PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of ductile iron pipe. Ductile iron pipe shall be furnished complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasement, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.

Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment under this Contract.

1-1.01. Pipe Manufacturer's Experience and Field Services. All ductile iron pipe, fittings, specials, bolts, gaskets, other jointing materials, and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer responsibilities, which shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials, and pipe appurtenances (except for furnished coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified test pressures and service conditions; ensuring and certifying that all pipe, fittings, specials, and other pipe materials, pipe gaskets and bolts specified herein, are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.

The pipe manufacturer’s minimum required experience qualifications shall include manufacture of interior and buried plant piping of similar diameters of at least two water or wastewater plants with joints, linings, and coatings suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.

All ductile iron pipe shall be installed in accordance with the pipe manufacturer’s recommendations.
1-2. **SUBMITTALS.** Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

- Certification by manufacturer for each item furnished in accordance with the ANSI/AWWA Standards.
- Restained joints details.
- Certification of gaskets by pipe manufacturer, certifying that gasket material is suitable for test pressures and services intended.
- Pipe laying schedule complete with a sequence of laying and an explanation of all abbreviations used in the schedule.

Submittal data shall clearly indicate the country of origin of pipe, fittings, flanges, restraining devices, and accessories.

1-2.01. **Acceptable Manufacturers.** Pipe manufacturers shall be American Cast Iron Pipe Company, U.S. Pipe Company, or Griffin Pipe Products Company. No substitution is permitted.

1-3. **SHIPPING, HANDLING, AND STORAGE.** Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining if such lining is specified.

Contractor-furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.

Contractor shall repair any damage to pipe coatings and linings before the pipe is installed.
PART 2 - PRODUCTS

2-1. PIPE CLASS. The class of ductile iron pipe shall be as indicated in the following table for the sizes indicated on the Drawings. The specified class includes service allowance and casting allowance.

<table>
<thead>
<tr>
<th>Pipe Size inches</th>
<th>ANSI/AWWA Pressure Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 and smaller</td>
<td>350</td>
</tr>
</tbody>
</table>

2-2. MATERIALS.

Pipe
Ductile iron, ANSI/AWWA C151/A21.51, Table 1 or Table 3.

Gaskets – All Joint Types
Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer unless another manufacturer’s product is indicated. Pipe manufacturer shall submit certificates of gasket suitability certifying that the gasket materials are compatible with the joints specified, are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall be certified for chlorinated and chloraminated potable water. Gas and oil-resistant gaskets shall be made of Nitrile (NBR) rubber. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.
Joint Lubricant

Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal-based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.

Fittings

ANSI/AWWA C110/A21.10 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the Drawings.

<table>
<thead>
<tr>
<th>Fitting Size</th>
<th>Material</th>
<th>Type</th>
<th>Min. Working Pressure Rating, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 to 24</td>
<td>DI</td>
<td>Mechanical and Push-on joints</td>
<td>350</td>
</tr>
<tr>
<td>3 to 24</td>
<td>DI</td>
<td>Flanged joints</td>
<td>250</td>
</tr>
</tbody>
</table>

All fittings shall be ductile iron and suitable for a factory test pressure of rated working pressure plus 100 psi or 1.5 times rated working pressure, whichever is less, without leakage or damage.

Push-on Joints

ANSI/AWWA C111/A21.11.

Restrained Push-on Joints, gaskets with stainless steel gripping segments

American "Fast Grip" or "Field Lok 350 Gasket" manufactured by U.S. Pipe and furnished to licensed Tyton® joint manufacturer.

Flanges

Ductile iron, Class 125, ANSI/AWWA C115/A21.15. All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
<table>
<thead>
<tr>
<th>Component</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolts</td>
<td>ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut.</td>
</tr>
<tr>
<td>Nuts</td>
<td>ASTM A563, hexagonal, ANSI/ASME B18.2.2, heavy semifinished pattern.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>ASTM D1330, Grade I rubber, full face type, 1/8 inch thick unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.</td>
</tr>
<tr>
<td>Mechanical Joints</td>
<td>ANSI/AWWA C111/A21.11, with ductile iron glands.</td>
</tr>
<tr>
<td>Restrained Mechanical Joints</td>
<td>American &quot;MJ coupled Joints&quot;, Griffin &quot;Mech-Lok&quot;, or U.S. Pipe &quot;MJ Harness-Lok&quot;.</td>
</tr>
<tr>
<td>Restrained Mechanical Joints</td>
<td>EBAA Iron &quot;Megalug&quot; Series 1100, Sigma “One Lok” SLDE series, or Star Pipe Products “StarGrip 3000” without exception.</td>
</tr>
<tr>
<td>(factory prepared spigot)</td>
<td>(4 inch through 48 inch)</td>
</tr>
<tr>
<td>Restrained Mechanical Joints</td>
<td>EBAA Iron &quot;Megalug&quot; Series 1100, Sigma “One Lok” SLDE series, or Star Pipe Products “StarGrip 3000” without exception.</td>
</tr>
<tr>
<td>(field cut spigot)</td>
<td>(4 inch through 24 inch)</td>
</tr>
<tr>
<td>Wall Pipes or Castings</td>
<td>Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron pipe; holes sized in accordance with the details on the Drawings and provided with removable plugs.</td>
</tr>
<tr>
<td>Mechanical Joints with Tie</td>
<td>As indicated on the Drawings.</td>
</tr>
<tr>
<td>Rods</td>
<td></td>
</tr>
<tr>
<td>Tie Rods</td>
<td>ASTM A307.</td>
</tr>
</tbody>
</table>
Steel Pipe
ASTM A53, Schedule 40 or 80 as indicated on the Drawings.

Washers
ANSI/ASME B18.22.1, plain steel.

Threaded Connections
ANSI/ASME B1.20.1, NPT; with boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.

Mechanical Couplings
Couplings
Dresser "Style 38"; Smith-Blair "411 Steel Coupling"; or Romac "Style 400" or "Style 501"; without pipe stop.

Gaskets
Oil-resistant synthetic rubber gaskets shall be as recommended by the coupling manufacturer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.

Restrained Mechanical Couplings
American Pipe “Restrained Coupling Gland Joint” coordinated with mechanical couplings furnished.

Dismantling Joints
Restrained (3 inch and larger) Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.
Romac "DJ400"; Dresser "Style 131 Dismantling Joint" or Viking Johnson. For use in potable water systems, coating to be in accordance with NSF-61.

Tapping Saddles
Ductile iron, with stainless steel straps and synthetic rubber sealing gasket, 250 psi pressure rating.
Shop Coating and Lining

Glass Lining
Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 10 mils, Mohs’ Hardness 5 to 6 density as determined by ASTM D792; Fast Fabricators, Inc. "MEH 32" or "SG-14".

Universal Primer
Manufacturer’s standard. If in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.

Liquid Epoxy
ANSI/AWWA C210, non-coal tar modified, or when in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.

Anti-Seize Thread Lubricant
Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize".

2-3. SHOP COATING AND LINING. The interior of all pipe and fittings, unless noted otherwise, shall be cement mortar lined and seal coated.

Lining for pipe and fittings for wastewater facilities services shall be as specified below:

<table>
<thead>
<tr>
<th>Service</th>
<th>Lining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge piping</td>
<td>Glass</td>
</tr>
</tbody>
</table>

Glass-lined pipe buried or embedded in concrete shall be ductile iron with mechanical or push-on joints; glass-lined pipe installed in interior locations may be flanged ductile iron with flanged cast or ductile iron fittings.

The exterior surfaces of all pipe and fittings which will be exposed in both interior and exterior locations shall be shop primed. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.
PART 3 - EXECUTION

3-1. INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site.

3-2. PROTECTION AND CLEANING. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work is completed. Before jointing, all joint contact surfaces shall be wire brushed if necessary and wiped clean.

Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

3-3. CUTTING PIPE. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or a power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be acceptable. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be acceptable.

Contractor shall use factory prepared pipe ends unless a field cut is required for connections.

3-4. ALIGNMENT. Piping shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated in Table 3 or Table 4 of AWWA C600, unless specially designed bells and spigots are provided. Either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the drawings.

Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the
pipe, precautions shall be taken to prevent or minimize further thermal deflections.

Additional requirements for alignment and grade are covered in the Excavation, Trenching, and Fill section and on the Drawings.

3-4.01. **Tolerances.** Each section of pipe shall be laid to the alignment and grade indicated on the Drawings with pipe ends within the following tolerances;

- +/- 0.10 foot in grade at any point
- +/- 0.20 foot in alignment at any point

In addition, piping shall be visually straight or on a smooth curve between the points of deflection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances, to make connections to existing pipe, to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

3-5. **LAYING PIPE.** Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material as specified in the Trenching and Backfilling section.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water from entering the pipe.

Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is specifically acceptable by Engineer.

3-6. **FIELD JOINTS.** Joints in buried locations shall be mechanical or push-on type unless otherwise indicated on the Drawings or where required to connect to existing piping or to valves. All other joints shall be flanged unless otherwise indicated on the Drawings.

Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11, Section 4.5, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure or 1-1/2 times the test pressure of the pipeline, whichever is higher. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports
covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.

Restained joints shall be extended after they are assembled to minimize further takeup.

Field closure pieces shall be located away from the bends beyond the length over which joints are to be restrained.

3-7. **MECHANICAL JOINTS.** Mechanical joints shall be carefully assembled in accordance with the pipe manufacturer’s recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be acceptable. The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top centerline for horizontal piping.

3-8. **PUSH-ON JOINTS.** The pipe manufacturer’s instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with a soap solution provided by the pipe manufacturer immediately before the joint is completed. Lubricant shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer’s recommendations.

3-9. **FLANGED JOINTS.** Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern and at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer’s recommendations.
Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges before any bolts are installed in the flanges.

Pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.

After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

3-10. FLANGED COUPLING ADAPTERS. Flanged coupling adapters shall be provided for restrained couplings 12 inch and smaller where indicated on the Drawings and as specified herein. Flange coupling adapters shall be installed in accordance with the coupling manufacturer’s recommendations. After the pipe is in place and bolted tight, the locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch larger than the diameter of the stud projection. Unless indicated on the Drawings, all flange coupling adapters shall be restrained.

Unless indicated otherwise on the Drawings, all flange coupling adapters 12 inches and smaller shall be restrained. Flange coupling adapters 14 inch and larger may only be used in unrestrained pipe applications.

The inner and outer surfaces of couplings, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.
3-11. **DISMANTLING JOINTS.** Dismantling joints shall be provided for restrained couplings 6 inch and larger piping where indicated on the Drawings and as specified herein. Dismantling joints shall comply with AWWA C219 and shall be restrained flange by flange couplings manufactured as a single unit. Dismantling joints shall be installed in accordance with the coupling manufacturer's recommendations. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.

The inner and outer surfaces of dismantling joints, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

3-12. **POLYETHYLENE ENCASEMENT.** All buried ductile iron pipe, including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, and all valves, shall be provided with at least one wrap of polyethylene encasement. Locations where ductile iron pipe shall be double wrapped with polyethylene encasement are indicated on the Drawings.

Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Preparation of the pipe shall include, but shall not be limited to, removal of lumps of clay, mud, cinders, etc., prior to installation.

The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

3-12.01. **Inspection and Testing.** Tests for preliminary acceptance of polyethylene encasement materials as required in the submittal paragraph shall be made at the expense of the Contractor.

The Owner may obtain samples from the material supplied in the field and have test conducted by an independent third-party laboratory, at the Owner's expense, of the requirements specified in ANSI/AWWA C105/A21.5.

3-13. **MECHANICAL COUPLINGS.** Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch, but not more than 1 inch, shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the
coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

All surfaces, including the interior surfaces of the middle rings, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210.

3-13.01. Restrained Mechanical Couplings. Pipe restraining glands with tie bolts shall be provided to restrain mechanical coupling connections where indicated on the Drawings. The connecting pipe shall be furnished with welded retainer rings as recommended by pipe manufacturer. The pipe manufacturer shall also coordinate the restrained connection with the pressure rating, length, and diameter dimensions of the mechanical coupling being furnished to assure proper clearance is provided for completing the restrained coupling installation.

3-14. GROOVED-END JOINTS. Grooved-end joints with rigid type grooving shall be installed in accordance with the coupling manufacturer’s recommendations. Completed joints shall be rigid and shall allow no angular deflection or longitudinal movement.

3-15. WALL AND FLOOR PIPES. Wall and floor pipes shall be installed where ductile iron pipes pass through concrete walls or floors, unless otherwise indicated on the Drawings.

Where a flange and mechanical joint pipe piece is to connect to a mechanical joint wall pipe or casting, the bolt holes in the bell of the wall pipe or casting shall straddle the top centerline of the horizontal pipe or casting and shall align with the bolt holes in the flange and mechanical joint piece. The top centerline shall be marked on the wall pipe or casting at the foundry or fabrication shop.

In vertical piping, the bolt holes of flanged and mechanical joint floor pipes or castings shall be aligned with the bolt holes of the flange or mechanical joint connecting piece. The required centerline alignment and orientation of the floor pipe or casting shall be marked on the floor pipe or casting at the foundry or fabrication shop.

3-16. WALL AND FLOOR SLEEVES. Wall and floor sleeves shall be installed where indicated on the Drawings and shall be installed where ductile iron pipe passes through concrete walls and floors or masonry walls, unless otherwise noted. To minimize sleeve size, piping on either side of the sleeve shall be provided with a screw-on flange, grooved coupling, or mechanical coupling with anchor studs to allow the pipe to pass through the sleeve. Where required,
sleeves in masonry walls may be enlarged enough for flange or other joint restraint to pass through the sleeve.

Where specified or indicated on the Drawings, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall or floor sleeves with the modular casing seal manufacturer. When soil may be present at wall sleeves, two sets of modular casing seals shall be installed, one at each face of the wall. Unless otherwise indicated on the Drawings, modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inch size.

3-17. REDUCERS. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

3-18. CONNECTIONS WITH EXISTING PIPING. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

3-19. PRESSURE AND LEAKAGE TESTS. After installation, pipe, valves, and fitting shall be subjected to a pressure test and leakage test. The Contractor shall provide all necessary pumping equipment; piping connections between the piping and nearest available source of test water; pressure gauges; and other equipment, materials, and facilities necessary for the tests. The minimum test pressure shall be 100 psi.

All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.

All joints shall be watertight and free from visible leaks. Any visible leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.