABLE 6

Allowable Leakage per 1,000 ft. (305 m) of Pipeline\*—gph

Average Test Pressure psi (Bar)	Nominal Pipe Diameter - in.					
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