

SECTION 02665

WATER DISTRIBUTION LINES

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide all labor, material and equipment to excavate pipe trenches and backfill after the installation of the pipe, all in accordance with the Drawings and as specified herein.
- B. Related work specified elsewhere
1. Site Preparation - Section 02110
 2. Rock Excavation – Section 2230
 3. Erosion and Sediment Control – Section 02270
 4. Stream and/or Highway Crossings – Section 02310
 5. Installation of Water Lines and Sanitary Sewer Lines by Horizontal Directional Drilling (HDD) Methodology – Section 02670
 6. Seeding and Mulching – Section 02900

1.2 LINES AND GRADES

- A. Pipes shall be laid true to the lines and grades as shown on the Drawings except as authorized by the OWNER/ENGINEER. The grade shown on the profile is the invert to which the work must conform. Work not conforming to the grade shall be corrected by the CONTRACTOR at his own expense in a manner acceptable to the ENGINEER.
- B. Locations of water mains:
1. The locations of the proposed lines are shown on the Drawings.
 2. Contours shown on the Drawings are for bidding and construction estimate only. The OWNER/ENGINEER does not guarantee the contours.
 3. The OWNER/ENGINEER reserves the right to make changes in lines and grades of pipe lines, and in locations of pipes and/or appurtenances when such changes may be necessary or advantageous.

1.3 SUBMITTALS

Submit shop drawings or manufacturer's "cuts" of all pipe materials and appurtenances in accordance with Section 01300 - SUBMITTALS AND SUBSTITUTIONS.

1.4 ALTERNATIVES

Type of pipe material used in construction of the specified water pipeline shall be at CONTRACTOR'S option unless a specific type of pipe is required by note on the Drawings.

1.5 APPLICABLE AWWA STANDARDS

The following AWWA Standards (latest revision) are hereby incorporated by reference. Where a conflict exists between these written standards, and the standards incorporated by reference, the PSA Director will determine which standard shall apply. In general, the PSA Director will select the Standard that gives a final product that is in best interest of the PSA. Applicant shall provide PSA with manufacturer's certification that materials meet these standards.

- A100 Standard for water wells.
- C104 Standard for cement-mortar lined for ductile-iron and gray-iron pipe and fittings.
- C110 Standard for ductile-iron and gray-iron fittings.
- C111 Standard for rubber gasket joints for ductile-iron and gray-iron pipe and fittings.
- C115 Standard for flanged ductile-iron and gray-iron pipe with threaded flanges.
- C150 Standard for thickness design of ductile-iron pipe
(Class 52 minimum to be considered for 12" diameter or less)
- C151 Standard for ductile-iron pipe
- C502 Standard for dry-barrel fire hydrants
- C504 Standard for rubber-seated butterfly valves
(approved for 14 inch or larger)
- C506 Standard for backflow prevention devices
- C508 Standard for swing-check valves
- C509 Standard for resilient-seated gate valves
- C512 Standard for air release, air/vacuum and combination valves
- C550 Standard for protective interior coatings for valves and hydrants
- C600 Standard for installation and testing of ductile-iron
water mains and their appurtenances
- C602 Standard for cement-mortar lining of water pipe lines
- C605 Standard for installation of polyvinyl chloride (PVC) pressure pipe
- C651 Standard for disinfecting water mains
- C652 Standard for disinfection of water storage facilities
- C700 Standard for displacement type water meter
- C701 Standard for turbine type water meter
- C702 Standard for compound type water meter
- C703 Standard for fire service type water meter
- C900 Polyvinyl chloride (PVC) pressure pipe, for water (DR-14 minimum class to be considered).
- C906 Polyethylene (PE) pressure pipe, for water (DR-11 minimum class to be considered).
- C909 Molecularly oriented polyvinyl chloride (PVCO) pressure pipe, for water (Minimum class 200 to be considered).
- D100 Standard for welded steel tanks for water storage

- D102 Standard for painting steel water storage tanks
- D103 Standard for factory-coated bolted water storage tanks

PART TWO – PRODUCTS

2.1 WATER PIPE AND APPURTENANCES

A. General:

1. Ductile cast iron pressure pipe of the push-on joint or "mechanical joint" variety, conforming to AWWA C151, latest revision. Pressure class 350 or thickness class 52 shall be used for all pipe twelve inches (12") in diameter or less. Water mains larger than 12" diameter in size, shall have thickness class as determined by thickness design of ductile-iron pipe AWWA C150, or;
2. Polyvinyl chloride (PVC) conforming to AWWA C900 with ductile iron O. D. Dimension Ratio (DR) 14 shall be minimum for PVC pipe. (SDR PVC pipe shall not be used as part of any water system). Water mains larger than 12-inch diameter in size, shall meet requirements, Uni-Bell-B-11 for DR-18, PR 235 and have integral bell with bonded in ring and spigot joint. On specific authorization of the PSA Director, transmission lines may be PVC meeting Uni-Bell-B-11 with DR-25, PR-165 rating, or:
3. Polyethylene (PE) conforming to AWWA C906, with outside dimension Ratio (DR) 11 shall be minimum for PE pipe. PE pipe shall be assembled and joined using the butt-fusion method in strict compliance with the manufacturer's recommendations, or:
4. Molecularly oriented polyvinyl chloride (PVCO) conforming to AWWA C909 with class 200 shall be minimum for PVCO pipe. This material is only acceptable for water mains up to 12-inch diameter in size.

B. Ductile Cast Iron Standard Mechanical Joint Pipe:

1. All ductile cast iron standard mechanical joint water pipe shall conform to AWWA C104 and ANSI Specification A21.51 and shall be lined with cement mortar and have a protective exterior coating. Linings and protective coatings equal to "Enameline" with tar coating in the exterior will be considered as a satisfactory lining for water pipe, however, any substitution in pipe lining and/or coating from ANSI A21.4 shall be specifically approved by the PSA Director. Joints of standard mechanical joint pipe shall conform to ANSI Specifications A21.11.
2. High strength cast iron tee head bolts, hex nuts, cast or ductile iron glands and rubber gaskets shall be as furnished by the pipe manufacturer. All tee bolts and nuts shall be constructed of same size and type material as head

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bolts and hex nuts.

3. In making connections of ductile cast iron pipe using standard mechanical joint, the gland followed by the rubber gasket shall be placed over plain end of the pipe, which shall be carefully inserted and aligned into socket end of pipe line. Gasket shall then be pushed into position so that it is evenly seated in the socket. Gland shall then be moved into position against 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 pipe before making joint shall be followed.

C. Ductile Cast Iron Pipe - "Push-On Joint".

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

D. Restrained Joint Pipe Systems:

1. Approved restrained joint pipe systems shall include the following:
 - a. Mechanical joint pipe with use of joint restraint gland such as EBAA Iron "Mega-Lug", Ford "Uni-Flange", Romac Industries "Grip Ring" or other restraint gland as approved by the PSA Director.
 - b. Ductile iron pipe push-on joint with use of U. S. Pipe "Field LOK" gaskets.
 - c. Restrained joint pipe such as U. S. Pipe "TR FLEX" pipe, Griffin Pipe "Snap-LOK" pipe or other restraint joint pipe as approved by the PSA Director.
 - d. Ductile iron, PE, or PVC pipe push-on joint with use of Mueller Company "AquaGrip" system.

E. PVC Plastic Bell and Spigot Joint:

1. PVC pipe meeting the AWWA Specification C900 for dimension ratio (DR) 14, pressure Class 200, may be used for water lines. DR-18 or DR-25 may be used as noted above for pressure pipe larger than 12" in diameter.
2. PVC pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions and AWWA Specification C605. To facilitate future locating of PVC water pipe, a 12 gauge solid copper wire shall be laid with pipe and in metal to metal contact with all fittings, valves, and service connections. Wire splices shall be made with a minimum of six tight twists of stripped (bare) wire and secured with a wire nut and adhesive

tape suitable for underground burial. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.

3. All service line connections to PVC pipe shall be made using a stainless steel service saddle and full port, teflon coated ball valve corporation stop. Service saddle shall be of the extra wide or double-band type and manufactured specifically for PVC pipe. No direct tap to PVC pipe shall be permitted.
4. Only bell and spigot with elastomeric gasket joints shall be used. Solvent-cement joints or use of couplings shall not be allowed.

F. PE Pipe:

1. PE pipe shall be high density polyethylene meeting the AWWA Specification C906 for dimension ratio (DR) 11 and applicable requirements of ASTM D3550, may be used for water lines.
2. PE pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions. To facilitate future locating of PE water pipe, a 12 gauge solid copper wire shall be laid with pipe and in metal to metal contact with all fittings, valves, and service connections. Wire splices shall be made with a minimum of six tight twists of stripped (bare) wire and secured with a wire nut and adhesive tape suitable for underground burial. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.
3. All service line connections to PE pipe shall be made using a fused service saddle and full port, teflon coated ball valve corporation stop. No direct tap to PE pipe shall be permitted.
4. PE pipe shall be assembled and joined at the site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections shall not be permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations.
5. Butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. Joint shall be allowed adequate cooling time before removal of pressure. Fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the OWNER and/or his representative prior to insertion. All defective joints shall be cut out and replaced at no cost to OWNER. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten

percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the OWNER and/or his representative shall be discarded and not used.

6. Terminal sections of pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp or equal. Butt gap between pipe ends shall not exceed one-half (1/2) inch. Also Unicore Plastic Fusion System, unicore can be used to butt fuse the pipe material.

G. PVCO Plastic Bell and Spigot Joint:

1. PVCO pipe meeting the AWWA Specification C909 for pressure Class 200, may be used for water lines up to 12" in diameter.
2. PVCO pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions. To facilitate future locating of PVCO water pipe, a 12 gauge solid copper wire shall be laid with pipe and in metal to metal contact with all fittings, valves, and service connections. Wire splices shall be made with a minimum of six tight twists of stripped (bare) wire and secured with a wire nut and adhesive tape suitable for underground burial. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.
3. All service line connections to PVCO pipe shall be made using a stainless steel service saddle and full port, teflon coated ball valve corporation stop. Service saddle shall be of the extra wide or double-band type and manufactured specifically for PVCO pipe. No direct tap to PVCO pipe shall be permitted.
4. Only bell and spigot with electrometric gasket joints shall be used. Solvent-cement joints or use of couplings shall not be allowed.

H. Ductile Cast Iron Pipe Fittings:

1. Fittings for all water pipes shall be ductile iron in accordance with AWWA Specifications C110, latest revision, with a minimum pressure rating of 250 PSI. All ductile iron water pipe fittings shall conform to ANSI Specifications A-21.10 and A-21.11 and shall have same type of connection, lining and coating as pipe. Ductile iron water pipe fittings in conformance with ANSI/AWWA C-153/A-21.53 Specs. for ductile iron compact fittings shall be considered as meeting the requirements of this Specification.

2. One Bolt, Incorporated "One Bolt" fittings may be used for ductile iron and PVC pipe.
3. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint fittings, valves and hydrant connections.

I. Gate Valve:

1. All gate valves shall be of superior quality iron body with resilient seat and full bronze mount. All gate valves shall withstand a working pressure of 200 psi and shall be in strict conformance to applicable AWWA Standards. Wrench nut shall turn to the left (counterclockwise) to open 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 with stainless steel or other extra strength stems.
2. On valves fourteen inches (14") or larger, butterfly valves conforming to AWWA C504 may be used.
3. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint fittings, valves and hydrant connections.

J. Fire Hydrants:

1. Hydrants shall be traffic model, dry-barrel type, meeting AWWA C502 latest revision standard; Mueller Centurion, Dresser 500 Traffic Model, Darling Model B-50-B, AVK Model 2780, or approved equal.
2. Hydrants shall be of compression type with main valve openings not less than four and one-half inches (4-1/2") in diameter. Hydrants shall have cast or ductile iron body with full, bronze trim, and shall withstand a hydrostatic test pressure of 300 psi. Hydrants shall have a six-inch (6") connection base for setting with a minimum of thirty-six inch (36") cover on connection pipe. Hydrants shall be equipped with hose connections as follows:
Two each 2-1/2", N.S.T. hose connections
One each 4-1/2", N.S.T. pumper connections
3. Hydrant shall be operated by a National Standard 1-1/2 inch (1-1/2") pentagon shaped, operating nut, opening counterclockwise. Direction of opening shall be clearly marked by an arrow cast on outside of hydrant. Hydrants shall be connected to the main with a six-inch (6") pipe and shall be controlled by an independent six-inch (6") gate valve. Six-inch (6") gate valve shall be located as near to service main as practical, and connected to the tee with tie rods. A gravel dry well shall be provided for hydrant drain.
4. All hydrant barrels and all 2-1/2 and 4-1/2 inch caps of the hydrant shall be

painted with red reflective paint. (Fire Department will color code caps after flow testing).

5. Hydrant assembly shall be restrained from connection to distribution main to hydrant. Approved restraint methods shall include threaded "Corten" rodding between hydrant, hydrant valve and connection to water distribution main with concrete thrust blocks behind hydrant and distribution main tee fitting. Approved mechanical joint gland restraint ("Mega-Lug", "Grip Ring" or "Uni-Flange") may be used in lieu of concrete thrust blocking.
6. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint valves, fittings and hydrant connections.

K. Valve Vaults:

1. Valve vaults shall be used for all main line valves unless otherwise approved in writing by the PSA Director. All vaults shall be precast manhole cone sections with water manhole covers as shown in the Detail Drawings.

L. Valve Boxes:

1. All valve boxes, base extensions, head and cover shall be of cast or ductile iron meeting AASHTO Designation M306-05. Valve boxes shall be of the Mueller sliding type, round head marked "Water". Shaft diameter shall not be less than five inches (5"). Valve boxes shall have a minimum range of extension to fit two inch (2") to twelve inch (12") valves inclusive, placed on mains at depths of three feet, (3') to five feet (5') of cover in order that cover of the valve box is set to finished grade. Valve boxes shall be two piece. Valve boxes shall be centered over valve screw and set plumb. Valve boxes shall only be allowed on fire hydrant valves or on other installations approved in writing by PSA Director.

M. Water Service Connection – Type "A":

1. Type "A" meter connection shall be installed when main line pressure is less than 80 PSI.
2. Water meter box and accessories therein necessary for Type "A" meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
3. All water services pipe from main connections to the meter box assembly shall be Endot SDR-9 200 psi CTS Polyethylene (PE) or "K" type copper.

All connections shall use approved compression, pack-joint type fittings. Twelve (12) gauge solid copper locator wire shall be laid with PE pipe and in metal to metal contact with all fittings, valves, and service connections. The minimum size service connection shall be 1 inch (1") I.D. for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.

N. Water Service Connection – Type “B”:

1. Type “B” meter connection shall be installed when main line pressure is 80 to 120 PSI. Type “B” connection incorporates an individual ¾-inch pressure reducing valve, Wilkins Model 600 LU or equal installed in a standard meter setter and box situated on the customer side of the meter.
2. Water meter box and accessories therein necessary for Type “B” meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
3. Pressure reducing valve and accessories shall be furnished and installed by CONTRACTOR on private property side of pressure reducing valve box and valve setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
4. All water services pipe from main connections to the meter box assembly shall be Endot SDR-9 200 psi CTS Polyethylene (PE) or "K" type copper. Twelve (12) gauge solid copper locator wire shall be laid with PE pipe and in metal to metal contact with all fittings, valves, and service connections. All connections shall use approved compression, pack-joint type fittings. The minimum size service connection shall be 1 inch (1") I.D. for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.

O. Water Service Connection – Type “C”:

1. Type “C” meter connection shall be installed when main line pressure is greater than 120 PSI. Type “C” connection incorporates installation of water meter and individual ¾-inch pressure reducing valve, Wilkins Model BR4EC or equal in a standard double meter setter and box situated on the public water system side of the meter.
2. Water meter, ¾-inch pressure reducing valve, connecting S-bar with integral

pressure relief valve and accessories therein necessary for Type "C" meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and double meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.

3. All water services pipe from main connections to the meter box assembly shall be Endot SDR-9 200 psi CTS Polyethylene (PE) or "K" type copper. Twelve (12) gauge solid copper locator wire shall be laid with PE pipe and in metal to metal contact with all fittings, valves, and service connections. All connections shall use approved compression, pack-joint type fittings. The minimum size service connection shall be 1 inch (1") I.D. for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.
- P. 1" to 3" Water Services: All service pipe from 1" to 3" in diameter shall be Endot SDR-9 200 psi CTS Polyethylene (PE) or "K" type copper. Twelve (12) gauge solid copper locator wire shall be laid with PE pipe and in metal to metal contact with all fittings, valves, and service connections.
- Q. Water Meters: All water meters shall be installed by the PSA per the current Basic Connection Fee schedule. Water meters shall conform to applicable AWWA standards as listed in 02665 Section 1.5.
- R. Wet Taps: All taps to PSA water system shall be made or coordinated by PSA at customer's expense. Wet taps shall be hydrostatically tested at 200 pounds per square inch (psi) for 15 minutes without loss.
- S. Pipeline Bedding Materials: Where pipeline installation requires granular bedding materials, they shall meet requirements of VDOT gradation 21-A, No. 57 or No. 68.
- T. Surface Water Crossings:
1. Surface water crossings, both over and under water, present special problems and should be discussed with the PSA Director before final plans are prepared.
 2. Above Water Crossings - The pipe above water crossings shall be:
 - a. Adequately supported;
 - b. Protected from damage from freezing;
 - c. Accessible for repair or replacement; and
 - d. Above 100 year flood level.
 3. Under Water Crossing:

- a. Pipe shall be of special construction, having flexible watertight joints; i.e. ball and socket, lock-joint, and shall be Class 54 or 55 DI. DR-9 HDPE may be used for under water crossings. In lieu of the above, Class 52 DI pipe may be used with a minimum of one foot on all sides being concrete encased within the one hundred (100) year flood way limits.
 - b. Pipe shall be provided with a minimum of one foot of cover over the concrete encasement from bottom of the stream bed where in rock and three of cover in other material. The trench and stream banks shall be adequately protected with concrete and/or riprap to prevent erosion.
 - c. Valves shall be provided at both ends of the water crossing so that the section can be isolated for tests or repair; the valves shall be easily accessible and not subject to flooding by the 100-year storm flood level.
 - d. Permanent sample taps shall be installed on each end of the crossing and at reasonable distance from each side of the crossing to facilitate testing.
- U. Special Conditions: PSA Director may require special material and/or construction be used where normal water pressure exceeds pressure rating used in these standards and where design will not permit reducing pressures to acceptable levels.

2.2 EXCAVATION CLASSIFICATIONS

- A. All excavated material shall be classified as either rock or earth excavation. The estimated quantity indicated for Rock Excavation in the Bid Form, if included, shall be the amount of rock expected to be encountered by the Contractor. The remainder of the excavation shall be assumed to be Earth Excavation, which shall be included in the unit price for installing the pipe complete-in-place.
- B. Rock excavation, if included in Bid Form, shall include boulders measuring three-quarter (3/4) cubic yards or more in volume and weighing more than eight hundred (800) pounds. Also included are solid ledges, bedded deposits, unstratified masses and conglomerations of materials so firmly cemented as to possess characteristics of solid rock, which cannot be removed without systematic drilling and blasting. Sidewalk, curb and gutter, paving and structures to be removed shall not be classified as rock.

PART THREE - EXECUTION

3.1 WATER LINE CONSTRUCTION

A. General:

1. Except as specifically modified below, water line construction shall meet requirements of AWWA C600 and/or C605 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 PSA Director or his authorized representative shall be advised and the PSA Director's 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.

B. Excavation, Bedding and Backfill:

1. Trench shall be dug so that pipe can be laid to the alignment and depth required and it shall be excavated not more than one hundred fifty feet (150') in advance of completed pipe laying operation. Trenches are not to be left open overnight unless adequate safety precautions are taken. Width of trench shall be ample to permit pipe to be placed, backfill and thoroughly compacted in accordance with requirements of these specifications. Trenches shall be of such extra widths as will permit convenient placing of timber supports, sheeting and bracing and handling of special fittings or appurtenances when required. Where consistent with safety and space considerations, excavated material is to be placed on uphill side of trenches. Trenches are to be adequately dewatered in a manner that will not adversely affect flowing streams, drainage systems, or off-site property. Pipe shall not be strung along trench in excess of that which can be installed each day.
2. Contractor shall do all sheeting, bracing and shoring necessary to perform the work, protect existing structure, and protect all excavations as required for safety, in conformance with all local, state and federal safety regulations.
3. Trench shall be excavated to depth required so as to provide a uniform and continuous bearing support for pipe on solid and undisturbed ground at every point between bell holes, except that it will be permissible to disturb and otherwise damage finished surface over a maximum length of eighteen inches (18") near middle of each length of pipe by withdrawal of pipe slings or other lifting tackle. Damaged area shall be refinished as near as possible. Any part of bottom of trench excavated below specified grade, shall be backfilled with approved materials, and be thoroughly compacted. Finished

subgrade shall be prepared accurately by means of hand tools.

4. Bedding shall be placed as required by the pipe manufacturer's written installation instructions.
5. Where excavation is made in fractured rock, boulders, or other unsuitable material, subgrade shall be made by backfilling with a minimum four inch (4") compacted depth of gravel or clean selected soil which shall be thoroughly compacted.
6. Bell holes shall be provided at each joint to permit the jointing to be made properly and to permit maximum bedding length.
7. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") below and at least twelve inches (12") on each side of pipe and appurtenances being laid and any part or projection of such rock, or stone.
8. No pipe shall be laid in water or when, in the opinion of the PSA Director, trench conditions are unsuitable. If the PSA is of the opinion that trench bottom consists of wet, washable material or is otherwise incapable of properly supporting the pipe or structures, such material shall be removed and replaced with proper bedding material in addition to the standard bedding required.
9. Backfill shall be placed in two (2) equal depth layers to the top of the pipe and each layer shall be thoroughly tamped to ninety-five percent (95%) of the maximum theoretical density as determined by a standard proctor test, the remainder of the backfill shall be placed in a maximum of two foot (2') layers mechanically tamped. Backfill material shall be free of perishable material, frozen clods, sticky masses of clay and other unsuitable matter. Rock pieces larger than two inches (2") shall not be used in backfill, which is within two feet (2') of pipe.
10. Backfill in areas not subjected to vehicular traffic shall be compacted to such a degree that any subsidence will not be objectionable or detrimental to normal use. Backfill and replacement in existing or proposed roads shall be executed in full accordance with requirements of the Virginia Department of Transportation Standards. All materials excavated, but not used in backfilling, shall be properly removed and disposed of by the Contractor in an approved location provided by the contractor. No stone or rock larger than five (5) inches in its greatest dimension shall be used in the backfilling of any water or sewer facility.

C. Blasting

1. The PSA may prohibit blasting whenever it is felt that the protection provided is inadequate. Extreme care shall be used whenever blasting for

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the removal of hard materials is necessary.

2. Blasting shall be prohibited on Sundays, Holidays, and between the hours of 7:00 p.m. and 7:00 a.m., unless previously approved in writing by the OWNER.
3. Only persons experienced in the handling and use of blasting materials shall perform this work. All licenses and blasting permits shall be kept on the job site at all times blasting is performed.
4. Only the quantity and strength of explosives necessary for proper trench excavation shall be used. All explosives shall be detonated by an approved electric blasting device. Under no circumstances shall electric current from batteries, telephone or power lines be used for detonation.
5. No blasting shall take place until all persons in the vicinity have been warned and had sufficient time to reach safety.
6. All blasting shots shall be covered with blasting mats or other approved material such that all structures, persons, and property are protected from injury. A pre-blast survey may be required if blasting is required in close proximity to structures.
7. Contractor shall take into consideration location of existing utilities, or other structures when blasting. Contractor shall be responsible for taking all necessary precautions during blasting and general construction activities such that existing structures and facilities are protected from damage and will not be affected by construction activities.
8. Contractor shall be responsible for notifying and coordinating with the proper authorities, utility companies, and potentially affected parties prior to and during all blasting activities.
9. When rock is encountered, Contractor shall notify the Construction Inspector in order that the quantities can be measured.

D. Installation of Pipe and Fittings:

1. When installing pipe in trench, proper implements, tools, and facilities satisfactory to the PSA Director and as recommended by material manufacturer shall be provided and used by contractor for safe and convenient prosecution of the work. All pipe, valves, fittings, hydrants and accessories shall be carefully lowered into 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 water main material and any protective coatings and linings. Under no circumstances shall water main materials be

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- dropped or dumped into trench. 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 ends of ductile iron pipe, and outside of the spigot and inside of the bell shall be wiped clean and dry and free from oil and greases before the pipe is laid.
 3. Every precaution shall be taken to prevent foreign material including nonpotable 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 it, 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 opening.
 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, not less than 36 feet of pipe shall be installed between valve and plugged stub end of pipe for adequate anchoring.
 6. 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 axis of the pipe.
 7. When machine cutting is not available for cutting metal pipe twenty inches (20") 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. Flame cutting of metal pipe by means of oxyacetylene torch will not be allowed.
 8. Whenever it is necessary to deflect pipe from a straight line, either in 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 maximum required, for satisfactory joining of the pipe, as specified in this manual. Maximum deflection permitted per joint shall be in accordance AWWA C600 Table 4 for push-on joint and Table 5 for mechanical joint pipe. C900 PVC pipe deflection may not exceed 75% of manufacturer's recommendation.

**INSTALLATION OF DUCTILE-IRON WATER MAINS
TABLE 4**

Maximum Joint Deflection Full-Length Pipe – Push-On Type Joint

| | | Maximum Offset – S Inches (Meters) | | Approximate Radius of Curve – R* Produced by Succession of Joints | |
|----------------------------------|---------------------|---|---|---|---|
| Nominal Pipe Size (Inches) | Deflection Angle | Joint Length 18-Foot (5.5 Meters) | Joint Length 20-Foot (6.1 Meters) | Joint Length 18-Foot (5.5 Meters) | Joint Length 20-Foot (6.1 Meters) |
| 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 (115) |
| 16 | 3° | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (115) |
| 18 | 3° | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (115) |
| 20 | 3° | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (115) |
| 24 | 3° | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (115) |
| 30 | 3° | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (115) |

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

**TABLE 5
Maximum Joint Deflection Full-Length Pipe -- Mechanical Joint Pipe**

| | | Maximum Offset – S Inches (Meters) | | Approximate Radius of Curve – R* Produced by Succession of Joints | |
|----------------------------------|---------------------|---|---|---|---|
| Nominal Pipe Size (Inches) | Deflection Angle | Joint Length 18-Foot (5.5 Meters) | Joint Length 20-Foot (6.1 Meters) | Joint Length 18-Foot (5.5 Meters) | Joint Length 20-Foot (6.1 Meters) |
| 3 | 8° - 18" | 31 (0.79) | 31 (0.89) | 125 (38) | 140 (43) |
| 4 | 8° - 18" | 31 (0.79) | 31 (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) |
| 16 | 3° - 35" | 13½ (0.34) | 15 (0.38) | 285 (87) | 320 (98) |
| 18 | 3° - 00" | 11 (0.28) | 12 (0.30) | 340 (104) | 380 (116) |
| 24 | 2° - 23" | 9 (0.23) | 10 (0.25) | 450 (137) | 500 (152) |
| 30 | 2° - 23" | 9 (0.23) | 10 (0.25) | 450 (137) | 500 (152) |

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 backing and/or tie rods. Reaction backing shall be designed and installed as indicated in the Detail Drawings. Hydrants shall be set to established finished grade as follows:
 - a. Bottom of the four and one-half inch (4-1/2") nozzle shall be between eighteen inches (18") and twenty-four inches (24") above finish elevation, or at the edge of the shoulder on streets without curb and gutter and between eighteen and twenty-four inches (18")-(24") above elevation of the curb on streets with curb and gutter as indicated in the Detail Drawings.
 - b. Two and one-half inch (2-1/2") hose connections shall have a minimum of four feet zero inches (4'0") clearance on all sides.
 - c. Surface shall be approximately level within a four-foot (4') radius of the hydrant.
 - d. Fire hydrant drains shall be plugged if seasonal water level is noted above drain outlet. The Engineer and PSA Director shall be immediately notified so that the fire hydrant can be properly relocated.

10. Water lines installed on slopes greater than 20% shall be secured by anchor blocks in conformance with Detail Drawing S-19. Restrained joint pipe per section 02665 Part 2, 2.1. D. shall be used if the pipe bells are installed on the downhill end of the pipe section. The PSA Director may require

restrained joint pipe systems per Section 02665 Part 2.1 D. on grades exceeding 20% where deemed necessary due to trench, subsurface, slope or surface conditions.

E. Installation of Valves, Air Relief Assemblies and Blow-Off Chambers

1. During construction, air and sediment accumulations may be removed through a standard fire hydrant. Compressed air and/or pumping may be used for dewatering 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 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 a sufficiently deep water table.

3.2 RELATION OF SEWERS TO WATER MAINS

A. General:

1. The following factors shall be considered in providing adequate water and sewer line 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 feet (10') horizontally from sewer lines whenever possible with distance measured edge-to-edge unless determined by PSA Director to be unusual conditions.
2. Unusual Conditions - When local conditions prevent horizontal separation described above, the following construction shall be used:
 - a. The bottom (invert) of the water main shall be at least eighteen inches (18") above the top of the (crown) of the sewer.
 - b. Where this vertical separation cannot be obtained, sewer shall be constructed of AWWA approved water pipe, hydrostatically pressure

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tested in place without leakage prior to backfilling. Pressure test shall be 30 psi.

- c. Sewer manhole shall be made 100% water-tight construction and vacuum tested in place without leakage for 30 minutes.

C. Crossing Installation:

1. Normal conditions - water lines crossing over sewers shall be laid to provide a separation of at least eighteen inches (18") 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, hydrostatically pressure tested in place without leakage prior to backfill. Pressure test shall be 30 PSI.
 - b. Length of sewer pipe shall be centered at the point of the crossing so that joints shall be equidistant and as far as possible from water line.
3. Water lines passing under sewers shall also be protected by providing:
 - a. A vertical separation of at least eighteen inches (18") 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 10' of the water line.
 - b. Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking of the water line.
 - c. The length of 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:

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, etc.) cross within six inches (6") above or below water lines, adequate structural support of the utilities shall be provided.
2. Parallel installations of other utilities shall be a minimum of 24" offset edge to edge from water lines.

3. Water lines shall be placed over storm drains wherever practical.

3.3 HYDROSTATIC TESTS FOR LEAKAGE

A. General:

1. All new water mains shall be tested, after backfilling to a hydrostatic pressure of not less than 100 psi above design water pressure for the system or 150 psi, whichever is greater. Allowable leakage shall be calculated by the following formula and is shown in columnar form in Table 6:

$$L = \frac{SD\sqrt{P}}{133,200}$$

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

TABLE 6
Allowable Leakage per 1,000 ft. (305 m) of Pipeline*--gph[^]

| Average Test Pressure PSI (Bars) | NOMINAL PIPE DIAMETER - Inches | | | | | | | |
|-------------------------------------|--------------------------------|------|------|------|------|------|------|------|
| | 3" | 4" | 6" | 8" | 10" | 12" | 14" | 16" |
| 300 (21) | 0.39 | 0.52 | 0.78 | 1.04 | 1.30 | 1.56 | 1.82 | 2.08 |
| 275 (19) | 0.37 | 0.50 | 0.75 | 1.00 | 1.24 | 1.49 | 1.74 | 1.99 |
| 250 (17) | 0.36 | 0.47 | 0.71 | 0.95 | 1.19 | 1.42 | 1.66 | 1.90 |
| 225 (16) | 0.34 | 0.45 | 0.68 | 0.90 | 1.13 | 1.35 | 1.58 | 1.80 |
| 200 (14) | 0.32 | 0.43 | 0.64 | 0.85 | 1.06 | 1.28 | 1.48 | 1.70 |
| 175 (12) | 0.30 | 0.40 | 0.59 | 0.80 | 0.99 | 1.19 | 1.39 | 1.59 |
| 150 (10) | 0.28 | 0.37 | 0.55 | 0.74 | 0.92 | 1.10 | 1.29 | 1.47 |
| 125 (9) | 0.25 | 0.34 | 0.50 | 0.67 | 0.84 | 1.01 | 1.18 | 1.34 |
| 100 (7) | 0.23 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.05 | 1.20 |

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

[^] To obtain leakage in liters/hour, multiply the values in the table by 3.785.

- B. 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 hydrostatic pressure during the leakage test. Testing of water mains shall be observed and documented by PSA Inspector/Engineer.

- C. All high points and service lines in portion of system under test shall be vented and all air expelled from system prior to beginning 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.
- D. After section of system under test has reached required pressure as stated above, said pressure shall be maintained for two (2) hours. At conclusion of pressure test, volume of makeup water required to refill pipeline shall be determined by measurement with displacement meter or by pumping from vessel of known volume.
- E. All joints or fittings at which leakage occurs shall be reworked to insure tightness. All visible leaks shall be repaired regardless of amount of leakage. If measured amount of leakage exceeds values for the appropriate size as found in AWWA Specification C600, AWWA Specification C605 or Hydrostatic Testing (Table 6), pipeline shall be repaired and retested until leakage is within limit set by the referenced specification. Methods of repair prior to retesting will be done with PSA Director'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.

3.4 DISINFECTION OF WATER MAINS

- A. General - After testing and before final inspection of the completed systems, water mains and service laterals shall be flushed and disinfected in accordance with AWWA Specification C651 latest revision. Flushing shall be accomplished at a flow velocity of not less than 2.5 feet per second.

- B. Disinfection Procedures:

- 1. Disinfection as described in AWWA C651 - "Placing of calcium hypochlorite tablets" shall be used. Five-gram (5g) 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:

| <u>Pipe Diameter</u> | <u>Number Tablets Per 18-20 Ft. Pipe Section</u> |
|----------------------|--|
| 6" | 1 |
| 8" | 2 |
| 10" | 3 |
| 12" | 4 |
| 16" | 7 |

or the number of tablets equal to $0.0012d^2L$ 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 PSA Director.

2. Disinfection solution shall remain in pipe line for not less than twenty-four (24) hours, after which time a chlorine residual of 10 ppm at all parts of line shall be required.
3. Following chlorination, piping shall be thoroughly flushed. Water in the new main shall be proven comparable in quality, by testing, to the existing public water supply. The Virginia Waterworks Regulations require at least two consecutive satisfactory bacteriological samples from distribution system for every 2,000 feet of pipe before system can be placed in service. Developer/Contractor shall pay all costs associated with disinfection and testing of installed facilities and any additional bacteriological samples required after first set.

3.5 LOCATOR WIRE CONTINUITY TEST

- A. All locator wire shall be tested for proper installation and service upon completion of hydrostatic leak testing. Testing shall be performed to verify that wire is without breaks and suitable for its intended purpose. Any breaks in the wire shall be repaired using proper materials and procedures.

3.6 CARE AND RESTORATION OF PROPERTY

- A. Excavating machinery and cranes shall be operated with care to prevent damage to existing structures and/or wires.
- B. On paved surfaces, the CONTRACTOR shall not use or operate tractors, bulldozers, or other power-operated equipment and treads or wheels which are so shaped as to cut or otherwise damage such surfaces.
- C. All surfaces, which have been damaged by CONTRACTOR'S operations shall be restored to a condition at least equal to that in which they were found immediately prior to beginning of operations. Suitable materials and methods shall be used for such restoration.
- D. CONTRACTOR shall replace and repair all lawns, terraces, shrubs, trees, plants, fences, sidewalks, curbs, cross walks, gutters, driveways, or pavements, and repair and make good all other damage, that may occur during construction work. CONTRACTOR will be held responsible for all damage that may occur after pipeline is constructed and which may be directly or indirectly attributed to operations as they are carried out. CONTRACTOR shall not operate equipment or store materials on private property without first having obtained written consent of property owner.

- END OF SECTION -