Section 2576

Wastewater Force Main Systems

PART 1: General

1.1 *General Description of Work* – Furnish pipe, fittings, and accessories required for wastewater force main systems.

1.2 *Quality Assurance* –

1.2.1 *AWWA Standards* – Construction materials and methods shall comply with the requirements of the latest published edition of American Water Works Association (AWWA) Standards. Applicable standards are listed herein these specifications; any other standards mentioned in the standards listed herein are incorporated by reference.

1.2.2 *ASTM Standards* – In addition, construction materials and methods shall also comply with the requirements of the latest published editions of the American Society for Testing and Materials (ASTM) Standards.

PART 2: Materials and Equipment

2.1 *General* – All piping materials shall conform to the "ECUA Pipe Material Chart." Items furnished shall be new and unused. Ductile iron pipe and fittings shall be epoxy lined ductile iron pipe.

2.2 *Delivery, Storage and Handling* – Certificates of compliance with specifications shall be required for all materials used on the project. All materials shall be protected during transportation, storage, handling and installation to avoid physical damage. All materials shall be stored to prevent physical deterioration due to sun and weather. The ECUA reserves the right to reject material, which in any way does not meet the requirements of these Specifications.

2.3 *Low Pressure Sewer Systems* –

2.3.1 For acceptable pipe materials see the "ECUA Pipe Material Chart".

2.3.2 *Valves* – All valves shall be resilient wedge gate valve with mechanical joint ends and a square nut.

2.3.3 *Service Laterals* – Typical Low pressure sewer service laterals for a single family residence shall be 1 1/2-inch green tubing (per "ECUA Pipe Material Chart") with tracer wire (#12 gauge with green insulation). Larger services may be used if approved by the ECUA Engineering Department. Services installed under the roadway shall be encased in 3-inch green PE tubing. See ECUA Standard Detail D-20.

2.4 *Force Mains* –

2.4.1 *Polyvinyl Chloride Pipe (PVC)* – PVC pipe shall meet the designations of the "ECUA Pipe Material Chart". PVC pipe shall be provided with push-on joints with bell integrally cast into pipe, and shall be installed with elastomeric gaskets, as provided in ASTM F477.

2.4.1.1 *Markings* – PVC pipe shall be marked to indicate the following:

2.4.1.1.1 Nominal Pipe Size and OD Base

2.4.1.1.2 Material Code Designation

2.4.1.1.3 Dimension Ratio

2.4.1.1.4 Pressure Class or Pressure Rating

2.4.1.1.5 Manufacturer's Name or Trademark

2.4.1.1.6 Appropriate AWWA or ASTM Designation Number

2.4.1.2 *Color-Coding* – One of the following methods of color-coding the pipe shall be used:

2.4.1.2.1 Force main pipe shall have 3 green stripes (1/2 inch wide) with permanent ink along the entire length of pipe with the word "FORCE MAIN" in 3/4-inch tall letters every 21 inches along each stripe.

2.4.1.2.2 Green pigment to color entire pipe.

2.4.2 *Ductile Iron Pipe (DIP)* – Ductile iron pipe shall meet the designations of the "ECUA Pipe Material Chart" and installed in Class 2 Trenching conditions. Pressure class shall be determined based on bedding class and surface loads as required by AWWA C151. DIP shall be constructed with push-on joints using rubber gaskets in accordance with AWWA Standard C111. Other methods of joint construction, such as mechanical, flanged, or ball-and-socket, may be required in special applications as appropriate.

2.4.2.1 *Coating Pipe* – Ductile iron pipe and steel pipe, fittings and appurtenances **including sleeves, couplings and joints**, shall have the same type of lining as specified herein. Unless otherwise noted, minimum lining thickness (nominal dry film) shall be 40 mils. Interior lining shall be Protecto 401 as manufactured by Induron Coatings (Birmingham, AL); or Permox-CTF as manufactured by The Permite Corp. (Stone Mountain, GA).

2.4.2.1.1 *Manufacturer's Qualifications* –

2.4.2.1.1.1 Provide products from a company specializing in manufacture of high-performance epoxy coatings with a minimum 10 years of experience.

2.4.2.1.1.2 Materials shall be products of a single manufacturer or items standard with manufacture of specified coating materials.

2.4.2.1.1.3 Submit Manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

2.4.2.1.2 *Applicator's Qualifications* –

2.4.2.1.2.1 Engage a single installer licensed or approved by the Manufacturer with a minimum of three years' experience performing this type of lining installation and with documented skill and successful experience in the installation of ceramic epoxy lining to interior of ductile iron pipe and fittings.

2.4.2.1.2.2 Submit name and qualifications to Engineer.

2.4.2.1.2.3 Submit proof of license or approval of applicator by Manufacturer to Engineer.

2.4.2.1.3 *Shop Surface Preparation* –

2.4.2.1.3.1 All internal surfaces of ductile iron pipe and fittings shall be delivered to the application facility without asphalt or any other protective lining on the interior surface. All oils, small deposits of asphalt paint and grease shall be removed in accordance with NAPF 500-03-01 Solvent Cleaning prior to abrasive blasting.

2.4.2.1.3.2 Uniformly rotary-abrasive blast to a NAPF 500-03-04: Internal Pipe Surface Condition, full removal of annealing oxide layer. When viewed without magnification, the interior surfaces shall be free of all visible dirt, dust, annealing oxide, rust, mold release coating and other foreign mater. The surface shall contain a minimum angular anchor profile of 3.0 mils (76.2 microns).

2.4.2.1.3.3 Coat surface within eight hours of surface preparation.

2.4.2.1.4 *High Voltage Holiday Detection* –

2.4.2.1.4.1 The lining system shall be high voltage discontinuity (spark) tested to determine the presence and number of discontinuities (holidays) in the lining. High voltage discontinuity (spark) testing shall be performed in accordance with ASTM D5162 or NACE SP0188. High voltage discontinuity (spark) testing shall be performed using a Tinker & Rasor model AP/W Holiday Detector (or approved equal) with a voltage setting of 100 volts per mil thickness at minimum. Therefore, High Voltage holiday detection shall be performed at 4,000 volts minimum.

2.4.2.1.5 *Prior to Shipment* – Visually examine all ceramic epoxy lined pipe and fittings for film defects, including any runs, sags, and debris in the film. Shop repairs shall be made in accordance with the Manufacturer's instructions.

2.4.2.1.5.1 All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic dry film thickness gauge. The thickness testing shall be in according with SSPC-PA2 film thickness rating.

2.4.2.1.5.2 The lining installer shall provide written verification that all pipe surfaces have been discontinuity tested as listed below. Verification shall be conducted by a NACE Certificated Coatings Inspector.

2.4.2.2 *Markings* – Each ductile iron pipe joint and fitting shall be marked: (1) with the Manufacturer's mark, (2) to indicate the country where cast, (3) to indicate the weight class or nominal thickness, (4) with the date when pipe produced and date of application of the lining system, and (5) with the letters DI or DUCTILE cast or stamped on the pipe.

All required markings shall be clear and legible, and all cast marks shall be on or near the bell. All letters and numerals on pipe sizes 14 inches and larger shall be not less than ½ inch in height. Ductile iron pipe, fittings and valves shall be marked, striped or coated with green coloring in accordance with paragraph 2.4.1.2 herein.

2.4.2.3 Pipe Design –

2.4.2.3.1 *Design Parameters* – All ductile iron pipes shall be designed and manufactured in accordance with AWWA C150 and AWWA C151, respectively, for the following minimum operating conditions:

2.4.2.3.1.1 The minimum internal design working pressure shall provide/ensure: (1) a 100-psi surge allowance, (2) a safety factor of 2, and (3) a total internal design pressure of 600 psi. No reduction of safety factor for transient pressures shall be allowed.

2.4.2.3.1.2 The external loads design criteria shall be a minimum of 4 foot depth of cover at 120 lbs. per cubic feet soil weight, and live load based on one AASHTO H-20 truck load. The thickness design of ductile iron pipe shall be in accordance with AWWA C150.

2.4.2.3.1.3 The horizontal deflection of epoxy lined ductile iron pipe resulting from external load conditions shall not exceed three percent of the pipe diameter.

2.4.2.3.1.4 For purposes of restrained joint calculations per the Ductile Iron Pipe Research Association (DIPRA) method, the soil classification for both the native trench soil and also the backfill soil to surround the pipe shall be defined with one or more of the following options:

Soil Classifications						
Option A	Option B	Option C	Option D	Option E	Option F	Option G
Clay 1	Silt 1	Clay 2	Silt 2	Coh-gran	Sand Silt	Good Sand

Note: As described in DIPRA's "Thrust Restraint Design for Ductile Pipe," latest edition.

2.4.2.3.2 *Minimum Pipe Class* – Ductile iron pipe shall conform to AWWA C151. All pipes shall have a minimum pressure class of 250 PSI. All pipe shall be made in the United States.

2.4.2.4 *Joint Design* –

2.4.2.4.1 *General* – Ductile Iron pipe and fittings shall be furnished with push-on joints, push-on restrained joints, and flanged joints, as required.

2.4.2.4.2 *Push-on Joints* – Push-on joints shall conform to AWWA C111. Unless otherwise specified, gasket material shall be standard styrene butadiene copolymer (SBR). Push-on joints shall be Fastite, as manufactured by American Cast Iron Pipe Company (ACIPCO), or equivalent. The pressure rating for push-on joints shall be a minimum of 350 psi or the specified pressure rating of the pipe, whichever is less.

2.4.2.4.3 *Restrained Joints* – Restrained joints shall be "Flex-Ring" restrained joints as manufactured by ACIPCO or equivalent. When restrained joints require factory welding, the Manufacturer shall qualify all welding procedures and welders used to produce the product per the requirements of a documented quality assurance system based on ANSI/AWS D11.2. Unless otherwise specified, gasket material shall be standard SBR. Restrained joints and restrained joint pipe shall have a working pressure rating of 350 psi for 3 to 16-inch sizes and 250 psi for 18 to 48-inch sizes. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes. The Manufacturer shall furnish test results showing that restrained joints in the sizes specified have been successfully tested to at least twice the specified pressure rating of the joint without leakage or failure. Tests shall be performed on pipe with nominal metal thickness less than or equal to that specified for the project.

2.4.2.4.4 *Flanged Joints* – Ductile iron pipe and fittings 3 to 54 inches for above ground service or in below ground concrete pits shall have flanged joints and meet the following requirements:

2.4.2.4.4.1 Flanged ductile-iron pipe shall conform to current AWWA/ANSI Specification C115/A21.15 and C110/A21.10 with factory-applied screwed long hub flanges except as otherwise specified hereinafter. Flanges shall be fully machined faced and drilled after being screwed tight on the pipe, with flanges true to 90 degrees with the pipe axis and shall be flush with end of pipe conforming to ANSI B161.1, 125 pound std. or Class 250, for the purpose intended. No welding of flanges or accessories in the field will be acceptable.

2.4.2.4.4.2 Full face type 1/16 inch thick red rubber ring gaskets shall conform to ANSI A21.11. Ring gaskets shall be of approved composition suitable for the required service.

2.4.2.4.5 *Fittings* –

2.4.2.4.5.1 *General* – Fittings shall be ductile iron in accordance with AWWA C110, AWWA C153, or AWWA C606, latest revisions. All fittings shall be made in the United States.

2.4.2.4.5.2 *Lining* – Fittings shall be internally lined with ceramic epoxy as specified in Section 2.4.2.1.

2.4.2.4.5.3 *Buried Service Fittings* – Fittings shall be provided with flex ring joint bells or spigots or their equivalent. Fittings, sizes 4 - 24 inches shall be rated for 350 psi working pressure. Fittings, sizes 30 - 64 inches shall be rated for 250 psi working pressure.

2.4.2.4.6 *Welded-on Outlets* –

2.4.2.4.6.1 *Outlet Size and Parent Pipe Size* – Welded-on outlets shall be limited to branch outlets having a nominal diameter not greater than 70 percent of the nominal diameter of the main line pipe or 36 inches, whichever is smaller, with all fabrications subject to further requirements of the following specification with regard to design and manufacture. The Manufacturer shall have the capability to furnish welded-on outlets as a radial (tee) outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main line pipe (in 15 degrees increments between 45 degrees and 90 degrees from the axis of the main line pipe), as indicated on the drawings. Welded-on outlets shall be fabricated by the pipe Manufacturer at the same facility where the pipe is produced. The pipe Manufacturer shall have a minimum of five years of experience in the fabrication and testing of outlets of similar size and configuration.

2.4.2.4.6.2 *Outlet Joint Types* – The joints on welded-on branch outlets shall meet, where applicable, the requirements of AWWA C111 and/or AWWA C115.

2.4.2.4.6.3 *Design* –

2.4.2.4.6.3.1 The pipe wall thickness and weld reinforcement design for welded-on outlet fabrications shall be based on a method similar to that which is described in Section 13 of AWWA Manual M11 for similar welded outlets on steel pipe (which in turn refers to Section VIII of the ASME Unfired Pressure Vessel Code for design method details). Reinforcing welds shall be placed using Ni-Rod FC 55-0 cored wire, Stoody Castweld Ni 55-0 cored wire, or Ni-Rod 55-0 electrodes manufactured by INCO Alloys (or an electrode with equivalent performance properties). Carbon steel electrodes are not acceptable. Upon request, the Manufacturer shall provide test results indicating typical mechanical properties of the utilized weld material (an all-weld sample), as well as typical mechanical properties from transverse tensile and impact specimens machined from butt-weld joined ductile iron pipe coupons to show the suitability or equivalence of the electrodes used.

2.4.2.4.6.3.2 Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron pipe designed in accordance with AWWA C150 and manufactured in accordance with AWWA C151. Minimum classes for parent and outlet pipe shall be: for sizes 4 - 54 inches, Special Thickness Class 53; for sizes 60 - 64 inches, Pressure Class 350.

2.4.2.4.6.3.3 All welded-on outlets 6 - 30 inches shall be rated for a working pressure of 250 psi. Welded-on outlets 36 inches and larger shall be rated for 200 psi. Welded-on outlets of all diameters and configurations must have a minimum safety factor of 2.5 based on proof of design hydrostatic test results. The Manufacturer shall, at the request of the Owner or Engineer, provide representative proof test data confirming the design, hydrostatic test results, and safety factors.

2.4.2.4.6.3.4 Prior to the application of any coating or lining in the outlet area, all weldments for branch outlets to be supplied on this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any leakage shall be detected by applying an appropriate foaming solution to the entire exterior surface of the weldment and adjoining pipe edges or by immersing the entire area in a vessel of water and visually inspecting the weld surface for the presence of air bubbles. Any weldment that shows any signs of leakage shall be repaired and retested in accordance with the Manufacturer's written procedures.

2.4.2.4.6.3.5 Application shall be performed by an applicator approved by the lining Manufacturer, in accordance with Manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe Manufacturer's plant. Applicator shall submit a certified affidavit of compliance with Manufacturer's instructions and requirements specified herein.

2.4.2.5 *Outside of Ductile Iron Pipe* – The options for protection of the exterior of ductile iron pipe, fittings, etc. shall consist of one of the following: (1) standard shop coating and annealing oxide layer, (2) standard coating and annealing oxide layer plus polyethylene-encased, (3) epoxy coating, or (4) epoxy coating plus heat shrink sleeves. Options (1) and (2) are typically used for buried pipe. Option (3) is typically used for pipe that is exposed, above grade. Option (4) is typically used in exposed locations where the presence of corrosive conditions may be present (e.g. ARV vaults)

2.4.2.5.1 *Standard Coating* – Coating type and amount per the requirements of the pipe and appurtenance Manufacturer.

2.4.2.5.2 *Encasement* – DIP shall be encased in the specified polyethylene material as indicated on the project plans. Where DIP is to be installed in locations where polyethylene encasement has not been identified on the plans, it shall be the Contractor’s responsibility to retain a Florida licensed Professional Geotechnical Engineer or Ductile Iron Pipe Research Association (DIPRA) recognized soil testing firm to determine the

location(s) where polyethylene encasement of the DIP is required, in accordance with ANSI/AWWA C105, Appendix A, latest edition and DIPRA DDM procedures. Copies of the reports or studies determining the locations for DIP polyethylene encasement shall be furnished to the Owner and Engineer prior to the start of DIP installation and be available onsite with the Contractor.

DIP shall be encased in 4 mil HDCL or 8 mil LLD polyethylene material in accordance with ANSI/AWWA Standard C105, using Encasement Method A (tube wrapped).

2.4.2.5.3 *Location Information* – The installed locations of polyethylene encasement of the DIP shall be documented on the final as-built project plans.

2.4.2.5.4 *Epoxy Exterior Coating* –

2.4.2.5.4.1 *Shop Surface Preparation* – Abrasive blast to remove loose annealing oxides, all rust and other contaminants. All surfaces shall have a minimum surface profile of 1.5 mils.

2.4.2.5.4.2 *Field Surface Preparation* – All abraded areas shall be abrasive blasted to remove all loose rust and shall result in a surface preparation equal to that listed above. All edges shall be feathered. All other surfaces shall be abraded to provide a sufficient surface profile for the proposed finish coat(s).

2.4.2.5.4.3 *Coating* – Utilize products by Sherwin Williams, SherGlass FF Epoxy for exposed piping, either above grade or within underground vaults, pits, etc. For pipe remaining exposed above ground, top-coating with a urethane (Acrolon Ultra) for color and gloss retention is required. The table below does not include the standard shop applied primer coating.

Approved Coating Products

Coat	Product	Color	Dft
1st	* SherGlass FF Epoxy **	White	10.0 – 20.0
2nd	* SherGlass FF Epoxy **	White	10.0 – 20.0
Final	* Acrolon Ultra **	Green	2.0 – 3.0

* Lining to be applied in a single coat
** Or approved equivalent

2.4.2.5.4.4 *Discontinuity Testing* – After cure of the lining, all surfaces shall be high voltage holiday tested in accordance with NACE RPO 188 (latest edition) and the recommendations of the Manufacturer.

2.4.2.5.5 *Heat Shrink Sleeves* – Heat shrink sleeve shall consist of a cross-linked and pre-stretched sheet (coated with a protective heat-sensitive adhesive) which, upon heating, will shrink to its original length. The sleeve adhesive will achieve the corrosion protection by preventing moisture and air ingress to the pipe surface. Further, the adhesive shall act to hold and anchor the backing around the joint through adhesion to the substrate and the backing. Careful attention required concerning the compatibility of the sleeves with pipe coatings. AWWA C216 covers the material and

application requirements of heat-shrinkable cross-linked polyolefin coatings for the exterior of special sections, connections, and fittings for steel pipelines.

2.4.3 *Polyethylene Pipe (PE)* – The pipe supplied under this specification shall be high performance, high molecular weight, high density polyethylene pipe and shall conform to "ECUA Pipe Material Chart". All pipe resin shall be manufactured by the same company that manufactures the pipe itself in accordance with these specifications to ensure complete resin compatibility and total product accountability. The fittings shall be molded or manufactured from a polyethylene compound having a cell classification equal to or exceeding the compound used in the pipe. To ensure compatibility of polyethylene resins, all fittings supplied under this specification shall be of the same manufacturer as the pipe being supplied.

Typical Physical Properties Of PE Pipe			
Property	Test Method	Unit	Value
Density	ASTM D1505	gms/cc	0.957
Melt Flow	ASTM D 1238 (190/21.60)	Gms/ 10 min.	1.5
Environmental Stress Cracking Resistance			
Condition A, B & C, F_0	ASTM D1693	hrs.	>5000
Compressed Ring, F_0	Proposed ASTM	hrs.	>5000
Tensile Strength, Ultimate	ASTM D 638	psi	5000
Type IV Specimen	(2"/min.)		
Tensile Strength, Yield	ASTM D 638	psi	3500
Type IV Specimen	(2"/min.)		
Elongation at Break Type IV Specimen	ASTM D 638 (2"/min.)	%	>600
Impact Strength Specimen Thickness 0.125 inch	ASTM D 256 Method A	ft.lbs./inch notch	>12
Vicat Softening Temperature	ASTM D 1525	°F	257
Brittleness Temperature	ASTM D 746	°F	<-180
Flexural Modulus	ASTM D 3350	psi	125,000
Hardness	ASTM D 2240	Shore D	65
Coefficient of Linear Thermal Expansion Molded Specimen	ASTM D 696	in./in./ °F	8.3x10-5
Extruded Pipe			1.2x10-4
Thermal Conductivity	Dynatech-Colora	TRU, in./	2.7
	Thermoconductor	ft.2/hrs./ °F	
Long Term Strength			
73°F	ASTM D 2837	psi	1600
140°F		psi	800
Material Cell Classification	ASTM D 3350		355434C
Material Designation	PPI		PE 3408

2.4.3.1 *Quality Control* – Refer to the following guidelines regarding quality control:

2.4.3.1.1 The resin used for manufacture of the pipe shall be manufactured by the pipe Manufacturer, thus maintaining complete control of the pipe quality. The pipe shall contain no recycled compound except that generated in the Manufacturer's own plant from resin of the same specification and from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other deleterious defects, and shall be identical in color, density, melt index, and other physical properties.

2.4.3.1.2 Approved Manufacturers shall be Performance Pipe (A Division of Phillips Chemical Company), others as approved by ECUA in writing. The Engineer may request, as part of the quality control records submittal, certification that the pipe produced is represented by the quality assurance testing. Additionally, test results from Manufacturer's testing or random Manufacturer's representation, may be cause for rejection of pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9.

2.4.3.1.3 *Verification* – The Owner or the specifying Engineer may request certified lab data to verify the physical properties of the materials supplied under this specification or may take random samples and have them tested by an independent laboratory.

2.4.3.1.4 *Rejection* – Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

2.4.3.1.5 *Pipe Dimensions* –

2.4.3.1.5.1 All 3-inch polyethylene pipe for force main installation supplied under this specification shall have nominal iron pipe size (IPS) O.D. size unless otherwise specified. Pipe shall have a Standard Dimension Ratio (SDR) of 11 unless otherwise specified.

2.4.3.1.5.2 All 4-inch & larger pipe supplied under this specification shall have a nominal DIPS (Ductile Iron Pipe Size) O.D. unless otherwise specified. Pipe shall have a DR of 11 unless otherwise specified.

2.4.3.1.6 *Stainless Steel Pipe and Fittings* –

2.4.3.1.6.1 Stainless steel pipe and fittings shall be Schedule 10 minimum, iron pipe size (IPS), of the nominal diameter shown on the Contract Plans. Transition to ductile iron pipe size (DIPS) outside diameter(s) shall be as shown on the Contract Plans. The stainless steel pipe and fittings shall be AISI 316L and comply with ASME/ANSI B 36.10, ASME/ANSI B36.19M, AWWA C220, latest editions and all applicable ASTM Standards.

2.4.3.1.6.2 All welded fabrication of pipe and fittings shall be in accordance with ANSI/AWS D10.4, latest edition. All welds shall be free from cold spots, pin holes, oxide inclusions, burrs, snags, rough projections and other defects. Welding shall be by AWS certified welders for austenitic chromium-nickel stainless steel pipe and tubing.

2.4.3.1.6.3 Flanged joints shall comply with AWWA/ANSI B16.5 Standards, latest edition.

2.5 *Force Main Appurtenances* –

2.5.1 *Force Main Fittings for PVC & Ductile Iron Pipe* – Force main fittings shall include tees, wyes, bends, reducers, and other appurtenances commonly used in pipe construction. Fittings shall meet AWWA Standard C110 or C153 with pressure ratings of not less than that specified for adjacent pipe. Fittings shall be constructed with mechanical joints, unless otherwise specified, and shall be supplied complete with low alloy steel bolts and nuts, EPR gaskets and other necessary parts required for field assembly. Fittings shall be ceramic epoxy lined as specified in paragraph 2.4.2.1.

2.5.2 *Force Main Fittings for HDPE Pipe* –

2.5.2.1 Mechanical connections of HDPE pipe (4 inch and larger) to ductile Iron or PVC piping, mechanical joint fittings, or valves shall be through a self-restraining, fusible mechanical joint adapter. Mechanical joint adapter shall be the same SDR rating as the pipe. Provide the mechanical joint adapter, including but not limited to longer tee bolts and all thread rods with nuts at the mechanical joint bell.

2.5.2.2 Mechanical connections of HDPE pipe sized under 4 inches to ductile iron or PVC piping, mechanical joint fittings, or valves shall be through the use of the above specified mechanical joint adapter if available. As an alternate, transition fittings of HDPE by male iron pipe threaded end installed by butt fusion may be used.

2.5.2.3 Polyethylene pipe and fittings may be joined using approved electro fusion couplings. Fittings shall be PE3408 HDPE. Electro fusion fittings shall have a pressure rating equal to the pipe.

2.5.3 *Pipe Cut-in Sleeves* – Cut-in sleeves shall be solid ductile iron, one end plain for insertion to female fitting, the other end flanged mechanical joint, furnished with loose attaching flange and fastener, nominal length of 20 – 21 inches. Rings and gaskets shall be sized to conform to the requirements of the pipe Manufacturer.

Approved Manufacturers		
Manufacturer	**Model**	**Application**
Clow	F-1220	for centrifugally cast or sand cast pipe (special)
Clow	F-3459	for all classes of centrifugally cast pipe
Union Foundry	21-4520 21-4610 24-4800	MJ X PE FLG X PE MJ X FLG
Clow	F-3459	for all classes of centrifugally cast pipe
Others as approved by ECUA in Writing		

2.5.3.1 *Repair Clamps* – Repair clamps shall not be used in the installation of new pipe except with the written permission of the Engineer. Repair clamps shall be full circle and selected based on the following table.

Repair Clamp Sizes	
Pipe Diameter	**Maximum Sections**
Up to 12”	Single Section
14” to 24”	Double Section
26” and above	Multi Section

Repair clamps shall be composed of stainless steel bands and corrosion resistant bolts, SS lugs and full gridded virgin EPR compounded gasket.

Repair clamps shall be sized so that the OD of the existing pipe being repaired falls within the designated range for the clamp size. For pipes with diameter less than 42 inches, repair clamps shall have a minimum length of one (1) times the diameter of the pipe to give full gasketing at both ends. For pipes with diameter equal to or greater than 42 inches, minimum length is 36 inches.

Approved Manufacturers (diameters equal to or less than 24”)	
Manufacturer	**Model**
Ford	FS series (all SS)
JCM	101,102,103,104,131,132,133,134
Others as approved by ECUA in writing.	

NOTE : See Manufacturer’s catalog to complete model numbers by size

Approved Manufacturers (diameters greater than 24”)	
Manufacturer	**Model**
PowerSeal	3123AS
Others as approved by ECUA in writing.	

2.5.4 *Pipe Restraints* – With advance approval by Engineer of Contractor’s request for substitution or where shown on drawings, retainer glands may be used in lieu of Flex-Ring or equivalent system on force main fittings and appurtenances. Such Mechanical Restraint systems shall be provided with 304 stainless steel bolts. Stainless steel all-thread tie rods may possibly be used with the advance approval of the Engineer. In cases of tees, tapping sleeves, and flushing hydrants up to 12 inches, the fitting may be restrained with thrust blocks. See ECUA Standard Details D-52 and D-62.

Approved Manufacturers	
Manufacturer	**Model**
EBAA Iron Works	MegaLug
Star Pipe Products	StarGrip Series
Romac Industries, Inc.	Roma-Grip Series
Others as approved by ECUA in writing.	

2.5.5 *Expansion Joints* – Expansion joint fittings shall be used where specified on the Construction Plans. They shall be of the rigid or flexible type as specified, and manufactured of ductile iron in accordance with 2.4.2 above. They shall be capable of

expanding or contracting to the extent shown on the plans, but in no case less than 4 inches axially, and designed to prevent separation beyond the maximum extension without the use of external tie rods.

2.5.6 *Mechanical Joints* – Fittings shall be provided with restrained mechanical joints, individually pressure tested to a minimum of 350 psi against their own restraints, and internally coated on all exposed surfaces with a minimum of 15-mils of fusion bonded epoxy conforming to AWWA C213. They shall be capable of deflecting not less than 15 degrees by means of an integral ball at each joint in the case of flexible types.

Approved Manufacturer		
Type	**Manufacturer**	**Model**
Rigid	EBAA Iron, Inc.	EX-TEND 200
Flexible	EBAA Iron, Inc.	Flex-Tend
Others as approved by ECUA in writing.		

2.5.7 *Tapping Sleeves* – The minimum size tapping sleeve shall be 4 inches. Connection of 3 inch lines to existing pipes 4 inches and larger shall be made by a 4 inch tapping sleeve with appropriate reducing fitting. Tapping saddles shall be used for smaller connections.

Tapping sleeves shall be mechanical joint or fabricated-type designed for a working pressure of 200 psig without leakage. The outlet branch connection shall have a recessed flanged face for connection of tapping valve with standard dimensions in accordance with MSS SP-60. A complete set of neoprene or other elastomer gaskets shall be furnished. Sleeves shall be furnished to fit DIP, cast-iron, cement-asbestos, Class 160 or C900/905 PVC pipe with side connection as shown on plans or specifications in standard pipe sizes of 4 x 4 inch through 16 x 12 inch. Sleeves shall be furnished with all necessary installation parts such as mechanical joint loose flange ends, bolts, fasteners, seals and gaskets. All hardware shall be stainless steel.

Approved Manufacturers		
Manufacturer	**Main Material**	**Model**
Clow	CI & C900 PVC	F-5205
	Class 50, 100, 150, 200 10-inch & 12-inch Class 50, 100	F-5207 4 F-5205
American Darling	CI & C900 PVC CI & CA	2800C 2800A
Mueller	CI, DI - 4-inch - 12-inch CA - 4-inch - 8-inch CI Class C & D - 10-inch - 14-inch CA - 4-inch-12-inch	H615 H615 H616 H619
M & H	MJ Class A-B Pipe MJ Class C-D Pipe	1174 1274
Others as approved by ECUA in writing		

Note: To specify exact fitting when ordering, state line diameter and line material.

2.5.7.1 *Mechanical Joint Tapping Sleeves* – Mechanical joint tapping sleeves shall be stainless steel with mechanical joint main ends and a standard special dimension tapping machine attaching flange on the branch connection. The sleeve shall be of split configuration and fabricated in accordance with AWWA Specification C110 with joints to AWWA Specification C111.

2.5.7.2 *Fabricated Tapping Sleeves* – Fabricated tapping sleeves shall be the high-strength type having a wide body, made of stainless steel, which conforms to and reinforces the pipe to be tapped. Body length must be at least twice that of the tap size. The sleeve shall have, as a minimum, a 7/8-inch wide recessed Buna-N gasket around the outlet, and 3/4-inch high-strength corrosion resistant alloy bolts. Sleeve to be furnished with Manufacturer's standard, corrosion resistant, coating.

Approved Manufacturers	
Manufacturer	**Model**
JCM Industries	Model 432
Smith & Blair	663
Ford	FAST
Others as approved by ECUA in writing.	

2.5.8 *Pipe Hangers and Supports* – Hangers and supports shall be in compliance with Federal Specification WW-H-171E, or Manufacturer's Standardization Society SP-69 or UL listed. Materials of construction shall be in accordance with the requirements outlined in the table below.

Pipe Hangers and Supports - Materials Of Construction	
Part I.D.	**Material**
Clamps	Steel - Epoxy Coated or Galvanized Cast Iron – Galvanized Malleable Iron
Hanger Rods	Steel - Electro Galvanized Steel - Stainless 304
Rollers/Bases/Roller Stands	Cast Iron
Fasteners/Fittings	Galvanized Steel Stainless
Hanger Rod Inserts	Steel: Cadmium Plated Steel: Galvanized Universal Concrete Insert - Cast Iron - Galvanized
Rod Attachments	Clevis - Forged Steel Turnbuckle: 1) Forged Steel, 2) Malleable Iron Sockets, Eye Nuts, Extension - Malleable Iron
Rollers	Steel or Iron Core, Insulated from Structure

Approved Manufacturer		
Manufacturer	**Part I.D.**	**Model No.**
ITT Grinnell	Clevis Hanger	590
	Socket Clamp	224 246
	<u>Concrete Inserts:</u> CB-Universal Screen Insert	 282 152
	<u>Rod Attachments:</u> Eye Nut Forged Clevis Forged Turnbuckle Carbon Steel Couplings Socket Eye Extension	 290 299 230 233 136 110R 157
	<u>Pipe Rolls:</u> Adjustable Swivel Adjustable Steel Yoke	 174 181
	Pipe Roll with Base	274
	Pipe Roll and Plate	277
Others as approved by ECUA in writing.		

2.5.9 *Valves* – All valves shall be manufactured in accordance with the current appropriate AWWA Standard.

2.5.9.1 *Resilient Seated Gate Valves* – Resilient seated gate valves shall be designed and fabricated in accordance with the current AWWA Standard C-509 or C-515. The basic design of the gate valves shall have a cast iron body, elastomer encapsulated cast iron disc, bronze stem and operating nuts with non-rising stem design. The valve working pressure shall be 250 psig with a test pressure of 500 psig.

2.5.9.1.1 *Materials and Construction* – Valves shall open counterclockwise with a 2 inch square cast iron operating nut secured to the valve stem by a corrosion resistant nut to threads on the valve stem. The valve stem shall be made of high tensile strength bronze and shall be of one piece construction sealed by O-Rings. The thrust collar shall be secured in place by a stuffing box or bonnet cover with a thrust washer located above the thrust collar. Valve construction shall be so that upper O-Rings can be replaced with the valve in service. The disk shall be cast iron encapsulated with an EPDM rubber material bonded in accordance with ASTM D429 and shall be secured to the threaded stem by a bronze nut. The disk shall affect a seal that is bubble-tight at 250 psig.

2.5.9.1.2 *Corrosion Resistant Coatings* – All interior and exterior cast iron surfaces shall be coated with fusion-bonded epoxy in accordance with AWWA Standard C550.

2.5.9.1.3 *Body Sizing* – Valve body length shall be per ANSI Standard B16.10 for the type of end connections specified. In the full open position, the valve internal bore shall be smooth and obstruction-free without cavities or projections that could accumulate solids. The internal cross-sectional area of the valve shall be not less than the full cross-section of the adjoining pipe.

2.5.9.1.4 *End Connections* – Valves shall be furnished with mechanical joint end connections, complete with flange kits, unless otherwise specified on the plans or purchase order.

When flanged ends are specified they shall be flat face nominal 125# ANSI B16.1 Standard with bolt holes straddling the vertical center line.

Approved Manufacturers				
Manufacturer	**Valve Body Connections**			**Tapping Valves**
	MJ x MJ	**MJ x FLG**	**FLG x FLG**	**MJ x SF**
American Flow Control	4" - 20" Series 2500	4" - 20" Series 2500	4" - 20" Series 2500 Specify Ends	4" - 20" Series 2500
Clow	2" - 12" F6100	4" - 12" F-6106	4" - 12" F-6102	4" - 12" F-6114 14" - 24" F-5093*
Kennedy	3" - 12" F-1571-XNRS	3" - 12" F-1572-XNRS	3" - 12" F-1561-XNRS	3" - 12" F-950X
M & H	4" - 12" S-4067-01 Model 7571	 Model 7572	4" - 12" S-4067 Model 7561	2" - 12" H-667 200 PSI 14" - 24" H-667 150 PSI Model 7950
Others as approved by ECUA in writing.				

Note: Metal seated only, specify bypass if required.
For 14" and larger valves specify special appurtenances.

2.5.9.2 *Resilient Seated Tapping Valves* – These resilient seated gate valves shall be designed and fabricated in accordance with the current AWWA Standard C515. The basic design of the gate valves shall have a cast iron body, EPDM rubber encapsulated cast iron disc, bronze stem and operating nuts with non-rising stem design. The valve working pressure shall be 250 psig with a test pressure of 500 psig.

2.5.9.2.1 *Materials and Construction* – Valves shall open counterclockwise with a 2 inch square cast iron operating nut secured to the valve stem by a corrosion resistant nut to threads on the valve stem. The valve stem shall be made of high tensile strength bronze and shall be of one-piece

construction sealed by O-Rings. The thrust collar shall be secured in place by a stuffing box or bonnet cover with a thrust washer located above the thrust collar. Valve construction shall be so that upper O-Rings can be replaced with the valve in service. The disc shall be cast iron encapsulated with an elastomer material bonded in accordance with ASTM D429 and shall be secured to the threaded stem by a bronze nut. The disk shall affect a seal that is bubble-tight at 250 psig.

2.5.9.2.2 *Corrosion Resistant Coatings* – All interior and exterior cast iron surfaces shall be coated with fusion-bonded epoxy in accordance with AWWA Standard C550

2.5.9.2.3 *Body Sizing* – Valve body length shall be per ANSI Standard B16.10 for tapping valves. Tapping valves shall conform to Specification AWWA C515, latest revision, covering gate valves except as modified for passage and clearance of tapping machine cutters. The opening through the valve shall be at least 1/4-inch larger than nominal valve diameter. Tapping valves shall allow full size shell cutters to be used.

2.5.9.2.4 *End Connections* – Valves shall be furnished at one end of the body with projecting face flange in accordance with specification MSS SP-60 for tapping valve/saddle connections to bolt to a standard tapping sleeve and the other end for mechanical joint.

2.5.9.2.5 *Approved Manufacturers* – See sections above.

2.5.9.3 *Combination Air Release and Vacuum Valves* –

2.5.9.3.1 *General* – Force mains shall be laid so as to minimize the number of high points. Air release valves shall be installed at all high points in force mains shown on the project plans. Exact locations of air release valves shall be field determined. In all cases, installation should be in the furthest downstream portion of each high point.

The valve shall be designed to operate with liquids carrying solid particles such as raw sewage. The air and vacuum air valve shall discharge air at high flow rates during the filling of the system and admit air into the force main at high flow rates during its drainage. High velocity air cannot blow the float shut. Sewage entry to the lower portion of the valve will cause the sealing of the valve. At any time during system operation, should internal pressure of the system fall below atmospheric pressure, air will re-enter the system. The smooth release of air shall prevent pressure surges and other destructive phenomena to the force main. Admitting air in response to negative pressure protects the force main from destructive vacuum conditions and prevents damage caused by water column separation. Air re-entry is essential to efficiently drain the force main.

2.5.9.3.2 *Valve Requirements* –

2.5.9.3.2.1 Working pressure range: 3 – 230 psi. Testing Pressure: 360 psi.

2.5.9.3.2.2 The valve's design shall prevent any contact between sewage and the sealing mechanism by creating an air gap at the top of the valve, under all operating conditions.

2.5.9.3.2.3 The conical body shape shall be designed to maintain the maximum distance between the liquid and the sealing mechanism.

2.5.9.3.2.4 A spring-loaded joint is to be furnished between the stem and the upper float. Vibrations of the lower float will not unseal the automatic valve. Release of air will occur only after enough air accumulates.

2.5.9.3.2.5 The funnel-shaped lower body shall be designed to ensure that residue sewage matter will re-enter the force main and will not remain in the valve.

2.5.9.3.2.6 Maintenance flushing shall be provided while the valve is under pressure, by opening a full port type 316 S.S. ball valve in the valve's lower body.

2.5.9.3.2.7 All inner metal parts of the valve shall be made of stainless steel SAE 316.

2.5.9.3.2.8 Maximum working temperature 203°F.

2.5.9.3.2.9 The valve shall be provided with an AWWA/ANSI C110 flanged joint at the base of the body.

2.5.9.3.2.10 The valve shall be furnished with an AWWA C517 resilient seat, cast iron eccentric plug valve with a hand wheel operated, worm gear actuator.

Approved Manufacturers		
Manufacturer	**Size**	**Model**
ARI Flow Control Accessories	2"	D-025 (plastic)
	4" and Larger	D-023 (Stainless Steel)
Others as approved by ECUA in writing.		

2.5.9.4 *Horizontal Swing-Check Valves* – These horizontal swing-check valves shall be the clear waterway type - designed and fabricated in accordance with the current AWWA Standard C508. Horizontal swing- check valves shall be iron body, bronze mounted with flanged ends rated for operation at 125 psi. The cover shall be cast iron with cover bolts of rust-proofed steel. The seating surfaces shall be bronze, and the disk shall be ductile or grey iron. The shaft shall be stainless steel with corrosion resistant bearing(s) at each end. Where extended outside the body, the shaft shall be sealed with double O-rings. There shall be a grease fitting between the O-rings. The check valve shall be of the adjustable external spring-loaded type. The Contractor shall adjust the tension in the spring as necessary to prevent slamming of the valve upon closing.

2.5.10 *Line Stops* – Line stops are to be used where specified to temporarily stop water line water flow without depressurizing the entire line. The line stop parts and installation

equipment are to be rated at a minimum of 150 psig working pressure unless otherwise specified.

2.5.10.1 *Materials and Construction* – Tapping saddles shall have 360-degree clamping on the main. All tapping saddles shall be fabricated of 304 Stainless Steel. All bolts and fasteners are to be 304 Stainless Steel, and the saddle shall be installed with Buna-N or neoprene rubber full facing gasket.

2.5.10.1.1 The stopping device attaching nozzle to be vendor's standard with connecting threads or flange face, and the nozzle I.D. to be manufactured with a shelf to provide a position stop for the closure plug.

2.5.10.1.2 The closure plug is to be fabricated carbon steel, ductile iron, or malleable iron with at least one Buna-N or neoprene O-Ring seal on the outside diameter.

2.5.10.2 Corrosion-Resistant Coatings – Non-stainless steel permanently installed parts to have Manufacturer's standard red or black water base epoxy coating.

2.5.10.3 *Connection* – Tapping saddle shall be fabricated with dimensions to fit on concrete, steel, CA, PVC, CI, DI main as specified.

2.5.10.4 *Installation* – Temporary line stops shall only be installed by vendor personnel or Contractor Personnel trained and certified for stop by the vendor.

2.5.11 *Valve Insertions* –

Approved Manufacturers (Main Sizes 4-inch – 42-inch)	
Manufacturer	**Contact**
Hydra-Stop, Inc.	Phone: 800-538-7867
JCM 440	Phone: 800-527-8482
Romac	Phone: 800-426-9341
Others as approved by ECUA in writing.	

2.5.12 *Vaults and Boxes* –

2.5.12.1 *Valve Vaults or Chambers* – All valves which are not designed for direct burial shall be installed in vaults, which shall be constructed from standard precast concrete manhole sections. They shall be sized to allow sufficient room for maintenance and repair in situ. See ECUA Standard Details D-44 and D-45.

2.5.12.2 *Valve Boxes* – Valve boxes shall be provided for all direct buried valves. Nominal 5 ¼-inch cast-iron sliding type pipe shaft with cover and base casting shall be used. The box top shall be set at finished grade and encased with a concrete ring in unpaved areas. Each valve box shall be furnished with a drop-in cover marked "SEWER". See ECUA Standard Detail D-43.

2.5.13 *Location Aids* – All new force main and service line installations shall include an approved method for locating lines from the ground surface after completion.

2.5.13.1 *Tracer Wire* – Tracer wire for force mains shall be minimum 12 gauge copper with green PVC insulation for open trench installation. For trenchless installation, 8-

guage copper shall be used. Tracer wire systems shall be electrically continuous covering all mains within the project. Wire-to-wire connectors shall be made with silicone-filled wire nuts. Wire-to-appurtenance attachments shall be made with lug-type terminals.

Approved Manufacturers	
Manufacturer	**Model**
Ideal Industries	Twister® DB Plus
King Technology, Inc.	Failsafe™
Others as approved by ECUA in writing.	

2.5.13.2 *Above Grade Location Markers* – The location of all valves and bends shall be indicated by a Rhino "FiberCurve" fiberglass marker post (CRM3/072/07), or approved equal, composite plastic, green color, and UV resistant. The utility marker post shall be placed with ECUA's standard label - indicating the location of the buried sewer / force main. Placement and location of the markers shall be coordinated with the Owner's Representative.

PART 3: Execution

3.1 *General* – The Contractor shall provide all labor, equipment and materials as required to install all pipes, valves, fittings, and other appurtenances as indicated on the construction plans or as specified in the Contract Documents.

3.2 *Potable Water Line Separation from Sewage Force Mains* – New or relocated sanitary sewer force mains must be laid to provide a horizontal separation of at least six feet, and preferably ten feet, between the outside of the sewer force main and the outside of the potable water pipe. Where it is not technically or economically feasible to comply, closer spacing may be allowed providing the following provisions are met:

3.2.1 If mains are 6 to 10 feet apart for any distance, use a higher rated pressure pipe for the force main.

3.2.2 If mains are 3 to 6 feet apart, use a higher rated pressure pipe for both water and force main.

3.3 *Pipe Installation* – The Contractor shall utilize equipment and methods in accordance with the standards and specifications in this project manual and sound construction practices to insure pipe installation to line and grade as indicated.

3.3.1 *Trench Excavation* – Refer to Section 2221-"Trench Excavation, Backfill and Compaction." Maintain minimum of 30 inches and maximum of 36 inches of cover below finished grade unless shown otherwise on the construction plans.

3.3.2 *Alignment* – Pipe shall be installed along the alignment indicated by the construction plans. Accomplish horizontal and vertical changes in alignment of pipe with bends or other appropriate fittings. Limit joint deflection to 50 percent of the pipe Manufacturer's allowable amount.

3.3.3 *Pipe Preparation* – Offloading, handling and installation of ductile iron pipe shall be in accordance with AWWA standards and applicable sections of this document. The Contractor shall clean the interior of all pipes, fittings, and joints prior to installation. Pipes shall be inspected for defects prior to installation. Damaged pipe shall be rejected and removed from the project.

3.3.4 *Pipe Installation* – Install pipe only when weather and trench conditions are suitable. Do not lay pipe in water. Join pipe in accordance with Manufacturer's recommendations.

Provide backfill, compaction and anchoring as per the standards referenced in this project manual to prevent displacement and preserve alignment after establishing final position.

Encase force main in steel casing or use ductile iron pipe when crossing under pipe, conduit, or structure when a 6-inch separation distance cannot be maintained. This protection shall extend a minimum of 5 feet beyond crossed structure.

3.3.5 *Crossings* – Where the crossing of a roadway, water body, rail, or other obstacle requires trenchless installation, the materials and installation methods shall conform to Section 2310-"Jack and Bore" or Section 2300-"Horizontal Directional Drilling", as applicable.

Jack and bore shall be the standard requirement for road crossings. If jack and bore is not possible, as determined by ECUA, a horizontal directional method will be allowed. If directional bore methods are used, the Contractor must install a sleeve or casing in addition to the primary carrier pipe.

3.3.6 *Protection* – Prevent the introduction of foreign matter into the pipefitting's and valves at all times. Close open ends of pipe with watertight fitting closures or plugs immediately after the installation of each piece or section and at the conclusion of each workday. Do not let water enter trench, and include provisions to prevent pipe flotation with suitable water control measures until completion of pipe installation and backfilling. Remove water, sand, mud and other undesirable materials from trench before removal of pipe closure piece.

3.3.7 *Cutting* – PVC pipe shall be cut in a neat workmanlike manner, and the spigot end shall be beveled per Manufacturer's recommendation. Ductile iron pipe shall be cut in accordance with Manufacturer's recommendation. Do not allow excessive heat to develop. Smooth and bevel cut end by power grinding. Ductile iron pipe lining and field cut repairs shall be in accordance with the lining Manufacturer and Paragraph 2.4.2 of this Section. Use of pipe with damaged lining is unacceptable.

3.3.8 *Closure Pieces* – Closure pieces shall only be used where called for on plans, or with written permission from ECUA. Closure may be accomplished with sleeve coupling as long as its length is such that gaskets are not less than 3 inches from pipe ends.

3.3.9 *Restrained Joints* – Restrained joints must be provided at all horizontal or vertical turns utilizing fittings, and at tees, 90 degree bends, dead-ends, and in-line valves. Restrained pipe joints shall be provided upstream and downstream of fittings and valves as indicated on the plans.

3.3.10 *Joint Restraints and Thrust Blocking* – Mechanical joint restraints shall be furnished and installed for all force main fittings and appurtenances (reference ECUA Standard Detail D-

62). Restraints and thrust blocks are required for all mechanical joint fittings, valves and appurtenances (reference ECUA Standard Details D-52 and D-62).

3.4 *Appurtenance Installation* –

3.4.1 *Valves* – Valves shall be installed with operating stems vertical for valves 24 inch and smaller. For valves larger than 24 inches, the valve may be installed horizontally. Horizontal valves shall be provided with a right-angle gear drive and flush port piping to the lower clean-out fitting (reference ECUA Standard Detail D-43). Extensions shall be provided if the valve operating nut is greater than 24 inches below finish grade. Valves shall be installed on a suitable bearing surface as shown on the project plan details, to prevent vertical displacement.

3.4.1.1 Air release valves shall be located and installed at the down-stream end of all high points as shown in ECUA Standard Detail D-30 as indicated on the approved construction plans.

3.4.1.2 Check valves, complete with vaults, shall be installed at locations shown in the approved construction plans in accordance with the Manufacturer's instructions.

3.4.2 *Valve Boxes* – Valve boxes shall be centered and plumbed on the valve-operating nut. The earth shall be compacted around each valve box to a distance of 4 feet on all sides of box, or to undisturbed trench face if less than 4 feet. An 18-inch diameter by 4-inch thick concrete collar shall be constructed and sloped to direct water away from the valve box.

3.4.3 *Tracer Wire* – Green colored tracer wire shall be installed on all new force mains. The tracer wire shall be placed directly above the pipe and electrically continuous throughout the project. The tracer wire shall be brought to the ground surface at each valve location in accordance with the project plan details and/or ECUA Standard Detail D-43. Splices and/or connections to the tracer wire shall be installed with silicone-filled wire nuts designed for direct burial.

3.5 *Taps on Pressurized Lines* – The Contractor shall perform taps on pressurized lines in accordance with these requirements. An ECUA representative shall be on-site during testing and cutting.

3.5.1 *Materials* – All materials used for taps on pressurized lines shall meet the requirements of these specifications. Tapping sleeves (Paragraph 2.5.7) shall be properly sized for the pipe being tapped. Resilient seated tapping valves (Paragraph 2.5.8.2) shall be furnished with special end connections. All other material used to accomplish the tap shall meet the relevant AWWA Standards.

3.5.2 *Procedure* – The Contractor shall:

3.5.2.1 Expose the existing pipe at the location shown on the plans, and clean the section of the pipe to receive the tapping sleeve.

3.5.2.2 Check the tapping sleeve and valve for defects and make sure the gate fully retracts in the valve to allow the shell cutter free passage.

3.5.2.3 Assemble the tapping sleeve on the pipe before installing the valve.

3.5.2.4 Pressure test the tapping sleeve and valve after it has been assembled on the force main using the test plug on the sleeve. The test pressure shall be 150 psi.

3.5.2.5 Pour a thrust block behind the tapping sleeve sufficient to withstand the pressure of the new line. Also, provide a suitable bearing surface sufficient to support the weight of the sleeve, valve, and tapping machine. Refer to Section 3.3 and ECUA Standard Detail D-52.

3.5.2.6 Assemble an approved tapping machine and proceed to make the necessary cut in accordance with the recommendation of the tapping machine Manufacturer. Approved tapping machines shall be:

3.5.2.6.1 In good working condition.

3.5.2.6.2 Designed for and having a cutting bit for the pipe material to be cut.

3.5.2.6.3 Equipped with a depth of cut gauge.

3.5.2.6.4 Designed to capture the coupon.

PART 4: Acceptance Requirements

4.1 *Inspection* – Upon completion of the installation, the system shall be inspected to ascertain that pipe, valves, fittings, air/vacuum valves, etc. are located in conformance with the plans, and confirm that all 'as-built' lengths and triangulation measurements have been taken. The Owner's Inspector shall observe all appropriate activities related to properly placing the line in service including flushing, pressure and leakage testing. Final connections shall be accomplished after final clearance of lines. Tracer wire shall be tested for continuity.

4.2 *New Force Main Cleaning* – All newly installed force mains shall be flushed to remove any sediment, solids and/or foreign matter prior to testing. ECUA may provide the water for this task under certain circumstances. A written request must be submitted in advance for consideration. Flushing shall be conducted at a sufficient velocity to clear the pipe. Discharge of flushing water must be through a 2-inch diameter pipe or larger and must be controlled so as not to cause any property damage. If flushing is unsuccessful in satisfactorily removing debris from the force main, then cleaning shall be performed by swabbing (pigging).

4.2.1 Larger Pipe – Pipe 12 inches or larger in diameter shall be flushed and swabbed a minimum of 3 passes until line is clear. To facilitate this process, pigging launch stations and receiving pits shall be installed and incorporated into system.

4.3 *Pressure/Leakage Test* –

4.3.1 *General* – All newly installed force mains and appurtenances shall be pressure/leak tested to assure the strength of materials and quality of workmanship of the installation. Testing shall be conducted generally in accordance with the requirements of AWWA Manual 23 for PVC and other flexible pipe or AWWA C600 for Ductile Iron Pipe. Leakage testing may be conducted concurrently with the pressure test.

4.3.2 *Procedure* – Tests are to be conducted in segments not to exceed 3,000 feet of pipe or between in-line isolation valves, whichever is less. Owner shall supply water for the first

test at no cost to the Contractor. An Owner's Inspector shall be present during all tests. Water in the new line shall be pumped up to a pressure of 150 psi. This pressure shall be maintained for a minimum of two (2) hours after the test pressure has been reached and stabilized due to water and pipe temperature equalization and release of all trapped air and then pumping a quantifiable amount of water into the line and recording the amount of water added during the test period. This represents the leakage.

Pressure/leakage tests shall be deemed acceptable when leakage does not exceed that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133200} \ (or\ 11.65\ \ gpd/mi/inch/dia)$$

Or $L = \frac{ND\sqrt{P}}{7400}\ for\ 18'long\ pipe\ sections$

Or $L = \frac{ND\sqrt{P}}{6600}\ for\ 20'long\ pipe\ section$

Where:
L = Maximum leakage, in gallons per hour.
S = Length of pipe under test, in feet.
N = Number of pipe joints in segment under test.
D = Nominal internal diameter of pipe, in inches.
P = Average actual leakage test pressure, psig.

Special notes and/or requirements: (1) record all data for submission with as-built plans, (2) refit and replace all pipes not meeting the leakage requirements, (3) repair clamps are not permitted, and (4) repair all visible leaks regardless of the amount of leakage.

PART 5: Measurement and Payment

5.1 *General* – Measurements shall be made to the nearest tenth of units and rounded to the nearest whole unit when totaled. Payments shall be for providing all labor, tools, equipment and materials as needed for: 1) furnishing, handling, and installing the required materials, fittings or fixtures; 2) excavation, backfill and compaction, including shoring, bracing and dewatering as required; 3) temporary removal and replacement of existing obstacles, including minor relocation and repair of other utilities; and 4) all required testing, and flushing. Payment for force main installations shall include the installation of tracer wire.

5.2 *Force Mains* – Force mains shall be measured in lineal feet by the specified pipe size along the pipe centerline with no deduction for fittings. Payment shall be based on the Contract unit price per lineal foot.

5.3 *Appurtenances* – Incidental appurtenances such as couplings, tracer wire, thrust blocks, etc. are not considered separate pay items and their cost should be included in the unit price of the installed pipe.

5.3.1 *Fittings* – Force main fittings including bends, reducers, tees, wyes, tapping sleeves, expansion joints, mechanical joint restraint, pipe hangers/supports, and cut in sleeves shall be measured and paid for on a unit (per each) basis. Fittings shall be listed by size and type.

5.3.2 *Valves* – Force main valves inclusive of any required valve boxes or other appropriate appurtenances shall be measured and paid for on a unit (per each) basis. Valves shall be listed by size and type.

5.4 *Taps on Pressurized Lines* – Taps on pressurized lines shall be measured and paid for on a unit price (per each) basis to include tapping sleeve, tapping valve, and valve box complete, in-place. Taps shall be listed by main and branch diameters.

5.5 *Polyethylene Wrapping* – Polyethylene wrapping shall be measured along the centerline of the pipe. Payment will be based on the Contract unit price per lineal foot.

5.6 *Dewatering* –

5.6.1 *Well Point Method* – Well Point method shall be used when specified and bid item included. Measurement shall be in linear feet of pipe trench dewatered and payment by unit price per foot.

5.6.2 *Screen and Packed Well Point* – Screened and Packed Well Point method shall only be used when specifically indicated and bid item included. Measurement shall be in linear feet of pipe trench and vertical feet of screened and packed points and payment by unit price per foot.

5.6.3 *Other Methods* – Deep Well, Eductor Well Point, Bleeder Well or Vacuum methods will only be considered when specified.

5.6.4 *Trench Bottom Sump Pumps* – Trench bottom sump pumps will not qualify for payment as dewatering.