**SECTION 02665**

**WATER DISTRIBUTION SYSTEM**

1. **GENERAL**
	1. **WORK INCLUDED**
		1. Work in this Section includes all exterior potable water distribution system piping and appurtenances.
		2. The work shall include the providing of all proper materials, equipment, tools, accessories, labor, and services required to install the water system, complete-in-place, using sound standard engineering techniques and construction practices.
		3. Reference Specifications are referred to by abbreviation as follows:

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

AWWA - American Water Works Association

CSE - Commercial Standard (National Bureau of Standards)

FS - Federal Standards

VDOT - Virginia Department of Transportation

* 1. **SEPARATION OF WATER LINES AND SANITARY AND/OR COMBINED SEWERS**
		1. Follow PSA Standards and State Health Department "Waterworks Regulations" for separation of water mains and sewer lines. In the event of difference or conflict, the stricter standard shall govern.
	2. **PARALLEL INSTALLATION**
		1. Normal Conditions - Water lines shall be constructed at least 10' horizontally from a sewer or sewer manhole whenever possible. The distance shall be measured edge-to-edge.
		2. Unusual Conditions - When local conditions prevent a horizontal separation of at least 10', the water line may be laid closer to a sewer or sewer manhole provided that:
			1. The bottom of the water line is at least 18" above the top of the sewer.
			2. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA ductile iron water pipe pressure-tested in place to 50 psi without leakage prior to backfilling. The sewer manhole shall be of watertight construction and tested in place.
	3. **CROSSING**
		1. Normal Conditions - Water lines crossing over sewers shall be laid to provide a separation of at least 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 of at least 18”, the following construction shall be used:
			1. Sewers passing over or under water lines shall be constructed of AWWA ductile iron water pipe pressure-tested in place to 50 psi without leakage prior to backfilling. The sewer manhole shall be of watertight construction and tested in place.
			2. Water lines passing under sewers shall, in addition, be protected by providing:
			3. A vertical separation of at least 18" between the bottom of the sewer and the top of the water lines.
				1. Constructing any water lines passing under sewers of AWWA ductile iron.
				2. Providing structural support for the sewer line to prevent excess deflection of the joints and settlement on and/or breaking of the water line.
				3. That the length of the water line shall be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.
		3. Sewers or sewer manholes - No water pipes shall pass through or come in contact with any part of sewer or sewer manhole.

# PRODUCTS

# PIPE

* + 1. Submit shop drawings on all products as required by the PSA.
		2. Provide certified test results of pipe testing as required by the PSA.
		3. All pipe for use in potable water systems shall be National Science Foundation (NSF) approved.
		4. Ductile iron pipe shall meet requirements of AWWA/ANSI C151/A21.51 Pressure Class 350, unless otherwise indicated on the drawings or called for otherwise in the PSA standards. All pipes shall have a cement mortar lining on the interior and a bituminous coating on the exterior.
		5. Flanged cast iron and ductile iron pipe shall meet the requirements of AWWA/ANSI C115/A.21.15 for Thickness Class 53, with 125 lb flanges, unless otherwise indicated on the drawings or called for otherwise in the PSA standards. Thickness class shall meet requirements of AWWA/ANSI C150/A21.50. All pipes shall have a cement mortar lining on the interior and a bituminous seal coat on the exterior.
		6. Polyvinylchloride (PVC) pipe in sizes 4" through 12" shall meet the requirements of AWWA C900. Pipe shall be DR-14 or DR-18 as indicated on the drawings or called for in the PSA standards. Pipe shall be bell and spigot type with rubber gasketed bell. Pipe shall conform to outside dimension of ductile iron pipe. Use of C900 shall be limited to working pressures of 200 psi or less for DR14 and 150 psi or less for DR18. C900 pipe used for potable water service shall be blue without exception.
		7. High Density Polyethylene (HDPE) pipe and fittings in sizes 4” to 12” shall meet the requirements of AWWA C906. Pipe shall be DR-11, DR-9, or DR-7 as specified on the drawings or called for in the PSA standards. Pipe shall be fusion welded in accordance with manufacturer’s recommendations. Pipe shall conform to outside dimension of ductile iron pipe. DR-11 shall be shall be limited to working pressures of 150 psi or less, DR-9 to 200 psi or less, and DR-7 to 250 psi or less. C906 pipe used for potable water service shall be solid blue or black with a blue stripe, without exception.
		8. Polyvinylchloride (PVC) pipe and fittings in sizes less than 4” shall be Schedule 80 meeting the requirements of ASTM D-1785, manufactured of material meeting the requirements of ASTM D-1784, Type 1120. Joints shall be one of the following:
			1. Screw joint, meeting requirement of ASTM D-2464;
			2. Solvent welded meeting requirements of ASTM D-1785, or;
			3. Bell and spigot, meeting requirements of ASTM D-1785, with pipe ends tapered for insertion into gasketed bells and fittings with built-in stops. Bell and spigot pipe shall require proper thrust restraint at fittings.
		9. Schedule 80 PVC pipe may be used in pressures up to 250 psi.
		10. High Density Polyethylene (HDPE) pipe and fittings in sizes 2” or less shall meet the requirements of AWWA C901 Pipe shall be SDR-9 PE3710 or PE4710. SDR-9 shall be shall be limited to working pressures of 250 psi or less. Pipe shall be fusion welded type. Pipe shall conform to outside dimension of ductile iron pipe. C906 pipe used for potable water service shall be solid blue or black with a blue stripe, without exception.
		11. Polyvinylchloride (PVC) pipe for use in 4” to 12” Directional Drilling shall be AWWA C900 internally restrained joint or fusible pipe. Pipe shall be DR-14 or DR-18 as indicated on the drawings or called for in the PSA standards. Pipe shall conform to outside dimension of ductile iron pipe. Use of C900 for directional drills shall be limited to working pressures of 200 psi or less for DR14 and 150 psi or less for DR18.
		12. High Density Polyethylene (HDPE) pipe for use in 4” to 12” Directional Drilling shall AWWA C906. Pipe shall be DR-11, DR-9, or DR-7 as specified on the drawings or called for in the PSA standards. Pipe shall be fusion welded in accordance with manufacturer’s recommendations. Pipe shall conform to outside dimension of ductile iron pipe. DR-11 shall be shall be limited to working pressures of 150 psi or less, DR-9 to 200 psi or less, and DR-7 to 250 psi or less. C906 pipe used for potable water service shall be solid blue or black with a blue stripe, without exception.
		13. Ductile Iron (DI) pipe for use in Directional Drilling shall meet requirements of AWWA/ANSI C151/A21.51 Pressure Class 350, unless otherwise indicated on the drawings or called for otherwise in the PSA standards. Joints shall be ball and socket type. All pipes shall have a cement mortar lining on the interior and a bituminous coating on the exterior.
		14. Copper tubing shall meet requirements of ASTM B88 for Type "L" copper, hard drawn, for above ground and Type "K" hard drawn for below ground.
		15. Gray iron and ductile iron fittings shall meet requirements of AWWA/ANSI C110/A21.10 for the pressure class of pipe. All fittings shall have a cement mortar lining on the interior and a bituminous coating on the exterior. Compact fittings may be used in lieu of standard fittings and shall meet requirements of AWWA/ANSI C153/A21.53. All fittings shall have a cement mortar lining on the interior and a bituminous coating on the exterior.
		16. Mechanical joints and jointing materials shall meet requirements of AWWA/ANSI C111/A21.11.
			1. Mechanical joint retainer glands shall meet requirements of AWWA/ANSI C111/A21.11 except that retainer glands shall be modified to accommodate set screws.
			2. Locked type mechanical joints may be used where restrained joints are required.
		17. Push-on joint and rubber gasket shall meet requirements of AWWA/ANSI C111/A21.11.
			1. Push-on joints and gaskets shall meet requirements of AWWA/ANSI C111/A21.11.
			2. Locked type restrained push-on joints or external restraint mechanisms may be used where restrained joints are required.
		18. Flanged joints for ductile iron pipe shall meet requirements of ANSI B16.1.
		19. Flanged joint gaskets shall be full-face, made of rubber, and shall meet requirements of ANSI B16.21. Flange gaskets shall be of a type rated for the maximum working pressure of the application.
		20. Cement mortar lining with bituminous seal coat for ductile iron pipe and fittings or for cast iron fittings shall meet requirements of AWWA C104. Cement mortar lining shall be standard thickness.
		21. Exterior, bituminous coating for ductile iron pipe and fittings and cast iron fittings shall meet requirements of AWWA C106 or AWWA C151 as applicable.
		22. Metal harness shall be stainless steel rods and clamps.
		23. Fittings for copper piping shall meet requirements of ANSI B16.22 for wrought copper, compression fitting.
		24. Nipples shall be constructed of materials as listed on drawings and/or details. Under no circumstances shall galvanized pipe be used.
	1. **GATE VALVES**
		1. Non-rising stem valves, 2" thru 14", shall be resilient seated and shall meet requirements of AWWA C509 and C515. Valves shall have 250 psi working pressure or pressure rating specified for the adjacent piping, whichever is greater. Valve ends shall be compatible with piping systems in which they are installed. Valve shall have ductile iron (ASTM A536) body, bronze mounted, bronze stem, ductile iron wedge coated with nitrile rubber. Nuts and bolts shall be 304 stainless steel. The interior and exterior of the body and bonnet shall have fusion bonded epoxy coating in accordance with ASNI/AWWA C550. Valve shall have o-ring seals and open counter-clockwise.
		2. Operators
			1. Buried valves shall be equipped with 2" square operating nuts unless otherwise shown on the Drawings. Where nuts will be more than 48" below finished grade, extension stems shall be pin connected to valve stem. Extension stem shall raise operating nut to within 24" of finished grade. Under no circumstances shall handwheel operators be used on buried valves.
			2. Interior valves shall be handwheel operated except where otherwise shown on the Drawings.
			3. Interior valves in inaccessible locations shall be provided with chain operators as shown on the Drawings.
		3. Valves shall be American-Darling, Clow, M&H, Kennedy, Mueller, or approved equal meeting this Specification.
		4. Tapping valves shall meet requirements of gate valves specified above except that seat opening shall be larger than nominal size and valve outlet end shall have mechanical joint. Inlet flange shall meet the requirements of ANSI B16.1, class 125 drilling and with MSS SP-60. Tapping valves shall be suitable for use with all approved tapping sleeves without modification.
	2. **BUTTERFLY VALVES**
		1. Butterfly valves 16" and larger shall be of the rubber seated, tight closing type meeting requirements of AWWA C504 and shall be Class 150B unless otherwise indicated. Wafer-type valves shall not be used.
		2. Valve ends shall be mechanical joint or bell joint in accordance with AWWA C111. Accessories (bolts, glands, and gaskets) shall be supplied by the valve manufacturer.
		3. Valve operator shall be of the traveling-nut type, sealed, gasketed and lubricated for underground service. Valve operator shall be capable of withstanding an input torque of 450' lb. at full open or closed position, without damage to the valve and valve operator. Valve operator shall be AWWA standard 2" square operating nut.
		4. Rubber seal may be applied to the body or to the disc.
		5. Valves shall open counter-clockwise.
		6. Valves shall be factory tested in accordance with Section 5.2 of AWWA Specification C504. Upon request the manufacturer shall furnish certified copies of test reports.
		7. Valves shall be American-Darling, Dresser "450", Pratt Groundhog or approved equal.
	3. **CHECK VALVES**
		1. Check valves 3" and larger shall be iron body, bronze mounted, swing check valves, meeting requirements of AWWA C508. Check valves 3 through 12" shall be for 250 psi non-shock cold water working pressure.
		2. Manufacturer shall be American Darling, Clow, Kennedy, M&H, or approved equal.
	4. **ELECTRONICALLY OPERATED CHECK VALVES**
		1. Electronically operated check valves are to be used on all above grade pumps. The valves are to be diaphragm or piston operated. Valves shall be globe or angle body type. No valve requiring service via bottom flange port access shall be accepted. Valves shall be manufactured by Cla-Val or Bermad.
	5. **CONTROL VALVES**
		1. This section is intended to cover the general requirements for various types of flow control valves that may be required in the water system. Specific valve requirements should be noted on the drawings and any additional specifications will be listed in these specifications. The valve types to be covered by this section include, but are not limited to:
			1. Pressure Reducing Valves
			2. Pressure Sustaining Valves
			3. Flow Control Valves
			4. Altitude Valves
		2. Control valves shall be diaphragm operated. Valves shall be globe body type. No valve requiring service via bottom flange port access shall be accepted. Valves shall be manufactured by Cla-Val or Bermad.
	6. **VALVE BOXES**
		1. Valve boxes shall be adjustable cast iron valve boxes of the two-piece type, consisting of lid and two-piece sliding extension. The word "WATER" shall be cast or embossed on the valve box lid in letters not less than 1" high. Valve box shall equal to Tyler 6850 Series with 5-1/4” drop lid.
	7. **TAPPING SLEEVES:**
		1. Tapping sleeves shall be either stainless steel or ductile iron body. No carbon steel body tapping sleeves shall be accepted.
		2. Stainless Steel:
			1. The body of tapping sleeve shall be of 18-8 type 304 stainless steel.
			2. Branch/flange to be 304 stainless steel, 150 lb. drilling.
			3. MJ Gland shall be permanently affixed to the outlet branch and be 304 stainless steel.
			4. Gaskets shall be Grade 60 compounded for use with water, alkalis, mild acids and most hydro-carbon fluids, up to 212oF.
			5. Clamping hardware (nuts, bolts and washers) shall be 18-8 type 304 stainless steel, with plastic anti-gall washers. Drop-in bolts or welded-on studs are acceptable.
		3. Cast Iron with Mechanical Joint Ends:
			1. The body and glands of the tapping sleeve shall be of ASTM-126, Class B cast or ductile iron. Sleeve shall be furnished complete with all mechanical joint accessories (bolts, nuts, gaskets and glands), and shall have a bituminous seal coating.
			2. Valve flange, body gaskets and clamping hardware (bolts, nuts and washers) shall be as specified for the fabricated steel tapping sleeve.
			3. Tapping sleeves shall meet requirements of AWWA C110 for pressure rating suitable for working pressure of 250 psi or pressure rating specified for the adjacent piping, whichever is greater. Sleeves shall be built in two sections and shall be mechanical joint type with flanged outlet. The tapping sleeve shall be for the size and type of pipe shown on the Drawings.
	8. **COUPLINGS**
		1. Couplings for use in pressure pipe systems shall be one of the following:
			1. Use of an integral restrained coupling. Restraint are to be compatible with the pipeline materials and working pressures. Couplings are to be Romac Alpha, EBAA Iron Series 3800, or approved equal.
			2. Use of a ductile iron mechanical joint long body solid sleeve complying with AWWA C153, pressure rating to comply with the pipeline. Sleeves shall be used with pipe restraints. The model numbers listed below are by EBAA Iron, which is identified as the standard of quality. Other manufacturers offering products of equal quality will be considered.
				1. Restraints for ductile iron shall be Series 1100 or 1100 TDM depending on working pressure.
				2. Restraints for 4”-12” PVC shall be Series 2000PV.
	9. **FLANGED ADAPTERS**
		1. Flanged adapters for joining ductile iron plain-end pipe to flanged ductile iron items shall be Uni-Flange Series 400 or 420 or approved equal rated for the working pressure of the pipe.
	10. **HDPE PIPE FITTINGS**
		1. Butt Fusion Fittings
			1. Butt Fusion Fittings shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.3.
			2. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to or greater than the pipe unless otherwise specified on the plans.
			3. Fabricated Fittings shall be Equivalent Dimension Ratio to DR9.
			4. Pipe stock used to manufacture fabricated fittings shall meet requirements of AWWA C906 and meet the material designation code of PE4710.
				1. Fabricated Fittings typically require a lower DR rating than the pipe to meet or exceed the pipe pressure rating. Calculate the difference for a fabricated fitting based on a published rerating percentage.
				2. Fabricated bend and tee fittings shall have a minimum of 3 segments.
				3. Fabricated bend fittings over 45 degrees through 90 degrees shall have a minimum of four segments.
				4. Field fabricated fittings are not allowed.
			5. All fittings shall meet the requirements of AWWA C906.
			6. Markings for molded fittings shall comply with the requirements of ASTM D 3261.
				1. Standard Designation (ASTM D 3261)
				2. Manufacturer’s name or trademark
				3. Material designation (PE4710)
				4. Date of manufacture or manufacturing code
				5. Size
				6. Dimension Ratio (example: DR11)
			7. Fabricated fittings shall be marked in accordance with ASTM F 2206.
				1. Standard Designation (ASTM F 2206)
				2. Manufacturer’s name or trademark
				3. Material designation (PE4710)
				4. Date of manufacture or manufacturing code
				5. Size
				6. Equivalent Dimension Ratio
		2. Electrofusion Fittings
			1. Electrofusion Fittings shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.3.
			2. Electrofusion Fittings shall have a manufacturing standard of ASTM F 1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.
			3. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting.
			4. Markings shall be according to ASTM F 1055.
				1. Standard Designation (ASTM F 2206)
				2. Manufacturer’s name or trademark
				3. Material designation (PE4710)
				4. Date of manufacture or manufacturing code
				5. Size
				6. Equivalent Dimension Ratio
		3. Stiffening Inserts
			1. Provide Stiffeners at each MJ adapter and coupling per Standard Details.
			2. Stiffening inserts shall be specially designed for use on the inside of HDPE pipe in conjunction with AWWA C111 mechanical joints.
			3. Stiffeners shall be constructed of Type 304 or 316 stainless steel per ASTM 240.
			4. Stiffener shall be manufactured within the pipe or MJ adapter by the factory or field installed. Fixed diameter or split ring type stiffeners are acceptable.
			5. Stiffener length must be sufficient to fully encompass the area of the pipe being restrained.
			6. Inserts must be designed for underground pressurized fluid service and are pressure rated to match the pipe DR pressure rating, derated as appropriate for service temperature. Maximum test pressure limited to pipe rated pressure.
			7. Stiffener design shall prevent movement causing fitting to slide or rotate on the pipe.
		4. Flex Coupling Restraints
			1. HDPE flex coupling restraint devices will be rated for minimum of 8,000 pounds of force.
			2. Resin used to manufacture device shall meet requirements of ASTM 3350 with minimum cell classification of 445474C.
			3. Device will include bar code and product label tag.
			4. Device will install by electrofusion.
		5. Wall Anchors
			1. Butt fusion wall anchors, or force restraint collars, shall comply with requirements of DR9, Iron Pipe Size (IPS), minimum cell class 445474C, and meeting this specification’s requirements for PE pipe except for striping.
		6. Mechanical Joint Restraint
			1. Mechanical Joint restraints shall only be allowed on HDPE with specific permission of the PSA in cases where an MJ Adapter is not feasible.
			2. Mechanical Joint wedge action restraint shall be designed specifically for use on HDPE pipe.
			3. The grip of the serrations shall increase as the hydrostatic pressure increases.
			4. There shall be no additional tool required for installation other than the tools required to install standard sizes of hex nuts from 5/8”-1 1/8”. The hex heads, bolts and rods shall be designed to tighten clockwise. The hex heads, bolts and rods shall be manufactured to allow for disassembly and re-installation of the restraint.
			5. The gland halves shall be manufactured of high strength ductile iron in accordance with the ASTM A536 Standard, Grade 65-45-12.
			6. Rods are manufactured from 304 stainless steel and hex nuts are manufactured from 316 stainless steel as per ANSI/ AWWA C111/A21.11.
			7. The restraining gland shall comply with all applicable dimensions of ANSI/AWWA C111/A21.11 and shall be compatible with all bell and spigot (push-on) joint sockets of the standard.
			8. Stiffening insert required.
		7. Service Connections
			1. Service connections shall be made with tapping. Butt fusion or electrofusion saddles are strictly prohibited.
			2. Tapping saddles shall be either the type specified for ductile iron pipe or shall be universal body service saddles as specified under the appropriate section below regarding water service connections.
	11. **FIRE HYDRANTS**
		1. Fire hydrants shall conform to the requirements of AWWA Standard C502, latest revision for "Dry Barrel Fire Hydrants" and shall comply in full with the following requirements.
		2. Hydrants shall be of the three post type of dry top design rated 250 psi or working pressure of line, whichever is greater. Hydrants shall be equipped with compression main valve opening counterclockwise against pressure. Each hydrant shall have a 6" standardized, mechanical joint inlet connection with accessories. The internal valve shall provide a minimum of 5-1/4" unobstructed flow area. Each hydrant shall be designed to allow the removal of all operating parts through the standpipe without excavation. Each hydrant shall be constructed with an oil lubricated dry type bonnet with "O" ring seals above and below operating threads.
		3. The standpipe sections shall be connected at the ground line by a two-part safety flange that prevents damage to the barrel sections when the hydrant is struck by a vehicle. The standpipe and safety flange design shall permit rotation of the hydrant nozzles to any desired position without excavation or disassembly of the operating components. Threaded joints, above or below ground, or breakable bolts will not be allowed for the barrel assembly.
		4. The main valve operating rod shall be designed with a travel stop so that the rod cannot be placed in compression. Travel stops located at the bottom of the hydrant will not be acceptable. The operating rod threads top and bottom shall be isolated from contact with water in the bonnet or in the inlet shoe. A safety stem coupling on the operating rod shall be placed at the ground line.
		5. The drain mechanism shall be co-related with the operation of the main valve to provide a momentary flushing of the drain ports each time the hydrant is opened. The drain ports shall be fully closed when the hydrant valve is more than 2 1/2 turns open. The drain ports shall be fully open when the hydrant is in the closed position.
		6. The nozzle outlets shall consist of two (2) 2-1/2" hose nozzles 180o apart and one
			1. 4-1/2" pumper connection. The nozzle threads shall conform to ANSI Standard B26. The nozzle caps shall be individually attached to the standpipe with heavy duty non-kinking chains that permit free turning of the cap. The operating nut and cap nuts shall be National Standard pentagon with 1 1/2" from point to flat.
		7. The exterior of the hydrants above the ground line shall be shop painted ”Safety Yellow” or nearest equivalent unless otherwise specified by the PSA.
		8. Fire hydrants shall be Mueller Model A-423 "Super Centurion", Kennedy K-81-A "Guardian", or American Darling B-84-B-5.
	12. **FLUSHING/BLOW-OFF HYDRANTS**
		1. Flushing/blow-off hydrants shall be non-freezing, self-draining type, with a depth of bury of 3.0 feet minimum. Hydrants shall be set in a meter box. Hydrants shall be furnished with a 2” FIP inlet, a non-turning operating rod, and shall be left hand open. All working parts shall be of bronze-to-bronze design with an aluminum plunger and serviceable from above grade with no digging. The outlet shall be bronze and shall be 2-1/2” NST or smaller. Hydrants shall be lockable to prevent unauthorized use, with no exceptions. Hydrants shall be Kuperferle Mainguard Model #78 or approved equal.
	13. **PRESSURE GAUGES**
		1. Pressure gauges shall be open front case type with bronze bourdon tube soldered to socket and tip, stainless steel movement, and a 4 1/2" white coated dial graduated from 0 to 500 psi. Compound gauges shall be open front case type with bronze bourdon tube soldered to socket and tip, stainless steel movement, and a 4 1/2″ white coated dial graduated from -15 to 100 psi. Gauges shall be equipped with a valve cock and diaphragm isolator. Gauges shall be Ashcroft No. 1279 or approved equal.
	14. **AIR RELEASE, AIR/VACUUM, AND COMBINATION VALVES**
		1. Low profile air release valves, combination valves, and air vacuum valves for water service located where indicated on Contract Drawings shall have a reinforced nylon body, noncorrosive internal parts including EDPM rolling seal, and solid polypropylene float. All valves shall have a polypropylene outlet flushing connection on the top that is easily accessible, using a ball valve as an isolation valve on the inlet side of the valve, and be rated at a working pressure of 250 psi or working pressure of line, whichever is greater. Air release only valves for sizes smaller than 2" shall be Model S-050 as manufactured by A.R.I. Air/vacuum valves, combination valves, or 2" and larger air release only valves shall be Model D-060/062 as manufactured by A.R.I.
	15. **WATER SERVICE CONNECTIONS – 3/4” AND 1”**
		1. Water service connection accessories for 3/4” and 1” services shall consist of corporation stop, service line, meter box and meter yoke in accordance with Standard Details and approved materials list. All brass or bronze materials shall be certified to be lead free.
		2. Tapping Saddles
			1. Tapping saddles for ductile iron pipe shall be ductile iron body with twin 304 stainless steel straps. Each straps shall be equipped with two 5/8” UNC threaded stainless steel bolts, one on each end of the strap. Straps shall be secured to the body via stainless steel nuts and washers. Body shall be coated with a black e-coating finish. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford FSD202 or approved equal.
			2. Tapping saddles for C900 PVC sizes 4” to 8” shall be brass body, single hinge style. Connection shall be made via 5/16” diameter screw on the body side with the bottom strap pre-drilled for connection. Hinge shall be joined with a silicon bronze pin. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S90 Design A or approved equal.
			3. Tapping saddles for C900 PVC sizes 10” and 12” shall be brass body, double bolt style. Connection shall be made two 3/8” or 1/2” diameter screws on the body side with the bottom strap pre-drilled for connection. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S90 Design B or approved equal.
			4. Tapping saddles for PVC materials other than C900 shall be brass body, single hinge style. Connection shall be made via 5/16” diameter screw on the body side with the bottom strap pre-drilled for connection. Hinge shall be joined with a silicon bronze pin. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S70 or approved equal.
			5. Universal service saddles may be used for pipe sizes 4” to 30” and outlets from ½” to 2” shall be one piece cast heavy duty fully passivated 304 18-8 stainless steel body rated for working pressures of 250 psi and hydrostatic test pressures of 375 psi. Connection shall be made via two 5/8” diameter drop in stainless steel bolts and stainless steel nuts and washers coated with fluoropolymer to prevent galling. No special tools shall be required for installation. Saddles with welded sheet metal lugs or welded threaded studs shall not be acceptable. Saddle shall be equipped with cam lug fingers for extended range and integrated handle. Cam lugs shall be connected to band utilizing low heat TIG welding with no ledge. Saddles utilizing higher heat MIG welding and/or having ledges shall not be acceptable. Saddle band shall be completely isolated from pipe via EPDM rubber barrier isolation boot. Sealing gasket shall be NSF-61 approved NBR rubber. Outlets shall be spin-extruded with high strength welds. Saddles shall be TPS Triple Tap T3. Other manufacturers may be considered upon demonstration of equal quality.
		3. Corporation Stops
			1. Corporation stops shall be the key/plug type conforming to AWWA C800. Stops shall be grip joint type with AWWA inlet and CTS outlet. Stops shall be bronze.
			2. Stops shall be Ford model F1000-3-GNL for 3/4" and F1000-4-GNL for 1” or approved equal.
		4. Service Line
			1. Service line shall be either:
				1. HDPE – SDR 9 CTS complying with AWWA C901. standard.
				2. Type K copper
			2. Service line shall be as manufactured by Endot Industries or approved equal.
		5. Service Line Fittings
			1. Couplings, Adaptors, Tees, Bends, etc., shall be CTS grip joint type.
			2. Fittings shall be as manufactured by Ford Meter Box or approved equal.
		6. Meter Setters
			1. Single meter setters shall be copper with horizontal inlet and outlet with CTS compression joints at inlet and outlet. Inlet shall have a ball valve angle stop. Outlet shall have an angle check valve. Setters shall be 5/8” x 3/4" for 3/4” meters and 1” for 1” meters. Riser minimum heights shall be 7” for 3/4" meters and 10” for 1” meters. Setters for 3/4" meters shall be Ford model VBH72-7W-44-33-G-NL or approved equal. Setters for 1” meters shall be Ford model VBH74-10W-44-44-G-NL or approved equal. Bypass features shall not be acceptable on any meter setter for any reason.
			2. Tandem meter setters shall be copper with horizontal inlet and outlet with CTS compression joints at inlet and outlet and shall also be equipped with an offset for installation of a pressure reducing valve. Inlet shall have ball valve angle stop. Outlet shall have an angle check valve. Setters shall be 5/8” x 3/4" for 3/4” meters and 1” for 1” meters. Riser minimum heights shall be 9” for 3/4" meters and 15” for 1” meters. Tandem setters for 3/4" meters shall be Ford model TVBH72-10W-44-33-G-NL or approved equal. Tandem setters for 1” meters shall be Ford model TVBH74-15W-44-44-G-NL or approved equal. Bypass features shall not be acceptable on any meter setter for any reason.
		7. Meter Boxes
			1. Single meter boxes shall be HDPE rectangular type. Boxes shall be a minimum of 10” x 15” cover size and shall be a minimum of 22” x 17” bottom opening. Boxes shall be a minimum of 18” depth. Extensions shall be provided as required. Boxes shall be Carson Industries Model 1520 or approved equal.
			2. Tandem meter boxes shall be HDPE blend round type. Boxes shall be a minimum of 24” diameter cover size for 3/4” meters and 30” diameter for 1” meters. Box depth shall be a minimum of 24”. Extensions shall be provided as required. Boxes shall be Carson Industries Model 0024-B for 3/4" meters and Model 0030-B for 1” meters or approved equal. Lids for tandem meter boxes shall be round cast or ductile iron to match the diameter of the box. Extension rings shall be provided as needed for fitting the lid. Lids shall be Ford Model A with extension rings or approved equal.
			3. Lids shall be pre-cut for fitting radio read meter heads.
		8. Meters (3/4” and 1”)
			1. 3/4" and 1” meters shall be suitable for potable water service. The meter shall contain and integrated register and measuring device encased in an external housing. The register shall be hermetically sealed with a tempered glass cover and an all-electronic, programmable, 9-digit register. The meter shall have the ability to capture approximately 1100 data points. The meter shall have no moving parts and shall be able to monitor for alarms such as leak detection, reverse flow, empty pipe, magnetic tampering, and multiple batter life. The meter shall have a 20-year life and come with a 20-year battery life guarantee. The meter shall be capable of two-way communication for AMR and AMI. The meter shall have no lead in its construction and comply with AWWA C700 and C710. Meters shall be NSF compliant.
			2. Meters shall be iPERL by Sensus with no exceptions.
		9. Pressure Reducing Valves
			1. Pressure Reducing Valves shall be provided for tandem meter setters. Body and access covers shall be bronze meeting ASTM B584. Fasteners shall be stainless steel. The bell housing and access caps shall be threaded to the body and shall not require the use of ferrous screws. Valves shall be equipped with a 20 mesh stainless steel strainer screen. Valves shall have separate access covers for the plunger and the strainer screen. Seat shall be stainless steel. Valves shall have a maximum working pressure of 300 psi, with a pressure range of 25 to 75 psi and a factory pre-set of 50 psi. Valves shall have a bolt to adjust the downstream pressure. Valves shall be of the balances piston design and shall reduce pressure in both flow and no-flow conditions. Valves shall be NSF listed. Valves shall be Zurn-Wilkins Model 600 XL or approved equal.
		10. Curb Stops
			1. Curb stop, if necessary and specified in the project, shall be ball type with either grip pack joints, male threads, or female threads as required.
			2. Curb stops shall be as manufactured by Ford Meter Box or approved equal.
	16. **WATER SERVICE CONNECTIONS – 1-1/2” AND 2”**
		1. Water service connection accessories for 1-1/2” and 2” services shall consist of 2” gate valve, 2” service line, meter box and 2” meter yoke in accordance with Standard Details and approved materials list. All brass or bronze materials shall be certified to be lead free.
		2. Tapping Saddles
			1. Tapping saddles for ductile iron pipe shall be ductile iron body with twin 304 stainless steel straps. Each straps shall be equipped with two 5/8” UNC threaded stainless steel bolts, one on each end of the strap. Straps shall be secured to the body via stainless steel nuts and washers. Body shall be coated with a black e-coating finish. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford FSD202 or approved equal.
			2. Tapping saddles for C900 PVC sizes 4” to 8” shall be brass body, single hinge style. Connection shall be made via 5/16” diameter screw on the body side with the bottom strap pre-drilled for connection. Hinge shall be joined with a silicon bronze pin. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S90 Design A or approved equal.
			3. Tapping saddles for C900 PVC sizes 10” and 12” shall be brass body, double bolt style. Connection shall be made two 3/8” or 1/2” diameter screws on the body side with the bottom strap pre-drilled for connection. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S90 Design B or approved equal.
			4. Tapping saddles for PVC materials other than C900 shall be brass body, single hinge style. Connection shall be made via 5/16” diameter screw on the body side with the bottom strap pre-drilled for connection. Hinge shall be joined with a silicon bronze pin. Body and strap shall be brass alloy meeting ASTMB62, ASTM B584, and AWWA C800. Body shall have a gasket for sealing to main line. Gasket shall be EPDM rubber o-ring meeting ASTM D2000. Saddles shall be sized for AWWA threads and shall be Ford S70 or approved equal.
			5. Universal service saddles may be used for pipe sizes 4” to 30” and outlets from ½” to 2” shall be one piece cast heavy duty fully passivated 304 18-8 stainless steel body rated for working pressures of 250 psi and hydrostatic test pressures of 375 psi. Connection shall be made via two 5/8” diameter drop in stainless steel bolts and stainless steel nuts and washers coated with fluoropolymer to prevent galling. No special tools shall be required for installation. Saddles with welded sheet metal lugs or welded threaded studs shall not be acceptable. Saddle shall be equipped with cam lug fingers for extended range and integrated handle. Cam lugs shall be connected to band utilizing low heat TIG welding with no ledge. Saddles utilizing higher heat MIG welding and/or having ledges shall not be acceptable. Saddle band shall be completely isolated from pipe via EPDM rubber barrier isolation boot. Sealing gasket shall be NSF-61 approved NBR rubber. Outlets shall be spin-extruded with high strength welds. Saddles shall be TPS Triple Tap T3. Other manufacturers may be considered upon demonstration of equal quality.
		3. Gate Valves
			1. 2” Gate valves for 1-1/2” and 2” meter services shall be per the gate valve standards elsewhere in this section. Gate valves shall be in an approved valve box and be top nut operated.
		4. Service Line
			1. 2” Service line shall be either:
				1. HDPE of CTS with dimensions meeting SDR 9 standard (up to 200 psi only).
				2. Type K copper
			2. Service line shall be as manufactured by Endot Industries or approved equal.
		5. Service Line Fittings
			1. Couplings, Adaptors, Tees, Bends, etc., shall be CTS grip joint type.
			2. Fittings shall be as manufactured by Ford Meter Box or approved equal.
		6. Meter Setters
			1. Meter setters shall be copper with horizontal inlet and outlet with CTS compression joints at inlet and outlet. Inlet shall have a ball valve angle stop. Outlet shall have an angle check valve. Setters shall be 2" for both 1-1/2” and 2” meters. Approved adapter fittings shall be used for 1-1/2” meters to make up length in the 2” setter. Riser minimum heights shall be 12” for 2” setter. Setters shall be Ford model VBH77-12-11-77-NL. Bypass features shall not be acceptable on any meter setter for any reason.
		7. Meter Boxes:
			1. Meter boxes shall be HDPE heavy wall rectangular type. Boxes shall be a minimum of 30” x 17” cover size and shall be a minimum of 25” x 12” bottom opening. Boxes shall be a minimum of 24” depth. Extensions shall be provided as required. Lids shall be Boxes shall be Carson Industries Model 1730BCF or approved equal.
			2. Lids shall be pre-cut for fitting radio read meter heads.
		8. Meters (1-1/2” and 2”):
			1. 1-1/2” and 2” meters shall be constructed of epoxy coated ductile iron. The epoxy coating shall standard fusion bonded and compliant with NSF standards for non-lead regulations. Meters shall be rated for operating ranges as listed below:
			2. Compound Meters:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Size | Low Flow (95% min) | Operating Range (98.5-101.5%) | Intermittent Flows (98.5-101.5%) | Pressure Loss (not to exceed) |
| 1-1/2” | 0.25 gpm | 0.5 – 160 gpm | 200 gpm | 6.9 psi @ 160 gpm |
| 2” | 0.25 gpm | 0.5 – 160 gpm | 200 gpm | 4.3 psi @ 160 gpm |

* + - 1. Turbo Meters:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Size | Low Flow (95% min) | Operating Range (98.5-101.5%) | Intermittent Flows (98.5-101.5%) | Pressure Loss (not to exceed) |
| 1-1/2” | 0.75 gpm | 1.25 – 160 gpm | 200 gpm | 6.9 psi @ 160 gpm |
| 2” | 1.0 gpm | 1.5 – 200 gpm | 250 gpm | 7.0 psi @ 200 gpm |

* + - 1. Measuring chambers shall consist of a measuring elements, removable housing, and all electronic register. Measuring element shall be mounted on a horizontal stationary stainless steel shaft with sleeve bearings and be essentially weightless in water. Measuring chamber shall be capable of operating within above accuracies without calibration when transferred from one maincase to another of the same size.
			2. Direct magnetic drive shall occur between the motion of the measuring element blade position and the electronic register. Additional intermediate magnetic or mechanical drive couplings are not acceptable.
			3. Meters shall be rated to 200 psi maximum working pressure.
			4. Strainers shall be integral and cast as part of the maincase. Screens shall have a minimum nets open area of at least 2 times the pipe opening and be V-shaped to maintain a full and unobstructed flow pattern. Strainer body shall be epoxy coated ductile iron constructed identically to the maincase. All fasteners shall be stainless steel.
			5. Meter lengths shall be as follows:
				1. 1-1/2” meter – 13”
				2. 2” meter – 17”
			6. A straightening vane assembly shall be included directly upstream of the measuring element and be an integral part of the measuring chamber.
			7. Meters shall be flange connection with 2-bolt oval flanges.
			8. Meters with expected pressures greater than 200 psi shall be designed with a PRV in a separate box prior to the meter box. Boxes shall be Carson Industries Model 1520 or approved equal
			9. Meters shall be Sensus Omni T2 or C2 (as determined by the PSA) with no exceptions.
		1. Pressure Reducing Valves
			1. Pressure Reducing Valves for 1-1/2” and 2” meters shall be provided when system pressures exceed 200 psi. When required, PRV’s shall be installed immediately in front of the meter per Standard Details. Body and access covers shall be bronze meeting ASTM B584. Fasteners shall be stainless steel. The bell housing and access caps shall be threaded to the body and shall not require the use of ferrous screws. Valves shall be equipped with a 20 mesh stainless steel strainer screen. Valves shall have separate access covers for the plunger and the strainer screen. Seat shall be stainless steel. Valves shall have a maximum working pressure of 300 psi, with a pressure range of 25 to 75 psi and a factory pre-set of 50 psi. Valves shall have a bolt to adjust the downstream pressure. Valves shall be of the balances piston design and shall reduce pressure in both flow and no-flow conditions. Valves shall be NSF listed. Valves shall be Zurn-Wilkins Model 600 XL or approved equal.
		2. Curb Stops:
			1. Curb stop, if necessary and specified in the project, shall be ball type with either grip pack joints, male threads, or female threads as required.
			2. Curb stops shall be as manufactured by Ford Meter Box or approved equal.
	1. **WATER SERVICE CONNECTIONS – LARGER THAN 2”**
		1. Water service connection accessories for services larger than 2” shall be designed on a case by case basis. At a minimum, all brass or bronze materials shall be certified to be lead free. The meters shall be Omni by Sensus with no exceptions (the model of meter shall be determined by the PSA in concert with the design and upon submission of a water meter sizing form).
	2. **MANHOLES**
		1. Manholes shall be constructed of pre-cast reinforced concrete manhole sections in accordance with the requirements of ASTM C478 and detailed in Standard Details.
		2. A maximum of two lift holes per manhole section may be provided.
		3. Provide tongue and groove type joints in manhole sections with a pre-formed groove in the tongue for placement of sealing gaskets.
			1. Bituminous mastic shall comply with requirements of ASTM C990 and C443.
			2. Gaskets shall provide the sole element in sealing the joint from either internal or external hydrostatic pressure.
		4. Provide flexible pipe connections to manholes, other than acid-resistant manholes, shall be sealed with a flexible boot. The port shall be cored or cast to the size, shape, surface finish, and location required. Connectors shall be suitable for field repair or replacement. Connectors not suitable for field replacement are unacceptable. Angular adjustments through 20o shall not be allowed. The flexible boot shall be a 3/8” thick neoprene compound complying with ASTM C443. The boot shall be secured to the port with an internal aluminum expanding band and to the pipe with a non-magnetic corrosion-resistant steel external band. The assembled connectors shall allow at least an 11° angular deflection of the pipe and at least one inch of lateral misalignment in any direction and be suitable for a normal variation in diameter or roundness for the pipe material used. Boot seal shall be Kor-N-Seal as manufactured by Trelleborg or approved equal.
		5. Manholes shall be coated, both exterior and interior, with a protective coating. Coating shall be Conseal CS-55 by Concrete Sealants or approved equal, applied per manufacturer’s recommendation.
		6. Liners for acid-resistant manholes shall be of fiberglass reinforced polyester or polyvinylchloride construction and shall be installed to protect the pre-cast manhole sections from the inside base of the manhole to the base of the manhole frame.
			1. FRP liners shall consist of a 3/16 in. thick fiberglass reinforced polyester with a 15 mil gel coat interior surface. The polyester resin shall be similar to Dion No. 6694. Joints between sections of the liner shall be sealed in accordance with the manufacturer's instructions.
			2. PVC liners shall consist of polyvinylchloride plates, not less than 0.060 in. thick, with integral bonding ribs and shall be similar to Amercoat "T-Lock Amer-Plate". Joints between sections of liner shall be welded in accordance with the manufacturer's instructions.
		7. Sealant for manhole frames shall be a one-component polyurethane sealant similar to Sika "Sikaflex" Type 1a.
		8. Sealant for flexible pipe connections shall be a two-component polyurethane sealant similar to Sika "Sikaflex" Type 2c with primer Type 429.
		9. Manhole steps shall be corrosion-resistant and shall be rubber-covered steel. The steps shall conform to the dimensions shown in the Standard Details.
		10. Manhole frames and covers shall be molded of gray cast iron conforming to ASTM A48, Class 35. Castings shall be coated with a coal tar pitch varnish, to which sufficient oil has been added to make a smooth coating, tough and tenacious when cold, but not tacky or brittle. Seating surfaces between frame and cover shall be machined. The dimensions shall conform to the requirements shown in the Standard Details.
			1. Standard Manhole Frame and Cover shall be similar to Neenah R-1642-G.
			2. Vandal-proof Manhole Frame and Cover shall be similar to R-1642-G with the inclusion of screws as outlined in Standard Details.
			3. Watertight Manhole Frame and Cover shall be similar to R-1642-G with the inclusion of a hold-down bar with tightening screw and inner cover with rubber gasket as outlined in Standard Details.
		11. All manhole frames and covers shall be manufactured in the United States.
		12. HDPE Adjusting Rings
			1. All casting shall be raised using round High Density Polyethylene (HDPE) rings manufactured from polyethylene plastic as identified in ASTM Designation D-1248 Standard Specification for Polyethylene Plastic Molding and Extrusion Materials.
			2. Material properties shall be tested and qualified for usage per the ASTM Test Methods referenced in the above ASTM standard.
			3. The plastic rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers).
			4. The adjustment rings shall be tested to assure compliance with impact and loading requirements per the ASSHTO Standard Specification for Highway Bridges.
			5. Installation shall be per manufacture's recommendations only.
			6. The annular space between the rings and cone basin, between each ring, and between the rings and cover frame shall be sealed utilizing an approved butyl sealant.
			7. All adjustment for matching road grade shall be made utilizing a molded and indexed slope ring.
			8. All grade rings shall be covered by a five year warranty.
			9. All adjusting rings shall be as manufactured by LADTECH, Inc. or approved equal.
		13. Globe valves smaller than 3" shall be of bronze construction with bronze plug type discs and solder joint ends.
		14. Thrust blocking shall be as shown in Contract Documents or as directed by Project Representative based upon field conditions. Concrete shall be “high-early” type having 3000 psi strength at 24 hours in accordance with Section 03300 - Cast-in-Place Concrete and shall meet requirements of ASTM C94.
	3. **DETECTABLE MARKING TAPE & TRACING WIRE**
		1. Plastic marking tape consisting of one layer of aluminum foil laminated between two layers of inert plastic film. Tape shall be resistant to alkalis, acids and other destructive agents commonly found in the soil. The laminate shall be strong enough that the layers cannot be separated by hand.
		2. Tape shall be a minimum of 4 1/2 mils thick with a minimum tensile strength of 60 lbs. in the machine direction and 58 lbs. in the transverse direction per 3" wide strip. Tape color shall be APWA Color Coded for marking the particular utility line and shall be imprinted with a continuous warning message to indicate the type of utility being marked, the message normally being repeated every 16 to 36". Tape shall be inductively locatable and conductively traceable using a standard pipe and cable locating device. Tape shall be 3" wide Terra Tape “Sentry Line Detectable 620” or approved equal.
		3. In addition to the marking tape, a tracing wire of 12-gauge copper shall be installed and taped directly on the pipe in a manner that a continuous tract results. Wire shall be turned up into meter boxes every 2,000 LF if no other appurtenances (valves, hydrants, etc.) are available within that distance.

# EXECUTION

* 1. **PIPE LAYING - GENERAL**
		1. 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.
		2. 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.
		3. Bedding of pipe shall be as specified in Section 02225 - Trenching & Backfilling and on Standard Details.
		4. Do not lay pipe when trench bottom is muddy or frozen, or has standing water.
		5. 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.
		6. Lay pipe with bell ends facing the direction of laying. Where grade is 10% or greater, lay pipe uphill with bell ends upgrade.
		7. All ductile iron pipe 8” in diameter and smaller and all PVC pipe 12” in diameter and smaller shall be driven home by hand. Under no circumstances will use of mechanical equipment to home pipes of these sizes be tolerated. The PSA reserves the right to require removal of the affected joint of pipe and as many joints as it has cause to believe were laid using such methods, up to and including all pipe previously laid on the project.
		8. Generally, water lines shall be located:
			1. Where curb and gutter are present, a minimum of 5 feet off the back of the curb;
			2. Where ditches are present, 1 foot off the edge of pavement.
		9. Install pressure line with a minimum depth of cover of 36" over the top of the pipe, where no grades are shown on the Contract Drawings.
		10. Where grades on the pressure line conflict with existing pipes or structures, lay pressure line to additional depth with a uniform vertical curve to provide proper clearance without the use of fittings. No additional payment will be allowed for additional excavation. Provide allowance for expansion as directed by Engineer.
		11. All lines shall be laid based on cut sheets.
	2. **JOINING MECHANICAL JOINT PIPE**
		1. Thoroughly clean inside of the bell and 8" of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating and other foreign matter. Paint the bell and the spigot with soap solution (half cup granulated soap dissolved in 1 gallon of 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. Apply a thin film of gasket lubricant supplied by pipe manufacturer that meets the requirements of AWWA C111/C600, to either the gasket or the spigot end of the joining pipe.
		2. 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:
			1. Bolt Size - Inches Torque Ft. - Lbs.

|  |  |
| --- | --- |
| 5/8 | 40 - 60 |
| 3/4 | 60 - 90 |
| 1 | 70 - 100 |
| 1¼ | 90 - 120 |

* + 1. Tighten nuts on alternate side of the gland until pressure on the gland is equally distributed.
		2. Join lock-type mechanical joint pipe according to manufacturer's recommendations.
		3. Permissible deflection in mechanical joint pipe shall not be greater than 2/3 of that listed in AWWA C600.
		4. Permissible deflection in lock-type mechanical joint pipe shall be as recommended by manufacturer.
	1. **JOINING PUSH-ON JOINT PIPE**
		1. Thoroughly clean inside of the bell and 8" 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 gasket lubricant supplied by pipe manufacturer, to either the gasket or the spigot end of the joining pipe. Start the spigot end of the pipe into the socket with care. Then complete the joint by forcing the plain end of the bottom of the socket with a forked tool or jack-type device. File the end of field cut pipe to match the manufactured spigot end.
		2. Join restrained push-on joints according to manufacturer's recommendations.
		3. Permissible deflection in push-on joint pipe shall not be greater than that listed in AWWA C600.
		4. Permissible deflection in restrained push-on joint pipe shall be as recommended by manufacturer.
		5. Join PVC pipe and fittings in accordance with manufacturers' instructions and install in accordance with ASTM D2321.
		6. Join copper pipe using 95-5 solder and suitable flux. Do not use acid core solder.
	2. **HDPE PIPE INSTALLATION**
		1. Installer Qualifications
			1. HDPE Pipe shall be only be joined by fusion methods by a formally trained and certified fusion technicians per Plastic Pipe Institute (PPI) TN-42.
			2. Qualification of the fusion technician shall be demonstrated by certification in fusion training within the past year for the type of fusion, and size of the pipe, and on the specific equipment to be used on this project. Documentation shall be provided showing current and up-to-date qualification of training obtained to fuse PE pipe in the appropriate sizes and equipment types for the job:
				1. Training in accordance with ASTM F 6220 for butt fusion.
				2. Training in accordance with ASTM F 1055 for electrofusion.
			3. Qualified technician shall have documented prior experience in performing HDPE pipe installations, head fusion procedures, and testing methods.
		2. Joining Methods
			1. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer’s recommendations.
			2. Saddle fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or PPI TR-41 or the fitting manufacturer’s recommendations and PPI TR-41.
			3. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2” in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer’s recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously and pressed together so the outside wall of the male end is fused to the inside wall of the female end.
			4. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion requires an electric source , a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used.
		3. Mechanical Connections
			1. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with this specification.
			2. Unless approved by the PSA, a restraint harness with a concrete anchor shall be used on mechanical couplings on HDPE pipe to prevent pullout per Standard Details.
			3. Mechanical coupling shall be made by qualified technicians.
		4. Joint Recording
			1. Butt Fusion: The butt fusion equipment must be capable of reading and storing the input parameters and the fusion results for later download to a record file.
			2. Electrofusion: The electrofusion equipment must be capable of reading and storing the input parameters and the fusion results for later download to a record file.
			3. The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician’s joint report.
		5. Installation
			1. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.
			2. Lay pipe with blue stripe within 45-degrees either side of crown, if pipe has blue stripe.
			3. Pipe embedment shall be as specified on the Standard Details.
	3. **SETTING VALVES AND VALVE BOXES**
		1. Install valves with operator stems in the vertical plane through the pipe axis and perpendicular to the pipe axis. Locate valves where shown on Contract Drawings. Thoroughly clean before installation. Check valves for satisfactory operation.
		2. Equip all underground valves with valve boxes where shown on the Contract Drawings. Set valve boxes in accordance with Standard Details. Set box in alignment with valve stem centered on valve nut. Set the valve box to prevent transmitting shock or stress to the valve. Set the box cover flush with the finished ground surface or pavement.
		3. Construct manholes for all underground valves where shown on the Contract Drawings. Construct manholes so as to prevent transmitting any load or shock to the valve or pipe. Locate manholes and valve relative to each other in order that packing, operator and other parts of the valve are readily accessible for minor repairs.
		4. Manhole shall be constructed to the elevations shown on the Contract Drawings in accordance with the provisions of the Standard Details.
			1. Set manhole base section on bed of VDOT #57 stone to a minimum depth of 6". Stone shall be thoroughly compacted and carefully leveled.
			2. Join all manhole riser and cone or flat slab top sections by the use of rubber gaskets.
			3. Plug lift holes and repair any defects in manhole.
		5. Set HDPE adjusting rings per manufacturer’s recommendation and seal rings with bitumastic sealant.
			1. Rings will not be required outside of paved roadways or walkways unless called for on the Drawings.
			2. Rings in paved roadways or walkways shall permit upward or downward adjustment of manhole frame by 6".
		6. Set manhole frame in bed of sealant. Bed shall consist of one, 3/8" bead laid flush with the inside edge of the frame base and another 3/8" bead laid flush with the outside edge of the frame base.
		7. Bolt watertight manhole frames to manhole cone or flat slab top section as shown on the Standard Details.
		8. Locate fire hydrants as shown on Contract Drawings and in accordance with Standard Details.
		9. Provide air, combination, or air/vacuum valve at locations shown on Contract Drawings. Install gate valve between water main and relief valves and construct manholes for air and vacuum relief valve in accordance with Standard Details.
		10. Provide concrete thrust blocking and/or pipe restraints at all tees, reducers, dead ends, fire hydrants, bends, vertical offsets, or other locations noted on the Contract Drawings. Install thrust blocks per Standard Details. Install pipe restraints per distance given in Standard Details.
		11. Concrete reaction anchors shall bear against undisturbed earth and shall be of the size and shape shown in Standard Details.
		12. Restraints shall either be Meg-a-Lug or approved equal appropriate for the pipe material OR the pipe provided shall have integral restrained joints.
		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.
	4. **INSTALLATION OF TAPPING SLEEVES AND TAPPING VALVES**
		1. Rigorous testing and conditions relating to tapping sleeves, applied to all manufacturers, is standard operating procedure. These conditions are as follows:
			1. The tapping sleeve shall be tested in place to a minimum of 200 psi or to 1.5 times the working pressure of the main it is placed on, whichever is higher. It is the contractor’s responsibility to order the correct pressure rated tapping sleeve.
			2. If the sleeve fails the pressure test, the original failed sleeve shall be replaced with an entirely new sleeve.
			3. The concrete thrust block shall be poured to also support the tapping sleeve from beneath. The tapping sleeve, valve and tapping machine assembly is to be adequately supported during the tapping operation to prevent movement or rotation of the tapping sleeve.
		2. The actual tap shall be made in presence of a representative of the PSA. The PSA shall be notified a minimum of 72 hours in advance of making the tap.
	5. **PIPE DETECTION MATERIALS**
		1. Install marking tape in all trenches containing buried, non-metallic, pressure pipe lines. Tape shall be installed in all trenches a minimum of 18” over the pipe. Place tape on edge of trench toward the center of the pavement in roadways. In other locations, place tape to the north or east of the utility line. Wrap tape around all valves, corporation stops and meter setters. Wrap tape three turns around base of fire hydrants and extend tape up above ground against fire hydrants. Tape shall be made electrically conductive throughout the entire system through the use of splices of a type recommended by the manufacturer.
		2. In addition to the marking tape, a tracing wire of 12-gauge copper shall be installed and taped directly on the pipe in a manner that a continuous tract results. Turn up into meter box every 2,000 LF if no other appurtenances (valves, hydrants, etc.) are available within that distance.
	6. **ACCEPTANCE TESTS – PVC & DI PIPELINES**
		1. Supply the pumps, calibrated gages and meters, and all the necessary apparatus. Notify the PSA at least 72 hours in advance of the test date and perform tests in presence of the PSA’s representative.
		2. The PSA will supply water at no cost for one test of potable water lines only; any additional water will be paid for by the Contractor.
		3. Contractor shall utilize the Flushing Mechanism detail provided in the Standard Details when filling waterlines
		4. 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 at the highest point along the test section,
			2. Not exceed thrust restraint pressure,
			3. Not vary by more than +/- 5 psi,
			4. Not exceed twice the rated pressure of the valves or hydrants when test includes closed gate valves, and
			5. Not exceed rated pressure of valves if resilient-seated butterfly valves are used,
			6. Measure pressure at the low point on the system compensating for gage elevation. Maintain this pressure for two hours. If pressure cannot be maintained, determine cause, repair and repeat the test until successful.
		5. A leakage test shall be conducted concurrently with the pressure test in accordance with AWWA C600, except as modified herein. Leakage shall be determined with a calibrated test meter, furnished by the Contractor. 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. Leakage shall not exceed that provided on the table in the Standard Details. If leakage exceeds that specified, find and repair the leaks and repeat the test until successful.
		6. All visible leaks shall be repaired regardless of the amount of leakage.
	7. **ACCEPTANCE TESTS – HDPE PIPELINES**
		1. Supply the pumps, calibrated gages and meters, and all the necessary apparatus. Notify the PSA at least 72 hours in advance of the test date and perform tests in presence of the PSA’s representative.
		2. The PSA will supply water at no cost for one test of potable water lines only; any additional water will be paid for by the Contractor.
		3. Contractor shall utilize the Flushing Mechanism detail provided in the Standard Details when filling waterlines
		4. Pressure and leak tests of HDPE water system shall be conducted in accordance with ASTM F2164.
		5. The pipeline shall be slowly filled with potable water and all trapped air bled off. The main shall undergo a hydrostatic pressure test using pressure at the lowest elevation in the system at 150 psi or 1.5x working pressure, whichever is greater, but no greater than the pipe design pressure.
		6. The pressure shall be maintained constant for 4-hour period by adding makeup water. After 4-hour period is completed, the pressure shall remain steady at the system low point within 5% of the target test pressure for one hour.
		7. The total test time shall not exceed 8 hours. If the pipeline has to be retested, the pipe must be depressurized and allowed to “relax” for at least 8 hours before the next testing sequence.
		8. No visible leakage shall be present. If leakage is observed at a fusion joint, complete rupture may be imminent. The Contractor shall move all personnel away from the joint and depressurize the main. Leaks, failure, or defective construction shall be promptly repaired by the Contractor at the Contractor’s sole expense.
		9. For safety reasons, pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited.
	8. **DISINFECTION OF WATER LINES**
		1. Disinfect and test water mains and accessories in accordance with AWWA Standard C 651 and this section:
		2. All water lines shall be disinfected prior to being placed in operation.
		3. Prior to disinfection all water lines shall be flushed. All valves and hydrants shall be operated during this operation. Flushing velocities should not be less than 3.0 ft./sec. Contractor shall make provisions for adequate drainage of flushed water.
		4. Contractor shall utilize the Flushing Mechanism detail provided in the Standard Details when filling waterlines and when disinfecting.
		5. Sodium Hypochlorite is the PSA’s accepted form of chlorine for waterline disinfection. Other forms of chlorine proposed by the Contractor will be evaluated on a case-by-case basis. Under no circumstances will the following methods be permitted:
			1. Introduction of chlorine gas directly from a supply cylinder.
			2. Use of tablet or powdered chlorine forms.
		6. Sodium hypochlorite is supplied in strengths from 5.25% to 16% available chlorine. The chlorine-water solution shall be prepared by adding hypochlorite to water. Product deterioration shall be factored in by the Contractor in computing the quantity of sodium hypochlorite required for the desired concentration.
		7. Chlorine Application
		8. Continuous feed method: Potable water shall be introduced into the pipe line at a constant flow rate. Chlorine shall be added to a constant rate to this flow so that the chlorine concentration in the water in the pipe is at least 50 mg/L.
		9. The chlorine residual shall be checked at regular intervals not to exceed 1200 feet to ensure that adequate disinfection is occurring. As the chlorinated water passes valves and appurtenances, they shall be operated to insure disinfection of these appurtenances.
		10. The filling velocity of the potable water in the pipe line shall be less than 1 ft/sec. The water chlorine solution shall remain in contact with the pipe for 24 hours. All valves and appurtenances shall be operated while the chlorinated water is in the pipe line in order to disinfect them.
		11. The chlorinated water shall remain in the pipe line at least 24 hours. At that time, the chlorine residual shall be checked at the same points tested during disinfection above. If the chlorine concentration in the water is less than 10 mg/L at any location, disinfection shall be repeated.
		12. Final Flushing: After 24 hours, if the residual is not less than 10 mg/l at any location, the heavily chlorinated water shall be flushed from the pipe line using potable water. The Contractor shall be responsible for ensuring that the heavily chlorinated water is neutralized prior to discharge. Neutralization shall be accomplished by use of sodium bisulfite, sodium thiosulfate, or other chemical approved for chlorine neutralization prior to discharge.
		13. Bacteriological Testing:
			1. After the lines have been flushed, the water lines shall be tested. Two samples shall be collected at least 16 hours apart at the same points tested above, plus one additional set of samples from the ends the main and each branch line. A minimum of two samples shall be collected from each sampling site for coliform analysis. Samples shall be tested by a VDH-ODW approved laboratory and results submitted to the Engineer and the PSA. Option B is not allowed.
			2. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. If laboratory results indicate the presence of coliform bacteria, the samples are unsatisfactory and 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 PSA for one round of testing. All water afterwards shall be paid for by the Contractor. The Contractor shall be responsible for loading, hauling, and/or discharging of water at his/her expense.
		14. Testing and disinfection of the completed sections shall not relieve the Contractor of his/her responsibility to repair or replace any cracked or defective pipe. All work necessary to ensure a tight line shall be done at Contractor expense.

END OF SECTION