

DIVISION 33 – UTILITIES
SECTION 33 11 00 – RECLAIMED WATER UTILITY DISTRIBUTION PIPING

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Reclaimed Water Piping and Fittings
 - 2. Reclaimed Waterline Detection and Marking
- B. Related Work:
 - 1. Section 33 08 10 – Testing of Reclaimed Water Utility Distribution
 - 2. Section 33 13 00 – Disinfection of Reclaimed Water Utility Distribution

1.02 REFERENCES

- A. American Society for Testing and Materials:
 - 1. ASTM A36, Standard Specification for Structural Steel.
 - 2. ASTM A48, Standard Specification for Gray Iron Casting.
 - 3. ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 4. ASTM A536, Standard Specification for Ductile Iron Castings.
 - 5. ASTM A307, Carbon Steel Externally and Internally Threaded Fasteners. ASTM D2657, Standard Practice for Heat Joining of Polyolefin Pipe and Fittings.
 - 6. ASTM D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
 - 7. ASTM D3035, Standard Specification for Polyethylene plastic Pipe Based on Controlled Outside Diameter.
 - 8. ASTM D3261, Butt Fusion Polyethylene Plastic Fittings for Polyethylene Plastic Pipe and Tubing.
 - 9. ASTM D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Material.
 - 10. ASTM F714, Standard Specification of Polyethylene Plastic Pipe Based on Outside Diameter
 - 11. ASTM F1055, Standard Specification for Electrofusion Type Polyethylene Fittings

for Outside Diameter Controlled Polyethylene Pipe and Tubing.

- B. American Nation Standard Institute:
 - 1. ANSI A21.4, Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. ANSI A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in., for Water and Other Liquids.
 - 3. ANSI A21.11, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
 - 4. ANSI A21.50, Thickness Design of Ductile Iron Pipe
 - 5. ANSI A21.51, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

- C. American Water Works Association:
 - 1. AWWA C104, Cement Mortar Lining for Ductile-Iron.
 - 2. AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems
 - 3. AWWA C110, Ductile-Iron and Gray-Iron Fittings, 3 in., Through 48 in., for Water and Other Liquids.
 - 4. AWWA C111, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
 - 5. AWWA C150, Thickness Design of Ductile Iron Pipe
 - 6. AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - 7. AWWA C153, Ductile Iron Compact Fittings for Water Service.
 - 8. AWWA C502, Dry-Barrel Fire Hydrants
 - 9. AWWA C509, Resilient-Seated Gate Valves for Water and Sewerage Systems.
 - 10. AWWA C600, Installation of Ductile Iron Water Mains and their Appurtenances
 - 11. AWWA C605, Underground Installation of PVC Pressure Pipe and Fittings for Water
 - 12. AWWA C800, Underground Service Line Valves and Fittings
 - 13. AWWA C900, PVC Pipe and Fabricated Fittings, 4 inch through 12 inch, for Water Transmission and Distribution
 - 14. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, ½ inch through 3 inch, for Water Service
 - 15. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch for Water Distribution and Transmission

- D. American Welding Society:

- 1. AWS D1.1, Structural Welding Code.
- E. National Electrical Manufacturers Association:
 - 1. NEMA Standard Specifications.
- F. NSF International:
 - 1. NSF-61 Listings.
- G. Plastic Pipe Institute
 - 1. PPI TR-3, Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
 - 2. PPI TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings.

1.03 SYSTEM DESCRIPTION

- A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation.
- B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section for a complete installation.
- C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.
- D. The work shall include, but not be limited to, the following:
 - 1. Connections to existing pipelines.
 - 2. Test excavations necessary to locate or verify existing pipe and appurtenances.
 - 3. Installation of all new pipe and materials required for a complete installation.
 - 4. Cleaning, testing and disinfecting as required.

1.04 SUBMITTALS

- A. Submit in accordance with the requirements of 01 33 00.
- B. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cu sheets or other data as required to provide a complete description of piping, fittings and other appurtenances specified.
- C. Certificates:
 - 1. The Contractor shall furnish to the Authority, a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.
- D. Where mechanical joint restraints are to be used, submit restraint lengths with supporting calculations.
- E. Operation and Maintenance Data: Furnish operation and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Design Criteria:
 - 1. Use only one type and class of pipe in any continuous line of waterline between structures, unless otherwise directed in writing by the Authority.
 - 2. Use pipe and fittings designed to withstand imposed trench loadings and conditions at the various locations.
- B. Source Quality Control:
 - 1. Shop Testing: Each pipe manufacturer must have facilities to perform listed tests. The Authority reserves the right to require the manufacturer to perform additional tests as may be deemed necessary to establish the quality of the material offered for use.
 - 2. Shop Tests:
 - a. Perform hydrostatic and leakage shop tests on all pipe and fittings in accordance with applicable AWWA Standards.
 - b. Perform hydrostatic and leakage shop tests on all gate, butterfly, angle and globe body valves, and check valves in accordance with appropriate AWWA Standards.
 - c. Additional Testing:

Material	Test Method	Number of Tests
1. Ductile Iron Pipe	ANSI A 21.51	As specified in ANSI A 21.51
2. Polyvinyl Chloride Pipe	ASTM D1784	As specified in ASTM D1784
3. Polyethylene Pipe	ASTM D2837	As specified in ASTM D2837

3. Laboratory Tests: The Engineer reserves the right to require that laboratory tests also be conducted on materials that are shop tested. Furnish without compensation, labor, materials, and equipment necessary for collecting, packaging, and identifying representative samples of materials to be tested and the shipping of such samples to the Testing Laboratory. These laboratory tests will be paid for by the Contractor.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle piping and related products in accordance with specifications, manufacturer's recommendations, and as supplemented herein.
- B. Pipe and related materials to be loaded and unloaded by lifting with hoists or skidding to avoid shock or damage. Under no circumstances drop or skid material against other products.
- C. Handle pipe and related materials at all times with care to avoid damage. Keep interior free from dirt and foreign matter. Lower or raise all pipe, and appurtenances carefully into place, with suitable equipment in a manner that will prevent damage. Do not drop or dump pipe or accessories. Do not use equipment to skid pipe across the ground.
- D. Thoroughly inspect pipe, pipe linings, fittings, and all related materials for defects prior to being unloaded and again prior to being installed. Repair or replace any defective, damaged, or unsound material, as determined by the Authority at no cost to the Authority.
- E. All lumps, blisters, and excess coating shall be removed from ends of each pipe. All joints shall be brushed and wiped clean, dry and free from oil and grease before pipe is installed.

1.07 SITE CONDITIONS

- A. Environmental Requirements:
 - 1. Keep trenches dewatered until initial bedding has been placed, pipe joints have been made, and initial bedding and concrete cradle and encasement, if any, have cured.
 - 2. Under no circumstances lay pipe in water or on bedding containing frost.
 - 3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.
 - 4. The Authority reserves the right to suspend work during inclement weather, if, in

the opinion of the Authority, the safety of its field personnel is endangered or if the quality of the work itself is threatened.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified Section 33 08 10.
- C. All exposed exterior piping shall have flanged joints, unless otherwise specified or shown on the drawings.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe (DIP) shall conform to ANSI A21.51 (AWWA C151). Piping having a diameter of 12 inches and less shall be of Pressure Class 350. Piping having a diameter greater than 12 inches and less than 18 inches shall be of a determined based on project specific design requirements. Ductile iron pipe shall be of minimum Grade 60-42-10 for centrifugally cast in metal molds or sand-lined molds.
- B. All ductile iron pipes shall conform to ANSI A21.50 (AWWA C150) for thickness design and shall be supplied in 18 or 20 foot nominal lengths or as required by the Authority.
- C. Fittings and specials shall be ductile iron, conforming to the requirements of AWWA C153 and shall have a minimum rated working pressure of 350 psi. Fittings and specials shall be supplied with either restrained or mechanical joints as applicable.
- D. All pipe and fittings shall be cement mortar lined. Lining shall conform to ANSI A21.4/AWWA C104 and shall be double thickness. The mortar lining shall be protected with an asphaltic coating. All buried DIP and fittings shall have a bituminous coating on the exterior surfaces in accordance with ANSI A21.51/AWWA C151. All exposed DIP and fittings shall have a factory applied prime coat.
- E. Polyethylene encasement shall be installed for all pipe, fittings, and service lines to be encased in concrete. Polyethylene encasement shall be in accordance with AWWA C105.
- F. Pipe and fittings shall be the class that equals or exceeds the pipe class as specified herein. Requirements for various types of joints are described in the following paragraphs.
- G. Pipe joints and fittings shall be restrained where indicated on the Contract Drawings. Restrained joints shall be in accordance with these specifications
- H. Push-on Joints
 - 1. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11

/AWWA C111. Fittings and specials shall be supplied with mechanical joints.

2. Mechanical joints and fittings shall conform to the requirements of ANSI A21.11, /AWWA C111 and have a minimum pressure rating of 350 psi. Joints shall incorporate a tapered rubber gasket forced into a tapered groove with a ductile iron follower ring. Bolts for mechanical joints shall be high strength corrosion resistant low-alloy steel tee-head bolts with hexagonal nuts. If required by installation conditions, pipe and fittings shall have cast-on lugs for adequately tying the pipe and fittings together. These shall be in conformance with standard practice and as outlined under the appropriate AWWA Specifications.

I. Restrained Joints

1. Mechanical joint restraint shall be used at all bends, tees, and changes in direction.
2. Mechanical Restrained Joints: Mechanical joint restraint consisting of a follower gland which when actuated imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. ASTM A 536-80 ductile iron follower gland of dimensions such that it can be used with AWWA C153 mechanical joints. Restraining devices shall be ductile iron, heat treated to a minimum hardness of 370 BHN. Twist-off nuts shall be used to insure proper actuating of the restraint device. Restraint device shall have a 250 psi minimum working pressure with 2:1 minimum safety factor. Coating for restraint devices shall consist of the following:
 - a. All wedge assemblies and related parts shall be processed through a phosphate wash, rinse and drying operation prior to coating application. The coating shall consist of a minimum of two coats of liquid fluoropolymer coating with heat cure to follow each coat.
 - b. All casting bodies shall be surface pretreated with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance.
3. Push-on Restrained Joints: Restrained joint pipe and fittings shall consist of one of the following restraint systems:
 - a. Bolted retainer rings and welded retainer bars or boltless, push-on type which include ductile iron locking segments and rubber retainers. Bolts for restrained joints (if applicable) shall conform to ANSI B18.2. For thrust restraint of field cut piping, the manufacturer's standard assembly shall be used (if applicable).
 - b. Restraint system integral to the gasket, with a minimum pressure rating of 350 psi. Gasket shall contain stainless steel or ductile iron locking segments that are embedded in the gasket. Gasket restraint system shall conform to the requirements of ANSI A21.11 (AWWA C111).
4. Restrain Harness (DI): Ductile iron pipe bell restraint shall consist of a wedge action restraint ring on the spigot joined to a split ductile iron ring behind the bell:
 - a. The restraint ring shall have individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The restraint ring and its wedging components shall be made of minimum grade 65-45-12 ductile iron conforming to ASTM A536. The wedges shall

be heat treated to a minimum hardness of 370 BHN. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges. The split ring shall be made of a minimum grade of 65-45-12 ductile iron conforming to ASTM A536. The restraint devices shall be coated with a thermoset epoxy. The connecting tie rods that join the two rings shall be made of low alloy steel that conforms to ANSI/AWWA C111/A21.11. The assembly shall have a rated pressure with a minimum two to one safety factor of 350 psi for sizes 4"-16" and 250 psi for sizes 18" and larger. The product shall be manufactured by EBAA Iron, Inc., or approved equal.

2.03 PVC PIPE AND FITTINGS

- A. Polyvinyl Chloride (PVC) Pipe shall conform to ANSI/AWWA C900. Size and pressure class shall be selected based on design conditions.
- B. All fittings and specials shall be ductile iron, conforming to the requirements specified.
- C. Push-on Joints - Use rubber-gasket joints for pipe and fittings installed underground meeting ASTM F477.
- D. Restrained Joints
 - 1. Mechanical joint restraint shall be used at all bends, tees, and changes in direction.
 - 2. Mechanical Restrained Joints: Mechanical joint restraint consisting of follower gland which when actuated imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Restraint shall be designed specifically for use with C900 PVC pipe. ASTM A 536-80 ductile iron follower gland of dimensions such that it can be used with AWWA C153 mechanical joints. Restraining devices shall be of ductile iron, heat treated to a minimum hardness of 370 BHN. Twist-off nuts shall be used to insure proper actuating of the restraint device. Restraint device shall have a 250 psi minimum working pressure with 2:1 minimum safety factor. Mechanical joint shall be specifically made for the given pipe material.
 - 3. Restraint Harness (PVC): Restraint for PVC pipe bell (AWWA C900) shall consist of the following: The restraint shall be manufactured of ductile iron conforming to ASTM A536. The restraint devices shall be coated with a thermoset epoxy coating. A split serrated ring shall be used behind the pipe bell. A split serrated ring shall also be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring. The combination shall have a minimum working pressure rated to the full pressure of the pipe. The restraint shall be manufactured by EBAA Iron, Inc., or approved equal.

2.04 HDPE (HIGH DENSITY POLYETHYLENE) PIPE AND FITTINGS (3" Diameter and larger)

- A. All HDPE pipe shall conform to all applicable provisions and requirements of the latest revision of AWWA C906 and be NSF Standard 61 certified. All HDPE pipe shall be Ductile Iron Pipe Size (DIPS). Pipe size and DR rating shall be selected based on design conditions.

- B. Polyethylene compounds utilized in the manufacturing of the pipe shall have a grade of PE 34 with a minimum cell classification of PE 345444C for PE 3408 materials in accordance with ASTM D3350.
- C. Polyethylene fittings shall be manufactured using the compounds previously specified and be pressure rated to match the system piping to which they are joined. Fittings shall be manufactured by the same manufacturer of the pipe.
- D. The minimum working pressure rating of the pipe and fittings shall be in excess of 1.5 times the projected typical operating pressure. Coordinate with the Authority to determine typical operating conditions for the existing system.
- E. HDPE pipe and fittings shall be joined by use of the following methods:
 - 1. HDPE pipe shall be joined through the use of butt fusion. Fusion of pipe shall be conducted in strict accordance with the manufacturer's instructions and recommendations and ASTM D2657. The Contractor shall provide qualified personnel trained in the manufacturer's fusion procedures and shall provide proof of such qualification to the Engineer.
 - 2. HDPE Fittings and specials shall be joined using the electrofusion process. Electrofusion shall be in strict accordance with the manufacturer's instructions and recommendations.
 - 3. No pipe or fitting shall be joined by fusion or electrofusion unless the Contractor has proven that the personnel making the joints have been adequately trained and are qualified in the techniques involved.
 - 4. A copy of each manufacturer's joining system and techniques shall be provided to the Authority for review prior to any pipe or fitting being joined.
- F. All pipe and fittings shall have product traceability. Pipe and fittings shall be heat indent printed with the manufacturer's name, the nominal pipe size, the dimension ration, the pipe grade, manufacturing standard reference, and the manufacturer' s production code, from which the date and place of manufacture can be determined.
- G. HDPE piping shall be provided with color stripe coding in accordance with the striping codes developed by the Utility Location & Coordination Council of the American Public works Association.
 - 1. Color stripe coding shall consist of a minimum 6 stripe pattern.
 - 2. Stripe color shall be Purple.
- H. Quality Control / Workmanship.
 - 1. HDPE pipe and fittings shall comply with AWWA C906, latest edition. All pipe and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, blisters, dents, or other defects. The piping and fittings shall be uniform in color, opacity, density, and other physical properties as commercially practical.

2.05 POLYETHYLENE TUBING AND FITTINGS (<3-INCH DIAMETER)

- A. Polyethylene tubing shall be designed for transporting potable water and shall have three evenly spaced blue strips along the length of the tubing. The tubing shall conform to ANSI/AWWA C-901, be manufactured of PE 3408 material, have a dimension designation of DR-9, and shall be rated for a minimum working pressure of 200 psi.
- B. Insert type fittings shall conform to ANSI/AWWA C800 and be constructed of stainless steel.

2.06 COPPER PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K, water tube, annealed temper.
- B. All copper tubing shall conform to AWWA C800 for thickness design.
- C. Copper Pressure Fittings: Fittings shall be compression or flared connections and shall conform to ASME B16.22.
- D. Bronze Flanges: ASME B16.24, Class 150, with compression end. Furnish Class 300 flanges if required to match piping.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and compression or threaded ends.

2.07 COUPLINGS

- A. Restraint Couplings
 - 1. Joint Restraint shall be incorporated into the design of the sleeve or coupling used to connect two plain pipe ends. The restraint mechanism shall consist of a plurality of individually actuated gripping surfaces to maximize restraint capability. Torque limiting twist off nuts shall be used to insure proper actuating of the restraint devices. The restraint devices shall be coated with a thermoset epoxy. Ductile Iron components shall be of a minimum of 65-45-12 ductile iron meeting the requirements of ASTM A536 of the latest revision and shall be tested in accordance with the stated standard. The restrained joining system shall meet the applicable requirements of AWWA C219, ANSI/AWWA C111/A21.11, and ASTM D2000. The restrained joining system shall be manufactured by EBAA Iron, or approved equal.
- B. Flanged Coupling Adapters
 - 1. Restrained flange adapters shall be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
 - 2. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.

3. Pressure and service shall be the same as connected piping.
4. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
5. Flanged adapters shall be provided with manufacturer's standard finished coat.
6. Bolts and nuts shall be stainless steel.
7. For ductile iron pipe, the flange adapter shall have a safety factor of 2:1

2.08 RECLAIMED WATERLINE DETECTION AND MARKING

A. Underground Warning Tape

1. Underground Warning Tape shall be installed 18-24 inches below final grade and directly above all buried piping. Tape shall be capable of being detected with inductive methods.
2. Detectable warning tap shall consist of a nominal 4.5 mil (0.0045") overall thickness, with a solid aluminum foil core. The imprinted warning message shall be encased to prevent ink rub-off and shall be impervious to acids, alkalis and other destructive soil elements.
3. Minimum width of 3"
4. Color shall be Purple
5. Tape shall be clearly and permanently labeled "CAUTION: BURIED RECLAIMED WATERLINE BELOW".

B. Reclaimed Waterline Marker

1. Reclaimed Waterline markers shall be provided at 500 ft intervals and at all points of access to the reclaimed waterline (valves, flush mounted tracer wire posts, etc.).
2. Markers shall be highly visible 100% recyclable triangular fiberglass composite posts with 360 degree visibility. Posts shall be capable of withstanding repeated vehicle impacts up to 55 mph and snap back to the original position. Markers shall be UV stable and fade resistant.
3. Marker shall be 66 inches in total length and extend a minimum of 48 inches above finished grade after installation.
4. Markers shall be purple, and be clearly and permanently labeled "WARNING RECLAIMED WATER PIPELINE"
5. Marker shall be installed directly above all buried piping. Install markers in accordance with the manufacturers' instructions.

C. Test/Tracer Wire and Stations

1. Test/Tracer Wire and Stations shall be installed on all forcemains.
 2. AWG No. 12 stranded copper wire with high molecular weight polyethylene (HMW/PE) insulation specifically designed for direct burial in corrosive soil or water. Polyethylene insulation shall conform to ASTM D 1248, Type 1, Class C.
 3. Terminate test/tracer wire in a flush mounted or above ground (pedestal) test station at 500 ft intervals. The Authority will identify the required station based on waterline location. Where the flush mount station is required, install a Marker Post at each station. Station shall come standard with integral internal tracer wire access points. Tube material shall be of high grade ABS, or equivalent rigid plastic that meets or exceeds ASTM D-1788, Type 1 requirements. Lid material shall be of cast iron or ductile iron. Tensile strength or ductility of such material shall be equal or superior to hi-tensile cast iron ASTM A-126-B requirements. Lid-locking bolt material shall be made of aluminum material equal or superior to ASTM B-253. Lid-locking mechanism material shall be made of plastic to meet or exceed ASTM A-126-B requirements.
 4. Test Stations shall be marked for reclaimed water and contain a purple insignia or be entirely purple.
- D. Utility Marking Sign
1. Provide a utility marking sign in accordance with applicable detail at all locations where the public could potentially come into contact with reclaimed water (i.e. all points where water can exit the pipeline, fire hydrants, yard hydrants, storage tanks, pump stations, discharge locations, point of use locations etc.).
 2. Utility Marking Sign shall be UV, chemical, abrasion and moisture resistant. It shall be constructed of rugged, enamel-coated aluminum and suitable for outdoor use at service temperatures from – 40 F to 180 F.
 3. Sign post shall be as detailed.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Carefully examine each section of pipe and each pipe fitting before laying on conformance with the inspection requirements of the appropriate referenced standard. No piece shall be installed which is known to be cracked, damaged, or otherwise defective.
- B. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense.

3.02 PREPARATION

- A. Clean piping interior and mating surfaces of bell, spigot and gasket before laying. Maintain clean until completed work is accepted.

- B. Perform trenching for water mains and place pipe bedding as specified in Division 33.
- C. Dig bell holes sufficiently large to permit proper joint making and to insure pipe is firmly bedded full length of its barrel.

3.03 LAYING PIPE

- A. General Requirements:
 - 1. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used.
 - 2. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade. Lay bell and spigot pipe with bell end up grade unless shown otherwise on the drawings or directed by the Engineer.
 - 3. Exercise care to insure that each length abuts against the next in such manner that no shoulder or unevenness of any kind occurs along inside bottom half of pipe line.
 - 4. Center spigot end in bell or socket end of previously laid pipe, shove tight and secure.
 - 5. No wedging or blocking permitted in laying pipe unless by written order of Engineer.
 - 6. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until the preceding length is embedded and securely in place.
 - 7. Walking or working on completed pipe line, except as necessary in tamping and backfilling, not permitted until trench is backfilled one-foot deep over top of pipes.
 - 8. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying.
 - 9. Take up and replace with new, such in-place pipe sections found to be defective. Replace at Contractor's expense.
 - 10. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.
 - 11. Take necessary precautions to prevent newly laid pipe from floating as a result of water accumulation in the trench; or the collapse of the pipe line from any cause. Restore or replace pipe as necessary at Contractor's expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.
 - 12. Bed pipe using materials specified in Division 33.

13. Cut pipe using only equipment specifically designed for that purpose such as an abrasive wheel, rotary wheel cutter, a guillotine pipe saw or a milling wheel saw. The use of chisels or hand saws will not be permitted. Grind smooth cut ends and rough edges. Bevel slightly, cut end for push-on connections.
 14. Where cutting of pipe is necessary, minimum laying length shall be five (5) feet.
- B. Joints:
1. Make pipe and fitting joints according to pipe manufacturer's specifications and to specifications previously specified for pipe.
 2. Make joints watertight. Immediately repair detected leaks and defects. Methods of repair subject to Authority's approval.
- C. Alignment and Grade:
1. Lay and maintain all pipe at the required lines and grades as shown on the Drawings. Place fittings and valves at the required locations with joints centered, spigots forced home, and all valve stems plumb. Do not deviate from the required line and grade, except with the approval of the Engineer.
 2. Deflect pipe joints where indicated on the drawings. Deflections shall not exceed pipe manufacturer's recommended maximum allowable deflection.
 3. Do not change grade or alignment without Engineer's approval.
- D. Pipe Anchorage and Support
1. Buried Lines Under Pressure: Contractor to provide restraints at all bends, tees and changes in direction. Contractor to develop and submit for review a Restrained Pipe Length Schedule.

3.04 SERVICE LINE AND FITTINGS

- A. Install water service lines where required. Unless otherwise approved, all water lines shall be installed at a minimum depth of 4 feet of cover over the top of the pipe.
- B. Clean and inspect each pipe and part of the fitting before installing and assemble to provide a flexible joint. Use joints or lubricants recommended by the manufacturers.
- C. Operate each valve before and after installation.
- D. When the work is not in progress and at the end of each work day, securely plug the ends of pipe and fittings to prevent any dirt or foreign substances from entering the lines.
- E. Test and disinfect lines as specified in Division 33.
- F. Provide concrete thrust blocking or restrained joints at all bends, tees and changes in direction.

3.06 FIELD QUALITY CONTROL AND TESTING

A. As specified in Division 33.

3.07 DISINFECTION

A. As specified in Division 33.

END OF SECTION