Special Specification 7203
Water Mains and Service Lines

1. DESCRIPTION

Provide and install a complete water main system in accordance with the plans and specifications and in compliance with the Department's Utility Accommodation Policy (UAP)(Title 43, T.A.C., Sections 21.31-21.55). The water mains must be of the sizes, materials and dimensions shown on the plans and must include all pipe, all joints and connections to new and existing pipes, all valves, fittings, fire hydrants, pipe joint restraint systems, blocking, and incidentals, as required to complete the work.

The abbreviations AWWA, ASA, ASTM, and ANSI, as used in this specification, refer to the following organizations or technical societies:

- AWWA – American Water Works Association
- ASA – American Standards Association
- ASTM – American Society for Testing and Materials
- ANSI – American National Standards Institute
- NSF – National Science Foundation

Where reference is made to specifications of the above organizations, it is to be construed to mean the latest standard in effect on the date of the proposal.

2. MATERIALS

All materials used in this project are to be new and unused unless otherwise specified on the plans, specifications or the proposal.

2.1. Ductile-Iron Pipe and Fittings.

2.1.1. Ductile-Iron Pipe: 3 in. through 64 in.

All ductile-iron pipe is to be manufactured by process of centrifugal casting and is to conform to AWWA Standard C-151, “American Standard for Ductile-Iron Pipe Centrifugally Cast with push-on or mechanical joints for Water or Other Liquids,” unless otherwise modified or supplemented herein.

Pipe is to conform to the following pressure classes, based on Type 3 bedding conditions, a depth of bury of 6 ft. and a working pressure of 150 psi:

Table 1
Pipe Pressure Classes

3”-12”	350 psi
16”- 20”	250 psi
24”	200 psi
30”- 64”	150 psi

Dimensions and tolerances for each nominal pipe size must be in accordance with table 51.5 (push-on) or table 51.5 (mechanical joint) of AWWA Standard C-151 for pipe with a nominal laying length of 20 ft.

All pipe is to have a standard water works cement mortar lining in accordance with AWWA Standard C-104 with outside coating per Section 51.8.1 of AWWA Standard C-151.

Exterior coating is to consist of a nominal one mil thick asphaltic material applied to the outside of the pipe as described in Section 51.8 of AWWA Standard C-151.

Rubber joint gaskets used on ductile-iron pipe are to conform with AWWA Standard C-111, latest revision.

Each length of pipe must bear identification markings in conformance with Section 51.10 of AWWA Standard C-151.

Manufacturer is to take adequate measure during pipe production to assure compliance with AWWA Standard C-151 by performing quality-control tests and maintain results of those test as outlined in Section 51.14 of that standard.

The Engineer may at no cost to the Contractor, subject random lengths of pipe for testing by an independent laboratory for compliance with this specification. Any visible defects or failure to meet quality standards here in will be grounds for rejecting the pipe.

2.1.2. Fittings for Ductile-Iron Pipe.

Unless otherwise modified or supplemented herein, the latest revision of AWWA Standard C-110 for Ductile-Iron Fittings, 3 in. through 48 in. for Water and Other Liquids" and AWWA Standard C-153 for Ductile-Iron Compact Fittings, is to govern the design, manufacture, and testing of all fittings under this specification.

For 3 through 24 in. size range, the pressure rating of all fittings is to be a minimum of 250 psi. The working pressure for all fittings of size greater than 24 in. is to be a minimum of 150 psi, unless a change in pressure rating is shown on plans.

Fittings are to be furnished with the type of end combination specified.

Mechanical joint fittings and anchor type fittings are to be furnished complete, with glands, gaskets, and bolts. Bolts for mechanical joints are to be ASTM A-536 specially alloyed and heat treated ductile iron conforming to ANSI/AWWA Standard CIII/A21.IL.

Flanged fittings are to be faced and drilled in accordance with ASA Specifications B 16.1, Class 125.

Anchor fittings are to be furnished in size and type or length as specified.

The exterior of all fittings is to be provided with a petroleum asphaltic coating in accordance with AWWA Standard C-110. The interior of flanged fittings supplied under this Item is to be either cement-mortar lined in accordance with AWWA Standard C-104 or lined with a petroleum asphaltic material in accordance with the latest revision of AWWA Standard C-110 as specified. The interior of all other fittings supplied under this Item is to be cement-mortar lined in accordance with the latest revision of AWWA Standard C-104.

Fittings for 2 in. size are to be manufacturer's standard design, designed in accordance with applicable design standard of AWWA Standard C-110.

2.2. Concrete Steel Cylinder Pipe and Fittings: 20 in. and larger.

The design, component materials, manufacture and testing of all concrete-steel cylinder pipe and fittings is to conform to AWWA Standard C-301 for "Pre-Stressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids." Except where otherwise indicated in the contract documents, all pipe is to be AWWA Class 150 and is to be designed for an internal working pressure of 150 psi and a minimum external load equivalent to 6 ft. of earth cover. Where the depth of bury of the pipe is indicated to be greater than 6 ft.

in the contract specifications or on the drawings the design of the pipe is to suitable for the earth loads indicated.

All data submitted by the Contractor is to include a tabulated layout schedule with reference to the stationing and grade lines shown on the plans. The Contractor is to provide a design summary for each size of pipe furnished for each pressure and depth of bury.

Each special length of straight pipe is to have plainly marked on the inside of the bell end the class of pipe and identification marks enough to show the proper location of the pipe by reference to layout drawings.

Pipe 20 through 42 in. in size is to be furnished in nominal lengths of 20 to 32 ft.; pipe 48 through 72 in. in size is to be furnished in nominal lengths of 16 ft. except as this requirement is to be modified by design requirements of the particular job.

Each joint of pipe is to be furnished with a rubber gasket and a 12 in. diaper.

2.3. Steel Pipe, Fittings and Flanges.

2.3.1. Steel Pipe.

Steel pipe with nominal diameters from 6 through 20 in. must conform to ASTM A 106, A 53 Grade B or A 139 Grade B standard weight class as the minimum

Steel Pipe greater than 20 in. must conform to AWWA C-200 and AWWA M-11 except as modified herein or as required by the engineer for special circumstances.

Pipe must be designed for a minimum of 150 psi working pressure with an additional 50% of the working pressure allowance for surge pressure unless otherwise specified. Pipe design must be in accordance with AWWA M-11.

Pipe must be designed to cover conditions as shown on the plans. The design for deflection must be in accordance with AWWA M-11.

Pipe for use with sleeve-type couplings must have plain ends at right angles to the axis.

Pipe ends are to be beveled and suitable for field butt welding except as otherwise specified.

Protective coatings and linings are to conform to AWWA Standard C-203, “Coal-Tar Protective Coatings and Linings for Steel Pipelines - Enamel and Tape Hot Applied.”

Pipe length is to be nominal 50 ft. lengths except for specials or as otherwise specified on the plans. Manufacturer is to prepare a lay schedule showing the location of each piece by a mark number with station and invert elevation at each bell end.

2.3.2. Fittings for Steel Pipe.

Unless otherwise shown on the Plans, all specials and fittings must conform to the dimensions of AWWA Standard C-208. Pipe material used in fittings must be of the same material and thickness as the pipe. The minimum radius of elbows must be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow must not exceed 11 1/4 degrees (One cut elbow up to 22 1/2 deg.). If elbow radius is less than 2.5 x pipe diameter, stresses must be checked per AWWA M-11 and wall thickness or yield strength increased if necessary. Fittings must be equal in pressure design strength. Specials and fittings, unless otherwise shown on the Plans, must be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe. All welds made after hydrostatic testing of the straight sections of pipe must be checked per the requirements of AWWA C-200 Section 5.2.2.1.

Joints

2.3.2.1. Rolled-Groove Rubber Gasket Joint: the standard joint must be rolled-groove rubber gasket joint unless otherwise noted on the plans. Rolled-grooved rubber gasket joints must conform to AWWA C-200 Standard and as shown in Chapter 8 of AWWA M-11.

The o-ring rubber gasket must have enough volume to approximately fill the area of the groove and must conform to AWWA C-200.

The joint must be suitable for a safe working pressure equal to the class of pipe furnished and must operate satisfactorily with a deflection angle, the tangent of which is not to exceed 1.00/D where D is the outside diameter of the pipe in in. with a pull-out of 1 in.

Rolled-Groove Rubber Gasket Joints may be furnished only by a manufacturer who has furnished pipe with joints of similar design for comparable working pressure. Pipe diameter, pipe length, and wall thickness that has been in successful service for a period of at least 5 yr.

2.3.2.2. Lap weld: Lap field welded joints must be used where tied joints are indicated on the plans. The standard bell must provide for a 2 1/2 in. lap. The minimum lap must be 1 in. The design maximum joint deflection or offset must be a 1" joint pull.

2.3.2.3. Mechanical Couplings: Mechanical couplings where indicated on the plans must be Smith Blair Style 411, Baker Style 200, Brico Depend-O-Loc or equal. Insulating mechanical couplings where indicated on the plans must be double insulated Smith Blair Style 416, Baker Style 216, or equal. Mechanical couplings must be rated to meet or exceed the working pressures and surge pressure of the pipe.

Couplings for buried service must have all metal parts painted with Epoxy paint and conform to AWWA C-219.

Pipe ends for mechanical couplings must conform to AWWA C-200 and M-11. The shop applied outside coating must be held back as required for field assembly of the mechanical coupling or to the harness lugs or rings.

Harness lugs or rings and pipe ends must be painted with one shop coat of epoxy conforming to AWWA C-210. The inside lining must be continuous to the end of the pipe.

2.3.3. Steel Flanges - Steel pipe flanges, where called for on the plans, are to conform to AWWA Standard C-207, “Steel Pipe Flanges” for Class D for operating pressures to 175 psi on 4 in. through 12 in. diameter, and operating pressures to 150 psi on diameters over 12 in.; or Flanges must be AWWA C-207 Class E for operating pressures up to 275 psi; or Flanges must be AWWA C-207 Class F for pressures to 300 psi. (drilling matches ANSI B 16.5 Class 250).

Shop lining and coating must be continuous to the end of the pipe or back of the flange. Flange faces must be shop coated with a soluble rust preventive compound.

Gaskets: Full face, 1/8 in. thick, cloth-inserted rubber, Garlock 3000, John Crane Co. Style 777 or equal.

Bolts and Nuts for Flanges

2.3.3.1. Bolts for flanges located indoors and in enclosed vaults and structures must be carbon steel, ASTM A-307, Grade B for class B and D flanges and nuts must be ASTM A-563, Grade A heavy hex. Bolts for class E and F flanges must be ASTM A-193 grade B7 and nuts must be ASTM A-194, grade 2 H, heavy hex.

2.3.3.2. Bolts for buried and submerged flanges and flanges located outdoors above ground or in open vaults in structures must be Type 316 stainless steel conforming to ASTM A-193, Grade B8M, Class 1 for class B and

D Flanges with ASTM A-194, Grade 8M nuts. For Class E and F flanges the bolts must be ASTM A-194 grade 2H nuts with bolt and nuts to be zinc plated in accordance with ASTM B-633.

2.3.4. Linings and Coatings.

2.3.4.1. Polyethylene Tape Coating:

2.3.4.1.1. Prefabricated Multi-layer Cold Applied Tape Coating - the coating system for straight-line pipe must be in accordance with AWWA Standard C-214. The system must consist of three layers of polyethylene material with a nominal thickness of 80 mills when complete

2.3.4.1.2. Coating Repair: Coating repair must be made using tape and primer conforming to AWWA Standard C-209, Type II. The tape and primer must be compatible with the tape system used for straight-line pipe.

2.3.4.1.3. Coating of Fittings, Specials and Joints:

2.3.4.1.3.1.1. General – Fittings, specials and joints which cannot be machine coated in accordance with above, must be coated in accordance with AWWA Standard C-209. Prefabricated tape must be Type II and must be compatible with the tape system used for straight-line pipe. The system must consist of 3 layers consisting of the following: Alternate coating methods for fittings specials and field joints would be Shrink sleeves per C-216, or paint per C-210, C-218, or C-222. The field coating must completely encapsulate the joint bonds on o-ring joints.

2.3.4.1.3.1.2. Coating Repair – Coating repair for fittings and specials must be in accordance with the procedure described above for straight-line pipe and as recommended by the manufacturer.

2.3.4.2. Other Coating Systems if specified must be governed by the appropriate American Water Works Association standard.

2.3.4.3. Cement Mortar per AWWA C-205

2.3.4.3.1. Cement Mortar Lining of Steel Pipe

2.3.4.3.1.1.1. Except as otherwise provided in AWWA Standard C-205, interior surface of all steel pipe, fittings, and specials must be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA Standard C-205.

2.3.4.3.1.1.2. The pipe ends must be left bare where field joints occur as shown on the Plans. Ends of the linings must be left square and uniform. Feathered or uneven edges will not be permitted.

2.3.4.3.1.1.3. Defective linings as identified in AWWA C-205 must be removed from the pipe wall and must be replaced to the full thickness required. Defective linings must be cut back to a square shoulder to avoid feather edged joints.

2.3.4.3.1.1.4. Cement mortar lining must be kept moist during storage and shipping.

2.3.4.3.2. Fittings. Fittings must be lined and coated per AWWA C-205.

2.3.5. Steel Casing Pipe.

The component materials, manufacture and testing of all steel pipe will conform to AWWA Standard C-200 for “Steel Water Pipe 6 in. and Larger.” The specified pipe size will be the actual inside diameter of the pipe, special or fitting in inches. The diameter and wall thickness of all steel pipe will conform to those shown on the plans.

Pipe will be either Grade E or Grade S, conforming to ASTM Designation A-53.

Pipe ends will be beveled and suitable for field butt welding except as otherwise specified.

2.3.6. Stainless Steel Casing Spacer.

The Casing Spacers are to be constructed of T-304 stainless steel segments which bolt together forming a shell around the carrier pipe. The spacers are to be designed with risers (when needed) and runners to support the carrier within the casing and maintain a minimum clearance of 0.50 in. between the casing ID and the spacer OD. On carrier pipes with an OD less than 16 in., each spacer is to have four (4) riser and runner combinations - two (2) on each segment. On carrier pipes with an OD of 16 in. and larger, each spacer is to contain six (6) riser and runner combinations - four (4) on the bottom segment and two (2) on the top segment. T-304 stainless steel bolts and nuts are to be supplied with the spacers.

The band is to be manufactured of 8 in. wide, 14 gauge, T-304 stainless steel material. The risers are to be constructed of 10 gauge, T-304 stainless steel with a minimum length of 6 in.

Abrasion resistant runners, with a minimum length of 7 in. and a minimum width of 1 in. are to be attached to each riser to minimize friction between the casing pipe and the carrier pipe as it's installed. Runner material is to be of glass reinforced plastic with compression strength of 25,000 psi, flexural strength of 32,000 psi and tensile strength of 22,000 psi. The ends of all runners are to be beveled to facilitate installation over rough weld beads or the welded ends of misaligned or deformed casing pipe.

Interior surfaces of the circular steel shell are to be lined with PVC or EPDM with a minimum thickness of 0.090 in. with a hardness of durometer "A" 85-90.

Spacers will be placed a maximum of 1 ft. on each side of the bell joint and every 8 to12 ft. apart thereafter.

Physical Properties

2.3.6.1. Band and Risers

- Band - 14 Gauge, T-304 Stainless Steel
- Riser - Minimum 10 Gauge, T-304 Stainless Steel

2.3.6.2. Liner - EDPM or Polyvinyl Chloride

- Thickness - 0.090 in. minimum
- Hardness - Durometer "A" 85-90
- Dielectric Strength - 1/8 in. thick
- 60,000 VPM
- Water Absorption - one (1) percent maximum
- Overlap edges

2.3.6.3. Studs, Nuts and Washers

- T-304 Stainless Steel - 5/16: - 18 in. x 2 in. studs
- 5/16 in. hex nuts
- 5/16 in. washers SAE 2330

2.3.6.4. Runners

1 in. wide or 2 in. wide glass filled polymer runners

Sizes Available:

Length - 7 in.

Effective heights (all lengths) - 1 in. and 1 1/2 in.

Materials Specifications:

Tensile Strength (ASTM D-638) - 22,000 psi

Flexural Strength (ASTM D-790) - 32,000 psi

Compression Strength (ASTM D-695) - 25,000

Deflection Temperature @ 264 psi (ASTM D-648) - 435 F (224 C)

Deformation Under Load, @ 122 F (50C) - 4000 pound Load, - (ASTM D-648) 1.2 percent.

2.3.6.5. Welding. All risers are to be welded by MIG welding. Welds are to be fully pasivated.

2.3.7. End Seals. Where carrier pipe is centered in the casing pipe, encasement pipe end seals must be Modular Seal, Linkseal or Engineer approved equal. Where carrier pipe is offset to the springline of the encasement, end seals must be one-piece synthetic rubber, molded “S” shape seals minimum 3/8 in. thick SBR with ½ in. wide 304 SS bands.

2.3.8. Quality Assurance Commercial Standards. (All manufacturing tolerances referenced in the below standards apply unless specifically excluded).

ANSI/AWWA C-200 Standard for Steel Water Pipe 6 In. and Larger.

ANSI/AWWA C-205 Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. and Larger-Shop Applied

ANSI/AWWA C-206 Standard for Field Welding of Steel Water Pipe.

ANSI/AWWA C-207 Standard for Steel Pipe Flanges for Water Works Service, 4" - 144.”

ANSI/AWWA C-208 Standard for Dimensions for Fabricated Steel Water Pipe Fittings.

ANSI/AWWA C-209 Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

ANSI/AWWA C-210 Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

ANSI/AWWA C-214 Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines.

ANSI/AWWA C-216 Standard for Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

ANSI/AWWA C-218 Standard for Liquid Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.

ANSI/AWWA C-219 Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

ANSI/AWWA C-222 Standard for Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings.

AWWA M-11 Steel Pipe - A guide for Design and Installation.

ASTM A-106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

ASTM A-53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

ASTM E-165 Method for Liquid Penetrant Examination.

ASTM E-709 Guide for Magnetic Particle Examination.

ASME Section V Nondestructive Testing Examination.

ASME Section IX Welding and Brazing Qualification.

AWS B2.1 Standard for Welding Procedure and Welding Qualifications.

2.3.9. Qualifications

2.3.9.1. The pipe and fittings must be designed, constructed and installed in accordance with the best practices and methods and must comply with these specifications as applicable

2.3.9.2. Pipe must be the product of one manufacturer. All pipe manufacturing including cylinder production, lining, coating and fittings must be produced by one manufacture. The pipe manufacturer must have a certified quality assurance program. This certified program must be ISO 9001: 2000 or other equivalent nationally recognized program.

2.4. Polyvinyl Chloride Pipe and Fittings.

2.4.1. Polyvinyl Chloride Pipe, 4 in. through 12 in.

4 in. through 12 in. polyvinyl chloride (PVC) pressure pipe is to be made from class 1245A or 1245B compounds as determined by ASTM Standard D-1784 and providing for a hydrostatic test basis (HBD) of 4000 psi.

All PVC pipe must conform to AWWA Standard C-900. The Manufacturer must supply the Engineer an affidavit that the materials supplied comply with all applicable requirements of AWWA.

All AWWA C-900 PVC pipe must have a pressure rating of 150 psi and a dimension ratio of 18 with cast iron equivalent outside diameters unless otherwise specified. It must have a sustained pressure requirement of 500 psi and a minimum burst pressure of 755 psi. AWWA C-900 PVC pipe installed in High Pressure Zones to have a pressure rating of 200 psi and a dimension ration of 14, a sustained pressure requirement of 650 psi and a minimum burst pressure of 985 psi. It must be furnished in nominal 20 ft. lengths, and must be self-extinguishing.

Dimensions and tolerances for each nominal pipe size are to be in accordance with Section 2.2, Table 1 of AWWA C-900.

Each pipe must have an integral bell formed on the pipe end, and be designed to be at least as strong as the pipe wall.

An elastomeric gasket must be designed with a retainer ring that locks the gasket into integral bell groove and must be installed at the point of manufacture. The dimensions and design of the gasket joint provided for the PVC pipe must meet requirements provided in ASTM D-3139 and ASTM D-2122. The gasket must be reinforced with a steel band and must conform to ASTM F-477.

Each length of pipe furnished is to bear identification markings in conformance with Section 2.6 of AWWA C-900.

2.4.2. Polyvinyl Chloride (PVC), 14 in. through 36 in.

2.4.2.1. Scope. This product specification covers 14 in. nominal diameter through 36 in. nominal diameter polyvinyl chloride (PVC) potable water transmission pipe with integral bell and spigot joints. The pipe must be extruded from Class 12454-A or 12454-B PVC compound as defined in ASTM D-1784 and provide for a hydrostatic design basis (HDB) of 4,000 psi. The pipe outside diameters must conform to dimensions of cast iron pipe (CI). All pipe furnished must be in conformance with American Water Works Association (AWWA) Standard C-905-97, or latest revision thereof.

Pipe must be homogenous throughout. It must be free from voids, cracks, inclusions, and other defects. It must be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces must be free from nicks and scratches. Joining surfaces of spigots and joints must be free from gouges and imperfections that could cause leakage.

2.4.2.2. Definitions. All definitions are defined according to AWWA C-905-97 Section 1.2 Definitions.

- Dimension Ratio (DR) – The ratio of the pipe outside diameter to the minimum wall thickness. The quotient is rounded to the nearest 0.5 when necessary.
- Pressure Rating (PR) – The nominal pressure rating of transmission pipe is determined from formulas in Section 5: Transmission-Pipe Ratings AWWA C905-97 using a safety factor of 2.0. There is no allowance for surge pressure in the pressure rating.

2.4.2.3. General

2.4.2.3.1. Except as noted on the plans or procurement specifications for specific jobs, all C-905 PVC pipe must have a pressure rating of 235 PSI and a dimension ratio of 18 or have the highest pressure rating available for each size of pipe.

2.4.2.3.2. Dimensions and tolerances for each nominal pipe size must be in accordance with Table 2 Dimensions for PVC Transmission Pipe with CI Outside Diameter of Section 3 Pipe Requirements in AWWA C-905-97. All pipe must be suitable for use as a pressure conduit.

2.4.2.3.3. Pipe must be gauged full length and furnished in standard laying lengths of 20 ft. ± 1 in. unless otherwise noted. Each pipe must have an integral bell formed on the pipe end, and be designed to be at least as strong as the pipe wall.

2.4.2.3.4. An elastomeric gasket must be designed with a retainer ring, which locks the gasket into integral bell groove and must be installed at the point of manufacture. The dimensions and design of the gasket joint provided for the PVC transmission pipe must meet requirements provided in ASTM D-3139 and ASTM D-2122. The gasket must be reinforced with a steel band and must conform to ASTM F-477.

2.4.2.3.5. Each length of pipe furnished must bear identification markings that will remain legible after normal handling, storage, and installation. Markings must be applied in a manner that will not weaken or damage the pipe. Markings must be applied at intervals of not more than 5 ft. on the pipe. The minimum required markings are given in the list below. Marking requirements must be in conformance with Section 4.7 Marking Requirements of AWWA C-905-97.

- Nominal size and OD base (for example, 24 CI).
- PVC.
- Dimension Ratio (for example, DR 25).
- AWWA pressure rating (for example, PR 165).
- AWWA designation number for this standard (AWWA C-905).
- Manufacturer's name or trademark.
- Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture.

2.4.3. AWWA C-900 and C-905 Requirements

2.4.3.1. Bundle pipe in pallets for ease of handling and storage. Package Pipe bundles to provide structural supports to insure that weight of upper units do not cause deformation to pipe in lower units.

Pipe bundles showing evidence of ultra violet radiation "sunburn" on exposed pipe as caused from extended unprotected storage conditions will not be accepted.

2.4.3.2. The pipe must be in compliance with AWWA Standards C-900 or C-905-97 as applicable by performing quality control-control test and maintaining results of those test as outlined in Section 3 of that standard. Submission of product constitutes certification of compliance with standard.

2.4.3.3. Pipe is intended for use as an underground, direct bury pressure pipe for transport of potable water. The expected life of pipe system after installation is 25 to 50 yr.

2.4.3.4. Provide a one year warranty for all material sold and delivered for use and incorporation into water system. Warranty take effect on the date that pipe is accepted by the Department.

2.4.3.5. Provide user reference and claims history for further investigation, before the Engineer rendering final decision on the acceptance of product furnished.

2.4.3.1. Table below identifies the approved manufactures and products for C-900 Polyvinyl Chloride (PVC) pressure pipe for 4 in. through 12 in.

Table 2A
Approved Manufacturers for C-900 Polyvinyl Chloride (PVC) pressure Pipe, 4 in. through 12 in.

Manufacturer	Type
PW Eagle	C900 PVC
J–M Manufacturing Company	C900 PVC
Certain Teed Corporation	C900 PVC
Diamond Plastics Corporation	C900 PVC Lok–21 PVC
North American Pipe Corporation	C900 PVC
VinylTech Corporation	C900 PVC
JM Eagle	C900 PVC
Northern Pipe Products, Inc.	C900 PVC
Underground Solutions	Fusible C900 PVC
Pipelife Jet Stream	C900 PVC

2.4.3.2. Test.

2.4.3.2.1. For both C-900 and C-905, water system may at no cost to manufacturer, subject random lengths of pipe for testing by an independent laboratory for compliance with this specification. Any visible defects of failure to meet quality standards here in will be grounds for rejecting entire order.

2.4.3.2.2. For C-905: The manufacturer must pressure test all pipe, including the joint, which is marked with the designation number of AWWA C-905-97 at 73.4º F. +/- 3.6ºF (23ºC +/- 2ºC). Each length of pipe must be proof tested at twice the pressure rating listed in Table 3 Transmission-Pipe Pressure Rating of AWWA C-905-97 Sec. 4.6 Pressure Strength and Hydrostatic Proof

2.4.3.3. References. The documents listed below are referenced in this specification.

- AWWA C-905-97; Polyvinyl Chloride (PVC) Water Transmission Pipe Nominal Diameters 14 in. through 36 in. ASTM D-1784; Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
- ASTM D-2122; Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings.
- ASTM D-3139; Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- ASTM F-477; Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.4.4. Bends and Fittings for PVC Pipe 4 in. through 36 in.

All bends and fittings must conform to the same requirements subparagraphs 2.A.2 Fittings for Ductile-Iron Pipe.

2.4.5. Joint Restraint System for PVC C-900/C-905 and Ductile Iron.

2.4.5.1. Scope. This specification covers pipe joint restraint systems to be used on domestic water mains for PVC C-900 pipe sizes 4 in. through 12 in. diameter and PVC C-905 pipe sizes 16 in. through 24 in. diameter, and for Ductile Iron pipe sizes from 4 in. through 24 in. diameter.

Joint restraint systems are classified as “compression, “mechanical joint” or “non-metallic restrained joint” for the specific type of pipe joint to be restrained.

2.4.5.2. General Requirements

2.4.5.2.1. Underwriter Laboratories (U.L) and Factory Mutual (FM) certifications are required on all restraint systems.

2.4.5.2.2. Unless otherwise noted, restraint systems to be used on PVC C-900 and C-905 pipe must meet or exceed A.S.T.M. Standard F1674-96, “Standard Test Methods for Joint Restraint Products for Use with PVC Pipe,” or the latest revision thereof. Restraint systems used on ductile pipe must meet or exceed U.L. Standard 194

2.4.5.2.3. Non-metallic restrained joint pipe and couplings must be used specifically for C-900 PVC pipe and fittings in sizes 4 in.-12 in.

2.4.5.2.4. Each restraint system must be packaged individually and include installation instructions.

2.4.5.3. Specific Requirements.

2.4.5.3.1. Restrainer for PVC C-900/C-905 & Ductile Iron Push-on Type Connections:

2.4.5.3.1.1.1. Pipe restraints must be used to prevent movement for push-on D.I. or PVC (C-900&C-905) (compression type) bell and spigot pipe connections or where a transition or flexible coupling has been used to join 2 sections of plain-end pipe D.I. or PVC (C-900&C-905). The restrainer may be adapted to connect a plain end D.I. or PVC pipe to a ductile iron mechanical joint (MJ) bell fitting. The restrainer must not be directionally sensitive.

2.4.5.3.1.1.2. The pipe must be restrained by a split retainer band. The band must be cast ductile iron, meeting or exceeding ASTM A-536-80, Grade 65-45-12. The inside face or contact surface of the band must be of enough width to incorporate cast or machined non-directionally sensitive serration to grip the outside circumference of the pipe. The serration must provide full (360 °) contact and maintain pipe roundness and avoid any localized points of stress. The split band casting must be designed to “bottom-out” before clamping bolt forces (110ft-lb minimum torque) can over-stress the pipe, but will provide full non-directionally sensitive restraint at the rated pressures.

2.4.5.3.1.1.3. Bolts and nuts used to attach the split retainer ring must comply with ANSI B-18.2/18.2.2, SAE Grade 5. Tee-bolts, nuts and restraining rods must be fabricated from high-strength, low-alloy steel per AWWA C-111-90, ANSI/AWWA C-111/A-21.11.

2.4.5.3.1.1.4. The split ring type non-directionally sensitive restrainer system must be capable of a test pressure twice the maximum sustained working pressure listed in Table 2 and be for both D.I. and PVC C-900.

2.4.5.3.1.1.5. Restraint systems sizes 6 through 12 in. must be capable of use for both ductile iron and PVC C-900.

2.4.5.3.1.1.6. The restraint system may consist of 2 types: the two split retainer rings and for new construction use only the 1 split and 1 solid cast backup ring.

2.4.5.3.2. Compression Ring Fitting Restrainer for Ductile Iron Pipe & PVC C-900.

2.4.5.3.2.1.1. Compression ring with follower gland type of restrainer may be used in conjunction with Mechanical Joint (MJ) bell end ductile iron pipe fittings for restraining PVC C-900 and ductile iron pipe.

2.4.5.3.2.1.2. The system must use a standard MJ gasket with a color-coded compression ring and replacement gland conforming to ASTM A-536-80, Grade 65-45-12.

2.4.5.3.2.1.3. Standard MJ fitting Tee-bolts and nuts must be fabricated from high strength steel conforming to ANSI AWWA C-111/A-21.11 and AWWA C-153/A-21.53-88.

2.4.5.3.2.1.4. Standard MJ gasket must be virgin SBR meeting AWWA C111.

2.4.5.3.2.1.5. The restraint system must be capable of a test pressure twice the maximum sustained working pressure listed in Table 2.

2.4.5.3.3. Non-metallic restrained joint pipe and couplings for PVC C-900 Type Connections:

2.4.5.3.3.1.1. Gasketed restrained coupling connections must join two sections of factory grooved PVC (C-900) pipe. The restrainer coupling or must not be directionally sensitive.

2.4.5.3.3.1.2. The coupling must incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F-477 and must be DR-14 Class 200 C-900 PVC in all applications, meeting or exceeding the performance requirements of AWWA C-900, latest revision. The inside face or contact surface of the coupling connection must be of enough width to incorporate a factory machined non-directionally sensitive groove in both pipe and coupling to grip the outside circumference of the pipe. The couplings must provide full (360 °) contact and maintain pipe roundness and avoid and localized points of stress. The coupling must be designed with an internal stop to align the precision-machined grooves in the coupling and pipe before installation of a non-metallic thermoplastic restraint spleen, and will provide full non-directionally sensitive restraint at the rated pressures.

2.4.5.3.3.1.3. High-strength flexible thermoplastic spleens must be inserted into mating precision–machined grooves in the pipe and coupling to provide full non-directional restraint with evenly distributed loading.

2.4.5.3.3.1.4. The non-metallic restrained joint pipe and couplings for PVC C-900 type non-directionally sensitive restrainer system must be capable of a test pressure twice the maximum sustained working pressure listed in Section D and be for PVC (C-900) pipe sizes 4 through 12 in.

2.4.5.3.3.1.5. Non-metallic restrained joint pipe and couplings for PVC C-900 restrained systems sizes 4 through 12 in. must be capable of use for both Class 150 (DR 18) and 4 through 8 in. for Class 200 (DR 14) PVC C-900 pipe.

2.4.5.3.3.1.6. The non- metallic restrained joint pipe and couplings for PVC C-900 restraint system must consist of a pipe and couplings system produced by the same manufacturer meeting the performance qualifications of Factory Mutual (FM) and Underwriters Lab (UL).

2.4.5.3.4. Retainer Gland for Ductile Iron Pipe (only):

2.4.5.3.4.1.1. Radial bolt type restrainer systems must be limited to ductile iron pipe in conjunction with Mechanical Joint (MJ) bell end pipe of fittings. The system must use a standard MJ gasket with a ductile iron replacement gland conforming to ASTM A-536-80. The gland dimensions must conform to Standard MJ bolt circle criteria.

2.4.5.3.4.1.2. Individual wedge restrainers must be ductile iron heat treated to a minimum hardness of 370 BHN. The wedge screws must be compressed to the outside wall of the pipe using a shoulder bolt and twist-off nuts to insure proper actuating of the restraining system.

2.4.5.3.4.1.3. Standard MJ fitting Tee-bolts and nuts must be high strength steel conforming to AWWA C111/A21.11and C153/A21.53-88.

2.4.5.3.4.1.4. Standard MJ gasket must be virgin SBR meeting AWWA C111.

2.4.5.3.5. Maximum Sustained Working Pressure Requirement

Table 2

Nominal Diameter	PVC C-900 / C-905	Ductile Iron
4 & 6 in.	150 p.s.i. (DR18) / 200 p.s.i. (DR14)	350 p.s.i.
8 in.	150 p.s.i. (DR18) / 200 p.s.i. (DR14)	350 p.s.i.
10 & 12 in.	150 p.s.i. (DR18) / 200 p.s.i. (DR 14)	350 p.s.i.
14 & 16 in.	150 p.s.i. (DR 18) / 200 p.s.i. (DR 21) / 235 p.s.i. (DR 18)	250 p.s.i.
20 & 24 in.	150 p.s.i. (DR18) / 200 p.s.i. (DR 21) / 235 p.s.i. (DR18)	200 p.s.i.

2.4.5.3.6. Tests. The Engineer may, at no cost to the Contractor, subject random joint restraint system products to testing by an independent laboratory for compliance with these standards. Any visible defect of failure to meet the quality standards herein will be ground for rejecting the entire order.

2.4.5.3.7. Product List. Other approved equal products from other manufacturers meeting these specifications may be submitted for review.

2.4.5.3.7.1.1. Slip on Joint Restraint Systems:

Table 3

Manufacturer	PVC C-900/C-905	Ductile Iron (D.I.)	D.I., 16" Above
Ford / Uni-Flange Corporation	Series 1390C	Series 1390C	1390C
EBBA Iron Sales, Inc.	1500	1700	1700
Romac Industries, Inc. 4-8 in.	Model 611	Model,611	47 OSJ
Star Pipe Products	1100	1100	1100
Tyler Union	3000	3000	3000
Sigma Corporation	PV-LOK (PVP)/PTP	PV-LOK (PVP)/PTP	SLDH SLDH

2.4.5.3.7.1.2. Compression Ring Systems:

Table 4

Manufacturer	PVC C-900	Ductile Iron
Romac Industries, Inc.	Grip Ring-DI	Grip Ring-DI
Tyler Corporation	MJR Gland	MJR Gland
Star Pipe Products	Ring Lock 3500 Series	

2.4.5.3.7.1.3. Non-metallic restrained joint pipe and couplings for PVC C-900 RJ Type Connections:

Table 5

Manufacturer	PVC C-900	Ductile Iron
CertainTeed Corporation, Certa-Lok C-900/RJ	4" – 12"	Class 150 (DR-18)
	4" – 8"	Class 200 (DR-14)

2.4.5.3.7.1.4. Retainer Gland (MJ):

Table 6

Manufacturer	PVC C-900	Ductile Iron
EBBA Iron Sales, Inc.	2000 PV	MEGALUG 1100
Romac Industries, Inc.	Not Approved	Not Approved
Ford/UniFlange	UFR-1500-C 4" – 24"	Series 1400
StarPipe Products	Stargrip 4000	Stargrip 4000
Sigma Corporation	One Lok SLC	One Lok SLD
Tyler Union	TUFGRIP 2000F	TUFGRIP 1000F

2.4.5.3.7.1.5. e) Restrained Flange Adapters:

Table 7

Manufacturer	PVC C-900	Ductile Iron
EBBA Iron Sales, Inc.	2100 Megaflange	2100 Megaflange
Ford/UniFlange	900	200, 400, 420

2.5. Copper Tubing and Brass Fittings for Copper Service Lines.

2.5.1. Copper Tubing.

All 3/4 in., 1 in., 1-1/2 in. and 2 in. copper tubing for underground service is to be of the type commercially known as Type "K" soft and conform to ASTM Designation B-88 and NSF Standard 61.

3/4 in. and 1 in. copper tubing is to be furnished in 60 ft. coils or 100 ft. coils as specified, 1-1/2 in. is to be furnished in 20 ft. lengths, 40 ft. coils or 60 ft. coils as specified, and 2 in. is to be furnished in 20 ft. lengths or 40 ft. coils as specified.

2.5.2. Brass Fittings.

2.5.2.1. General requirements

Unless otherwise modified herein, water works brass goods consisting of corporation stops, curb stops, couplings, connectors, nipples, etc., will be required in underground installations of service lines in the water distribution system.

The brass composition is to conform to ASTM Designation B-62 and the threads are to conform to AWWA Standard C-800-01 for “Threads for Underground Service Line Fittings.”

All casting is to have a natural, clean uniform and smooth surface, and be free from internal porosity.

All machining is to be done in a workmanlike manner and within the acceptable tolerances.

Unless otherwise specified each fitting is to be furnished with a 1/16 in. thick fiber gasket.

2.5.2.2. Design Criteria for Curb Stop and Angle Valves Ball Type

All Curb Stop, Corporation and Angle valves must be ball valves. “Inverted and Ground Key,” type angle valves will not be accepted.

Ball angle valves will not have a stop.

Laying dimensions the same as present inverted key style or equal to Mueller H-14258.

Reduced port design will be acceptable provided there is no compromise on flow capacity compared to the “Inverted and Ground Key” type angle valve.

Pack joints will not be acceptable.

APPROVED MANUFACTURER LIST

In Line FIP X FIP

Table 8
Approved Manufacturers and Models:
2 in. FIP X FIP

Manufacturer	Model
Ford Meter Box	B11777WR
A.Y. McDonald	6111W
Mueller	B-20200-3
James Jones	J1900

Table 9
Angle Curb Stop Meter Coupling x Compression
Approved Manufacturers and Models

	Size			
Manufacturer	¾"	1"	1.5"	2"
A.Y. McDonald	4652BQ	4652BQ		4612BQ
Ford Meter Box	BA43-232WRQ	BA43-344WRQ	BFA43-666WRQ	BFA43777WRQ
Mueller	B24258-R3	B24258-3	B24276-3	B24276-3
James Jones	J1963WSG	J1963WSG	J1975WSGLS	J1975WSGLS
Hays	2520CGJ-R			

Table 10
F.I.P. X METER SWIVEL NUT/COUPLING
Approved Manufacturers and Models:

	Size
Manufacturer	¾"
A.Y. McDonald	4654B
Ford Meter Box	BA13232WR
Mueller	B24265-R3
James Jones	J-1966WLS
Hays	2521-R

Table 11
Ball Corporation Valve
Approved Manufacturers and Models:

Manufacturer	CC X CMP	IP X CMP
A.Y. McDonald	4701BQ	4704 BQ
Mueller	B-25008	B-25028
James Jones	1937 SG	1935 SG
Ford Meter Box	FB-1000Q	FB-1100Q

2.6. Gate Valves, Tapping Valves and Tapping Sleeves.

2.6.1. Gate Valves.

2.6.1.1. General Requirements

2.6.1.1.1. Except as otherwise modified or supplemented herein, AWWA Standard C-509-01 or the latest revision thereof, must govern the design, component materials, construction; manufacture and testing of all resilient seated gate valves. Valves must be suitable for frequent operation as well as service involving long periods of inactivity. Valves must be NSF-61 certified.

2.6.1.1.2. The Engineer reserves the right to limit the purchase of resilient seat gate valves from manufacturers and to the models specified, as shown in Table 12, provided such resilient seat gate valves conform to the provision contained herein.

Table 12

APPROVED MANUFACTURER	PRODUCTS LIST
Sizes Four through Sixteen In.	
Manufacturer	Model
Clow Valve Company	C515
Mueller Company	2361 Series Gate Valve

2.6.1.1.3. The minimum design working water pressure for gate valves with nominal diameters of 3 in., 4 in., 6 in., 8 in., 10 in., and 12 in. must be 200 psig unless otherwise specified.

2.6.1.1.4. The minimum design working water pressure for gate valves with nominal diameters of 16 in., and 20 in. must be 150 psig unless otherwise specified.

2.6.1.1.5. Valves must be resilient-seated types, bronze mounted with non-rising stems. The closure member must be fully encapsulated by an elastomer without thin spots or voids. When open the valve must have a clear, full-port, unobstructed waterway.

2.6.1.1.6. Gray iron, ductile iron, steel, brass and bronze materials must meet or exceed the material requirements of Section 2: Materials of AWWA C-509-01.

2.6.1.1.7. Gaskets, O-rings, Coatings, and elastomers must meet or exceed the material requirements of Section 2: Materials of AWWA C-509-01.

2.6.1.1.8. The gate valves must be designed and constructed for installation in either a horizontal or vertical position. Valves must be designed for buried installation with stem in the vertical position and must be furnished for mounting in a horizontal pipeline, unless otherwise specified.

2.6.1.1.9. Valve components of brass or bronze must be manufactured to ASTM recognized alloy specifications of low zinc content bronze, as shown in Table 1 of Section 2.2.4. of ANSI/AWWA Standard C-509-01 or the latest revision thereof. Materials for the stem have minimum yield strength of 40,000 psi. A minimum elongation in 2 in. of 12% and must be made of bronze per ASTM B763, alloy number UNS C99500. A maximum zinc content of 2% as shown in Table 2 Chemical Requirements of ASTM B763-96 or the latest revision thereof. Stem nut material must be ASTM B-62 UNS C83600 or ASTM B-584 UNS C84400. The stem must have a visible external marking at the top to indicate low-zinc, high strength material. The marking must include a red plastic or neoprene washer placed around the top of the stem under the operating nut.

2.6.1.1.10. Valve ends must be either flanged, tapping valve, mechanical joint, push-on joint or any combination thereof, as specified. All mechanical joint valves must be supplied with glands, bolts, and gaskets. Valve body bolts and nuts must meet the strength requirements of ASTM A-307 with dimensions conforming to ANSI B18.2.1. The size of the bolt head must be equal to the size of the nut and must be stainless steel in accordance with ASTM 276.

2.6.1.1.11. All gate valves must open left (counter clockwise), unless otherwise specified.

2.6.1.1.12. The following parts of the valve must be made of either gray or ductile iron: bonnet, body, yoke, wrench nut, O-ring packing plate or seal plate, and gland follower. The gate may be made of gray or ductile iron.

2.6.1.1.13. If glands and bushings are used for NRS valves they must be made of ASTM B-763 bronze UNS C99500. The stem must be made of cast, forged, or rolled ASTM B-763 bronze UNS C99500. The stem nut material must be ASTM B-62 bronze UNS C83600 or ASTM B-584 bronze UNS C84400. The gate may be made of bronze ASTM B-763 bronze UNS C99500. Stem seals must be “O” ring type. The seals must be designed for dynamic applications.

The design must be such that the seal above the stem collar can be replaced with the valve under full pressure in the fully open position.

Materials for the “O” ring packing plate must be in accordance with Section 4.8.3 of the ANSI/AWWA C509-01 Standard or the latest revision thereof.

2.6.1.1.14. Enclosed and buried valves must be coated inside and outside with a fusion bonded epoxy with a nominal 8 mils dry film thickness, which meets or exceeds AWWA C-550-01 and to the maximum extent possible must be free of holidays. All coatings in contact with the potable water must be approved for potable water immersion service per ANSI/NSF Standard 61.

2.6.1.1.15. The Contractor must submit three sets of certified drawings showing the principal dimensions, general construction and material specification of the valve proposed. The number of turns to open (close) must be clearly noted in the valve information. The number of turns to open or close the valve must be consistent for each valve size for each approved manufacturer.

2.6.1.1.16. Valves furnished under this specification must be supplied from the San Antonio Water System approved manufacturer list. To be included on the qualified product list, the manufacturer must provide an Affidavit of Compliance in accordance with the Section 1.5 of the ANSI/AWWA C-509-01 Standard or latest revision thereof, to include compliance with San Antonio Water System Specification No. 21-02. Records of all tests performed in accordance with Section 6.1 and Section 6.2 of the ANSI/AWWA C-509-01 Standard or latest revision thereof will be made available or provided. These records will be representative test results for Section 6.1 and certificate of testing for Section 6.2. An affidavit of testing for the valve assembly as outlined in Section 6.2.2 of the ANSI/AWWA C-509-01 Standard, (350 ft-lbs) will also be provided. A copy of the manufacturer's Quality Assurance Program will be submitted. Blueprints and parts list for the valve must also be provided.

2.6.1.1.17. All gate valve parts must be designed to withstand the following two pressure requirements, without being structurally damaged. (1) An internal test pressure of twice the rated design working pressure of the valve. (2) The full rated internal working pressure when the closure member is cycled once from a fully open to a fully closed position against the full rated unbalanced working water pressure. In addition to these pressure requirements, the valve assembly and mechanism must be capable of withstanding an input torque as follows: 200 ft.-lbs. for a 3 in. nominal diameter. 200 ft.-lbs. for a 4 in. nominal diameter. 300 ft.-lbs. for a 6 in. nominal diameter. 300 ft.-lbs. for a 8 in. nominal diameter. 300 ft.-lbs. for a 10- in. nominal diameter. And 300 ft.-lbs. for a 12 in. nominal diameter. For sizes larger than a 12 in. nominal diameter refer to the manufacturer's specifications.

2.6.1.1.18. Resilient seats must be applied to the gate and must seat against a corrosion resistant surface. The non-metallic seating surface must be applied in a manner to withstand the action of line fluids and the operation of the sealing gate under long-term service. A metallic surface must have a corrosion resistance equivalent to or better than bronze. A non-metallic surface must be in compliance with ANSI/AWWA C-550. The gate must be fully encapsulated by an elastomer without thin spots or voids. Resilient seats must be bonded. ASTM D-429 either method A or method B must prove the method used for bonding or vulcanizing. For method A, the minimum strength must not be less than 250 psi. For method B, the peel strength must be 75 lb./in.

2.6.1.1.19. Flanged Ends: The end flanges of flanged valves must conform to dimensions and drillings of ANSI/AWWA C-110/A21.10 or ANSI B-16.1, Class 125.

2.6.1.1.20. Mechanical Joint Ends: Mechanical joint bell dimensions must conform to ANSI/AWWA C-111/A21.11.

2.6.1.1.21. Push-on Joints: Push-on joints must conform to the requirements of ANSI/AWWA C-111/A21.11.

2.6.1.1.22. The tapping valves must be mechanical joints with tapping flange on the other end. The tapping valves must be furnished complete with glands, bolts, and gaskets. The tapping valve must have a clear unobstructed waterway.

2.6.1.1.23. The seat rings must be of a large diameter to the permit entry of the full diameter tapping machine cutters. The valve end which mates with the tapping sleeve must have an alignment lip to fit the recess in the tapping sleeve flange for proper alignment. The lip will be dimensioned in accordance with MSS SP-60 for valves 20 in. nominal pipe size and smaller.

2.6.1.1.24. All interchangeable parts must conform to their required dimensions and must be free from defects that could prevent proper functioning of the valve. When assembled, valves manufactured in accordance with this standard must be well fitted and operate smoothly. All like parts of valves of the same model and size produced by the same manufacturer must be interchangeable.

2.6.1.1.25. All castings must be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves must comply with the testing requirements of this specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

2.6.1.1.26. All gate valves must be hydrostatically tested with twice the specified rated pressure applied to one side of the gate and zero pressure applied to the other side. The test is to be made in each direction across the gate. All tests are to be performed at the manufacturer's plant.

2.6.1.1.27. All gate valves must be operated through a complete cycle in the position for which it was designed to ensure free and proper functioning of all parts in the intended manner. Any defects in workmanship must be corrected and the test repeated until satisfactory performance is demonstrated. All tests are to be performed at the manufacturer's plant.

2.6.1.1.28. A hydrostatic test pressure equal to twice the rated working pressure of the valve must be applied to all assembled valves with the gates in the open position. The test must show no leakage through the metal, pressure containing joints, or stem seals. All tests are to be performed at the manufacturer's plant.

2.6.1.1.29. A test must be made from each direction at rated working pressure to prove the sealing ability of each valve from both directions of flow. The test must show no leakage through the metal, pressure containing joints, or past the seat. All tests are to be performed at the manufacturer's plant.

2.6.1.1.30. Markings must be cast on the bonnet or body of each valve and must show the manufacturer's name or mark, the year the valve casting was made, the size of the valve, and the designation of working water pressure, for example "200 W."

2.6.1.1.31. The Engineer may, at no cost to the Contractor, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failure to meet the quality standards herein will be grounds for rejecting the entire order.

2.6.1.1.32. Table 12 identifies specified manufacturers that are approved.

2.6.1.2. Workmanship

2.6.1.2.1. All parts of the resilient seat gate valve must be designed and manufactured to the tolerances specified in ANSI/AWWA C-509-01 or latest revision thereof and this specification.

2.6.1.2.2. All parts of the resilient seat gate valve manufactured by a given manufacturer must be interchangeable with like parts from another resilient seat gate valve of the same model and size and by the same manufacturer.

2.6.1.2.3. All interchangeable parts must conform to their required dimensions and must be free from defects that could prevent proper functioning of the valve.

2.6.1.2.4. All castings must be clean and sound, without defects that will weaken their structure or impair their service. Plugging, welding, or repairing of cosmetic defects is allowed. Repairing of structural defects is not allowed. Repaired valves must comply with the testing requirements of this specification after repairs have been made. Repairs within the bolt circle of any flange face are not allowed.

2.6.1.2.5. The resilient seat gate valves must be well fitted.

2.6.1.2.6. Operation of the resilient seat gate valve must be smooth.

2.6.1.2.7. All parts must be free of structural defects.

2.6.1.2.8. The resilient seat gate valve must be watertight.

2.6.1.3. Painting

2.6.1.3.1. All exterior and interior surfaces of the valve must be coated with epoxy, N.S.F. 61 certified. The epoxy must have a nominal dry film thickness of 8 mils, and must be in accordance with AWWA C-550, latest revision.

2.6.1.3.2. Coating must be as close to holiday free as is technologically possible.

2.6.1.4. Testing

2.6.1.4.1. Hydrostatic Test: Hydrostatic Test must be performed on the valve in accordance with Section 6.1 Proof of Design Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.2. Torque Test: Torque Test for prototype valves must be performed on the valve in accordance with Section 6.1 Proof of Design Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.3. Leakage Test: Leakage Test must be performed on the valve in accordance with Section 6.1 Proof of Design Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.4. Pressure Test: Pressure Test must be performed on the valve in accordance with Section 6.1 Proof of Design Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.5. Operation Test: Operation Test must be performed on the valve in accordance with Section 6.2 Production Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.6. Shell Test: Shell Test must be performed on the valve in accordance with Section 6.2 Production Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.7. Seat Test: Seat Test must be performed on the valve in accordance with Section 6.2 Production Testing of ANSI/AWWA C-509-01 or latest revision thereof.

2.6.1.4.8. An Affidavit of Compliance certifying that all required tests have been performed must be provided in accordance with Section 6.3 Affidavit of Compliance of ANSI/AWWA C-509-01.

2.6.1.4.9. The Affidavit of Compliance, the results of ASTM testing procedures and requirements for materials, Manufacturer's Quality Assurance Program, and the records of all tests performed on the valve must be kept and provided by the supplier or manufacturer in a single hard cover bound notebook with the bid or with the shipping documents and must be approved by the Engineer.

2.6.1.5. Quality Assurance

Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system or is in the process of achieving this certification by June 2001. Noncompliance to this registered commercial quality system requirement by June 2001 will result in removal of the manufacturer's product from Attachment I of this specification. If on receipt of resilient seat gate valves they are found to be non-compliant the manufacturer must replace the defective resilient seat gate valves according to resilient seat gate valve size with a resilient seat gate valve that meets the San Antonio Water System's specifications. The defective resilient seat gate valve will be returned to the manufacturer, freight collect, and the manufacturer must replace the resilient seat gate valve, freight prepaid.

2.6.1.6. References

2.6.1.6.1. American National Standards Institute and American Water Works Association Standard C-509-01 (ANSI/AWWA C-509-01).

2.6.1.6.2. Manufacturers Standardization Society MSS SP-60.

2.6.2. Tapping Valves and Tapping Sleeves.

2.6.2.1. Tapping Sleeves

Band must conform to the minimum OD size ranges and lengths specified in this specification. The flange must be manufactured in compliance with AWWA C-223.07, Class D ANSI B.16.1 drilling, recessed for tapping valves MSS_SP60. Mechanical Joint tapping sleeve outlet must meet or exceed all material specifications as listed below and be suitable for use with Standard mechanical joint x mechanical joint (mjxmj) resilient wedge gate valves per AWWA C-509-94.

2.6.2.1.1. General Requirements

2.6.2.1.1.1.1. Tapping sleeves (All sizes).

Entire fitting to be stainless steel type 304 (18-8). The body, lug and gasket armor plate to be in compliance with ASTM A-240. The flange must be cast stainless steel in compliance with ASTM A-743. The MJ outlet must be one-piece casting made of stainless steel.

The test plug must be ¾" NTP in compliance with ANSI B2.1 and must be lubricated or coated to prevent galling. All metal surfaces must be passivated after fabrication in compliance with ASTM A-380.

The gasket is to provide a 360-sealing surface of such size and shape to provide an adequate compressive force against the pipe after assembly, to affect a positive seal under combinations of joint and gasket tolerances. The materials used must be vulcanized natural or synthetic rubber with antioxidants and antioziant ingredients to resist set after installation. No reclaimed rubber must be used. A heavy-gauge-type 304-stainless armor plate must be vulcanized into the gasket to span the lug area.

Lugs are to be heliarc welded (GMAW) to the shell. Lug must have a pass-through-bolt design to avoid alignment problems and allow tightening from either side of the main. Bolts must not be integrally welded to the sleeve. Finger Lug designs are not approved; it is the intent of these specifications to allow tapping sleeve that has a lug design similar to the approved models.

Bolts and nuts must be type 304 (18-8) stainless steel and lubricated or Teflon coated to prevent galling or seizing. Bent or damaged unit will be rejected.

Quality control procedures must be employed to insure that the shell, Lug, (4" and larger nominal pipe diameter) armor plate, gasket and related hardware are manufactured to be free of any visible defects. Each unit, after proper installation, must have a working pressure rating up to 200 psi, and a test pressure of 250 psi.

The sleeve construction must provide a positive means of preventing gasket cold flow and extrusion.

Each sleeve must be stenciled, coded or marked in a satisfactory manner to identify the size range. The markings must be permanent type, water resistant that will not smear or become illegible.

2.7. Inline Insert Valves. These valves are insertable gate valves designed to be installed onto a working, pressurized pipe to provide a flow isolation control point that allows for bi-directional flow in a piping system while the pipe remains in service. Insert valves must be designed and constructed to operate under a normal maximum working pressure of 250 psi with a test pressure of 375 psi.

Allowable range of operating torque for the valve must be 100-350 ft-lbs for closing and 100-850 ft-lbs for opening.

The valve body clamp (the bottom portion of the valve body), the valve body branch (the upper portion) and associated hardware must be manufactured out of 304 stainless steel. The gasket for the clamp must be made of Buta-N and SBR.

The valve stem must be compliant with AWWA C509-09 and made of 303 Stainless Steel. The valve stem will have 2-3 stub Acme threading. The stem nut must seat within the valve gate and be made of UNS C95400 Aluminum Bronze per ASTM B148. The operating nut will be ductile iron per AWWA 509-09 All

insert valves should open right (clockwise) and the operating nut will be painted red for corrosion resistance in accordance with AWWA C509-09.

The valve gate and gate housing must be made of Food Grade Type 6 Cast Nylon. The gate seals must be composed of EPDM rubber.

Insert valves must be Hydra-Stop IVP 250 or Engineer approved equal.

2.8. Valve Boxes.

All valve box assemblies are to conform to the details shown on the plans. Each valve box assembly is to be of cast-iron and is to consist of a base, top section, and lid.

Valve boxes are to be of a single size with a nominal diameter of 6 in.

The valve box lid is to be labeled “water” and is to be so designed so that it will remain firmly seated in place when subjected to vehicular traffic.

The valve box assembly is to be of enough toughness and strength to withstand impact loads and shock resulting from vehicular traffic.

The valve box assembly is to be coated with a standard bituminous coating of either coal tar or asphalt base applied to all inside and outside surfaces.

2.9. Meter Boxes.

For non-traffic bearing locations, the meter box assembly for 5/8 in. through 1 in. meters box and lid is to be black and constructed out of modified polyethylene material for maximum durability and corrosion resistance. The black material is for maximum UV protection and must be uniform throughout meter box and lid for maximum longevity and not have a foaming agent that creates air pockets within the plastic wall. The body and lid must withstand a 20,500 lb. loading in a non-deliberate and incidental traffic. Plastic Lid is to have the following:

2.9.1. “Water Meter” and “CITY OF BOERNE” molded into the lid

2.9.2. Seat securely and evenly inside the meter box and must not overlap the top edge of the meter box

2.9.3. “Overlap” and securely and evenly on the existing CITY OF BOERNE cast iron meter box with like dimensions.

2.9.4. A diamond pattern for skid resistance and an AMR Slide Mount molded into the lid on the underneath side and off center for placement for an AMR transponder to help in the protection of the radio antenna.

2.9.5. A brass worn gear lock that will secure the existing CITY OF BOERNE cast iron meter box of like dimensions and secure the plastic meter box. See detail.

2.9.6. A molded receptacle for placement of CITY OF BOERNE key.

2.9.7. One (1) piece of ½” rebar secured in lid. See detail.

2.9.8. Plastic body is to have the following:

- A crush resistant ribbing along the outside of box.
- A flange around the top opening to help prevent setting and aide in adjustment to grade.
- Designed to accommodate all plastic lids.

For traffic bearing locations, the meter box assembly for 5/8 in. through 2 in. meters is to consist of cast-iron rectangular boxes box and a steel checkered plate rectangular with raised lug pattern as shown on the plans.

The castings are to be dipped in coal tar at a temperature of 350ºF and the metal is to be at a temperature of 300ºF before dipping. The casting is to be dipped and cured independently and the coating is to have ceased to be "tacky" within 72 hr. after dipping.

The steel checkered plate rectangular cover is to be hot dip galvanized after fabrication.

The meter box is to have an ultimate tensile strength of 25,000 psi and is not to be brittle.

The casting is to have an "as cast" clean smooth surface and be free from internal porosity; castings that are made smooth by grinding are unacceptable.

Quality Assurance: If on receipt of meter boxes or lids they are found to be non-compliant, the Contractor is to replace defective product at no cost to the Department. Any visible defect of failure to meet specification will be grounds for rejecting entire order.

Approved Plastic Meter Box and Lid Manufacturer:

DFW Plastics Inc. Model Numbers:

- D-1218-RWSBSM-Complete box
- D-1218-RWSBSM-lid
- D-1218 – body

2.10. Fire Hydrants.

2.10.1. General Requirements

2.10.1.1. The Engineer reserves the right to limit the purchase of fire hydrants from manufacturers and to the models specified, as shown on Table 15, provided such fire hydrants conform to the provision contained herein.

2.10.1.2. Each hydrant must be designed for a minimum working pressure of 200 psig.

2.10.1.3. All parts of the hydrant must be designed to withstand, without being functionally impaired or structurally damaged, a hydrostatic test of not less than 400 psig or twice the rated working pressure, whichever is greater, with the hydrant completely assembled and pressurized as follows:

2.10.1.3.1. With the nozzle caps in place, the main valve open, the hydrant inlet capped, and the test pressure applied to the interior of the hydrant.

2.10.1.3.2. With the main valve closed, the hydrant inlet capped, and the test pressure applied at the hydrant inlet.

2.10.1.3.3. The design safety factor of the operating mechanism must not be less than 5 and must be based on the foot-pounds of torque required for the closing and opening of the hydrant at a working pressure of 200 psig. Hydrants must be functional and capable of being opened or closed without difficulty following an application of an operating torque of 200 lbf-ft at the operating nut in the opening direction with the hydrant fully opened and the closing direction with the hydrant fully closed. The torque requirements apply only to hydrants of 5 ft. bury or less.

2.10.1.4. The length of bury must be as specified.

2.10.1.5. The fire hydrant must have 2 hose nozzles and 1 pumper nozzle.

2.10.1.6. The nominal inside diameter of the hose nozzle must be 2 ½ in.

2.10.1.7. The nominal inside diameter for the pumper nozzle must be 4 in.

2.10.1.8. The outlet-nozzle threads are to conform to the National Fire Protection Association (NFPA) 2003, Standard for Fire Hose Connections.

2.10.1.9. The nominal diameter of the main valve opening must be 5 ¼ in.

2.10.1.10. The hydrant shoe must be provided with a 6 in. mechanical joint connection to fit the connecting pipe.

2.10.1.11. The fire hydrant must open left (counter-clockwise).

2.10.1.12. The color of the finish paint must be safety red with safety yellow cap and bonnets

2.10.1.13. The fire hydrant must have a non-rising stem.

2.10.1.14. No more than one 6" stem extension must be provided if required to make the base of the fire hydrant grade level.

2.10.1.15. The bonnet section must be designed so all bearing surfaces and stem threads are sealed in a lubricant reservoir. If oil is used as a lubricant, the reservoir must be designed to allow for easy filling through a fitting or plug. Where grease is used as a lubricant, the reservoir will be sealed. The reservoir will be adequately sealed with "O" rings or other suitable sealing system approved by the Engineer.

2.10.1.16. The fire hydrant must have a safety flange or breakaway flange at the ground line as stipulated in Section 3.1 General Design of ANSI/AWWA C-502-05 or latest revision thereof.

2.10.1.17. Fire hydrant nozzle cap chains must be required and must be attached permanently to the fire hydrant as stipulated in Section 3.2 Detailed Design of ANSI/AWWA C-502-05 or latest revision thereof.

2.10.1.18. Parts that require lubrication and come into contact with water must be lubricated with a non-toxic food grade lubricant that does not pose a health hazard to the public if consumed.

2.10.2. Workmanship

2.10.2.1. All foundry and machine work must be performed in accordance with good standard practice for the class of work involved and in conformance with accepted drawings, if required. When assembled, hydrants manufactured in accordance with this specification must be well fitted and must operate smoothly. The body and shaft must be watertight.

2.10.2.2. All parts must conform to the required dimensions and must be free from defects that could prevent proper functioning of the hydrant.

2.10.2.3. All castings must be clean and sound without defects that will weaken their structure or impair their service.

2.10.3. Paint

2.10.3.1. The exterior surface of the hydrant must be coated with a coating that must meet or exceed the requirements of Federal Specification TT-C-494b. A second coat of water based or oil based enamel paint will then be applied from the top of the hydrant to a point 18 to 20 in. below the centerline of the pumper nozzle or down to the traffic safety flange connection at the ground line.

2.10.3.2. All interior surfaces, machined surfaces, such as the threaded portion of the stem or stem nut, which must fit closely with the adjacent parts, must be coated with a coating that must meet or exceed Federal Specification TT-C-494b. Stem surfaces contained within a lubricant reservoir and not in contact with potable water may be free of coating.

2.10.3.3. The interior and exterior of the hydrant shoe must be coated with a fusion-bonded epoxy with a nominal dry film thickness of 8 mils, conforming to ANSI/AWWA C-550-05, and certified to NSF 61.

2.10.3.4. Coating must be as close to holiday free as is technologically possible.

2.10.4. Testing and Inspection

2.10.4.1. Each assembled hydrant must be subjected to two shop tests under a hydrostatic pressure of 400 psig or twice the rated working pressure, whichever is greater. One test must be made with the entire interior of the hydrant under pressure and another test made with the main valve closed and the base under pressure from the inlet side. Under the test procedure, there must be no leakage through the main valve or seals or through the castings or the joints of the assembled hydrant. Under the test conditions, the leakage through the drain valves must not exceed 5 fl. oz. min. Other leakage or other imperfections found in either test must be corrected or the hydrant retested. The tests must be conducted for enough time to allow a check of all points of possible leakage and for a minimum of 30 seconds after all air has been exhausted.

2.10.4.2. Each assembled hydrant must be operated through a full open-close cycle when not under pressure. The torque required for performing this operation must not exceed 200 lbf ft.

2.10.4.3. All fire hydrant tests and inspections must conform to ANSI/AWWA C-502 Section 5.1 Production Testing, ANSI/AWWA C-502 Section 5.2 Prototype Testing, and ANSI/AWWA C-502-05 Section 5.3 Inspection and Rejection.

2.10.4.4. The manufacturer must provide an Affidavit of Compliance conforming to Section 1.7 Affidavit of Compliance of ANSI/AWWA C-502-05 or latest revision thereof.

2.10.5. Quality Assurance

Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system or is in the process of achieving this certification by June 2001. If on receipt of fire hydrants they are found to be noncompliant the Contractor must replace the defective fire hydrants according to fire hydrant size with a fire hydrant that meets this specification.

APPROVED FIRE HYDRANT MAINTENANCE KITS

The San Antonio Water System will attempt to use fire hydrant maintenance kits in the approved hydrants. Table 16 of this specification provides the product model numbers.

2.10.6. References

2.10.6.1. American National Standards Institute and American Water Works Association Standard C-502-05 (ANSI/AWWA C-502-05).

2.10.6.2. American National Standards Institute and American Water Works Association Standard C-550-05 (ANSI/AWWA C-550-05).

APPROVED MANUFACTURERS

The manufacturers listed in Table 15 are approved by the Department

Table 15

Manufacturer	Model
American Darling	B84B 5-1/4" (w / metal weather cap)
Clow Valve Company	Medallion
Kennedy Valve Company	Guardian

M & H Valve Company	Reliant Model 929
Mueller Company	Super Centurion 250
United States Pipe and Foundry, Inc.	Metropolitan
Waterous	Pacer 100
American AVK Company	Model 2780

The fire hydrant maintenance kits listed are the reference product model numbers.

Table 16

Manufacturer	Model
American Darling	B84B 5-1/4" (w / metal weather cap)
Clow Valve Company	Medallion
Kennedy Valve Company	Guardian
M & H Valve Company	Reliant Model 929
Mueller Company	Super Centurion 250
United States Pipe and Foundry, Inc.	Metropolitan
Waterous	Pacer 100
American AVK Company	Model 2780 Dry

2.11. Polyethylene Wrapping Material.

Polyethylene wrapping material is to be used to encapsulate all ductile and cast-iron pipe.

Polyethylene wrapping for ductile and cast iron water mains is to consist of a 4 mil tubular section of cross-laminated high-density polyethylene, which has a high dielectric and tensile strength, for use in insulating cast-iron and ductile-iron pipe from the electrolytic action encountered in highly active soils.

Polyethylene wrapping is to consist of opaque cross-laminated high-density polyethylene sheet continuously thermally bonded to form a tubular section. The tubes may be supplied in bulk length on rolls or in individual pre-cut lengths. See Table 17 for size and length chart, in accordance with AWWA C-105 (Table 1) for minimum requirements. When supplied in specific pipe lengths, the tubes are to contain a minimum of 4 ft. over the actual pipe length to allow for overlap.

The polyvinyl sheet of film for the tubular wrapping is to be of virgin resins meeting raw and physical properties of ASTM D-1248 and AWWA C-105, latest edition. The material is to be 4 mil cross-laminated high-density polyethylene of uniform film thickness and be free of imperfections such as pin holes, etc., after being thermally seamed into tubular form. The finished product will have a nominal thickness of 4 mils, with tolerances of minus ten percent.

The material is to have no volatile constituents, the loss of which may affect ductility. The material is also to have the following properties:

Mechanical: The polyethylene film is to have a tensile strength per latest ASTM D-882 test, of 6300 psi min. The film is to have an elongation of not less than 100% of the test strip per latest ASTM D-882 test. The film is to have an impact resistance 800 gram min per (ASTM D-1709 Method B). The film is to have a propagation tear resistance of 250 gf minimum in machine and transverse direction (ASTM D1922).

Dielectric: The film is to have a dielectric strength of 800 volts per mil thickness per ASTM D-149.

Marking Requirements

The polyethylene film supplied must be clearly marked, at a minimum of every 2-ft along its length, containing the following information.

- Manufacturer's name or trademark
- Year of manufacture
- ANSI/AWWA C-105/A21.5
- Minimum film thickness and material type.
- Applicable range of nominal pipe diameter sizes.
- Warning-Corrosion Protection-Repair any Damage.

The Engineer may at no cost to the Contractor, subject random testing by an independent laboratory for compliance with this Specification. Any visible defect of failure to meet the quality standards herein will be grounds for rejecting the entire order.

Table 17
4 MIL POLYETHYLENE WRAPPING MATERIALS

SIZE & LENGTH (All sizes lay flat size)	
Pipe Size	Product Size Width x Length
4", 6" & 8"	20" x 200/500
8", 10" &12"	27" x 200/500
16" & 18"	37" x 200/500
20"	41" x 200/500
24"	54" x 200/500
30"	67" x 140/500
36"	81" x 120/500
48"	95" x 100/500
54"	108" x 100/500

APPROVED MANUFACTURER AND PRODUCTS LIST

Table 18

Manufacturer	Product
Van Leer Flexibles Inc.	Valeron
Manufactured Plastics and Distribution Inc.	Cross Tuff 450 Black

2.12. Mechanical Couplings.

Mechanical coupling of Dresser solid sleeve or similar type is to be used to connect plain ends of concrete steel cylinder pipe and plain ends of steel and ductile-iron pipe and to connect new and existing ductile iron water main in conjunction with casing installation in accordance with the details shown on the plans.

The body of the coupling must be Class B gray iron that meet ASTM A126. The follower rings (2) must consist of ASTM A536 ductile iron. The gaskets will be rubber.

The flexible and transition couplings are to be manufactured to fit the type size and class of pipe specified. Bolts are to be high strength low alloy steel meeting the requirements of AWWA Standard C-111. The exterior body of the coupling must be coated with an enamel paint.

2.13. Air Release Assemblies.

Valve body and cover is to be cast iron fabricated in accordance with ASTM A-48-35 or ASTM A-126 Class B. Non-metallic Valve Body must be fabricated from fiberglass reinforced nylon. Inlet sizes through 2 in. are to be screwed (National Pipe Taper Thread, NPT).Pipe sizes above 3 in. and above are to have flanged inlets (125 pounds ANSI B16.1). A protective hood or cowl is to be installed on the outlet of flange-bodied valves.

Internal seat trim float arm and pivot pin is to be stainless steel Type 303 or 304 or 316. Floats are to be stainless steel ASTM A-240. Other internal parts are to be stainless steel ASTM A-240 or ASTM A-276.

Non-metallic floats must be foamed polyethylene with stainless steel type 316 fasteners.

Internal seat or orifice button is to be of Buna-N rubber compounded for water service. Cover gasket is to be composition-type, equal to Armstrong CS-231, Garlock 3000, or Lexide NK-511. Cover bolts are to be alloy steel. Rolling seals must be furnished for non-metallic valves 2" and below.

Valve body is to have a test pressure rating of 300 psi and working pressure rating of 150 psi.

The air release valve is to be designed to vent accumulated air automatically. The outlet orifice is to be properly sized to facilitate valve operation at pressures up to 150 psi. The air release valve is to be either simple lever or compound lever, depending upon venting volume requirements.

The air and vacuum valve is to be designed with the inlet and outlet of equal cross-sectional area. The valve is to be capable of automatically allowing large quantities of air to be exhausted during the filling cycle and also capable of automatically allowing air to re-enter the system to prevent a negative pressure during the draining cycle. The float is to be guided to minimize premature closure by air and to provide proper alignment for normal closure by floating on the water surface.

Combination valves are to provide for both automatic air release under system pressure and to allow air movement during filling or draining operations. The combination valve may be housed in a single casting. The housing is to be designed to incorporate conventional or kinetic flow principles to properly vent the air without premature closure. Flanged sizes (4 in. and larger) may be furnished in a dual housing. When dual castings are used, a bronze manual isolation valve is to be installed. This will allow the air release valve to be serviced when the system is under pressure.

The Engineer may at no cost to the Contractor, subject random valves to testing by an independent laboratory for compliance with these standards. Any visible defect or failures to meet the quality standard herein will be grounds for rejecting the entire order.

The following qualified products list identifies specific manufactured items by catalog number that are approved.

Approved Manufacturers and Models:

2.13.1. Air Release Valves (Inlet x Orifice)

Manufacture	1" NPT x 3/16"	2" NPT x 3/16"
Apco Valve Company	200A	200A
G.A. Industries, Inc. (Empire)	920	920
Multiplex Mfg. Co. (Crispin)	P1-10	PL-10A
Val-Matic Mfg. Co.	38	38
PowerSeal Corporation	5401-D	5401-E
ARI Flow Control	S-050 1T	D-040 2T

2.13.2. Air & Vacuum Valves (Inlet x Orifice)

Manufacture	2" NPT x 3/16"	4" flg. with cowl
Apco Valve Company	144	152
G.A. Industries, Inc. (Empire)	930	930-C
Multiplex Mfg. Co. (Crispin)	AL20	AL41
Val-Matic Mfg. Co.	102	104
PowerSeal Corporation	5402-B	5402-D
ARI Flow Control	SD-040 2T	K060 C-HF

2.13.3. Combination Air Valves (Inlet x Orifice)

Manufacture	1"NPT X 5/64"	2"NPT x 3/32"	4"flg. x 3/32 w/ cowl
Apco Valve Company	143C	145C	149C
G.A. Industries, Inc. (Empire)	945 (1" NPT)	945	960C
Multiplex Mfg. Co. (Crispin)	U10	UL20 (1/4")	UL41 (1/4")
Val-Matic Mfg. Co.	201C	202C	204C
PowerSeal Corporation	5403-A	5403-B	5403-D
ARI Flow Control	D-040 2T	D-040	D-060 C-HF

2.14. Blow-off Assemblies and Jumper Connections.

The materials required for both permanent and temporary 2 in. and 4 in. blow-off assemblies and 4 in. jumper connections are shown on the plans.

2.15. Backfill

2.15.1. Where services ¾" – 2" copper are installed, initial backfill must be sand conforming to the following requirements: Natural sand or sand produced from crushed gravel or crushed rock maximum 1/4 in.; 95 percent must pass No. 4 sieve, free from clay and organic material, with a maximum 8 percent passing the No. 200 sieve. Larger services utilizing ductile iron pipe or PVC (C-900) pipe must be backfilled the same as mains. Bedding and Initial Backfill for Water Mains.

Well graded gravels or crushed stone meeting the following requirements:

Modified Grade 5 gravel:

Retained on ½" sieve	0%
Retained on 3/8" sieve	0 – 5 %

Retained on No. 4 sieve	20 - 80%
Retained on No 10 sieve	75 - 100 %
Retained on No 20 sieve	98 - 100%

The quantity and thickness of lifts and compaction of initial backfill materials is to be in accordance with subsection 3. 4. 1 of this specification.

2.15.2. Secondary Backfill for Water Mains. Approved materials excavated from the trench free of brush, debris, large rock or stones and earth clods 6" or larger. Secondary backfill material must be primarily composed of compactable soil materials.

2.16. Asphalt.

2.16.1.1. All asphaltic concrete used in the replacement of pavement over the trench line is to conform to Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA), Type "C," except when the use of 6 in. of asphalt treated base is directed., unless otherwise specified on the plans.

2.17. Concrete.

2.17.1.1. All concrete used as the trench cap and in sidewalks and blocking mains is to conform to Item 421, "Hydraulic Cement Concrete." Class "A" concrete is to be used in sidewalks and for blocking concrete steel cylinder mains;

2.18. Reinforcing Steel.

2.18.1.1. All bar reinforcement is to be Grades 60, conforming to the requirements of Item 440, "Reinforcing Steel."

2.19. Affidavit of Compliance.

2.19.1.1. Unless otherwise directed, the Contractor is to furnish a manufacturer's affidavit of compliance for each of the materials used in this project. The affidavit is to certify that factory inspection and all specified tests have been made and that the material furnished complies with the requirements outlined herein.

2.20. Butterfly Valves

2.20.1. General Requirements

2.20.1.1. Except as otherwise modified or supplemented herein, AWWA Standard C504 or the latest revision thereof, must govern the design, component material construction, manufacture and testing of all butterfly valves.

2.20.1.2. Valves must be Class 150 of the short-body type with a 150 psig bidirectional shut-off rating, a 300 psig hydrostatic body shell test and a line velocity rating of 16 ft. per second.

2.20.1.3. Valve must be in the same alignment as a horizontal pipe and must be for buried service, unless otherwise specified. Valve must be configured with a horizontal valve shaft and a vertical actuator shaft with standard 2" AWWA operating nut. The actuator must be side mounted.

2.20.1.4. Valve body must be of cast iron conforming to ASTM Specification A-126, Class B.

2.20.1.5. Valve body ends must be flat-faced flanged with facing and drilling in accordance with ANSI B16.1, Class 125. All valves must conform to AWWA C504, Table 2, laying lengths for flanged valves and minimum body shell thickness for all body types.

2.20.1.6. Valve must be of such design that the disc will seat at 90 degrees with the pipe axis.

2.20.1.7. Valve must be of such design that the disc will not flutter or vibrate when operated in a throttled position

2.20.1.8. Valves disc must be of Cast Iron A-48, Cast Iron A-126, class B or Ductile Iron ASTM A-536, grade 65-45-12 and must be of disc design to provide 360 degree uninterrupted seating.

2.20.1.9. The valve seat must be natural or synthetic rubber and may be applied to the disc or body. For valves 30 in. or larger, the rubber seat must be capable of mechanical adjustment in the field and must be field replaceable without the need for special tools. Mechanical adjustment or attachment of the seat and seat ring does not include welding. The mating seat surface must be type 304 or type 316 stainless steel, ni-chrome or monel. Sprayed or plate mating seat surfaces are not acceptable.

2.20.1.10. Valve shafts must be type 304 stainless steel conforming to ASTM A-276 and must have a diameter equal to or greater than that shown for Class 150B in Table 3 of AWWA C504. Shafts must conform to the requirements of Section 3.3, Valves Shaft of AWWA C504 for one-piece or stub shaft types. Connection between the shaft and disc must be dowel or taper pins, which are mechanically secured.

2.20.1.11. The valve assembly must be furnished with a factory-set, non-adjustable disc shaft thrust bearing that insures the valve disc is centered within the valve body seat at all times.

2.20.1.12. Valve shaft bearings must be permanent, self-lubricated bearings which provide continuous, low-friction maintenance-free operation. Shaft bearing must be contained in integral hubs of the valve body.

2.20.1.13. Valve shaft seal must consist of “O” rings or “vee” ring packing where the shaft projects through the valve body for the actuator connection.

2.20.1.14. The valve must be provided with a fully enclosed, permanently lubricated actuator of the traveling nut or worm gear design. The operator must be designed such that constant input speed results in variable output speed with slowing down valve closure at the ends of travel. The effect is to maintain the rated output torque throughout the entire travel. The actuator must be connected to the valve shaft by means of a key and keyway connection.

2.20.1.15. All actuators must have adjustable, mechanical stop limits in accordance with AWWA C504 Section 3.8.2. All 6” – 42” valve actuators must be capable of withstanding 450 ft-lbs of input torque against the open or closed stops without damage.

2.20.1.16. Valves for below ground applications must be provided with an AWWA wrench nut. The wrench nut must have an arrow cast thereon, indicating the direction on of opening. The wrench nut must be suitably fastened to the actuator input shaft. If the shaft is smooth, the wrench nut must be fastened to the input shaft by means of a minimum 5/16" diameter steel pin passing entirely through the shaft and the wrench nut. Key with keyway will be acceptable. If the shaft is splined, the wrench nut must be formed to fit the splined shaft. The actuator must be designed to produce the specified torque with a maximum input of 150 ft-lbs applied to the wrench nut.

2.20.1.17. Valves for aboveground applications must be provided with a handwheel. The handwheel must have an arrow thereon, indicating the direction of the opening. The handwheel must be suitably fastened to the actuator input shaft. Actuators equipped with handwheels must be designed to produce the specified torque with a maximum pull of 80 pounds of the handwheel rim.

2.20.1.18. The requirement for either wrench nut or handwheel and the direction of opening will be specified on each purchase order.

2.20.1.19. The number of turns to open (close) the valve must be consistent for each valve size for the manufacturer and must be approved by the Engineer.

2.20.1.20. All interior wetted ferrous surfaces of the valve, including the disc, must be coated with epoxy N.S.F. 61 certified. All exterior surfaces of the valve must be coated with epoxy. The epoxy must have a nominal thickness of 10 mils, and must be in accordance with AWWA C550, latest revision.

2.20.1.21. The Contractor must submit three sets of certified drawings showing the principal dimensions, general construction and material specification of the valve proposed. The number of turns to open (close) must be clearly noted in the valve information submitted with the proposal documents.

2.20.1.22. The supplier or manufacturer must provide Affidavit of Compliance with applicable sections of AWWA C504 to include the following: Results of ASTM testing procedures and requirements for materials will be provided to the Owner upon request, Manufacturer's Quality Assurance Program, leak-tightness testing and proof of design testing of representative actuators in accordance with AWWA C504 Section 3.8.5.2 as modified herein (450 ft.- lbs.). Compliance assurance will be required in accordance with AWWA C504 Section 5.1.2, Affidavits. Results of performance tests, proof of design test, AWWA C504 Section 5.2.4, hydrostatic test, leakage test, and Affidavit of Compliance must be provided with the bid or with the shipping documents and must be approved by the San Antonio Water System.

2.20.1.23. The Engineer reserves the right to limit the purchase of Butterfly valves from manufacturers and to the models specified, as shown in the list below, provided such butterfly valves conform to the provisions contained herein.

Manufacturer	Product
M&H Valve Company	Model 450 & 4500
Henry Pratt	Groundhog & Triton HP-250
Mueller Company	Lineseal III & Lineseal XP
Crispin Multiplex	K-Flo Model 504 and K-Flo Model 47
DeZurik AWWA Valve	No. 9239757

2.20.2. Workmanship

2.20.2.1. All parts of the butterfly valve must be designed and manufactured to the tolerances specified in ANSI/AWWA C509 or latest revision thereof and this specification.

2.20.2.2. All parts of the butterfly valve manufactured by a given manufacturer must be interchangeable with like parts from another butterfly valve of the same model and size and by the same manufacturer.

2.20.3. Painting

2.20.3.1. All interior and exterior ferrous surfaces of the valve, including the disc, must be coated with epoxy, N.S.F. 61 certified. The epoxy must have a nominal thickness of 8 mils, and must be in accordance with AWWA C550, latest revision.

2.20.3.2. Coating must be as close to holiday free as is technologically possible.

2.20.4. Testing and Inspection

2.20.4.1. Performance Tests: Performance tests must be performed on each valve in accordance with Section 5.2.1 Testing of ANSI/AWWA C504 or latest revision thereof.

2.20.4.2. Leakage Tests: Leakage tests must be performed on each valve in accordance with Section 5.2.2 Testing of ANSI/AWWA C504 or latest revision thereof.

2.20.4.3. Hydrostatic Tests: Hydrostatic tests must be performed on each valve in accordance with Section 5.2.3 Testing of ANSI/AWWA C504 or latest revision thereof.

2.20.4.4. Proof-of-Design Tests: Proof-of-Design tests must be performed on each valve in accordance with Section 5.2.4 Testing of ANSI/AWWA C504 or latest revision thereof.

2.20.4.5. An Affidavit of Compliance certifying that all required tests have been performed must be provided.

2.20.4.6. The Affidavit of Compliance and the records of all tests performed on the valves must be kept and provided in a single hard cover bound notebook.

2.20.5. Quality Assurance

2.20.5.1. Manufacturers must have an ASME or I.S.O. 9001 registered commercial quality system. If on receipt of butterfly valves they are found to be noncompliant the manufacturer must replace the defective butterfly valves according to butterfly valve size with a butterfly valve that meets the San Antonio Water System's specifications. The defective butterfly valves will be returned to the manufacturer, freight collect, and the manufacturer must replace the butterfly valve, freight prepaid. If San Antonio Water System audits, product inspection and performance data review in accordance with these specifications determine excessive butterfly valve non-compliance, the manufacturer will be subject to removal by the Products Standards Committee. If the butterfly valve becomes defective during the manufacturer's specified warranty period a San Antonio Water System quality assurance and manufacturer review will ensue. If the review determines manufacturing non-conformance the manufacturer must replace the butterfly valve according to size with a butterfly valve that meets the San Antonio Water System's specifications. The defective butterfly valve removed from the field will be returned to the manufacturer, freight collect, and the manufacturer must replace the butterfly valve, freight prepaid. If the nonconformance product amounts are excessive and result in increased product replacement by San Antonio Water System field staff the manufacturer may be subject to time and material charges.

2.20.6. References

2.20.6.1. American National Standards Institute and American Water Works Association Standard C504 (ANSI/AWWA C504).

3. CONSTRUCTION METHODS

3.1. Excavation.

Excavation (trenching) as required to complete the water main installation is to be performed in accordance with Item 400, “Excavation and Backfill for Structures,” as outlined herein, as shown on the plans and as directed

3.1.1. Trenches.

Trench walls must be vertical. The practice of undercutting at the bottom or flaring at the top will not be permitted except where it is justified for safety or at the Engineer’s or Inspector’s direction. In special cases, where trench flaring is required, the trench walls must remain vertical to a depth of at least 1 ft. above the top of the pipe.

The trench bottom must be square or slightly curved to the shape of the trenching machine cutters. The trench must be accurately graded along its entire length to provide uniform bearing and support for each section of pipe installed upon the bedding material. Bell holes and depressions for joints must be dug after

the trench bottom has been graded and bedding installed. The pipe must rest upon the new bedding material for its full length

Where over-excavation occurs, the under-cut trench must be restored to grade at no cost to the Department by replacement with a material conforming to the requirements of the bedding material or a material approved by the Engineer.

The depth of cut indicated on cut sheets, as furnished by the engineer, is from the off-set or cut hub elevation to the invert.

3.1.2. Width of Trench.

Minimum Width of Trench. The minimum width of pipe trenches, measured at the crown of the pipe, must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of bells. The minimum base width of such trench must be not less than 12 in. greater than the exterior diameter of the pipe, exclusive of special structures or connections. Such minimum width must be exclusive of trench supports and not greater than the width at the top of the trench.

Maximum Width of Trench. The maximum allowable width of trench for pipelines measured at the top of the pipe must be the outside diameter of the pipe (exclusive of bells or collars) plus 24 in. A trench wider than the outside diameter plus 24 in. may be used without special bedding if the Contractor, at his expense, furnishes pipe of the required strength to carry additional trench load. Such modifications must be submitted to the Engineer and approved in writing. Whenever such maximum allowable width of trench is exceeded, except as provided for on the drawings, or in the specifications, or by the written approval of the Engineer, the Contractor, at his expense, must encase the pipe in concrete from trench wall to trench wall, or other pipe bedding material approved by the Engineer. Any excavation wider than this maximum width or subsequent Surface or Paving work, will be done at the Contractor's expense.

3.1.3. Classification of Excavated Materials.

No classification of excavated materials will be made. Excavation and trench work is to include the removal and subsequent handling of all materials excavated in accordance with Item 400, "Excavation and Backfill for Structures."

3.1.4. Grade of Trench Bottom.

The trench is to be over-excavated to a depth of 6 in. below the grade line established for the bottom of the pipe, regardless of the type of pipe. The grade line of the pipe is to then be met by the addition of a layer of approved bedding material as directed.

3.1.5. Excavation Below Grade.

Any part of the bottom of the trench excavated below the limits specified in Section 3.A.4., "Grade of Trench Bottom," is to be corrected with approved material and compacted as directed. Should excessive over-excavation occur, except at bell holes, the grade is to be restored in accordance with the methods described in Section 3.A.6, "Unstable Conditions at Grade," at no cost to the Department.

3.1.6. Unstable Conditions at Grade.

Where the bottom of the trench at grade is found to be unstable or to include ashes, cinders, any type of refuse, vegetable or other organic material, or large pieces of fragments or inorganic materials which in the judgment of the Engineer should be removed, the Contractor is to excavate and remove such unsuitable material to a depth at least 6 in. below pipe. Before the pipe is laid the grade is to be restored by backfilling with an approved material in layers of 3 in. before compaction. The layers are to be slightly moistened and thoroughly compacted so as to provide a uniform and continuous bearing and support for the pipe at every point between bell or collar holes. The finished grade is to be accurately graded to provide uniform bearing

and support for each section of pipe at every point along its entire length except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper seating of pipe joints.

3.1.7. Trench Excavation Protection.

All trench excavation required on this project is to be accomplished as required by the provisions of Item 402, “Trench Excavation Protection.”

3.1.8. Caution in Excavation.

The Contractor is to proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures and utilities may be determined whether shown on the plans or not. Machine excavation is not permitted closer than 12 in. on either side of other existing underground utilities. The Contractor is to be responsible for the repair of such structures and utilities when broken or damaged. He is also to be responsible for adjusting alignment and trench grades with reference to such structures to obtain specified clearance for the water main construction.

Whenever the Engineer determines that it is necessary to explore and excavate to determine the location of existing underground structures and utilities, the Contractor is to make explorations and excavations for such purposes at his expense.

3.1.9. Protection and Restoration of Underground Structures and Facilities.

The Contractor is to furnish temporary support, adequate protection, and maintenance of all underground and surface structures, drains, sewers, and other obstructions encountered in the progress of the work. All underground structures and utilities which are disturbed are to be restored by the Contractor at his expense. Materials and methods used for restoration are to be in accordance with the City Code of San Antonio, Texas for Building, Electrical, and Plumbing and the requirements of the utility agency involved.

If a sanitary sewer is broken by the Contractor's operations the release of sewage into the trench is to be immediately intercepted by the insertion of a section of sheet metal tubing known as a “tin-horn” between the broken ends of the sewer. All leakage at the ends of the “tin-horn” is to be effectively stopped. The “tin-horn” is to remain in place until permanent repairs can be made. It is to be the responsibility of the Contractor to determine in advance of his trenching operations the size of all sanitary sewer lines and services which will require this treatment.

All sanitary sewer lines crossing the excavation, whether bridged or replaced, are to have proper support consisting of sound timber supports with a minimum 2 in. nominal thickness and a minimum 6 in. nominal width placed with the width horizontal and extending a minimum of 12 in. into the trench wall on either side.

In all cases where a sewer pipe is replaced or bridged, the backfill material is to be thoroughly compacted to the bottom of the pipe and compacted by hand from this point to a distance of 6 in. above the top of the sewer line being replaced.

The locations of all sewer lines crossing excavations, whether replaced or bridged are to be properly marked, and care is to be taken to avoid damage to the pipe by a hydratamping machine or other mechanical equipment. The Contractor is to be liable for the failure of such lines due to negligence or poor workmanship.

3.1.10. Backfill Material Derived from Excavation.

All excavated materials which the Engineer determines are suitable for reuse as trench backfill is to be separated where practicable from the general excavation material, or as directed.

3.1.11. Trench Restoration

The surface of the backfilled trench must be restored to match the previous existing conditions. This must include final grading, placement of topsoil and seeding, placement of sod (such as at homes or businesses that had maintained lawns), or other unprepared and prepared surfaces. Trenches in alleys actively being used by vehicles (such as trash pickup, vehicle parking, etc.) must be restored by grading and compacting to 98% or higher with a minimum of 4 in. of flex-base materials for the entire width of the alley. Alleys not actively used by vehicles must be graded and compacted to 98% or higher, then spread grass seed for entire width of the alley.

3.1.12. Pavement.

The Contractor is to remove pavement and surfaces as a part of the trench excavation. The removal of pavement and surfaces and their restoration is to be based on the minimum trench widths as specified, plus 6 in. either side or as otherwise provided herein. The Contractor is to use such methods as sawing, drilling, or chipping to assure the breaking of the pavement along straight lines.

If the Contractor removes or damages pavement or surfaces beyond the limits specified above, such pavement and surfaces are to be restored at the expense of the Contractor.

Where water line construction necessitates cutting through existing streets outside the limits of new street construction, said streets are to be replaced in kind as directed.

Where, in the opinion of the Engineer, it is necessary to maintain traffic across a trench, the Contractor is to install temporary metal bridges as necessary to facilitate the movement of traffic.

The street surface adjacent to the trench is to be kept free of surplus spoil. Construction materials are to be placed at locations that will minimize interference with the traveling public.

3.1.13. Concrete Sidewalks, Driveways, Etc.

All concrete sidewalks, driveways, etc., are to be cut with a concrete saw. When transverse expansion or “dummy” joints are encountered, the concrete is to be removed to the nearest transverse joint on each side of the trench and restored. The depth of cut is to be such that upon removal of the concrete, the sides of the cut are to be straight and square.

Existing reinforcing wire fabric or bars are to be cut and removed to permit completion of trench excavation, pipe laying, and backfill operations. When the backfill operations have been completed, the existing reinforcement is to be replaced in its original position and satisfactorily spliced before the replacement of concrete over the new trench alignment.

Transverse “dummy” joints are to be made by a jointing tool or other means acceptable, and are to match in depth and thickness in the existing transverse joints.

Expansion joint material is to be provided where new construction abuts the existing curb or driveway if the Engineer deems it necessary.

Concrete is to be spaded, tamped, and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface is to be floated, troweled, and finished to match the existing concrete surface.

Immediately after finishing, the concrete surface is to be protected by a membrane compound curing agent, or by wetted cotton or burlap mats. Either method is to be subject to approval.

3.1.14. Dewatering.

Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding areas.

3.1.14.1. The contractor must not allow water to accumulate in excavations or at subgrade level. Remove water to prevent softening of foundation bottoms and soil changes detrimental to stability of subgrades and foundations. Provide and maintain dewatering system components necessary to convey water from excavations.

3.1.14.2. Convey water removed from excavation and rainwater to collecting or runoff areas away from buildings and other structures. Establish and maintain temporary drainage ditches and other diversion outside excavation limits. Do not use trench excavations as temporary drainage ditches.

3.1.14.3. Dewatering devices must be provided by the Contractor with filters to prevent the removal of fines from the soil.

3.1.14.4. Should the pumping system draw fines from the soil, the Engineer must order immediate shutdown, and remedial measures will be responsibility of the Contractor.

3.1.14.5. Upon completion of the dewatering work, the Contractor must remove all equipment and leave the construction area in a neat, clean, condition that is acceptable to the Engineer.

3.1.14.6. The Contractor must maintain ground water table at least 12 in. below the finished excavation subgrade.

3.1.14.7. Dewatering Performances. Performances of the dewatering system for lowering ground water must be measured by observation wells on piezometers installed I conjunction with the dewatering system, and these must be documented at least daily. The Contractor must maintain a log of these readings and submit them to the Engineer.

No direct payment must be made for costs associated with dewatering. All costs in connection therewith must be included I the applicable contract price for the item to which the work pertains.

3.2. Pipe Laying.

3.2.1. General Requirements.

The Contractor is to start his work at a tie-in point, unless otherwise indicated on the plans. Pipe is to be laid with bell ends facing the direction of lying, unless otherwise authorized or directed. Under no circumstances is pipe to be laid in water and no pipe is to be laid under unsuitable weather or trench conditions. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. Pipe is to be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations.

Spigots are to be centered in bells or collars, all valves and hydrant stems are to be set plumb, and fire hydrant nozzles are to face as shown on the plans or as directed. No valve or other control on the existing system is to be operated for any purpose by the Contractor unless approved.

The Contractor is to maintain a neat and orderly work area. Complete cleanup is to be maintained at all times as closely behind the pipe laying operations as possible, but in no case is such cleanup be permitted to lag more than 1,000 ft. behind the pipe laying, unless otherwise directed.

The Contractor is to maintain service to water connections, whether connected to the existing or proposed water lines, at all times for the duration of the construction, unless directed otherwise by the Engineer.

3.2.2. Crossing other Underground Lines.

New water mains crossing other utilities are to have a minimum of 30 in. of cover over the top of the pipe unless otherwise waived or modified. Excavation around other utilities is to be done by hand for at least 12

in. all around. Any damage to the protective wrap on gas lines or electrodes is to be reported immediately to City of Boerne Public Works (830) 249-9511. Any damage to other utilities must be reported to their proper governing entity.

3.2.3. Pipe Grade.

Water mains must have a minimum of48 in. and a maximum of 72 in. of cover from the proposed final finish ground/street elevation and 60 in. of cover when the main is installed in a parkway or under the pavement where there are no existing or proposed curb or existing drainage facilities.

Pipe grades are to be as required on the plans, or as directed. Grades are to be met as specified by Sub article 3.A, "Excavation." Care is to be taken to insure that the pipe barrel has uniform contact with the bedding material for its full length except at couplings. The coupling is not to be in contact with the original trench bottom before backfill. Bedding material is to be placed under the coupling and compacted by hand before backfilling so as to provide an even bearing surface under the coupling and pipe. Change in grade is to be made only at joints.

3.2.4. Bedding and Bedding Materials.

Before placing pipe in a trench, the trench is to have been excavated to the proper depth as required in Subarticle 3.A, "Excavation." Approved materials are to be smoothly worked by hand across the entire width of the trench bottom to provide supporting bedding for the pipe.

Structures to Support Pipe: Whereas the bottom of a trench at subgrade consist of material that is notably unstable by the Engineer and cannot be removed and replaced with approved material may be properly compacted in place to support the pipe. The Contractor must also construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer. Extra compensation will be allowed for the Contractor for the additional work done. Coordinate with Engineer for approval of extra compensation before beginning work.

3.2.5. Lowering Materials into Trench.

Proper implements, tools and facilities satisfactory to the Engineer are to be approved and used by the Contractor for the safe and convenient execution of work. All pipe, fittings, valves, and hydrants are to be carefully lowered into the trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and lining. Under no circumstances are water main materials to be dropped or dumped into the trench. Take care to avoid damaging polywrap films. Use of chains or slings is not allowed unless entire sling is wrapped with a protective nylon web sock.

3.2.6. Installing Pipe.

Every precaution is to be taken to prevent foreign material from entering the pipe while it is being placed in the line. Under adverse trench conditions, extended period of time or otherwise required by the Engineer, a manufactured cap/plug is to be used to prevent any foreign type material entering. Leave the cap or plug in place until a connection is made to the adjacent pipe. Inspect the interior of each pipe for defects and reject if defects are found.

After placing a length of pipe in the trench, the jointed end is to be centered on the pipe already in place, forced into place, brought to correct line and grade, completed in accordance with the requirements specified herein. The pipe is to be secured in place with approved backfill material tamped around it. Pipe and fittings which do not allow enough and uniform space for joints will be rejected and are to be replaced with pipe and fittings of proper dimensions. Precautions are to be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is not in progress the open end of pipe in the trench is to be closed by a watertight plug or other means approved. Pipe in the trench which cannot temporarily be jointed is to be capped or

plugged at each end to make it watertight. This provision is to apply during all periods when pipe laying is not in progress.

Should water enter the trench, the seal is to remain in place until the trench is completely dry. The Contractor is to provide plug & caps of various sizes required.

3.2.6.1. Steel Pipe: Steel pipe must be installed as specified within "Water Main." The Contractor must furnish all steel piping including fittings, couplings, specials, pipe supports, eyebolts, nuts, and accessories which are shown on the plans and as required for proper connection to existing piping. The Contractor's attention is directed to the fact that the exact location and elevation of existing piping must be determined in the field before fabrication of connecting piping.

All steel pipe and specials may be either mill pipe or fabricated pipe and, in either case, must be fabricated to the sizes, dimensions and shapes as indicated on the plans and as shown on the plans. Unless otherwise indicated on the plans, all steel pipe, bends, or specials must have an outside diameter minimum wall thickness and unit weights as shown on plans.

3.2.6.1.1. Ends of Sections: Ends of pipe sections, bends, and specials must be beveled for field welding, unless shown otherwise on the plans.

3.2.6.1.2. Seams: All piping must be made from steel plate rolled into cylinders or sections thereof, with not more than two longitudinal butt welds, or must be spirally formed and butt welded. Girth seams must be butt welded and not be closer than 6 ft. apart except in specials and bends.

3.2.6.1.3. Length tolerance: Standard and special section must be within 1/16 in. (plus or minus) of the specified or theoretical lengths.

3.2.6.1.4. Welded Joints: Except where ends are shown on the plans to be joined by mechanical couplings, all joints for steel pipe installed on a bridge structure and in open trench must be welded.

Welders appointed to do welding on steel pipe must be certified with 4F and 5G certification. All welds must be sound, free from embedded scale and slag, must have a tensile strength across the weld not less than that of the thinner of the connective sections, and be water tight. Use butt welds for all welded joints in line-pipe assemblies and in the fabrication of bends and other specials. Welds are subject to Pre-Manufacturing inspection and available to the Engineer by request.

Welding for field joints must conform to the applicable requirements of the AWWA “Standard Specification for Field Welding of Steel Water Pipe Joints, C-206.” Parties involved in the construction of mains must pay special attention to the AWWA “Standard Specification for Field Welding of Steel Water Pipe Joints, C-206, Control of Temperature Stresses.” After welding, the joints must be prepared, primed and painted, or wrapped in accordance with this specification.

Repair leaks in welds by chipping our defective material and re-welding. Hammering is not permitted.

3.2.6.2. PVC (C-900 and C-905): Lay PVC mains to the depths and grades shown on plans. Lay pipe by inserting spigot end into bell flush with insertion line or as recommended by manufacturer. At no time is bell end allowed to go past “insertion line.” A gap between end of spigot and adjoining pipe is necessary to allow for expansion and contraction.

3.2.7. Defective or Damaged Material.

Pipe and accessories are to be inspected for defects before being lowered into the trench. Any pipe section, fitting, or special which shows dents, kinks, abrupt changes of curvature other than specified, or any other damage will be rejected. Any pipe section, fittings, or special section that has been dropped from a truck or

crane will be rejected. The Contractor must, at his expense, replace or recondition each rejected section. Reconditioning procedures must be acceptable to the Engineer. Any defective, damaged, or unsound material is to be repaired or replaced as directed.

Should a damaged piece of pipe furnished by the Contractor be placed in the water main, the Contractor is to furnish, at his expense, all labor and materials required for removing and replacing the defective pipe and restoring the street to its condition just before the failure of the pipe. Should the Contractor damage the pipe after installation, the Engineer may permit the damaged section to be cut from the length unless it is the opinion of the Engineer that the entire length was damaged. The cost and replacement of broken pipe is to be at the expense of the Contractor.

3.2.8. Holes at Bells and Collars.

Bell holes of enough size are to be provided at each joint to permit the joints to be made properly. For mechanical type joints the minimum clearance between the bell and natural ground is to be 6 in. in all directions. Bell holes for concrete steel cylinder pipe are to be of enough size to properly joint the pipe and place the required grout. Subject to the above provisions the length of excavation for bell holes below grade of the trench bottom is to be kept to a minimum.

3.2.9. Deviations in Line or Grade.

Wherever obstructions, not shown on the plans, are encountered during the progress of the work and such obstructions interfere to such an extent that an alteration on the plan is required, the Engineer is to have the authority to change the plans and direct a deviation from the line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstruction. Any deviation from the line is to be accomplished by the use of appropriate bends unless such requirements are specifically waived by the construction inspector.

Whenever it is necessary to deflect pipe from a straight line the deflection is to be as directed. In no case are the amounts shown in Table 19, “Maximum Deflections of Ductile-Iron Pipe,” for ductile-iron pipe, and Table 20, “Maximum Defections of Concrete-Steel Cylinder Pipe,” for concrete pipe to be exceeded.

Table 19
Maximum Deflections of Ductile-Iron Pipe

Norm Pipe Dia	Max Joint Open	Max Defl Angle	Max Deflection in In. with Pipe Length of:		Approx Rad of Curve in Ft Produced by Succession of Joints with Pipe Lgth of:	
(In.)	(In.)	Deg/Min	18ft	20ft	18ft	20ft
6	0.58	4/25	16.7	18.5	234	260
8	0.65	3/51	14.6	16.2	268	297
10	0.75	3/42	14.0	15.5	279	310
12	0.75	3/08	11.9	13.2	327	363
16	0.75	2/21	8.8	9.7	440	488
20	0.75	1/55	7.2	8.0	540	600
24	0.75	1/35	6.0	6.7	648	720

Table 20
Maximum Deflections of Concrete-Steel Cylinder Pipe

Normal Pipe Diameter (In.)	Maximum Deflection Angle Deg/Min	Maximum Deflection (In.)		Approx Radius of Curve (Ft.)	
		16' Lay Length	20' Lay Length	16' Lay Length	20' Lay Length
16	2/20	-	9.8	-	500
20	1/52	-	7.8	-	600
24	1/34	-	6.6	-	750
30	1/16	-	5.3	-	900
36	1/02	-	4.3	-	1100
42	0/54	-	3.8	-	1300
48	0/47	2.6	-	1170	-
54	0/44	2.5	-	1237	-
60	0/54	3.0	-	1024	-

3.2.10. Cutting Pipe.

The cutting of pipe for inserting valves, fittings or closure pieces is to be accomplished so as to produce a smooth end at right angles to the axis of the pipe. Strictly follow the recommendations of the pipe manufacturer. Under no circumstances is a workman not equipped with proper safety goggles and helmet and other required safety attire permitted to engage in this work.

Asbestos-Cement (AC): No field cutting will be allowed on asbestos-cement pipe. Repairs to AC pipe must be accomplished by removing one full joint of AC pipe and replacing with appropriate PVC or Ductile Iron pipe and fittings. Information about handling AC pipe may be obtained through the CITY OF BOERNE homepage at http://www.City of Boerne.org.

All cuts made on ductile-iron pipe are to be done with a torch or power saw. The cuts are to be made at right angles to the pipe axis and are to be smooth. The edges of the cut are to be finished smoothly with a hand or machine tool to remove all rough edges. The outside edge of pipe should be finished with a small taper at an angle of about 30°.

Field Cut PVC (C-900 and C-905) using a power saw with a steel blade or abrasive disc depending on the size of pipe. If a bevel is needed after field cutting, it should be in accordance with Uni-Bell recommendations.

To facilitate future repair work on water mains, no sections less than 3 ft. in length between fittings is allowed.

3.2.11. Coating and Wrapping Underground Pipe.

3.2.11.1. Steel Pipe.

Steel pipe, bends and special are to be prepared, primed, painted or wrapped in the field as follows.

3.2.11.1.1. Exterior Surface Above Ground: Exterior surfaces of new pipe and appurtenances installed are to be thoroughly cleaned to bare metal by high speed wire brushing, scraping or other suitable methods approved by Engineer, given a single coat of industrial grade rust inhibitive primer and two finish coats of aluminum paint.

3.2.11.1.2. Exterior Surfaces Underground: Exterior surface of steel pipe, bends and specials installed in open trench are to be thoroughly cleaned to bare metal by high speed wire brushing, scraping or other suitable methods approved by Engineer, given a single coat rust inhibitive primer and wrapped with polyvinyl tape in accordance with AWWA C-203-91 “Protective Coatings for Steel Water Pipelines,” (Appendix C).

3.2.11.1.3. The procedure for coating flanged joints and mechanical coupling joints when used with steel pipe is to be as specified.”

3.2.11.1.4. Interior Surfaces: The interior surfaces of steel pipe, fittings and specials are to be cleaned by sandblasting and then primed and coated in the shop with coal tar enamel.

3.2.11.2. Ductile-Iron Pipe.

3.2.11.2.1. Open Trench: Ductile-iron pipe to be installed in a trench is to be protected in the following manner. Each pipe joint is to be covered with a 4 mil thick polyethylene sleeve that is 2 ft. longer than the pipe joint. The sleeve is to cover the full length of the pipe joint, lap over 1 ft. on each end of the adjoining pipe joints and be secured with a minimum of 2 circumferential turns of pressure sensitive polyvinyl tape. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe and held in place by means of pieces of pressure sensitive tape at approximately 5 ft. intervals. After assembling the joint, the polywrap tube from the previously installed pipe is to be pulled over the joint and secured by the contractor. The polywrap tube from the new joint is to be pulled over the first tube and secured to provide a double seal.

Cast iron and ductile-iron fittings are to be completely wrapped in 8 mil thick polyethylene films with a minimum of 1 ft. overlap on each end and appropriately taped. Laps are to cover joints with adjoining pipe joints or fittings when installed. Fire hydrant barrel from the surface to the valve is to be wrapped as specified herein.

Any damaged areas in the polyethylene film are to be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 ft. minimum in any direction and appropriately taped. Take care at service to locations to insure that tape extends beyond corporation and onto service line pipe 1 ft.

Before placing pipe in the trench, a cushion of approved materials is to be placed in the trench as required by Section 3.D., Backfill material is to be carefully placed on the pipe so as to avoid any damage to the polyethylene sleeve.

Use care to protect and preserve polyethylene wrap around ductile iron water mains when installing service corporations. The required method is to wrap pipe tape around pipe over polywrap in the area to be tapped. The tap is to be made through the tape and polywrap. It is not necessary to remove and replace polywrap. All exposed pipe, the corporation and the first 3 ft. of the service must be wrapped and taped to achieve a complete seal. In addition, a sand envelop must extend over and around the connection to a depth of eight in. above the main.

3.2.12. Protective Coating and Wrapping on Joints.

All bolts and nuts installed for underground service on valves, fire hydrants, cast-iron mechanical joint fittings, pipe joints, and other ferrous metal appurtenances are to be packed in an approved protective coating material after installation. After the joint has been made and bolts drawn to proper tension, the joint including glands, flanges, bolt heads, and nuts are to be covered with an approved coating. Such protective coating is supplemental to anti-corrosive sand embedment. Asphaltic coatings such as Talcote is not allowed. Coating and wrapping of joints is to be considered subsidiary to the installation and will not be paid for directly.

Steel Pipe Field Welded Joints: After installation of pipe, bends and specials, all end of pipe adjacent to welded field joints, including the weld proper, must be cleaned, primed, painted or wrapped as specified for the pipe adjacent to the weld.

3.2.13. Joint Assembly.

3.2.13.1. Rubber Ring Joints: The installation of pipe and the assembly of rubber ring joints for ductile-iron pipe, concrete-steel cylinder pipe and asbestos cement pipe, is to conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as “stabbing” is not permitted with pipe larger than 6 in.in size. Spigot ends of pipe larger than 6 in. in size must be properly inserted in the joint by means of suitable pushing or pulling devices.

3.2.13.2. Mechanical Couplings: The installation of mechanical couplings is to be assembled and installed according to the standards recommended by the manufacturer. Before the installation of the mechanical coupling, the pipe ends are to be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe is to be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts are to be drawn up finger tight. Uniform pressure on the gaskets is to be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Final tensioning is to be accomplished with a torque wrench and in a manner similar to the tightening procedure. The coupling is to then be left undisturbed for 24 hr. to allow the gaskets to “pack-in.” Final torque check is to then be made before coating and wrapping the joint. Table 21, Torque for Mechanical Couplings, sets forth the proper torque for various sized mechanical couplings and is included for the convenience of the Contractor.

3.2.13.3. Restrained Joints: Install restraint joints as shown on plans or as directed by Engineer. Install in accordance with manufacturer’s recommendations.

Table 21
Torque for Mechanical Couplings

Coupling Size	Bolt Diameter	Torque
2" to 24"	5/8"	75 ft/lb
2" to 24"	3/4"	90 ft/lb
30" and 36" (1/4"x7" Middle Rings)	5/8"	65 ft/lb
30" thru 36" (3/8" & heavier Middle Rings)	5/8"	70 ft/lb
30" to 48"	3/4"	80 ft/lb
48" to 72"	3/4"	70 ft/lb

3.2.14. Gray Iron and Ductile Iron Fittings.

3.2.14.1. Fittings: Fittings 6 in. through 12 in. in size are to be either mechanical joint, push-on joint short body, or push-on joint compact body unless otherwise stated on the plans. Fittings must be installed with the thrust blocking or joint restraint shown in standard drawing DD-839 series. Fittings 16 in. through 24 in. in size are to be mechanical joint type unless otherwise specified on the plans. Adaptors are to be used where necessary to provide a transition between asbestos-cement pipe and the fittings. Restraint or thrust blocking is to be provided as specified on the plans or as directed. Anti-corrosion embedment incidental to all installed cast-iron fittings must be provided as specified in and no separate payment will be made for this embedment.

3.2.14.2. Cleaning Ductile Iron: All lumps, blisters, and excess coal-tar coating is to be removed from the ends of ductile-iron pipe fittings. The outside of the spigot and the inside of the bell is to be wire-brushed and wiped clean, dry, and free from oil and grease before the pipe is laid. The interior of the pipe is to be blown clean with compressed air or swabbed out clean and dry as directed. Immediately before placing any pipe in the trench the interior is to be cleaned by an approved brush or swab or with compressed air to remove all dirt and foreign materials. All pipe and fittings are to be inspected by the Contractor for defects while suspended above ground.

3.2.15. Corrosion Protection for Ferrous Pipe, Fittings, and Valves

Except as otherwise shown on plans or as direct, anticorrosion embedment is to be provided for all ductile-iron pipe, fittings, and valves and at all valve fittings or outlets for nonferrous or reinforced concrete steel cylinder pipe. The embedding material is to be Modified Grade 5 gravel washed sand which conforms to the requirements set forth in Section 2.14., "Backfill."

Prepare the trench in accordance with applicable provisions of Section 3.1., "Excavation." After subgrade has been prepared, lay pipe to grade in accordance with plans and specification. Pipe, fitting or valve are to be firmly embedded in and surrounded by an insulating blanket of embedding material. The minimum thickness of this blanket is to be 6 in. in every direction

3.2.16. Tie-in to Existing Mains.

The Contractor is to make all ties to existing mains as shown on plans or as directed. Only City of Boerne staff will operate existing valves for shut downs and isolations. Contractor is responsible for: coordinating with Boerne Water Utility staff on site before cutting pipe for connection, dewatering the excavation, customer notification of shutdown, proper material and all other requirements as directed by Engineer to provide completion in a safe and secure manner. Tie-ins are to be done as noted on the construction plans. During construction, planned shutdown and tie-in must be coordinated through and approved by the Engineer. Planned shutdown and tie-in is to be accomplished at a time which will be at the least inconvenience to customers. No additional compensation will be provided for tie-ins accomplished after normal working hours. Tie-in to existing mains of asbestos cement (AC) pipe, the Contractor must observe and comply with all

federal, state and local laws, ordinances and regulations regarding the management of asbestos containing materials. At the minimum, work involving AC pipe should be overseen by a person who has received asbestos training and is familiar with the National Emissions Standards for Hazardous Air Pollutants (NESHAP). If greater than 260 linear ft. of pipe is to be removed, written notification to the Texas Department of Health (TDH) 10 days prior commencing with the removal of AC pipe is required. At each location shown on the plans or identified by the Contractor to involve AC pipe, the Contractor will be required to coordinate with TxDOT's Evergreen Contractor for the removal of the necessary amount of AC pipe required to make the connection without creating any friable material. TxDOT's Evergreen Contractor will remove whole sections of AC pipe so that the Contractor can make the tie-in at the nearest joint. TxDOT's Evergreen Contractor will remove the AC pipe, store it in a secure Engineer approved location, and then dispose of it. Before requiring the services of TxDOT's Evergreen Contractor, the Contractor must notify the Engineer and the Owner of the Utility of the work schedule a minimum of two weeks in advance of requiring such services in order not to delay the overall project. Delays or claims made by the Contractor, resulting from the failure to provide advanced notification and schedule coordination with TxDOT's Evergreen Contractor, will not be a basis for additional compensation.

3.2.17. Abandonment of Old Mains and Valves.

The Contractor is to accomplish all cutting, capping, plugging, and blocking necessary to isolate those existing mains retained in service from those abandoned. The open ends of abandoned mains and all other openings or holes in such mains occasioned by cutting or removal of outlets are to be blocked off by manually forcing cement grout or concrete into and around the openings in enough quantity to provide a permanent substantially watertight seal.

Valves abandoned in the execution of the work are to have the valve box and extension packed with sand to within 8 in. of the finished surface. The remaining 8 in. are to be filled with 2,500 psi" concrete or an equivalent sand-cement mix and finished flush with the adjacent pavement or ground surface. The valve covers are to be salvaged and returned to the Water System Company. Abandoning old mains and valves is to be considered subsidiary to the installation and will not be paid for directly.

3.2.18. Jacking, Boring, or Tunneling Pipe.

3.2.18.1. Jacking: Suitable pits or trenches must be excavated for the purpose of jacking operations for placing end joints of the pipe. When trenches are cut in the side of embankment, such work must be securely sheeted and braced. Jacking operations must in no way interfere with the operation of railroads, streets, highways or other facilities and must not weaken or damage such facilities. Barricades and lights must be furnished as directed to safeguard traffic and pedestrians.

The pipe to be jacked must be set on guides to support the section of pipe being jacked and to direct it in the proper line and grade. Embankment material must be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the opening thus provided. The excavation for the underside of the pipe, for at least ⅓ of the circumference of the pipe, must conform to the contour and grade of the pipe. A clearance of not more than 2 in. may be provided for the upper half of the pipe.

The distance that the excavation must extend beyond the end of the pipe must depend on the character of the material, but it must not exceed 2 ft. in any case.

The pipe must be jacked from downstream end. Permissible lateral or vertical variation in the final position of the pipe from line and grade will be as shown on the plans or as determined by the Engineer.

Any pipe that cannot be repaired to its original condition or is damaged in jacking operations must be removed and replaced at the Contractor's expense. Jacking pits must be backfilled immediately upon completion of jacking operations.

Excavation for "Boring" pits and installation of shoring must be as outlined under "Jacking." Boring operations may include a pilot hole which must be bored the entire length of crossing and must be used as a

guide for the larger hole to be bored. Water or drilling fluid may be used to lubricate cuttings. Variation in line and grade must apply as specified under "Jacking."

3.2.18.2. Tunneling: Tunneling may be used when the size of the proposed pipe would make the use of tunneling more satisfactory than "Jacking" or "Boring." The excavation for pits and the installation of shoring must be as specified under "Jacking." The lining of the tunnel must be of the material shown on the plans.

Access holes for grouting annular space must be spaced a maximum of 10 ft.

3.2.18.3. Joints: Joints for pipe for "Jacking," "Boring," or "Tunneling," must be as specified in "Water Mains," or as shown on the project plans or shop drawings as per pipe manufacturer's recommendation.

3.2.18.4. Grouting of Bores or Tunnels: Annular Space between casing pipe and limits of excavation (borehole) must be pressure grouted, unless otherwise specified on the plans.

3.2.19. Cutting-in Valves.

The work involved in cutting a valve into an existing main is to consist of excavation and backfilling with approved selected material; hauling and disposition of surplus excavation and other materials; installation of the valve, valve box assembly, all pipe cut used to complete cut-in; reaction blocking; polyethylene wrapping where required.

3.2.20. Tapping Sleeves and Valves.

Size on size taps is not permitted. The work involved in the installation of a tapping sleeve and valve is to consist of excavation, backfilling the excavation with approved selected material, installing the tapping sleeve, reaction blocking, tapping valve, valve box assembly, concrete collar where subjected to street traffic, and a cast iron lid. New taps will not be permitted closer than 2 ft. of a joint or existing tap. The use of a shell type cutter must be required with tapping sleeves and valves. Whenever working on potable or recycled water system, disinfect the shell cutter with bleach before start of work. The cutting edge is to be sharp and round. Inspector will reject defective cutters.

Air test tapping sleeves to 90 psi before tapping main line.

Place valve box in such a manner to prevent shock or stress from being transmitted to valve. Center valve box over valves operating nut with box cover flush with finished pavement surface or located at another level as directed by Engineer. Valve boxes must be provided with concrete collars as shown on plans. Form collars around such valve boxes and finish off neatly and in a workmanlike manner.

3.2.21. Cutting-in Tees.

The work involved in cutting in a tee is to consist of excavation, shut-down and isolation of existing main to which the new main is to be connected, cutting pipe for connection, dewatering the excavation, customer notification of service interruption where required, installation of all pipe used to complete the connection, all necessary tie-ins (connection to existing or new main), fittings, approved reaction blocking required and backfilling the excavation with approved selected materials or flowable backfill if required. Where the installation of a valve is required, payment will be for valve accordance with this specification.

3.2.22. Pipe Joint Restraint System.

Pipe joint restraints must be used to prevent movement for PVC push-on bell and spigot pipe connections. The restrainer may be adapted to connect a plain end PVC pipe to a ductile iron mechanical joint (MJ) bell fitting. Joint restraint is to be non-directional and installed to fully restrain system.

3.2.23. Concrete Encasement, Cradles, Saddles and Collars.

Concrete Encasement. When concrete encasement is shown on the plans or when directed, the trench is to be excavated and fine graded to a depth conforming to the details and sections shown on the plans. The pipe is to be supported by pre-cast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement concrete is to be placed to a depth and width conforming to details and sections shown on the plans.

Concrete Cradles. When concrete cradles are shown on the plans or when directed, the trench is to be prepared and the pipe supported in the same manner as described in Concrete Cradles, of this Section. The cradle must be constructed in accordance with details and sections shown on the plans. Strap and Tie Downs must be No. 4 rebar diameter minimum or better as determined by the Engineer.

Concrete Saddles. When shown on the plans or when directed, pipe to receive concrete saddle is to be backfilled in accordance with Section 3.D. of this specification to the spring line and concrete placed for a depth and width conforming to details and sections shown on the plans.

Concrete Collars. When shown on the plans or when directed, concrete collars are to be constructed in accordance with details and sections shown on the plans.

3.3. Fire Hydrants and Miscellaneous Appurtenances.

3.3.1. Fire Hydrants.

Hydrants are to be connected to the main as shown on the plans or as directed. They are to be installed in a manner which will provide complete accessibility and in a sage location where there is a minimum possibility of damage from vehicles or injury to pedestrians.

When the hydrant is placed directly behind the curb the hydrant barrel is to be set so that no portion of the hydrant will be less than 12 in. nor more than 7 ft. from the back of the curb.

When the hydrant is set in the lawn space between the curb and the sidewalk or between the sidewalk and the property line no portion of the hydrant or nozzle cap is to be within 6 in. of the sidewalk. Setting final grade of fire hydrants to match proposed or existing field conditions is the responsibility of the contractor.

Hydrants are to be set in accordance with plans and details are to be set plumb and are to have their nozzles parallel with or at right angles to the curb with the pumper nozzle facing the curb. Drainage and concrete pad are to be provided at the base of the hydrant as shown on the plans. No fire hydrant drainage system or pit is to be connected to a storm sewer or to a sanitary sewer.

3.3.1.1. Restrained Joints: Restrained mechanical joints that require field welding or groove cuts into the pipe barrel for restrain will not be accepted. Restrained joints must be furnished for pipe at all changes in direction at indicated on plans, details, or as directed. Restrained mechanical joints must be locked mechanical joints. Joints must be capable of test pressure twice the maximum sustained working pressure of 350 psi for ductile iron pipe and PVC.

3.3.1.2. Replacing and Relocating Existing Fire Hydrants: When existing fire hydrants are to be replaced or relocated, the work is to be accomplished by either of the following:

3.3.1.2.1. Cutting or installing a tee of the size and type indicated on plans or as directed.

3.3.1.2.2. Using a tapping sleeve and valve of the size and type indicated on plans to install a new fire hydrant to an existing or new water main. Size on size taps is not permitted.

3.3.1.2.3. Relocating the existing fire hydrant by closing the existing fire hydrant, extending the fire hydrant branch and installing the existing fire hydrant as specified herein.

Salvage the existing fire hydrant and other materials as designated in the field by the Construction Inspector and deliver to Water System material storage yard located at 3930 East Houston Street. Fire hydrant branches are to be abandoned by cutting and capping fire hydrant cast iron tee at the service main and surface restored to its original condition.

After the fire hydrant has been set, paint hydrant with suitable primer and finish with oil-based aluminum paint from top of hydrant to a point 18-20 in. below centerline of the pumper nozzle and apply to all exposed metal surfaces above the hydrant base flange. The payment for fire hydrant painting is to be included in the unit cost for installing the fire hydrant.

Pipe, fittings, and valves used in the placement of fire hydrants and connections to the main are to be considered subsidiary to the fire hydrant installation and not a part of the main construction and will not be paid for directly.

3.3.2. Valve Boxes, Adjustments.

Valves are to be provided with valve boxes, manholes, or valve pits as shown on the plans.

The valve box is to be placed in such a manner to prevent shock or stress from being transmitted to the valve. It is to be centered and set plumb over the operating nut of the valve with the box cover flush with the surface of the finished pavement or at such other level as directed. Valve boxes are to be provided with concrete collars as shown on the plans. Collars around such valve boxes are to be formed and finished off neatly.

Valve box is to be located so that the valve operating nut is readily accessible for operation through the opening in the valve box. The valve box is to be set flush with the surface of the finished pavement or at such other elevations as specified. Pits are to be constructed to permit minor valve repairs and to afford protection to the valve and pipe from impact where they pass through the pit walls.

Existing valve boxes located within the limits of new street construction which are in conflict are to be adjusted to match proposed finish grades.

Valve boxes installed as part of a new valve and mainline construction project are considered “new valves.” Adjustments to “new valves” are incidental to the installation of the valve. No separate pay will be given to adjust “new valves” to finished grade.

3.3.3. Air Release Assembly.

Air release valves and appurtenant items are to be installed at the locations shown on the plans unless otherwise directed.

Install air release assemblies in open trench in accordance with plans and details. Assemblies include the valve, valve box, tapping saddle, pipe fittings, accessories and appurtenances. It also includes service line and tap to main. Air release assemblies installed in parkways or easements and outside of street pavement must be installed in accordance with plans.

Air release assemblies installed on steel pipe attached to bridge structure includes the outlet on the steel pipe, valve, valve box, pipe fittings, security enclosure, accessories and appurtenances.

3.3.4. Blow-offs.

Permanent and temporary blow-off assemblies are to be installed at the locations shown on the plans or where otherwise directed. The permanent blowoff is to consist of all galvanized pipe, valve, and fittings of the various sizes detailed on the plans, 6 in. valve box assembly including the 6 in. valve box and concrete collar around the valve box where subjected to vehicular traffic. The temporary blowoff is to consist of all

galvanized pipe, valve, and fittings of the various sizes detailed on the plans. Valve box is to be raised on installed to finished grade in accordance with details.

3.3.5. Gate Valves

Gate valve installation must include; valve, reaction blocking when required conforming to plans, valve box, concrete collar, and valve box lid. Gate Valves constructed in terrace must be constructed with No. 3 bars all around.

The valve box must be placed in such a manner to prevent shock or stress being transmitted to the valve. All valves located 6 ft. and deeper must include valve key extensions inside the valve box. The Contractor has the option to install fully adjustable valve box and valve key extension systems, on all valves located between 6 ft. and 13 ft. Adjustable valve box and valve key extension systems must be centered over the valve's operating nut with the box cover flush with the finished pavement surface or located at another level as directed. Valve boxes must be provided with concrete collars as shown in plans. Collars around such valve boxes must be formed and finished off neatly and in a workmanlike manner.

Inline insert gate valves will be installed per manufacturer's guidelines and specifications.

3.3.6. Anchorage and Blocking.

Suitable reaction blocking or anchorage is to be provided at all dead ends, plugs, caps, tees, crosses, valves and bends as shown on the plans. All mechanical restraints are to be bidirectional. Anchor blocks are to be constructed solidly behind the fitting and symmetrical with the axis of resultant thrust except where this is not possible as in the case of gravity anchorage for vertical bends. Special ties and anchor fittings may be used in conjunction with blocking when shown on the plans or as directed.

Thrust blocking is to be a minimum of Class "A" (3,000 psi), concrete placed between solid ground and the fitting except as otherwise shown on the plans. The area of bearing in contact with solid ground is to be that shown on the plans or as directed.

All thrust blocking placed in conjunction with mains and appurtenances constructed in Pressure Zones 9 through 15 must be in accordance with CITY OF BOERNE Standard Drawings DD-839 Series. In all cases, the design of thrust blocking must be of enough size to withstand a soil pressure of 3000 psf, unless specified otherwise in the job plans or specifications. The maximum soil pressure value that will be allowed for the design of thrust blocking must be 5000 psf. When soil pressure bearing values of 4000 psf or 5000 psf are recorded for design of thrust blocks, copies of soil tests made for determining the bearing value of the soil is question must be submitted to the Engineer for verification.

The blocking is to be placed so that pipe and fitting joints will be accessible. Pipe polywrap is to be placed between the pipe or fitting and the concrete.

The reaction block on the unused branch of a tee is to be poured separately from the block across the back of the tee. If they are poured simultaneously, a rigid partition is to be placed between the blocks.

Valves 12 in. and larger in size are to be supported on a concrete pad extending vertically from 12 in. below the bottom of the valve to the lower quarter point of the hub and laterally from face to face of hubs and transversely from wall to wall of the trench.

3.3.7. Butterfly Valves

Butterfly valve installation must include: butterfly valve, coated and wrapped steel pipe nipple with reaction stop ring, concrete reaction blocking, cast-iron boot, valve box extension (ductile iron riser pipe), valve box and lid, concrete collar where subjected to vehicular traffic, all couplings and all coupling adapters required to complete the connection. The entire valve except for the operating nut must be coated with an approved

CITY OF BOERNE sewer structural coating, and wrapped with Polywrap. Butterfly Valves constructed in terrace must be constructed with No. 3 bars all around..

The valve box must be placed in such a manner to prevent shock or stress being transmitted to the valve. All valves located 6 ft. and deeper must include valve key extensions inside the valve box. The Contractor has the option to install fully adjustable valve box and valve key extension systems on all valves located between 6 ft. and 13 ft. Adjustable valve box and valve key extension systems must be centered over the valve's operating nut with the box cover flush with the finished pavement surface or located at another level as directed. Valve boxes located in streets or other areas subject to vehicular traffic must be provided with concrete collars as shown on the plans. Collars around such valve boxes must be formed and finished off neatly and in a workmanlike manner.

3.4. Backfill.

3.4.1. Initial Backfill.

Initial backfill is defined as backfill with a thickness in its compacted state from the surface of the bedding to a point 1 ft. above the top of pipe. The first lift of initial backfill is to be inspected and approved before placement of the second lift. The second lift of initial backfill material is to extend from the spring line of the pipe with a minimum of 1 ft. above the top of the pipe. The second lift is to be evenly spread in a similar manner as the first lift.

For diameters 24 in. and larger, simultaneously spread initial backfill material alongside, under the lower quadrant of pipe and over the pipe in 12 in. lifts to a minimum of 1 ft. above the top of pipe.

Consolidate initial backfill material to assure it is incorporated. A handheld vibrator, commonly used for concrete work, can be used for this purpose. The vibrator must be inserted every 3 ft. on each side of pipe.

3.4.2. Secondary Backfill.

Secondary backfill is defined as backfill from 1 ft. above the top of pipe to the top if the trench. Secondary back fill is to be constructed in accordance with details shown on plans and these specifications.

Secondary backfill material must be placed in maximum 12 in. loose lifts or as directed.

3.4.3. Sand Backfilling of Cross Trenches and Open Holes.

Air release valves, and service lines, meter boxes, or other specials are to be backfilled with sand and thoroughly consolidated by saturating with water, unless otherwise directed. The use of mechanical tamping equipment for compaction of backfill will not be permitted at such locations. Disposal of surplus excavated material and placement of sand is to be considered subsidiary to trenching and backfilling and will not be paid for directly.

3.4.4. Trench Backfill Across Traffic Arteries.

Any trench in or across traffic arteries is to be backfilled immediately after the pipe is installed unless the Engineer determines unusual conditions exist that render immediate backfilling unfeasible.

3.4.5. Flowable Backfill.

Instead of normal backfill materials, the Contractor is to backfill the trench with flowable backfill with fly ash material at the locations shown on the plans or at locations directed. The flowable backfill material and operation is to be in accordance with Item 401, "Flowable Backfill."

3.5. Flushing and Testing Mains.

3.5.1. Flushing.

Immediately upon completion of pipe lying, the Contractor is to flush all mains. This flushing is to be at the direction of the Engineer and is to consist of completely filling sections of main between valves and then displacing such initial volumes of water by introducing clear water from existing facilities into and through the main to the point of discharge from the main being flushed.

The flow-through is to continue until the Engineer determines all dust, debris, or foreign matter that may have entered during pipe laying operations has been flushed out. The new line is to then be left under system pressure for testing.

To avoid damage to pavement and inconvenience to the public, fire hoses are to be used to direct flushing water from the main into suitable drainage channels or sewers.

3.5.2. Operation of Valves.

No valve in the distribution system is to be operated by the Contractor. The Contractor is to notify the owner when a valve is to be operated and schedule time for Boerne staff to operate the valve.

3.5.3. Hydrostatic Tests.

Except in high pressure sections of the water distribution system where test pressures will exceed 150 psi, all new mains are to be hydrostatically field tested at a maximum test pressure of 150 psi before approval by Engineer. Where designated as “high pressure area,” all new mains must be hydrostatically field tested at a maximum test pressure of 200 psi before acceptance by the Engineer. All joints which are found to leak either by observation or during any test are to be made watertight by the Contractor. In case repairs are required, the hydrostatic field test is to be repeated until the pipe installation conforms to the specified requirements and is acceptable. The expense for tests which meet specified requirements is to be made in accordance with the unit price for the hydrostatic pressure test. No payment is to be made for tests which fail to meet specified test leakage requirements.

After the new main has been laid and backfilled as specified, but before chlorination and replacement of pavement, it is to be filled with water for a minimum of 24 hr. and then subjected to a hydrostatic pressure test. The specified test pressure is to be supplied by means of a pump connected to the main in a satisfactory manner. The pump, pipe connection, and all necessary apparatus including gauges and meters are to be furnished by the Contractor. Unless otherwise specified, the Water System Company will furnish water for filling lines and making tests through existing mains.

Before applying the specified test pressure, all air is to be expelled from the main. To accomplish this, taps are to be made, if necessary, at the points of highest elevation and afterwards tightly plugged at no cost to the Department. At intervals during the test, the entire route of the new main is to be inspected to locate any leaks or breaks. If any are found, they are to be stopped or repaired. The test is to be repeated until satisfactory results are obtained.

The hydrostatic test is to be made so that the maximum pressure at the lowest point does not exceed the specified test pressure. The duration of each pressure test is to be a minimum of 4 hr. for new mains in excess of 1,000 ft. and a minimum of 2 hour for new mains less than 1,000-ft after the main has been brought up to test pressure. The test pressure is to be measured by means of a tested and properly calibrated pressure gauge acceptable to Engineer. All pressure tests are to be continued until the Engineer is satisfied that the new main meets the requirements of these specifications. Should any test of pipe in place disclose leakage greater than listed in Table 22, Hydrostatic Test Leakage Allowances, the Contractor is to, at his expense, locate and repair the defective joints until the leakage is within the specified allowance. Leakage is defined as the quantity of water supplied into the newly laid main, or any valve section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the

air expelled. The Contractor is to notify the Engineer before beginning the test, and the Water System Company's Inspector is to be present during the pressure test.

Maximum allowable leakage in ductile iron pipe in gallons per hour per 1,000 feet of pipe is shown in Table 22.

Table 22

Avg. Test Pressure (psi)	Nominal Pipe Diameter (IN)						
	4	6	8	10	12	14	16
450	0.64	0.95	1.27	1.59	1.91	2.23	2.55
400	0.6	0.9	1.2	1.5	1.8	2.1	2.4
350	0.56	0.84	1.12	1.4	1.9	1.97	2.25
300	0.52	0.78	1.04	1.3	1.56	1.82	2.08
275	0.5	0.75	1	1.24	1.49	1.74	1.99
250	0.47	0.71	0.95	1.19	1.42	1.66	1.9
225	0.45	0.68	0.9	1.13	1.35	1.58	1.8
200	0.43	0.64	0.85	1.06	1.28	1.48	1.7
175	0.4	0.59	0.8	0.99	1.19	1.39	1.59
150	0.37	0.55	0.74	0.92	1.1	1.29	1.47

3.6. Disinfection of New Mains Utilizing Machine Chlorination.

After the new mains have successfully passed the pressure test specified in Section 3.5.3, “Hydrostatic Tests,” the Contractor will disinfect those mains shown on the plans or otherwise indicated as “Machine Chlorination.” This disinfection is to include chlorination, flushing, and placing the mains in service. Each affected segment of the system will be flushed at a velocity of at least 2.5 feet per second.

3.6.1. Operation of Valves.

During and after the disinfection of mains, the Contractor is to be notified by the Engineer sufficiently in advance to enable the Contractor to have a competent representative present whenever valves are to be operated that will affect the pressure in any part of the work for which the Contractor is responsible.

3.6.2. Contractor's Personnel and Equipment.

The Contractor is to supply labor and equipment necessary to make all excavations required for chlorination, equipment connections, subsequent flushing, and placing the mains in service.

3.6.3. Safeguarding and Backfilling Open Holes.

The Contractor is to be responsible for safeguarding any open holes excavated or left open for flushing and disinfection purposes. Following completion of disinfection, the Contractor is to backfill such holes in accordance with appropriate provisions of Section 3.4., “Backfill.”

3.6.4. Disinfection of Mains.

Main disinfection will be performed using either a chlorine gas and water mixture administered by a solution-feed chlorinating device or the application of one of calcium hypochlorite or sodium hypochlorite. Liquid chlorine must comply with AWWA B301 and solid chlorine compounds must comply with AWWA B300.

Pipe disinfection, initial chlorine concentrations, and residual chlorine concentrations will meet the criteria of AWWA C651. Compliant chlorine concentrations levels must be demonstrated to the City of Boerne using an approved test method. Chlorine application may be by either continues feed or slug methods. System must be tagged during chlorination procedure.

After disinfection, a reducing agent will be used in compliance with AWWA C651 to neutralize chlorine residual. All treated water will then be flushed completely from the system. Two samples will be drawn for bacteriological testing for compliance with TCEQ requirements. Disinfection procedure and testing will be repeated until satisfactory results from two samples are obtained.

Filling and flushing must occur between the hours of 12am and 4am, unless otherwise approved in advance by the City of Boerne Director of Public Works. Contractor will obtain a bulk water meter at the commencement of the work and purchase all water at City of Boerne bulk rates.

3.6.5. Dosage.

Disinfectant dosage will conform with AWWA C651.

3.6.6. Filling the Main.

Those sections of main to which dry choline compound has been applied is to be filled slowly to allow for the even distribution of the disinfecting material. The manipulation of valves is to be performed only by City of Boerne staff.

3.6.7. Holding Time.

The length of time that sections of main are disinfected will conform with Texas Commission on Environmental Quality (TCEQ) criteria and AWWA C651.

3.6.8. Flushing.

Following the expiration of the specified holding time, the treated section of main is to be flushed thoroughly by the Contractor in accordance with the applicable provisions of Subarticle 3.5, “Flushing and Testing Mains.” Flushing is to continue until no chlorine remains detectable by taste or odor or until the chlorine residual is less than 0.3 ppm. The Contractor must make provisions for the disposal and runoff of the flushing operations to minimize erosion or impact to residents.

3.6.9. Preventing Reverse Flow.

The use of jumpers and backflow prevention between existing mains and new construction will be required to prevent reverse flow into system.

3.6.10. Supervision.

All disinfection is to be done as directed.

3.6.11. Additional Treatment.

Should the new main fail to meet minimum public health standards for bacteriological quality after flushing, further treatment is to be as directed. If further disinfection is required, chlorination is to be done in accordance with Subarticle 3.6, “Disinfection of New Mains Utilizing Machine Chlorination.” In no case, however, is the new line to be acceptable as complete and satisfactory until the bacteriological quality of the water taken from the main meets the Standards of the TCEQ.

If an open hole is unsafe and does not have proper trench protection, owner’s chlorination crew will not chlorinate project until acceptable trench protection is provided.

3.6.12. Safeguarding and Backfilling Open Holes.

The requirements for safeguarding and backfilling all holes excavated or left open for chlorinating and sampling is to be as specified in Section 3.F.3, “Safeguarding and Backfilling Open Holes.”

3.7. Service Supply Lines.

Service supply lines and fittings, meter boxes and appurtenances must conform to material specifications and must be installed by the contractor as specified herein, or as directed and in accordance with plans.

3.7.1. Designation of Service Supply Lines: A service supply line located between the Water main and the inlet side of the water meter is designated as a “water service line.” A service supply line located between the outlet side of the water meter to the point of connection within the limits of the Customers lot or property is designated as “Customer’s yard piping.” Services 2” and smaller are designated “small services”; services 4” and larger are designated “large services.”

3.7.2. Service Relays: New transfer mains to which services are to be relayed and are on the same side of the streets as the Customer’s meter are defined as “short relays.” New transfer mains to which services are to be relayed and are on the opposite side of the street from the Customer’s meter are defined as “long relays.”

Service Reconnects: New transfer mains to which services are to be reconnected and on the same side of the street as the old main are defined as “service reconnects.”

Existing services on the opposite side of the street to the new main must be defined as a “long relay.”

3.7.3. Service Relocates: Service Relocates are defined as services that are relocated from an alley to a side or front street. New transfer mains to which services are to be relocated and are on the same side of the street as the Customer’s new meter box location, are designated as “short relocates.” New transfer mains to which services are to be relocated and are on the opposite side of the street from the Customer’s new meter box location, are designated as “long relocates.”

3.7.4. New Services: If a new main is required to be extended to provide water service for new Customers, the service lines laid to the new main must be designated as "new services." New laid mains to which new services are on the same side of the street as the Customer's new meter box location, are designated as "new short services." New laid mains to which new services on the opposite side of the street from the Customer's new meter box location, are designated as "new long services."

3.7.5. New Un-metered Services: New Un-metered services are defined as services that are installed on existing mains or new mains to provide service to Customers platted vacant lots. Where the new main or existing main to which new un-metered services are being installed is on the same side of the street as the Customer's new or existing meter box location, (Inspector to set location of new meter box if no existing meter box is set), the services to be laid are designated "new un-metered short services." Where the new main or the existing water main to which new un-metered services are installed is on the opposite side of the street from the Customer's new or existing meter box location, (Inspector to set location of new meter box if no existing meter box is set), the services to be laid are designated "new un-metered long service.” New un-metered long services and new un-metered short services will not include "Customer's yard piping" and no meter will be set.

3.7.6. Tap Holes: Tap holes are defined as excavations at existing mains, which are required in association with replacements of water service lines by pulling, boring or jacking operations.

All backfill material must be as specified for main and service line trench excavation.

For service lines and tap holes, payment for bedding, initial backfill and secondary backfill must be included in the various sizes of each service placed.

3.7.7. Service Line Installation: Unless otherwise notified, service relays, service reconnects, service relocates and new services must be installed as described herein, and in plans. Unless otherwise indicated, existing meter and meter box relocation must be included in the service line installation.

All service line installation must include a dielectric union to be installed within the meter box on the outlet side of the meter, as shown in plans.

Cutting, excavation, backfill and replacement of pavement must be done as specified herein and in accordance with applicable sections of this specification and the contract documents. The minimum trench width for small service lines must be 8 in., while the minimum trench width for large service Lines must be the nominal pipe diameter plus 16 in., except when specified otherwise by the Engineer. For ¾" to 2" Service lines, minimum bury depth must be 3 ft. For services greater than 2", minimum depth of bury must be 4 ft.

All service lines must be installed in accordance with plans, and specifications, except that two strap service saddle clamps must be installed for all tap connections made on water mains located within boundaries of Pressure Zones (formally known as Service Levels) 9 through 16.

The Contractor must use precaution to protect and preserve the polyethylene wrap around Ductile-Iron (DI) water mains when installing service corporations. The required method is, wrap pipe tape around the pipe, over the polywrap, in the area to be tapped. The tap must be made through the tape and polywrap. It is not necessary to remove and replace polywrap. All exposed pipe, corporation and the first three feet of the service, must be wrapped and taped to achieve a complete seal. In addition, a sand envelope must extend over and around the connection to a depth of 8 in. above the main.

Small service lines must be embedded in sand in accordance with specification

Where approved by the Construction Inspector, the Contractor may lay the new service line from the corporation stop to the curb stop or angle valve. Upon completion, the Contractor must isolate the new service line by closing the curb stop or angle valve until the meter box is set.

3.7.8. Splicing: A long service line single splice may be permitted by means of a 3-part compression or flared coupling only when approved in advance by the Engineer, provided the location of the splice is not under pavement or concrete. The segment added is required to be the same material as the existing service line, unless otherwise directed by the Engineer. Splicing short service lines will not be permitted.

3.7.9. Boring or Jacking Service Lines: Service lines which cross paved streets may be installed at the Contractor's option by boring or jacking operations. Where it becomes necessary to widen the main trench section to accommodate a bore pit, such widening must not extend more than one additional foot into the traffic side of the street.

3.7.10. Tapping Asbestos Cement (AC) Water Mains: All necessary service line tapping of AC pipe must be completed during the period immediately before or after hydrostatic pressure testing operations so that subsequent flushing will maximize the elimination of contaminants associated with the tapping process.

Tapping of AC pipe must be done in accordance with manufacturers' recommendation and done only with tap machine with a built in flush valve and the flush valve must be open during the entire procedure.

3.7.11. Abandonment of Service Lines: The Contractor must accomplish all cutting, capping, and plugging necessary to isolate new service lines transferred to new and existing mains from those abandoned, including service lines designated on the plans as "tap plug" and "tap kill." The corporation stop for an abandoned service line tapped on a ferrous main must be removed, and the tap at the main must be plugged with an appropriately sized brass plug. For a non-ferrous main, the corporation stop must not be removed from the main. Instead, the corporation stop must be closed and the flared nut must be removed from the corporation stop. After the appropriately sized copper disc is inserted inside the flared nut, replace the flared nut on the corporation stop. The Contractor must salvage copper service line tubing, brass fittings, and other materials as directed by the Inspector and return them to the Owner.

3.7.12. Tapping PVC (C-900): Tapping of PVC must be done in accordance with Uni-Bell procedures. Direct Tapping will not be allowed. All drill cutting tools must be the "shell type" with internal teeth or double slots which will retain the coupon.

The shell cutters must be designed for C-900 pipe, thus with enough root depth to handle the heavier walled pipe.

3.7.13. Small Service Lines: Copper tubing must be used for ¾" through 2" service lines. Brass fittings for ¾" and 1" service lines must be of the flared or compression type for the use with Type 'K' soft annealed copper tubing. Brass fittings for 1½" and 2" lines must be of the flared or compression type for use with type 'K' soft annealed copper tubing, except as modified by this specification.

Copper tubing must be cut squarely by using an approved cutting tool and by avoiding excessive pressure on the cutting wheels which might bend or flatten the pipe walls. Following the copper tubing cut, but before flaring, a reamer must be used to remove the inside rolled lip from the tubing. Flared ends must be expanded by the use of a flaring tool using care to avoid splitting, crimping, or overstressing the metal. Pipe adjacent to the fittings must be straight for at least 10 in. Bending of tubing must be accomplished by using an appropriate sized bending tool. No kinks, dents, flats, or crimps will be permitted, and should such occur, the damaged section must be cut out and replaced. When compression fittings are used, the copper tubing must be cut squarely before insertion into the fitting Final assembly must be in accordance with the manufacturer's recommendations.

3.7.14. Small Service Lines on New Mains: Installation of new copper service lines must consist of all excavation through miscellaneous material encountered; trench excavation protection; drilling and tapping the new main with an approved tapping machine; setting the curb stop or angle valve at the meter; laying the new copper service line at the specified depth between the main and the meter and its tie-in at the corporation and the curb stop or the angle valve; relocating the existing meter and installing a new meter box where required in accordance with this specification, herein; backfilling the trench with approved selected material and disposal of surplus excavated material; capping the tap hole with asphalt treated base, including the outer limits of the main trench line with service line trench; cutting and replacing pavements, curbing and sidewalks of all types over the limits of the main line trench and the completed service line trench.

3.7.15. Reconnecting Service Lines: Both old and new water mains at existing service line connections as shown on the plans must be exposed. The old main must be exposed for the purpose of gaining access to the existing service corporation stop and the new main for the purpose of installing the new corporation stop. The new main must be exposed for the purpose of being drilled and tapped with an approved tapping machine, a new corporation stop installed under pressure, and the trench extended laterally to expose enough length of the existing service line to provide slack to bend it to position for tying to the new corporation stop. After suitable notification to the Customer, the Contractor must "kill" the existing service by closing the corporation stop, removing the existing flare nut, inserting the existing flared nut on the corporation stop if the main is non-ferrous, or plugging the existing service line at the main if the main is ferrous. The Contractor must then immediately open the stop and restore water service to the Customer. Where it is not possible to obtain enough length in the existing service to tie directly to the new main, at the direction of the Engineer, the Contractor must splice the necessary length of new tubing and tie it to the existing service by means of a compression coupling at a point as close as practicable to the new main.

Cutting and bending of the tubing, introduction of slack to compensate for soil movement, and completion of the installation must be as specified in this specification.

Where old and new mains are on opposite sides of the street, service lines may be installed under the street pavement by boring rather than trenching.

3.7.16. Relaying Service Lines: The existing or new mains shown on plans must be exposed opposite location stakes placed on site at the direction of the Engineer. The existing or new main must; be drilled and tapped with an approved tapping machine, a new corporation stop installed, and the trench extended laterally to the location specified for the meter box. The existing meter must be reset and the meter box and base must be installed at its staked location and perpendicular to the corporation stop in the water main. The meter box location must not vary more than 24 in. in any direction from its staked location. The service line must be installed with enough slack to compensate for soil movement. Where the location of the existing meter is not changed, the new service line must be extended from the main to the existing meter, a new curb stop installed at the end of the service line, and connected to the inlet side of the meter. If disturbed, the existing

meter box must be reset to correct grade. Long service relays may be placed under the street pavement by boring or jacking rather than trenching.

3.7.17. Single Service Line - Dual Meters: The single service line - dual meter installation must consist of a 1" copper service line reducing to two ¾" copper service lines at a tee which must be set in line with the front edge of meter boxes for ⅝" and ¾" meters. A single service line with dual meters must be installed in those new residential developments where new ⅝" and ¾" meters are required and in main replacement work where it is necessary to change the location of existing ⅝" and ¾" meters. Single service line - dual meter materials and installation requirements must conform to requirements established herein.

3.7.18. Small Service Lines on Existing Mains: The work involved in the installation of new copper service lines on existing mains must consist of jacking, boring, tunneling, and, where authorized, open trench operations all excavation through whatever material encountered; trench excavation protection; using the existing corporation when approved by the Engineer; tapping the existing main and installing the new corporation and setting the curb stop or angle valve at the meter; relocating the existing meter and installing a new meter box where required in accordance with this specification; abandoning the existing corporation stop, removing the existing flared nut, inserting inside the existing flared nut an appropriately sized copper disc and replacing the existing flared nut on the corporation stop if the main is non-ferrous, or plugging the existing service line at the main if the main is ferrous; installing the new service line at the same grade as the existing service line or at the specified grade between the main and the existing meter and its tie-in at the corporation and the curb stop; disposal of surplus excavated material; capping the tap hole with asphalt treated base including the outer limits of the main line trench and the service line trench; cutting and replacing all surfaces of whatever type encountered over the completed service line trench; restoration of the site.

3.7.19. Large Service Lines: DI pipe and cast-iron fittings used for metered service lines and non-metered fire service lines larger than 2" must be installed in accordance with the applicable provisions of this specification, except where otherwise approved by the Engineer.

3.7.20. Large Service Lines on New Mains: Work involved in the installation of a new metered service lines and non-metered fire service lines must consist of all excavation through whatever material encountered; trench excavation protection, installing tees, pipe and fittings of various sizes including main line and service line valves, valve boxes, DI pipe, fittings, in accordance with plans and reaction block required; backfilling with approved selected material; cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed DI service line.

3.7.21. Large Service Lines on Existing Mains: The work involved in the installation of the new metered service lines and non-metered fire service lines must consist of all excavation through whatever material encountered, trench excavation protection, cutting-in tees and installing tapping sleeves and valves, pipe and fittings of various sizes including main line and service valves; valves boxes, DI pipe, fittings and reaction block required; backfilling with approved selected material; cutting and replacing pavements, curbing, and sidewalks of all types over the limits of the main line trench and the completed DI service line.

3.7.22. Meter Boxes. Physical movement of existing meters and meter boxes to new locations may be required where service lines are transferred to new mains in conjunction with main replacement work. Unless specified otherwise, the Contractor must move existing meters and meter boxes and reconnect and adjust customer's yard piping as part of transferring service lines. A dielectric coupling PVC schedule 80 must be installed within the meter box between the meter and the customer's yard piping.

Round and oval meter boxes with round covers must be salvaged and returned to the Owner by the Contractor. The Contractor must also replace the salvaged meter boxes with the new, appropriately styled oval plastic meter box with oval cover, or rectangular meter box. Unless otherwise specified, the old service line must be abandoned after the existing meter has been reset in the existing or new meter box.

Where meter boxes are installed in sidewalks or driveways, the Contractor must install a number one meter box (2 pieces) as shown in the Specification and plans.

New meters will be set by the Owner where mains are extended and new services lines are installed for new or initial customer service. Instead of the new meter, the Contractor must furnish and install a meter template in accordance with plans.

Meter and meter box configuration, must have the meter set horizontal, approximately 6 in. below the top of meter box, so that the meter is above the bottom of the meter box and in line with the meter box lid opening. The top of the meter box must be flush with the existing ground surface. All excess soil above the meter coupling, meter flange and meter nuts inside the meter box must be removed so that the meter register is clearly visible. The Contractor must exercise special precautions during excavation at the existing meter location to minimize the disturbance of the customer's yard piping. However, if the existing meter elevation is low, the Contractor must raise the existing meter to conform to the correct configuration indicated herein. Adjustment of meter to proper grade is incidental to the construction and will not be paid for separately.

Where required, pressure reducing valves must be installed by the customer in accordance with the Uniform Plumbing Code and must be placed beyond the outlet side of the meter, but not within the Owner's meter box. The pressure reducing valve must be the property of the water user who will be responsible for its installation, maintenance, and replacement as required.

The meter box adjustment must not exceed 10 feet from the existing box.

3.7.23. Water Service for Fire Lines

3.7.23.1. Start of Work: Three working days' notice will be given to the assigned

Inspector before start of a project after permit has been issued. The Contractor must start his work at a tie-in or point designated by the Engineer. Pipe must be laid with bell ends facing in the direction of laying, unless otherwise authorized or directed by the Engineer. All valves and fire hydrants must be installed as soon as pipe laying reaches their established location. Pipe must be installed to the required lines and grades with fittings, valves, and hydrants placed at the required locations. Spigots must be centered in bells or collars, all valves and hydrant stems must be set plumb, and fire hydrant nozzles must face as shown on the plans or as directed. No valve or other control on the existing system should be operated for any purpose by the Contractor.

3.7.23.2. Crossing Other Underground Lines: New fire line services crossing any other utilities must have a minimum of 48 in. of cover over the top of the pipe and a minimum clearance to other utilities of 12 in. unless otherwise waived or modified by the Engineer. Excavation around other utilities must be done by hand for at least 12 in. all around. Any damage to other utilities must be reported to their proper governing entity.

3.7.23.3. Pipe Grade: Fire line services must have a minimum of 48 in. of cover for mains 16" and below, and 60 in. for mains 20" and above, over the top of the pipe unless otherwise waived or modified by the Engineer. Pipe grades must be as required by the plans or as directed. Grades must be met as specified. Precautions must be taken to insure that the pipe barrel has uniform contact with the Modified Grade 5 for its full length except at couplings. Couplings must not be in contact with the original trench bottom before backfilling. Modified Grade 5 material must be placed under the coupling and compacted by hand before backfilling so as to provide an even bearing surface under the coupling and pipe. Changes in grade must be made only at joints.

3.7.23.4. Modified Grade 5 Materials: Before placing pipe in a trench, the trench must have been excavated to the proper depth as required of these specifications. Approved imported materials or Engineer approved materials selected from suitable fines derived from the excavation must be smoothly worked across the entire width of the trench bottom to provide a supporting cushion.

3.7.23.5. Structures to Support Pipe: Whereas the bottom of a trench at subgrade consist of material that is notably unstable by the Engineer and cannot be removed and replaced with approved material may be properly compacted in place to support the pipe. The Contractor must also construct a foundation for the pipe consisting of piling, concrete beams, or other supports in accordance with plans prepared by the Engineer.

3.7.23.6. Lowering Materials into Trench: Proper implements, tools, and facilities satisfactory to the Engineer must be provided and used by the Contractor for the safe and convenient completion of work. All pipe, fittings, valves, and hydrants must be carefully lowered into the trench piece by piece, by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to water service materials and protective coatings and linings. Under no circumstances must water service materials, pipes, fittings, etc., be dropped or dumped into the trench. Extreme care must be taken to avoid damaging polywrap films. No chains or slings must be allowed unless the entire sling is wrapped with a protective nylon web sock.

3.7.23.7. Laying of Pipe: Every precaution must be taken to prevent foreign material from entering the pipe during its installation. Under adverse trench conditions or otherwise required by the Engineer, a heavy, tightly woven canvas bag of suitably sized must be placed over each of the pipe.

The Canvas bag must be left in place until a connection is made to the adjacent pipe. The interior of each pipe must be inspected for defects, and the pipe must be rejected if any defects are found.

After placing a length of pipe in the trench, the jointed end must be centered on the pipe already in place, forced into place, brought to correct line and grade, and completed in accordance with the requirements of these Specifications. The pipe must be secured in place with approved backfill material tamped around it. Pipe and fittings which do not allow enough and uniform space for joints must be rejected and must be replaced with pipe and fittings of proper dimensions. Precautions must be taken to prevent dirt or other foreign matter from entering the joint space.

At times when pipe laying is halted, the open end of pipe in the trench must be closed by a watertight plug or other means approved by the Engineer. Pipe in the trench which cannot temporarily be joined must be capped or plugged at each end to make it watertight. This provision must apply during all periods when pipe laying is not in progress. Should water enter the trench, the seal must remain in place until the trench is pumped completely dry. The Contractor must provide all plugs and caps of the various sizes required.

3.7.23.8. Deviations in Line or Grade: Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to an extent that an alteration in the plan is required, the Construction Inspector must have the authority to change the plans and direct a deviation from the line and grade or to arrange with the owners of the structures for the removal, relocation, or reconstruction of the obstructions. Any deviation from the line must be accomplished by the use of appropriate bends unless such requirement is specifically waived by the Engineer.

Whenever it is necessary to deflect pipe from a straight line, the deflection must be as directed by the Construction Inspector and as described herein. In no case must the amounts exceed those shown in Table 19 "Maximum Deflections of Ductile-Iron Pipe" for ductile-iron pipe

3.7.23.9. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces must be accomplished in a neat manner so as to produce a smooth end at right angles to the axis of the pipe. The recommendations of the pipe manufacturer must be strictly followed by the Contractor. Under no circumstances, must a workman not equipped with proper safety goggles, helmet and all other required safety attire be permitted to engage in this work.

3.7.23.10. Asbestos-Cement (AC): No field cutting will be allowed on asbestos cement pipe. Installation of fire line services to AC pipe mains must accomplished according to paragraph 3.B.16.

Joint Assembly:

3.7.23.10.1. Rubber Ring Joints: The installation of pipe and the assembly of rubber ring joints for Ductile-Iron pipe must conform to the pipe manufacturer's assembly instructions. The method of inserting spigot ends of pipe in bells or collars known as "stabbing" must not be permitted. Spigot ends of pipe must be properly inserted in the joint by means of suitable pushing or pulling devices or a manufacture approved method.

3.7.23.10.2. Mechanical Couplings: Mechanical couplings must be assembled and installed according to the standards recommended by the manufacturer.

Mechanical coupling consists of a cylindrical steel middle ring, two steel follower rings, two rubber compound gaskets, and a set of steel bolts. The middle ring is flared at each end to receive the wedge-shaped gasket which is compressed between the middle ring flare and the outer surface of the pipe by pressure exerted on the follower rings through the bolt circle.

Before the installation of the mechanical coupling, the pipe ends must be cleaned by wire brush or other acceptable method to provide a smooth bearing surface for the rubber compression gasket. The pipe must be marked to align the end of the coupling which will center it over the joint. After positioning, the nuts must be drawn up finger tight. Uniform pressure on the gaskets must be applied by tightening alternate bolts on the opposite side of the circle in incremental amounts. Soap and final tensioning must be accomplished with a torque wrench and in a matter similar to the tightening procedure after 15 min.

3.7.23.10.3. Restrained Joints: Restrained Joints must be installed as shown on the plans or as directed by the Construction Inspector. Installation must conform to the manufacture's recommendations.

3.8. Installation of the Nonmetallic Pipe Detection System.

The nonmetallic pipe detection system is to be installed concurrently with the proposed pipe placement. Tracer wire must be used for location purposes and taped directly to the pipe. The tracer wire must be solid core (14 gauge insulated), and must be taper to the main in 10-inhc increments. Wire must also come up to the top of valve extensions and fire hydrant stems, as directed.

3.9. High Pressure Zone

Work performed for construction of a high pressure water distribution system, including water mains, services, fire hydrants, and all related appurtenances, is to be done in accordance with this specification. This subsection applies solely to the construction of high pressure water systems and must govern when in conflict with of subsections of this specification.

3.9.1. High Pressure Systems. Each water distribution system that furnishes water in Pressure Zone 9 through 16 must be designated as a high pressure system. The static water pressure in each in each Service Level must be not less than 35 psi nor exceed 175 psi with no fire hydrants in use.

3.9.2. Locations of High Pressure Levels. Geographically, boundaries of Pressure Zones 9 through 16 conform to the surface contour tabulation shown in Table 23, High Pressure Levels. Most of the area within Pressure Zones 9 through 16 is located north of Loop 1604 between IH-35 North and Bandera Road.

Table 23

Static Gradient Service Level	Max Ground Elevation (ft)	Ground Elevation (ft)	Ground Elevation 110 psi (ft)	Ground Elevation 150 psi (ft)	Ground Elevation 175 psi (ft)
9	1125	1000	870	780	720
10	1290	1160	1040	940	880
11	1400	1270	1150	1050	1000
12	1520	1390	1270	1170	1120
14	1630	1500	1380	1280	1230
15	1860	1730	1600	1510	1460
16	1990	1860	1740	1640	1590

4. MEASUREMENT

4.1. This Item will be measured as follows: "Ductile Iron Pipe," "PVC Wtr Ln (Op Ct)," "Pipe Water Main (DI)," "Pipe Water Main (PVC)," "Pipe Water Main (PVC Casing) (Open Cut)," and "Pipe Water Main (Steel Casing) (Open Cut)" for water pipe of the various sizes shown on the plans, will be measured by the linear foot as follows: From the centerline intersection of runs and branches of tees to the end of the valve of a dead-end run.

Between the centerline intersections of runs and branches of tees, and where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.

The measurement of each line of pipe of each size will be continuous and is to include the full laying lengths of all fittings and valves installed between the ends of such line except that the laying lengths of reducers will be divided equally between the connected pipe sizes. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

4.2. "Fire Lines" will be measured by the linear foot for each size and type from the centerline intersection of the fire line with the main distribution line to the property line. The measurement will include the entire laying length of the branch or branches of the fitting and valves. Line leading to a tapping connection with an existing main will be measured to the center of the main tapped.

4.3. "Jacking or Boring (Water Main)" will be measured by the linear foot of bore or tunnel as measured from face to face of jacking pits.

Carrier pipe used in bores and tunnels or backed into place will be measured by the linear foot of pipe installed from end to end of pipe to the limits shown on the plans

Carrier pipe installed in open trenches, where required by the plans, will be measured by the linear foot of pipe installed from end to end of pipe to the limits shown on the plans.

Casing or liners used in bores and tunnels, where required by the plans, of the size and material required will be measured by the linear foot actually installed in accordance with plans.

Casing installed in open trenches, where required by the plans, of the size and material required will be measured by the linear foot actually installed in accordance with plans.

4.4. "Butterfly Valve and Box (Complete)" will be measured as each assembly of the various sizes installed.

4.5. "Gate Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.6. "Inline Insert Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.7. "Cut-in Butterfly Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.8. "Cut-in Gate Valve and Box (Complete)" will be measured as each assembly of the various sizes installed to finished grade.

4.9. "Tapping Sleeve, Valve and Box (Complete)" will be measured as each assembly of the various sizes installed.

4.10. "Cut-in Tee (Complete)" will be measured as each assembly of the various sizes of cast-iron tees cut-in to the existing water main.

4.11. "Adjust Existing Valve Box" will be measured as each assembly adjusted to correspond to finish grade.

4.12. "Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars" for pipe will be measured by the cu. yd. as dimensioned on the plans, 6' in depth measured from the outside pire diameter (0.0) or as directed. Reinforcing if required will not be measured for payment.

4.13. "Fire Hydrant with 6 in. Valve and Box" will be measured as each fire hydrant installed. Also included will be enough pipe, valve and fittings.

4.14. "Relocate Fire Hydrant" will be measured as each fire hydrant relocated.

4.15. "Permanent Blow-off (Complete)" will be measured as each assembly of the various sizes installed.

4.16. "Temporary Blow-off (Complete)" will be measured as each assembly of the various sizes installed.

4.17. "Automatic Air Release Valve (Complete)" will be measured as each assembly of the size installed.

4.18. "Trench Excavation Protection" and "Joint Trench Excavation Protection" will be measured by the linear foot along the centerline of trench where the depth of trench exceeds 5 ft.

4.19. "Tie-In (Complete)" will be measured as each of the various sizes and types completed.

4.20. "New Short Service" will be measured as each of the various sizes and types of new service lines installed.

4.21. "New Long Service" will be measured as each of the various sizes and types of new service lines installed.

4.22. "New Unmetered Short Service" will be measured as each of the various sizes and types of new unmetered service lines installed.

4.23. "New Unmetered Long Service" will be measured as each of the various sizes and types of new unmetered service lines installed.

4.24. "Reconnect Short Service" will be measured as each of the various sizes of service lines reconnected.

4.25. "Reconnect Long Service" will be measured as each of the various sizes of service lines reconnected.

4.26. "Relay Short Service" will be measured as each of the various sizes of service lines re-laid.

4.27. "Relay Long Service" will be measured as each of the various sizes of service lines re-laid.

4.28. "Relocate Short Service" will be measured as each of the various sizes of service lines relocated.

4.29. "Relocate Long Service" will be measured as each of the various sizes of service lines relocated.

4.30. "Relocate Existing Meter and Existing Meter Box" will be measured as each assembly relocated and customer's service reconnected.

4.31. "Relocate Existing Meter and New Meter Box" will be measured as each assembly relocated and customer's service reconnected.

4.32. "Cut and Replace Concrete Sidewalk, Driveway, Etc." will be measured by the sq. yd. of surface area of the concrete sidewalk cut and replaced, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on plans.

4.33. "Cut and Replace Concrete Sidewalk (Asphalt)" will be measured by the sq. yd. of surface area of concrete sidewalk to be cut and replaced with temporary asphalt (4 in. depth, Type C) pavement, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on the plans.

4.34. "Cut and Replace Asphalt Pavement" will be measured by the sq. yd. of surface area of the asphalt pavement cut and replaced, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on plans.

4.35. "Concrete Curb" will be measured by the linear foot of the concrete curb cut and replaced, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on plans.

4.36. "Cut and Replace Asphalt Pavement with 6 in. Asphalt Treated Base" will be measured by the sq. yd. of surface area of the asphalt pavement cut and replaced with 6 in. of asphalt treated base, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on plans.

4.37. "Hydrostatic Test" will be measured as each successful test conducted.

4.38. "Excavation" will not be measured for payment, but is to be considered subsidiary to the pipe installation.

4.39. "Flowable Backfill." Will be measured by the cu. yd. in accordance with Item 401, "Flowable Backfill," but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench" or as shown on the plans.

4.40. "Installation of the Nonmetallic Pipe Detection System" will not be measured for payment, but is to be considered subsidiary to the pipe installation.

4.41. "Removing and Replacing Chain-Link or Wire Fence" will be measured by the linear foot of fence removed and replaced, regardless of the type or height of the fence. The existing fence materials may be reused unless, the existing materials were damaged during removal and should not be reused, the Contractor is to provide new material for the replacement work at his expense.

4.42. "Water Service Line Breaks Leak Repair" will be measured by the unit of each such assembly of all types and sizes of service lines, repair and tap clamps required to repair the service line break and or leak.

4.43. "Water Main Breaks Leak Repair" will be measured by the unit of each such assembly of the various types and sizes of water mains, services, repair and tap clamps required to repair the water main break or leak.

4.44. "Ductile Iron and Gray Iron Fittings" will be measured by the weight to the nearest one-hundredth of a ton of the various sizes of fittings installed.

4.45. "Remov & Dispose Exist WL All Sizes (AC)" will be measured by the foot for all lines removed from pipe joint to pipe joint.

4.46. "Grout Abandonment Water Main" will be measured by the foot of abandoned main per each size diameter of pipe.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for the items of work hereinafter described. These prices are to be full compensation for furnishing and hauling all materials; for placing or installing the materials; for inspection and testing; and for all other items of material, labor, equipment, tools and incidentals necessary to complete the work in accordance with the plans and specifications.

5.1. Payment for "Ductile Iron Pipe," "PVC Wtr Ln (Op Ct)," "Pipe Water Main (DI)," "Pipe Water Main (PVC)," "Pipe Water Main (PVC Casing)(Open Cut)," and "Pipe Water Main (Steel Casing)(Open Cut)"

will be made at the unit price bid per foot of pipe of the various sizes installed by the open cut method. This payment is also to include selected bedding, excavation, backfill materials, polyethylene sleeve, and hauling and disposition of surplus excavated materials.

5.2. Payment for "Fire Lines" installed will be made at the unit price bid for pipe of various sizes installed. Such payment must include excavation selected embedment material, backfill, compaction of trench backfill, testing of compaction, tie-in, polyethylene sleeve where required, hauling, disposing of surplus excavated material, and restoration of surface. All replacement mains must include tie-in costs for existing fire lines.

5.3. Payment for "Jacking, Boring or Tunneling" will be paid for at the contract unit price bid per linear foot of jacking, boring or tunneling, which price must be full compensation for furnishing all materials (except carrier pipe, casings or liners), labor, tools, equipment and incidentals necessary to complete the work, including excavation, grouting, backfilling, restoration to original ground conditions, and disposal of surplus materials.

Carrier pipe used in bores or tunnels must be paid for at the contract unit price bid for "Carrier Pipe" per linear foot of pipe installed and measured as prescribed above.

Carrier pipe installed in open cut trenches must be paid for at the contract unit price bid for "Carrier Pipe" per linear foot of casing installed and measured as prescribed above.

Casings or liners used in bores or tunnels must be paid for at the contract unit price bid for "Casing (Bore)" per linear foot of casing or liner installed and measured as prescribed above.

Casings installed in open cut trenches must be paid for at the contract unit price bid for "Casing (Open Cut)" per linear foot of casing installed and measured as prescribed above.

5.4. Payment for "Gate Valve and Box (Complete)," "Inline Insert and Box (Complete)," "Tapping Sleeve, Valve and Box (Complete)," and "Butterfly Valve and Box (Complete)" will be made at the unit price bid for each such assembly of the various sizes installed. This payment is also to include selected embedment material, anti-corrosion embedment when specified, concrete collar at the valve box where subjected to vehicular traffic, ductile iron riser pipe, cast-iron boot, packing, tarpaper, concrete grout, concrete reaction blocking, asphaltic material for bolts, nuts and ferrous surfaces, polyethylene sleeve, hauling and disposition of excavated surplus material and backfill where required. For butterfly valves only, such payment is also to include mechanical or transition couplings, and coated and wrapped steel pipe nipples required to complete the connection.

5.5. Payment for "Cut-in Gate Valve and Box (Complete)" and "Cut-in Butterfly Valve and Box (Complete)" will be made at the unit price bid for each such assembly of the various sizes installed. This payment is to include backfill, installation of valve, valve box assembly, all pipe cut and used to complete cut-in, reaction blocking, and polyethylene sleeve where required.

5.6. 5.7. Payment for "Cut-in Tee (Complete)" will be made at the unit price bid for each of the various sizes of cast iron tees cut-in to ductile and cast iron mains. This payment is also to include necessary tie-ins, protective coating for bolts, nuts, ferrous surfaces, selected embedment material, anti-corrosion embedment when specified, backfill, pipe, fittings, polyethylene sleeve when required, concrete reaction blocking, and site restoration.

5.8. Payment for "Adjust Existing Valve Box" will be made at the unit price bid for each valve box adjusted to finish grade.

5.9. Payment for "Concrete Encasement, Concrete Cradles, Concrete Saddles and Concrete Collars" will be made at the unit price bid by the cu. yd. of concrete placed. Reinforcing, if required, must not be measured for payment.

5.10. Payment for "Fire Hydrant with 6-in Valve and Box" and "Relocate Fire Hydrant" will be made at the unit prices bid for each such assemblies installed.

These payments are to include backfill, selected material, anti-corrosion embedment when specified, branch line pipe, fittings exclusive of the tee from the main line pipe, polyethylene sleeve, hauling and disposition of excavated surplus material where required, asphaltic material for ferrous surfaces, concrete reaction blocking, concrete pad restoration of existing fire hydrant sites and installing a new fire hydrant as directed.

5.11. Payment for "Permanent Blow-off (Complete)" and "Temporary Blow-off (Complete)" will be made at the unit price bid for each such assembly installed in accordance with the details shown on the plans. Payment for the eccentric reducer will be made at the unit price bid for each ton of fittings of all types and sizes installed. Payment for the pipe nipple with reaction stop ring will be made at the unit price bid for each linear foot of pipe of the various sizes installed by the open cut method. These payments are also to include excavation, anti-corrosion when specified, the housing and disposition surplus excavated materials and approved selected backfill.

5.12. Payment for "Automatic Air Release Valve (Complete)" will be made at the unit price bid for each assembly of the various sizes installed in accordance with the details shown on the plans. This payment is also to include selected embedment material, anti-corrosion embedment when specified, excavation and hauling and disposition of surplus excavated materials, blocking and various sizes and types of meter boxes.

5.13. Payment for "Gray Iron Fittings" and "Ductile Iron Fittings" will be made at the unit price bid for each ton of fittings of all sizes and types installed and will be based upon the weights of fittings shown in Table 24, "Weights of Ductile-Iron and Gray Cast-Iron Fittings." Such payment must also include excavation, selected embedment material, anti-corrosion embedment when specified, hauling and disposition of surplus excavated materials, polyethylene sleeve, asphaltic material for ferrous surfaces, all glands, nuts, bolts, gaskets and concrete reaction and thrust blocking. If compact fittings are not manufactured and other fittings are installed, Contractor will provide quantities and unit weights with pay request.

Weigh tables are estimated quantities and can be verified by vender information. Payments will be made by the lesser of the two (weights versus supplier) at the inspectors discretion.

5.14. Payment for "Trench Excavation Protection" and "Joint Trench Excavation Protection" is to be made on the basis of the unit price bid for each linear foot of "Trench Excavation Protection" and "Joint Trench Excavation Protection" in place. Payment is to include all components of the trench protection system which can include, but not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage. Payment is also to include the additional excavation and backfill required, any jacking, jack removal and removal of the trench support after completion and be full compensation for all other labor, materials, tools, equipment and incidentals necessary to complete the work.

5.15. Payment for "Tie-In (Complete)" will be made at the unit price bid for each tie-in of the various sizes and types completed. This payment is to include shutdown and isolation of the existing main to which the tie is to be made, cutting pipe for connection, de-watering the excavation, and customer notification of service interruption where required. Connections between new and existing mains which are made with tapping sleeves and valves by cutting-in tees will be as a no-separate pay item.

5.16. Payment for "New Short Service" and "New Long Service" will be made at the unit price bid for each new service line of the various sizes and types installed. This payment is to include reconnection of new service to the existing meter and the adjustment of the meter, meter box, and Customer valve. Such payment must also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of whatever type fittings of the various sizes used in the service line relay and copper tubing or ductile iron pipe (4 in. and larger).

5.17. Payment for "New Unmetered Short Service" and "New Unmetered Long Service" will be made at the unit price bid for each new un-metered service line of the various sizes and types installed. This payment is to include excavated materials, trench excavation protection, sand backfill, cutting in pavement and surface structures of whatever type encountered and replacement with whatever type specified, a new meter box where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the installation of new service lines.

5.18. Payment for "Reconnect Short Service" and "Reconnect Long Service" will be made at the unit price bid for each service line of the various sizes and types reconnected. This payment is to include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, meter box relocation where required, cutting pavement and surface structures of whatever type encountered and replacement with whatever type specified, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line reconnection.

5.19. Payment for "Relay Short Service" and "Relay Long Service" will be made at the unit price bid for each service line of the various sizes and types relaid. This payment is to include reconnection of new service to existing meter, sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger), valve and valve box assembly, and fittings of the various sizes used in the service line relay.

5.20. Payment for "Relocate Short Service" and "Relocate Long Service" will be made at the unit price bid for each service line of the various sizes relocated. This payment is to include sand backfill, meter box relocation where required, copper tubing or ductile iron pipe (4 in. and larger) when required, valve and valve box assembly when required, and fittings of the various sizes used in the service line relocation.

5.21. Payment for "Relocate Existing Meter and Existing Meter Box" will be made at the unit price bid for each assembly relocated. This payment is also to include excavation protection, hauling and disposition of surplus excavated materials, sand backfill, removal and replacement of yard piping with piping of the various sizes and types and in the quantities necessary to complete the connection between the relocated existing meter and existing meter box, and the existing yard piping.

5.22. Payment for "Relocate Existing Meter and New Meter Box" will be made at the unit price bid for each assembly relocated. This payment is also to include sand backfill, removal and replacement of yard piping with piping of the various sizes and types and in the quantities necessary to complete the connection between the relocated existing meter and new meter box, and the existing yard piping.

Payment for the number one meter box installation in sidewalks and driveways must be paid in the amount difference between the standard meter box and the number one meter box.

5.23. Payment for "Cut and Replace Concrete Sidewalk, Driveway, Etc." will be made at the unit price bid.

5.24. Payment for "Cut and Replace Asphalt Pavement" will be made at the unit price bid.

5.25. Payment for "Cut and Replace Asphalt Pavement with 6 in. of Asphalt Treated Base" will be made at the unit price bid.

5.26. Payment for "Cut and Replace Concrete Sidewalk (Asphalt)" will be made at the unit price bid.

5.27. Payment for "Concrete Curb" will be made at the unit price bid.

5.28. Payment for "Hydrostatic Test" will be made at the unit price bid for each successful test. Such payment includes all materials and equipment required to conduct test.

5.29. Payment for "Flowable Backfill" will be made at the unit price bid for each cu. yd. of flowable backfill placed, but not to exceed the minimum trench width specified in Section 3.1.2, "Width of Trench."

5.30. Payment for "Removing and Replacing Chain-Link or Wire Fence" will be by the unit price bid per linear foot of fence removed and replaced.

5.31. Payment for "Remove & Dispose Exist WL All Sizes (AC)" will be by the unit price bid per linear foot of AC pipe, of any size, removed and disposed of in accordance with the specifications. Payment must include excavation, backfill, and all incidentals required to complete the work.

5.32. Payment for "Water Service Line Breaks Leak Repair" will be made for if during construction, certain water service lines break or if leaks occur within or immediately adjacent to the Contractor's specified area of construction operations, the Inspector may authorize the replacement or repair to be performed. However, the Contractor is cautioned that no payment will be made by the City when particular breaks or leaks are a direct results of the Contractor's construction operations. Where encountered, payment to the Contractor for cutting and replacing pavements (any type), curbs, trench protection, sidewalks, and sodding must be considered subsidiary to this item and no direct payment will be made. Such payment must include any necessary hauling and disposition of surplus excavated material, and pumping of water.

5.33. Payment for "Water Main Breaks Leak Repair" will be made if during construction, certain water main breaks or if leaks occur within, or immediately adjacent to, the Contractor's specified area of construction operations, the Inspector may authorize the replacement or repair to be performed by the Contractor. The work involved must consist of excavation, hauling of disposition material, dewatering, shut-down and isolation of the existing main if required, installation of the necessary repair clamps and or new water main (length to be determined by the Inspector) to include all necessary tie-ins, fittings, approved reaction blocking required, backfilling the excavation with approved materials; customer notification or service interruption where required. Cutting and replacing pavements (any type), curbs, sidewalks, trench protection, and sodding will be considered subsidiary to the work. However, the Contractor is cautioned that no payment will be made by the City when particular breaks or leaks are a direct results of the Contractor's construction operations. Where encountered, payment to the Contractor for cutting and replacing pavements (any type), curbs, trench protection, sidewalks, and sodding must be considered subsidiary to this item and no direct payment will be made. Such payment must include any necessary hauling and disposition of surplus excavated material, and pumping of water.

No direct payment will be made for concrete blocking of water mains; coating and wrapping pipe joints; trench excavation below specified limits; excavation and removal of unsuitable material at bottom of trench grade and restoration with approved material; supporting pipe or conduits of public utilities; abandonment of water mains and valves; resetting existing meters and meter boxes in proper configuration; salvaging fire hydrants, valve boxes and meter boxes; flushing water mains; and disinfection of water mains. This work is to be considered subsidiary to the various bid items.

No direct payment will be made for furnishing and installing the nonmetallic pipe detection system. This work and materials are to be considered subsidiary to the various pay items. In addition, the Contractor is to ensure that the detection system is complete and operational to the satisfaction of the Engineer.

No direct payment will be made for furnishing and installing the pipe joint restraint system. This work and materials must be considered subsidiary to the various bid items.

No direct payment will be made for furnishing and installing the Joint Restraint System for PVC C-905. This work and materials must be considered subsidiary to the various pay items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the various unit prices. These prices are full compensation for furnishing materials and for equipment, labor, tools, and incidentals.

5.34. Payment for "Grout Abandonment Water Main" will be made for all types of pipe abandonment with grout, including asbestos-concrete pipe, and will be paid for at the contract bid price per foot for each size diameter of pipe, irrespective of the depth of the main, which will include the cost of removing content within the pipe, cleaning, grouting, plugging, capping and abandoning all pipe, pipe bend section and all other appurtenances, and for dewatering, trenching, excavation and backfill, removal, transportation and disposal and all material or work necessary to properly abandon the pipe. Payment for abandoning water lines will be made on the contract unit price per foot per each size diameter of pipe at locations shown on the plans. Said price will be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

TABLE 24
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

BENDS							
Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/4 Bend (90 Degrees)				1/8 Bend (45 degrees)			
4	25	55	44	4	21	51	36
6	43	86	67	6	35	75	57
8	61	125	115	8	50	110	105
12	119	258	236	12	96	216	196
16	264	454	478	16	200	345	315
20	447	716	878	20	337	555	485
24	602	1105	1085	24	441	777	730
30	979	1740	1755	30	775	1393	1355
36	1501	2507	2135	36	1140	2163	1755
42	2277	3410	3055	42	1652	2955	2600
48	3016	4595	4095	48	2157	4080	3580
BENDS							
Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB	Size (In.)	MJ Compact (C153)	MJ (C110)	FLG SB
1/16 Bend (22-1/2 Degrees)				1/32 Bend (11-1/4 degrees)			
4	18	50	35	4	17	50	40
6	32	75	64	6	30	73	56
8	46	110	90	8	42	109	90
12	85	220	194	12	74	220	193
16	175	354	315	16	153	354	315
20	314	550	505	20	265	553	505
24	414	809	528	24	339	815	760
30	668	1500	1385	30	603	1410	1395
36	963	2182	1790	36	830	2195	1805
42	1354	3020	2665	42	1210	3035	2680
48	1790	4170	3665	48	1523	4190	3695

TABLE 24 CONTINUATION

WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

TEES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	26	56	53
4	3	31	76	54
	4	33	80	60
6	4	49	114	90
	6	60	124	98
8	4	65	163	155
	6	76	175	148
	8	89	188	179
12	4	99	316	322
	6	115	325	297
	8	127	339	346
	12	162	407	369
16	6	226	563	573
	8	240	565	555
	12	283	615	590
	16	326	676	635
20	6	344	750	773
	8	371	766	720
	12	427	799	816
	16	503	975	950
	20	566	1068	1005

TEES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	466	1035	1089
	8	487	1047	1060
	12	539	1075	1125
	16	625	1109	1070
	20	729	1504	1510
	24	785	1617	1685
30	8	739	1808	-
	12	800	1842	1801
	16	959	1885	-
	20	1026	1941	-
	24	1228	2496	2475
	30	1373	2531	2615
36	24	1548	2710	2255
	30	1901	3545	3000
	36	2012	3686	3160
42	24	2272	3690	3245
	30	2512	4650	4125
	36	3048	5119	5360
	42	3225	6320	5580
48	24	2934	4995	4385
	30	3147	5140	4455
	36	4046	6280	5555
	42	4249	8130	7195
	48	4469	8420	7385

TABLE 24 CONTINUATION
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

CROSSES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
3	3	34	70	-
4	3	42	90	-
	4	46	105	-
6	4	63	140	-
	6	74	160	160
8	4	88	185	185
	6	97	205	205
	8	105	239	234
12	4	114	340	-
	6	135	360	360
	8	151	382	385
	12	199	493	495
16	6	250	590	575
	8	270	619	605
	12	332	685	-
	16	409	811	790
20	6	358	760	-
	8	379	822	790
	12	413	883	860
	16	550	1117	1085
	20	598	1274	1230

CROSSES				
Size (In.)		Weight		
Run	Branch	MJ Compact (C153)	MJ (C110)	FLG Short Body
24	6	566	1025	-
	8	578	1085	1045
	12	610	1153	1110
	16	663	1256	1200
	20	975	1733	1675
	24	907	1906	1835
30	8	650	1795	-
	12	870	1925	1865
	16	900	1950	-
	20	1220	2060	-
	24	1497	2776	2675
	30	1808	3188	3075
36	24	1853	2928	2980
	30	2580	3965	-
	36	2698	4370	4370
42	24	2415	3910	-
	30	2920	5040	-
	36	3788	5835	-
	42	3908	6493	7145
48	24	3435	5210	-
	30	4145	5495	-
	36	4873	6790	-
	42	5465	8815	-
	48	5588	9380	-

TABLE 24 CONTINUATION
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

CAPS			PLUGS	
Size (In.)	MJ Compact (C153)	MJ (C110)	MJ Compact (C153)	MJ (C110)
4	10	17	12	16
6	16	29	19	28
8	24	45	30	46
12	45	82	54	85
16	95	160	97	146
20	141	235	146	218
24	193	346	197	350
30	362	644	381	626
36	627	912	688	884
42	893	1322	1200	1222
48	1076	1737	1550	1597

TABLE 24 CONTINUATION
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

SOLID SLEEVES				
Size (In.)	Weight			
	MJ Short Compact (C153)	MJ Long Compact (C153)	MJ Short (C110)	MJ Long (C110)
4	17	21	35	46
6	28	35	45	65
8	38	48	65	86
12	57	77	113	143
16	127	172	192	257
20	201	258	258	359
24	264	337	340	474
30	500	651	690	1005
36	725	960	947	1374
42	877	1209	1187	1628
48	1406	1516	1472	2033

TABLE 24 CONTINUATION
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

CONCENTRIC REDUCERS			
Size (In.)			Weight
Large End	Small End	MJ Compact (C153)	MJ (C110)
6	4	27	59
8	4	38	81
8	6	41	95
12	4	70	136
12	6	69	150
12	8	70	167
16	6	134	234
16	8	136	258
16	12	126	310
20	12	213	427
20	16	221	492
24	12	304	562
24	16	315	633
24	20	315	727
30	16	596	1027
30	20	599	1085
30	24	492	1204
36	20	1042	1459
36	24	785	1580
36	30	655	1868
42	24	1356	2060
42	30	1112	2370
42	36	1116	2695
48	30	1722	3005
48	36	1650	3370
48	42	1429	3750

TABLE 24 CONTINUATION
WEIGHTS OF GRAY IRON AND DUCTILE IRON FITTINGS (LBS.)

2" Tapped Tees and Crosses		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C153)
4	24	47
6	36	71
8	54	97
10	69	130
12	87	169
20	-	259
24	-	320

OFFSETS		
Size (In.)	Weight	
	MJ Compact (C153)	MJ (C110)
4 x 6	35	75
4 x 12	55	83
6 x 6	35	110
6 x 12	67	138
6 x 24	96	189
8 x 6	82	164
8 x 12	98	209
8 x 24	141	280
12 x 6	121	320
12 x 12	178	420
12 x 24	240	645
20 x 12	-	1025
20 x 24	-	1245