

SECTION 11 - WATER DISTRIBUTION SYSTEM

11.1 GENERAL

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

11.1.1 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

11.2 PRODUCTS

- A. Submit shop drawings on all products supplied and installed for the project in accordance with submittals procedures.
- B. Provide certified test results of pipe testing.

11.2.1 Underground Pipe

- A. Ductile Iron Pipe
 - 1. Ductile iron pipe shall meet the requirements of AWWA C151 and AWWA C150. Rubber-gasket joints shall meet the requirements of AWWA C111. 3” through 24” pipe shall be, at a minimum, class 52 with a working pressure of 350 psi. Pipe shall have a single cement-mortar lining and a bituminous seal coat conforming to the requirement of AWWA C104. A minimum of 5% of the pipe furnished shall be gauged for roundness full length and so marked. Pressure class of pipe shall be increased if the specific installation warrants it.
- B. PVC Pipe
 - 1. PVC pipe shall meet requirements of AWWA C900 (DR-14, CL. 200) for sizes up to 8 inches in diameter. Joints shall be in accordance with manufacturer’s instructions and ASTM D2564, D2464, D2467, D319, and F477. If working pressures over 150

psi are encountered, ductile iron pipe shall be used. Cell classification for water pipe shall be 12454-B

C. Polyethylene pipe

1. 3 Inches and Smaller –Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-02 with a cell classification of PE 345464C. Pipe shall have a manufacturing standard of ASTM D2737 (copper tubing size), ASTM D2239 (iron pipe size, controlled inside diameter) and ASTM D 3035 (iron pipe size, controlled outside diameter). Pipe shall have a pressure class as specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, and per AWWA C901, have nominal burst values of three times the Working Pressure Rating (WPR) of the pipe. Pipe shall also have the following agency listing of NSF 14.
2. 4 Inches and Larger - Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE 345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. size shall be ductile iron pipe size (DIPS). Pipe shall be pressure class as indicated on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 61, and per AWWA C906. Pipe shall have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe. Peak flow water velocity of 5 ft/sec or the actual velocity whichever is greater shall be used in the hydraulics engineering design.

D. Copper Tubing

1. 1 inch and smaller for underground services shall be seamless, annealed copper tubing Type K, in conformance with ASTM B88. Fittings shall be case bronze with flared joints.
2. Copper Tubing 1-1/4 through 2” for underground services shall be seamless hard copper tubing Type K, in conformance with ASTM B88. Fittings shall be wrought copper with soldered joints.

3. Solder shall be 95-5 lead free solder meeting the requirements of NSF 61.

11.2.2 Underground fittings

A. Ductile Iron Fittings

1. Fittings for PVC pipe and DI pipe shall be ductile iron. Ductile iron fittings shall be in accordance with AWWA C110 or AWWA C153. Pressure ratings shall be a minimum of 350 psi for fittings 24-inch and smaller and 250 psi for 30-inch. All fittings shall have a single cement mortar lining on the interior and a bituminous seal coating on the exterior. Fittings shall have mechanical joints conforming to the requirements of AWWA C111. Bolts for mechanical joint fittings shall be high strength, corrosion resistant low alloy steel with hexagon nuts having a minimum yield point of 45,000 psi in accordance with AWWA C111. Mechanical joint bolts shall be torqued with a torque wrench as per manufacturer's recommendations.
2. Couplings for underground or buried service shall be ductile iron mechanical joint in accordance with underground ductile fittings in this section.

B. Polyethylene Pipe Fittings

1. Fittings for polyethylene pipe shall be manufactured specifically for the intended use and be approved by the piping manufacturer to be compatible with their product. All fittings shall have a working pressure rating equal to or greater than the pipe, and shall meet all requirements of NSF 61.
2. Butt Fusion Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, shall have a nominal burst value of three and one-half times the Working Pressure Rating (WPR).
3. Electro-fusion Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electro-fusion

Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe. All electro-fusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR).

4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261.

C. Thrust Restraint

1. Contractor shall install concrete thrust blocks at all tie in points and as indicated on the contract drawings or as directed by the Project Representative based upon field conditions. Thrust blocks shall be sized as indicated on the thrust block Standard Details. Concrete shall have 3,000 psi strength at 28 days, and shall meet the requirements of ASTM C94.
2. All pipe fittings, plugs, caps, tees, and bends in underground ductile iron or PVC piping shall be restrained utilizing Megalug Series 1100 retainer glands by EBAA Iron Sales, Inc. (or approved equal) for ductile iron pipe and Megalug Series 2000PV retainer glands by EBAA Iron Sales, Inc. (or approved equal) for PVC pipe. Glands shall be manufactured of ductile iron conforming to ASTM A 536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and C153/A21.53. Twist-off nuts shall be used to insure proper actuating of the restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2.
3. All ductile iron bell and spigot pipe joints shall be restrained using US Pipe Field Lok 350 type gaskets or harness type restraints utilizing Megalug Series 1700 retainer glands by EBAA Iron Sales, Inc. (or approved equal). If all joints are not required to be restrained the minimum restrained lengths and locations shall be indicated on the drawings. Gaskets shall be manufactured by the pipe manufacturer to be compatible with their pipe.
4. PVC pipe bell and spigot joints shall be restrained on either side of valves and fitting for a length to be indicated on the drawings.

Harness type restraining devices shall be used on bell and spigot pipe joints utilizing Megalug Series 2800 restraint harness by EBAA Iron Sales, Inc. (or approved equal).

11.2.3 Above Ground or Exposed Piping

A. Ductile Iron Pipe

1. Ductile iron pipe installed above ground, inside buildings or underground vaults, shall be flanged ductile iron pipe class 53 in accordance with ANSI A21.15 (AWWA C115). Unless indicated otherwise on the drawings pipe shall have Class 125 flanged joints utilizing factory installed screwed flanges (no uniflange type flanges are permitted) meeting the requirements of ANSI B 16.1, outside coating shall be red primer, and gaskets for flanged pipe shall be 1/8" thick full face red rubber. All steel flanges mating to flat face flanges shall have the raised face machined off. Pipe shall have a single cement mortar lining with asphaltic seal coat meeting the requirements for AWWA C104.

B. Ductile Iron Fittings

1. Fittings for ductile iron pipe shall be flanged ductile iron in accordance with AWWA C110/ANSI A21.10. Fittings up to 30" diameter shall have a minimum working pressure rating of 250 psi. Unless indicated otherwise on the drawings, pipe shall have Class 125 flanged joints meeting the requirements of ANSI B 16.1, outside coating shall be red primer, and gaskets for flanged pipe shall be 1/8" thick full face red rubber. Fittings shall have a single cement-mortar lining and a bituminous seal coat conforming to the requirement of AWWA C104.
2. Couplings for above ground or exposed service shall be Dresser Style 38 or approved equal. Transition couplings shall be Dresser Style 162 or approved equal. All couplings shall be rodded unless otherwise noted.
3. Flange adaptors shall only be used for final connections to equipment or to allow for disassembly of pipe for equipment maintenance in approved locations. Flange adaptors are not to be used to make up for misaligned pipe. Flanged Adaptors shall be JCM flanged coupling adaptors model 301R or approved equal. Uniflanges are not permitted.

C. Copper Tubing

1. Copper tubing for exposed services shall be seamless, hard copper tubing Type L, in conformance with ASTM B88.
2. Fittings shall be wrought copper with soldered joints.
3. Solder shall be 95-5 lead free solder meeting the requirements of NSF 61.

11.2.4 Pipe Insulation and Heat Tracing

A. Pipes exposed to freezing temperatures shall be heat traced and insulated.

B. Pipe Insulation

1. Manufacturers: Johns Manville or approved equal.
2. Glass Fiber: Micro-Lok meeting ASTM C 547, Type I; rigid molded, noncombustible.
 - a) 'K' ('ksi') Value: 0.23 at 75 degrees F Mean Temperature.
 - b) Maximum Service Temperature:
0 degrees F to 850 degrees F.
3. Vapor Retarder Jacket: AP-T PLUS White kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples coated with vapor barrier mastic as needed.
4. Field Applied Jackets
 - a) Field applied Jackets shall be aluminum 0.016 inch (0.045 mm) thick sheet, smooth finish, with longitudinal slip joints and 2 inch (50 mm) laps, die shaped fitting covers with factory applied moisture barrier.
 - b) Sheet metal screws shall be aluminum or stainless steel.
 - c) Jackets shall be secured with 0.020 by 3/4 inch type 304 stainless steel expansion bands.
5. Insulation Covers

- a) Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

C. Heat Tracing

1. All pipes, valves, equipment, and appurtenances shall be provided with heat tracing where shown; or, where not shown, heat tracing shall be provided in all cases where such items could be endangered by freezing. Such heat tracing shall consist of spiral wrapping with electrical heating cables as recommended by manufacturer and subsequent installation of insulation. The heating cables shall be controlled from thermostats installed in representative locations and accessible for adjustment. The heat tracing systems shall be installed complete, including heating elements, power connections, end seals, and controlling thermostats in accordance with the manufacturer's printed installation instructions.
2. Materials
 - a) Heating Cable: The electrical heat tracing system shall consist of a flat, flexible, low heat density, electrical heating strip of parallel construction, consisting of a continuous inner core of conductive material between two parallel copper bus strips. The electrical insulation of the heater strip shall be polyester and rated for 140 degrees F temperature, and its width shall be a minimum of ½-inch. It shall be suitable for operation on 120 volts.
 - b) Thermostats: A thermostat with a range of 40 degrees to 120 degrees F shall be provided for each heat pipe. It shall be double-pole, single-throw and mounted in a weatherproof NEMA 4X enclosure.
 - c) The capillary bulb shall be mounted on the pipe under the insulation. Heating strips for pipes over 2 inches in size shall be rated at 8 watts per foot; for pipes 2 inches and smaller they shall be rated at 4 watts per foot.
 - d) All heat tracing circuits shall be provided with indicating lights at the beginning and end of all heat tracing runs for a visual indication that the heat tracing is on for the complete run.

- D. Manufacturers: Electric heat tracing systems and components shall be as manufactured by Chromalox or approved equal.

11.2.5 Temporary Above Ground Pipe and Fittings

- A. Temporary above ground piping used for bypass piping, hydrant jumping or other temporary services shall be manufactured from high tensile strength, abrasion-resistant steel that is hot-dipped galvanized and is available in 3 foot, 6 foot, 10 foot, and 20 foot lengths. Pipe and fittings shall be joined with quick connections with degree of articulation on coupling joints as indicated in the table below. Working pressure shall be as indicated in the following table.

Pipe diameter	Working pressure (psi)	Deflection (degrees)
2"	290	30
3"	290	30
4"	175	30
6.25"	175	20
7.625"	175	20
10"	99	10

- B. Pipe and fittings shall be Bauer QD pipe and fittings or approved equal.

11.2.6 Gate Valves

- A. Gate valves 3" through 12" shall open counter-clockwise, have a resilient seat and meet the requirements of AWWA C509 or AWWA C515. Body shall be of ductile iron with a 250 psig maximum working pressure and hydrostatically tested to 500 psig. Wedge shall be constructed of cast iron or ductile iron, bonded in synthetic rubber in accordance with ASTM D2000. Valve shall be coated inside and out with a fusion epoxy coating of a nominal 10 mil thickness on all exposed iron surfaces in compliance with AWWA C550 and be NSF 61 certified. Valves shall be bi-directional flow and have a ten year limited warranty.
- B. Above ground valves or exposed valves in vaults shall utilize outside screw and yoke (OS&Y) with rising stems and have flanged ends meeting the requirements of ANSI B 16.1, Class 125.
- C. Underground valves shall utilize non rising stems, mechanical joint ends with a 2" operating nut in accordance with AWWA C111.
- D. Gate valves 3" and larger when located 6ft. or more above the finish floor or operating platform shall have chain operators.

- E. Valves shall be Mueller series 2361, Kennedy series KS-RW, M & H Valve Company series 7000 or approved equal.
- F. Gate valves 14” through 24” shall: open counter-clockwise, have a resilient seat and meet the requirements of AWWA C515. Body shall be of ductile iron. Valves 14”-24” shall have a 250 psi working pressure and be hydrostatically tested to 500 psig. Wedge shall be constructed of ductile iron and bonded in synthetic rubber in accordance with ASTM D2000. Valves shall be coated inside and out with a fusion epoxy coating of a nominal 10 mil thickness on all exposed iron surfaces in compliance with AWWA C550 and be NSF 61 certified. Valves shall be bi-directional flow and have a ten year limited warranty.
- G. Underground valves shall utilize non rising stems, mechanical joint ends with a 2” operating nut in accordance with AWWA C111.
- H. Valves shall be Mueller series 2361, Kennedy series KS-RW, M & H series 7000 or approved equal.
- I. Buried gate valves 2” in size shall utilize a non-rising stem, open counter-clockwise, resilient seat and meet the requirements of AWWA C509. Valve shall be equipped with a 2-inch square AWWA operating unit. Valve ends shall be NPT connections. Valves shall be Mueller series 2360, or approved equal.
- J. Above ground gate valves 2” and smaller shall be 150 lb. bronze body union bonnet, rising stem gate valves with threaded connections. Valves shall be Crane Figure 431UB or approved equal.

11.2.7 Butterfly Valves

- A. Butterfly valves shall have a ductile iron body, seat in body design, ductile iron disk with a 316 stainless steel disc edge (3” and 4” valves to have 316 disk), symmetrical disc, nonmetallic bearings, chevron self-adjusting “V” type packing and have a 250 psi working pressure. Valves shall meet or exceed all the requirements of AWWA C504 standard class 250B and be NSF 61 certified. Exposed piping shall have flange ends Class 125 and underground valves shall have mechanical joint ends. Valves 4” and larger shall have gear operators. All exposed valves with gear operators shall have a position indicator.
- B. Butterfly valves shall be Mueller Linesal XP, Kennedy series 4500, M & H CL250 or approved equal.

11.2.8 Ball Valves - Above Ground

- A. Ball valves 2" and smaller shall be 150 lb rated, threaded ends, bronze or stainless steel body (stainless steel valves are to be used on stainless steel pipe), full port, lever operated, ball valves, with stainless steel ball and stem, and Teflon seats. Ball valves shall be Crane figure 9201 (bronze body), 9231 (stainless steel) or approved equal.

11.2.9 Check Valves

- A. Swing check valves
 - 1. 3 inch and larger
 - a) Check valves 3" and larger shall be Class 125 flanged ends, ductile iron body, bronze mounted, bronze disc facing, swing type lever and weight check valves in accordance with AWWA C508. Flanged end dimension and drilling shall comply with ANSI B 16.1, Class 125. Check valves 3" through 24" shall have a 250 psig maximum working pressure.
 - b) Check valves shall have an adjustable air decelerator (air cushion) installed on the outside of the valve to control valve closing.
 - c) All check valves shall have a factory installed limit switch to indicate close position for flow confirmation.
 - d) Valves shall be Apco series CVS 250, Val-Matic series 7900S-S, Milliken Series 8501 or approved equal.
 - 2. Check valves 2" and smaller shall be class 150 bronze or stainless steel y-pattern swing check valves with threaded ends. Valves shall be Crane figure 137 (bronze), Crane Aloyco figure 49 or approved equal.
- B. Silent check valves
 - 1. Silent check valves shall be the globe type with a spring loaded disk. Valve shall have a ductile iron body, bronze plug, 316 stainless steel spring and a working pressure rating of 250 psig. Valves shall be flanged in accordance with ANSI B 16.1 class 125.

2. Valves shall be APCO globe style series 600 or Milliken series 821A or approved equal. Wafer type check valves shall not be permitted.

11.2.10 Corporation Stops and Tapping Saddles for Underground Service

- A. Corporation stops shall be Ford Ballcorp or approved equal with corporation thread by flared or compression end for 1" copper tubing or; removable 1.50 inch NPT or removable 2" inch NPT for hard tubing adaptors. All corporation stops shall be installed with a tapping saddle. Saddles shall be double strap epoxy coated ductile iron with stainless steel straps, bolts and nuts. Saddles shall be Ford Style FC202 or approved equal.

11.2.11 Above Ground or Exposed Taps

- A. All taps on exposed pipe. Flanged pipe or above ground pipe shall be made on fitting bosses. No tapping saddles or tapping of pipe will be allowed. All taps shall have a shutoff valve at the tap.

11.2.12 Valve Boxes

- A. Valve boxes for buried valves shall be cast iron, screw adjustable shaft boxes, with a minimum shaft diameter of 5-1/4 inches, unless otherwise specified on the Drawings. Valve box covers shall be marked with the word "WATER". Valves with valve boxes shall have an extended shaft pinned to the 2" operating nut and terminate 12" below finish grade. Valve box shall have a 24" x 24" x 4" concrete collar around top of valve box as per Standard Details.

11.2.13 Air Release Valves

- A. Air release valves shall have a minimum of a 1" N.P.T. inlet for pipe sizes 16" and smaller with a 3/32" minimum size outlet orifice and a 2" N.P.T. inlet for pipes 18" and larger with 3/16" minimum size outlet orifice. Valves shall have a cast iron body and cover, stainless steel float, Buna -N seat, Delrin lever frame and all other internal part shall be stainless steel or bronze. Air release valves shall be suitable for 150 psi working pressure at a minimum. 1" size air release valves shall be Apco model 143C or approved equal. 2" size air release valves shall be Apco model 145C or approved equal.
- B. All air release valve installations shall contain an isolation valve to allow removal of the air release valve while the line is under pressure and to remove air release valve for maintenance and upsizing if required.

- C. Air release valve shall have a manual valve on the body to allow manual venting of the pipeline without removal of the air release valve.

11.2.14 Reduced Pressure Zone (RPZ) Backflow Preventer

- A. Reduced Pressure Zone Backflow Preventer assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Service of all internal components shall be through a single access cover secured with stainless steel bolts. The assembly shall also include two resilient seated isolation valves, four resilient seated test cocks, a protective bronze wye strainer with a 20-mesh screen and an air gap drain fitting.
- B. The assembly shall meet the requirements of the latest available American Water works Association (AWWA) standards including Std. C511; hold current University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USC) approval, and hold the American Society of Sanitary engineers (ASSE) listing.
- C. All RPZ backflow preventers shall be installed in strict accordance with the manufacturer's instructions.
- D. The RPZ backflow preventer shall be a Watts Regulator Co. Series 009QT-S or approved equal and shall be sized as indicated on the construction drawings.

11.2.15 Sample Taps

- A. All sample taps shall be threadless.

11.2.16 Wall Pipes and Sleeves

- A. Pipes through concrete walls and slabs shall be provided with wall pipes or penetration seals. Wall pipes shall comply with cast iron fittings specification and shall have flanged joint connections unless otherwise noted on the drawings. Penetration seals shall be Link-Seal as manufactured by Thunderline Corporation of Wayne, Michigan, or approved equal. All hardware shall be stainless steel. Sleeves inside diameters shall be sized to fit the outside diameter of the penetrating pipe and the link seal. Sleeves shall be of a thickness to maintain their shape and shall be manufactured by the seal manufacturer. All Sleeves shall have waterstops and be hot dipped galvanized after fabrication. Where pipe penetrations are in existing concrete structures, core drilling is acceptable provided the hole size is coordinated with the seal manufacturer.

- B. Core drilling shall be coordinated with structural drawings, ground penetrating radar or other methods to determine the location of the steel reinforcement bars or post tensioning cables within the concrete walls or slabs as to avoid any damage to the structural integrity of the concrete walls or slabs.

11.2.17 Flushing Hydrants

- A. Flushing hydrants shall comply with AWWA C502 standards for “dry barrel” compression type hydrants that open against pressure. Hydrants shall have a working pressure rating of 150 psi and a test pressure of 300 psi. They shall meet all the requirements of fire hydrants regarding operating nuts, stems, working parts, stem design, full 360 rotation, body castings, and repairs without dismantling. Flushing hydrants shall be equipped with a threaded or mechanical joint inlet of the size as indicated on the plans and have one 2-1/2 inch outlet with cap and chain. Outlet thread type will be as required by owner.
- B. Flushing hydrants shall be 2” Aquarius “One-O-One” HH or 2” Main Guard Model #78 as manufactured by Kupferle Foundry Company, Mueller model A-411 or approved equal.

11.2.18 Water Service Accessories

- A. The corporation stop shall be as described in paragraph 11.2.10 A.
- B. Meter coppersettors shall be provided for all 5/8” thru 1” meters. Each shall have removable pack joints suitable for copper tubing. All coppersettors shall have saddle nuts, padlock wings, and two valves and shall be similar to the Ford series 270, the Mueller coppersetter, the A.Y. McDonald series 27 & 28, or approved equal. Meters and copper settors shall be installed in accordance with Standard Drawings.
- C. Meter coppersettors shall be provided for all 1-1/2” thru 2” meters. Each shall have removable NPT connections for hard copper tubing adaptors. All coppersettors shall have saddle nuts, padlock wings, and two valves and shall be similar to the Mueller 300 Ball Angle meter valve with setter B-2423, or approved equal. Meter settors for 1.50 inch and 2 inch meters shall have a lockable bypass. Meters and copper settors shall be installed in accordance with the Standard Drawings.
- D. The meter box shall be in accordance with Standard Drawings.

11.2.19 Detector Double Check Valves

- A. Detector Check Valves shall be epoxy coated UL and FM approved, fusion epoxy coated ductile iron with brass by-pass meter trim. Valves shall be FEBCO Model 800, Zurn Model 350 DA or approved equal.

11.2.20 Hydraulic Operated Control Valves

- A. Hydraulic operated control valves shall consist of pressure reducing valves, pressure sustaining valves, altitude valves, pump control valves, surge relief valves, surge anticipator valves, flow control valves or other similar type hydraulically controlled valves.
- B. The main valve shall be pilot-controlled, hydraulically operated, differential piston actuated and full ported.
- C. The control valve shall be “self-contained” and incorporate a system of pilot controls, factory assembled to and tested with the main valve. The valve shall be operated by line pressure and utilize the pilot system to open, close or throttle the differential piston main valve to perform the specified function(s).
- D. The main valve body shall be [globe][angle] style, constructed of high-strength cast iron conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125.
- E. The valve shall be “full-ported” so that when fully open the flow area through the valve is no less than the area of its nominal pipe size. Globe body valves shall have an integral bottom pad or feet to permit support directly beneath the body.
- F. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area and the area on the upper surface is greater than that of the underside. There shall be no diaphragms or springs in the main valve.
- G. The valve piston shall be fully guided on its outside diameter and all guiding and sealing surfaces shall be bronze. To minimize the consequences of throttling, throttling shall be by long, stationary vee-ports located downstream of the seat and not by the seat itself. Sawtooth attachments or other add-on devices are not permitted.
- H. Valves shall be provided with an anti-cavitation ring or similar device to prevent cavitation in the valve if required by the operating conditions.

- I. The valve shall be fully capable of operating in any position without the need of springs and shall not incorporate stems, stem guides or spokes in the waterway. A visual position indicator shall be provided.
 - J. The main valve shall be serviceable in the line through a single flanged top cover that provides easy access to all internal components.
 - K. The valve shall be shop coated with NSF-61 certified epoxy on internal surfaces in accordance with American Water Works Association Standard C550 (latest revision).
 - L. The valve shall be operated by a system of pilot controls necessary to perform the specified function(s).
 - M. The pilot system shall be factory pre-piped, installed on the main valve and tested as an assembly.
 - N. In addition to the necessary pressure regulating and/or electrically operated pilots, the system shall incorporate a wye-strainer and opening and/or closing speed control valves.
 - O. Sufficient isolating valves and pipe unions shall be provided to facilitate removal and maintenance of the pilot system without disturbing the main valve.
 - P. Pilots, controls, piping and fittings shall be corrosion resistant copper, bronze or brass.
 - Q. Valves shall be manufactured by GA Industries, Cla-Val or approved equal.
- 11.2.21 Tapping sleeves shall meet requirements of AWWA C110 for pressure ratings shown on the Drawings. Sleeves shall be built in two sections and shall be mechanical joint type with flanged outlet or two part stainless steel, bolted tapping sleeves furnished with stainless steel bolts and nuts as manufactured by JCM Industries. The tapping sleeve shall be for the size and type of pipe shown on the construction drawings.
- 11.2.22 Bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters for above ground or exposed service used to join plain-end pipe shall meet the requirements of AWWA C219. Each coupling shall have similar components: a center sleeve (sometimes called a “middle ring”), end rings (sometimes called “followers”), and threaded fasteners (bolts and nuts), that, when tightened, pull the end rings together. These components compress elastomeric gaskets in the space formed between the end rings, center sleeve, and pipes being joined, thereby sealing the coupling/pipe combination. They

shall be manufactured from ductile iron and are intended for use in systems conveying water. All couplings shall be rodded. Couplings shall be manufactured by Dresser Manufacturing Division of Dresser Industries, Smith-Blair, Ford Meter Box Company, Cascade Waterworks Manufacturing Company (styles CRC and CRCA), or approved equal.

11.2.23 Fire Hydrants

- A. Fire hydrants shall be of the safety, flange, breakaway top type, meeting requirements of AWWA C502. Hydrants shall have a barrel diameter no smaller than 6 inches. The hydrant valve diameter shall be 4-1/2 inches and shall be equipped with two 2-1/2 inch hose nozzles and one 4-1/2 inch pumper connection. Hose and pumper outlet threads shall be National Standard. The fire hydrant base shall be coated with fusion bonded epoxy and all hardware below grade shall be ASTM F593/F594 rated stainless steel. Fire hydrant tees shall be used.
- B. Per the Goochland County code, fire hydrants shall be "Fire Hydrant Red" in color with the tops painted reflective silver.
- C. Paint shall be as manufactured by Tnemac, Rustoleum or approved equal.

11.2.24 Tracer Wire

- A. Copper tracer wire shall be THHN, 12 gage, insulated with a blue colored insulation. Tracer wire access boxes are to be utilized and spaced no more than 1000 feet apart. A concrete mow collar shall be installed at finished grade around all tracer wire access boxes.
- B. Tracer wire access boxes shall be installed adjacent to all fire hydrants.

11.2.25 Wire Connectors

- A. Connector, Wire, Set Screw Pressure type for use with No. 12 stranded wire size.
- B. Holub Industries MA-2 or equivalent
- C. Ideal Industries Model 30-222 or equivalent
- D. Wire nuts shall not be allowed underground.

11.2.2 Tracer Wire Access Boxes

- A. Tracer wire access boxes shall be made of cast iron with a permanently attached 3" x 12" ABS tube with a flared end to secure it in the ground. Its

tamper-resistant cast iron locking lid has stainless steel terminal connectors on the bottom side to which tracer wires are attached. Lid is opened using a standard AWWA pentagon key. Enough slack shall be coiled inside the box to allow the removal of the lid. Lid shall be marked water.

11.2.26 Marking Tape

- A. Tape shall be 3.5 mil polyethylene tape, 3” in width, with a 14 gage metallic core, with the continuous printed message “Caution – Waterline Buried Below.” Tape shall be style 48288 as manufactured by the Seton Safety and Identification or approved equal.

11.2.27 Bore Casing Pipe

- A. Steel casing pipe shall be welded or seamless or smooth wall, consisting of Grade “B” steel as specified in ASTM A-139. Minimum yield strength shall be 35,000 psi, and pipe thickness shall be as specified on the construction plans. All pipe shall be furnished with beveled ends prepared for field welding of circumferential joints. Welds shall be a full penetration welds subject to visual inspection. All burrs at pipe ends shall be removed. Encasement pipe must be approved by the appropriate controlling agency (V.D.O.T., R.R., etc.) and the Engineer prior to ordering. Spiral weld casing pipe will not be allowed.

11.2.28 Pressure Gages

- A. Pressure gauges shall be of all stainless steel construction, 3.5 to 4 inch case size, accuracy of 1% over the entire dial arch and a ¼” NPT bottom connection, Pressure range shall be as indicated on the drawings.
- B. Pressure gages shall be Ashcroft stainless steel case 1009 pressure gauges or approved equal.
- C. All pressure gages shall be installed with a ¼” stainless steel ball valve and stainless steel nipples.
- D. Gages shall be graduated so the system operating pressures are in the middle third of the scale.
- E. All pressure gages shall be mounted with fittings or on fitting bosses. NO TAPPING OF PIPE OR SADDLES WILL BE ALLOWED.

11.2.29 Pipe Supports

- A. Pipes shall be supported by steel pipe hangers, clamps, brackets, rods and inserts as required to support the imposed pipe loads. Hangers in general shall be new, manufactured of carbon steel and hot dipped galvanized after fabrication or 304 stainless steel.
- B. Pipes 2 ½ inches and larger shall be supported with adjustable floor stand type pipe supports as detailed on the drawings. Pipe supports shall be Standon Model S89 flange support, Standon Model S96 cradle support as manufactured by Material Resources, Inc. or approved equal.
- C. Pipes 2” and smaller shall be supported from the floor, walls or ceiling depending on the type of building construction. Pipe supports for these size pipes shall be as manufactured by Unistrut Building Systems, B-Line or approved equal. Supports shall consist of floor stands, wall brackets or clevis type hangers. Strut and appurtenances shall be stainless steel. Clips for copper tubing shall be copper coated. Minimum threaded rod size shall be 3/8 inch.
- D. Ductile Iron and steel pipe supports shall be spaced in accordance with the following schedule:

Pipe sizes (inches)	½ - 3/4	1- 1 1/4	1 ½ - 2	3 – 4
Max spacing (feet)	4	6	8	10

- E. Copper tubing pipe supports shall be spaced in accordance with the following schedule:

Nominal tubing size (inches)	1/2 - 3/4	1- 1 1/4	1 1/2 - 2
Max spacing (feet)	4	5	6

- F. PVC pipe supports shall be spaced in accordance with the following schedule:

Nominal pipe size (inches)	1/2 - 3/4	1- 1 1/4	1 1/2 - 2	3-4
Max spacing (feet)	2.5	3	4	6

- G. Maximum spacing between pipe supports shall be 10 feet for all pipes 6” and above. This is a maximum spacing and does not take into account

valves, fittings, flow meters, risers, drops and other devices. Locations where these are installed will require additional supports.

H. In addition to the above, pipe supports shall be located as per the following:

1. Maximum spacing as indicated above.
2. Maximum of 12 inches from all horizontal and vertical changes in direction.
3. On the suction and discharge of pump piping to eliminate pipe stresses on the pump flanges.
4. On the connections to all equipment to eliminate pipe stresses on the equipment connections and allow equipment removal.
5. On the inlet and outlet piping to the water meter to allow the removal of the water meter.
6. At the location of valves, fittings or other devices that cause additional weight to the piping.
7. Additional pipe supports as indicated on the drawings.

11.2.30 Air and Vacuum Valves

- A. Air and vacuum valves shall be constructed with cast iron or stainless steel bodies, type 304 stainless steel floats, bronze trim and Buna-N seats. Valves shall be of the size and at the locations indicated on the Drawings. Valves shall be of the combination type to relieve large volumes of air as the lines are filled or emptied and also release small quantities of entrained air under pressure. Valves shall be for working pressures indicated on Drawings. Valves shall be installed with a full size gooseneck on the outlet.

11.2.31 Service Saddles

- A. Service saddles shall be stainless steel with stainless steel double straps and bolts, and tapped for AWWA threads. Service saddles shall be as manufactured by Cascade, Mueller, Romac, or approved equal.

11.3. EXECUTION

11.3.1 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. Bed pipe as specified in Section 9 - Trenching & Backfilling.
- D. Do not lay pipe when trench bottom is muddy or frozen, or has standing water.
- E. Use only those tools specifically intended for cutting the size and material and type pipe involved. Make cut 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 upgrade.
- G. Separation of sanitary sewer lines and water lines shall be in accordance with Virginia Department of Health Regulations.

11.3.2 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 Blue Lube pipe lubricant or as supplied by the pipe manufacturer suitable for potable 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 screw nuts up finger tight. Then tighten all nuts to torque listed below with a calibrated torque wrench:

- | | | |
|----|-------------------------|--------------------------|
| C. | <u>Bolt Size-Inches</u> | <u>Torque Ft. - Lbs.</u> |
| | 1. 5/8 | 40 - 60 |
| | 2. 3/4 | 60 - 90 |
| | 3. 1 | 70 - 100 |
| | 4. 1-1/4 | 90 - 120 |
- D. Tighten nuts on alternate side of the gland until pressure on the gland is equally distributed.
- E. Join lock-type mechanical joint pipe according to manufacturer's recommendations.
- F. Permissible deflection in mechanical joint pipe shall not be greater than 1/2 of that listed in AWWA C600 or as allowed by the pipe manufacturer.
- G. Permissible deflection in lock-type mechanical joint pipe shall be as recommended by manufacturer.

11.3.3 Joining Push-On Joint Pipe

- A. Thoroughly clean inside of the bell and 8 inches of the outside of spigot end of the joining pipe to remove oil, grit, excess coating, and other foreign matter. Flex rubber gasket and insert in the gasket recess of the bell socket. Apply a thin film of approved gasket lubricant (Blue Lube), to the gasket and the spigot end of the joining pipe. (Note: Use of any unapproved lubricant other than Blue Lube has been shown to cause significant taste and odor conditions when used in drinking water disinfected with chloramines. The County will not accept completed water lines that exhibit taste and odor conditions as a result of the use of unapproved lubricants.) 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. No joint deflection is allowed in PVC push on joints. All pipe deflections shall be by bending of the pipe in accordance with manufacturers instructions.

11.3.4 Setting Valves and Valve Boxes

- A. Install gate valves with operator stems in the vertical plane through the pipe axis and perpendicular to the pipe axis. Install valves with gear operators with the operating nut in the vertical plane. Locate valves where shown on Drawings. Thoroughly clean before installation. Check valves for satisfactory operation.

- B. Provide all underground valves with valve boxes where shown on the Drawings. Set valve boxes in accordance with Standard Drawings. Set box in alignment with valve stem centered on valve nut. Set the valve box to prevent transmitting shock or stress to the valve. PVC extensions shall not be permitted.
 - C. All underground valves shall have valve stem extensions. Extension shall be pinned to the operating nut and terminate 1 foot below grade with a 2" operating nut.
- 11.3.5 Locate Fire Hydrants as shown on Drawings and in accordance with Standard Drawings.
 - 11.3.6 Provide combination air/vacuum valves at locations shown on Drawings. Install gate valve or ball valve between water main and combination air/vacuum valves. Construct manholes for air and vacuum relief valve as shown in the Standard Drawings.
 - 11.3.7 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 2 inch above top surface.
 - 11.3.8 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. Seal pipe using link-seals.
 - 11.3.9 Provide "link-seal" pipe to wall closures manufactured by Thunderline Corp., Wayne, Michigan 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 watertight seal between pipe and wall opening.
 - 11.3.10 Provide reaction anchors of concrete blocking, metal harness, retainer gland type or restrained joint type pipe at all changes in direction of pressure pipelines and as shown on Drawings. Always restrain the joints at bends, valves and fittings.
 - 11.3.11 Concrete reaction anchors shall bear against undisturbed earth and shall be of the size and shape shown on the Standard Drawings.
 - 11.3.12 Use metal harness restraints as specified elsewhere in this section.

- 11.3.13 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.
- 11.3.14 Encase water pipelines crossing under highways and railways in a casing pipe. The casing pipe shall be of the diameter and wall thickness indicated in the Standard Drawings. Joining of steel casing pipe shall meet requirements of AWWA C206. Install casing pipe by jacking or boring.
- A. The installation shall meet requirements of AREA Standards for installation of pipelines carrying nonflammable substances under railway tracks. Install as per standard drawings or as required by the railroad. Casing ends shall be sealed to protect against foreign matter entering casing. Prior to beginning work, notify the Railway Company or VDOT and acquire the necessary permits.
- 11.3.15 Installation of Tapping sleeves and Tapping Valves
- A. All tapping sleeves shall be set to avoid interference with existing pipe joints.
- B. After all tapping sleeves and valves have been set in place, a pressure test of 150 psi shall be made to ensure that there are no leaks around the sleeve or through the valve. All leakage shall be corrected.
- C. The actual tap shall be made in presence of a representative of the Owner. The Owner shall be notified 48 hours in advance of making the tap.
- 11.3.16 Detectable tracer tape shall be installed in utility trenches directly above all water mains approximately 18-inches directly above the pipe but no less than 18-inches below finished grade and in accordance with manufacturer's recommendations. The detectable tape shall comply with the product specifications and as specified herein.
- 11.3.17 Tracer wire shall be installed with all water mains and attached to fittings in addition to metallic tape installed above the pipe. The tracer wire shall comply with the product specifications. The tracer wire shall be taped directly to the top of the pipe at a maximum spacing of 8 ft and on each side of fittings, and be installed in a continuous traceable manner. When non-metallic water lines have metallic service lines attached, the conductive tracer wire shall be attached to the corporation stop. The tracer wire shall be brought up in valve boxes to within 6 inches of the surface and left in a coil. The tracer wire shall also be adequately connected to tracer wire access boxes as described herein.

11.3.18 Acceptance Tests

- A. Owner will supply water at no cost, for testing potable water lines only.
- B. A temporary RPZ Backflow Preventer flushing apparatus is required if a direct connection to public water is used to fill the line.
- C. 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, 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 1.5 x the working pressure or 150 psi whichever is greater. Test pressures shall:
 - 1. Not be less than 1.25 x the working pressure or 125 psi at the highest point along the test section.
 - 2. Not vary by more than plus or minus 5 psi.
 - 3. Not exceed twice the rated pressure of the valves or hydrants when test includes closed gate valves.
 - 4. Not exceed rated pressure of valves if resilient-seated gate valves or butterfly valves are used. Thrust restraint shall be designed for the test pressure Measure pressure at the low point on the system compensating for gage elevation.
 - 5. Maintain this pressure for two hours. If pressure cannot be maintained, determine cause, repair and repeat the test until successful.
- D. A leakage test shall be conducted concurrently with the pressure test. Leakage 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 filled with water.
- E. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148,000}$$

In which L is the allowable leakage, in gallons per hour; S is the length of pipeline tested, in feet; D is the nominal diameter of the pipe, in inches;

and P is the average test pressure during the leakage test in pounds per square inch gage.

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

11.3.19 Disinfection

- A. Disinfect, flush and test water mains and accessories in accordance with the procedures listed below. The water used in the disinfection process shall be potable water from an approved supply. If water is to be transported to the subject site, then the tank trucks must also be properly disinfected prior to transporting water. Disinfection of the vehicle should also include all appurtenances used such as valves, hoses, etc.
- B. Preliminary Flushing: The main shall be flushed prior to disinfection. Flushing shall be at a velocity of not less than 3.0 ft/sec. Adequate provisions shall be made for drainage of flushing water.
- C. 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, and 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 tabular 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.
- D. 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.

E. 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 1,200 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 pitot gage at the discharge or by measuring the time to fill a container of known volume. Table I gives the time to fill a container of known volume. Table I gives the amount of chlorine required for each 100 feet of pipe of various diameters. Solutions of one percent (1%) 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 I

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

<u>PIPE SIZE</u> <u>(IN.)</u>	<u>100 PERCENT</u> <u>CHLORINE</u> <u>(LB.)</u>	<u>1 PERCENT CHLORIDE</u> <u>SOLUTIONS</u> <u>(GAL.)</u>
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

2. During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. 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.
3. As chlorinated water flows past tees and crosses, related valves and hydrants shall be operated so as to disinfect appurtenances.
4. Final flushing: After the applicable retention period the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 MG/L.
5. Chlorinated water shall be de-chlorinated before disposal. Do not allow flow into a waterway without neutralizing disinfectant residual. See the appendix of AWWA C651, C652, and C653 for acceptable neutralization methods.
6. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

11.3.20 Bacteriologic Tests:

- A. After final flushing, and before the water main is placed in service, samples shall be collected and tested for bacteriologic quality and shall show the absence of coliform organisms. At least 2 samples shall be collected at least 24 hours apart at intervals not exceeding 1,200 feet and tested by a State Health Department approved laboratory and results submitted to engineer.
- B. In the case that trench water and/or excessive soil or construction debris has entered the new water main as determined by the contractor, owner, or county inspector, bacteriological samples shall be collected at approximately every 200 feet along the water main from water that has stood within the water main for at least 16 hours after final flushing.
- C. The Developer may have an independent testing laboratory collect and test samples in accordance with these specifications. The samples shall be taken by laboratory personnel in the presence of the County Construction Inspector. The testing laboratory shall submit the results to the County Engineer.

- D. 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 will 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.
 - E. 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. After bacteriological testing is completed the piping shall be removed and the corporation cock shall be closed and capped
- 11.3.21 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 done at the contractor's expense.

END OF SECTION 11