

CHAPTER 5
TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATION INDEX

Land development projects shall be constructed in accordance with the 2003 Interim Standard Specifications for Construction, Michigan Department of Transportation and the following Special Provisions.

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SPECIAL PROVISION
FOR
SPECIAL CONTROLS

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7/10/02

a. Description. It is the responsibility of the Contractor to take such measures as may be necessary and to comply with all federal, state, and local laws and regulations for the protection of the public health, safety, welfare, and environment in the performance of the work.

The following are specific requirements with regard to environmental protection matters:

1. Control of Air Pollution
 - A. Dust Control: During the construction of any project, adequate dust control measures shall be maintained by the Contractor so as not to cause detriment to the safety, health, welfare, or comfort of any person or cause damage to any property, residence or business. If not shown as a pay item, dust control will be at the Contractor's expense.
 - B. Open Burning: At the site of land clearing operations, the burning of trees, logs, brush, or stumps is not allowed.
2. Control of Water Pollution and Siltation: Construction operations shall be conducted in such a manner as to prevent sedimentation of watercourses, streams, lakes or wetlands, and in accordance with the Part 91 of Act 451, P.A. 1994, as amended, Permit issued for this Project.
3. Control of Hazardous Materials: All hazardous materials, hazardous waste, toxic materials, or polluting materials shall be used, stored, and disposed of according to applicable federal, state, and local laws and regulations.
4. Noise Pollution: The Contractor shall exercise judgment in the conduct of operations, which by nature result in excessive noise. All such operations shall take place during a reasonable daylight period, which is defined as 7:00 a.m. through 8:00 p.m. unless otherwise stated in the governing municipal ordinance, or authorized by the Owner.
5. Housekeeping: The project work area shall be maintained in a neat and clean condition and all debris and waste materials shall be removed from work areas on a daily basis.
6. Hauling on Local Roads and Streets: The Contractor is advised that the hauling of construction materials over local roads and streets must be with the approval of the respective County and Municipal authorities having jurisdiction over the proposed hauling routes. All loads shall be within legal limits established by the local governing authorities. The Contractor is responsible for preventing the tracking of material onto local roads and streets. If any material is tracked onto local roads or streets, it shall be removed. It shall be the Contractor's responsibility to make arrangements with local authorities for hauling routes.

SPECIAL PROVISION
FOR
SUBGRADE UNDERCUTTING, SPECIAL

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7/10/02

a. Description. The work of **Subgrade Undercutting, Special** shall consist of subgrade undercutting and backfilling with Structural Geogrid and 12 inches of Michigan Class 21AA dense-graded aggregate. This work shall be performed in accordance with Section 205 of the standard specifications unless modified by this Special Provision or otherwise directed by the Engineer.

1. Definitions and References:

Structural Geogrid - A Structural Geogrid is formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.

Geosynthetic Research Institute

GG1-87 Standard Test Method for Geogrid Rib Tensile Strength
GG2-87 Standard Test Method for Geogrid Junction Strength

b. Materials

1. Structural Geogrid shall be as manufactured by Tensar Earth Technologies, Inc., Structural Geogrid BX1100 (Tensar SS1) or BX1120, or approved equal.
2. Backfill shall be Michigan Class 21AA, dense-graded aggregate in accordance with Section 902 of the standard specifications.

c. Methods of Construction. The subgrade shall be undercut a uniform 12 inches.

1. Structural Geogrid Storage and Installation

The Structural Geogrid shall be laid horizontally on the prepared subgrade and pulled taut and anchored prior to backfill placement. At longitudinal and transverse edges, the Structural Geogrid shall be overlapped a minimum of 12 inches.

Rolled Structural Geogrid may be laid flat or stood on end and shall be stored at temperatures above -20 Degrees F (-29 Degrees C.). The Structural Geogrid shall be protected from excessive mud, wet cement, epoxy, and other deleterious like materials.

2. Backfill Placement

Backfill shall be placed, spread, and compacted via a method that minimizes the development of slack in the Structural Geogrid. Backfill shall be placed and compacted in accordance with Section 302 of the standard specifications.

3. General

Tracked construction equipment shall not be operated directly on the Structural Geogrid. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the Structural Geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the Structural Geogrid.

Rubber-tired equipment may pass over the Structural Geogrid at slow speeds, less than 10 MPH. Sudden braking and sharp turning shall be avoided.

SPECIAL PROVISION
FOR
SANITARY SEWER

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7/12/02

a. Description. The work of **Sanitary Sewers** shall consist of furnishing all labor, equipment, and materials required for the installation of all sanitary sewers and appurtenances as shown on the plans and specified herein, including testing.

b. Materials.

1. Detailed material lists and specifications for all sanitary sewer system materials shall be submitted to the Engineer for review. All sanitary sewer system materials shall be new and shall meet the requirements of the standard specifications, and the following.
2. Sanitary Sewer: Six inch (6") through fifteen inch (15") diameter sanitary sewer shall be Polyvinyl Chloride (PVC) or Ductile-Iron (D.I.) in accordance with the following.

A. Pipe:

- (1) Polyvinyl Chloride (PVC): Shall be in accordance with ASTM D3033 or ASTM D3034.
 - (a) Minimum pipe wall thickness shall be SDR 26.
 - (b) All pipe shall have a "home" mark.
 - (c) Pipe joints shall be of the elastomeric gasket push-on type conforming to ASTM D3212.
- (2) Ductile-Iron (D.I.): Shall be in accordance with ANSI A21.51.
 - (a) Pipe class shall be as noted on the drawings.
 - (b) All pipe shall have a "home" mark.
 - (c) Pipe joints shall be mechanical joints or push-on joints meeting ANSI A21.11.
 - (d) Pipe lining shall meet the following requirements.
 - (i) Ceramic Epoxy: Shall be Protecto 401 Ceramic Epoxy Lining, 40 mil thickness, factory applied.
 - (ii) Polyethylene: Shall be Polybond Lining, 40 mil thickness, ANSI/ASTM D1248, or equal.
 - (e) Exterior Coating: Shall be bituminous, 1 mil thick.
 - (f) Polyethylene Encasement: Shall be in accordance with ANSI A21.5.

B. Fittings: All pipe connections and pipe type, size, and/or direction changes shall be made with standard manufactured fittings in accordance with the following.

- (1) Polyvinyl Chloride (PVC): Shall be full fittings in accordance with ASTM D3033 or ASTM 3034 for pipe wall thickness of SDR 26. Joints shall meet ASTM D3212. Service lateral connections shall be made with standard wye fittings. Tees or tee-wyes shall not be used; saddles shall not be used.

- (2) Ductile-Iron (D.I.): Shall be standard manufactured fittings in accordance with ANSI A21.10 for mechanical joints and push-on joints. Fittings shall be lined and have the standard exterior bituminous coating. Service lateral connections shall be made with tee fittings. Plugs shall be iron or plastic suitable for air testing.
- C. Connections of Dissimilar Pipe Materials: Shall be made utilizing one of the following methods:
 - (1) Standard Adapters: Shall be a manufacturer's standard adapter with joints conforming to the above specifications.
 - (2) Couplings: Shall be an elastomeric coupling complete with 300 series stainless steel tension bands conforming to ASTM C425. Couplings shall be Clow Band-Seal Couplings, Fernco Flexible Couplings or equal.
- D. Changes in Pipe Sizes: Shall be made using standard smooth flow increasers or reducers.
- E. Lubricants: All lubricants for the making of pipe joints shall strictly conform to the recommendations of the pipe manufacturer.
- 3. Sanitary Sewer Manholes: Sanitary sewer manholes shall be precast concrete conforming to the details on the plans. Joints between the pipe and the manhole shall be as detailed on the plans.
- 4. Chemical Grout: For sealing minor joint leaks shall be an EPA approved type.
- 5. Marking: All pipe, fittings and appurtenant items furnished to the job site shall be marked in accordance with the applicable specification. Any unmarked materials are subject to rejection by the Engineer.
- 6. Pipe Bedding and Backfill Materials: Shall be in accordance with the Michigan Department of Transportation Standard Plan R-83 (Series) Utility Trenches.

c. Methods of Construction

- 1. Sanitary Sewer System Installation, including sanitary sewers and their appurtenances, shall be in accordance with the following.
 - A. General: Handling, storage, installation, and the making of joints shall strictly follow the manufacturer's recommendations. Plastic and rubber materials affected by ultraviolet rays including all PVC products shall be protected from direct sunlight. Material handling during cold weather shall take into account increased brittleness of plastic materials. Pipe which is warped or bowed due to temperature variations such that the deviation from straightness is greater than one inch shall not be installed.
 - B. Grade and Alignment: All sewer shall be laid utilizing an "in-line" laser for vertical and horizontal control. Vertical and horizontal alignment of the invert shall, at any point, be within plus or minus 0.04 feet (1/2 inch) of plan elevation and line.

- C. Cutting of Pipe: Full lengths of pipe shall be used whenever feasible. Cutting of pipe where required shall be done only using methods as recommended by the manufacturer, utilizing tools and equipment as required to provide a neat, perpendicular cut without damage to the pipe or coatings. All burrs shall be removed. Spigot ends of cut pipe shall be beveled similar to factory beveling. If field cutting or coring of pipes exposes any bare metal surface, the surface shall be covered with an epoxy coating.
- D. Laying of Sewer: Each pipe shall be inspected before being placed in the trench. Joint surfaces shall be free of earth or frozen matter. Pipe shall be laid with bell ends upgrade to line/grade as called for on the plans. The line/grade of each pipe as laid shall be checked by the Contractor. Pipe shall be laid from the low end of the sewer upgrade. The use of brick, lumps of clay, wood, etc., to bring the pipe to grade shall not be permitted.
- (1) Joints: Shall be made in strict accordance with the manufacturer's recommendations utilizing the recommended lubricant. Wood blocks or other approved materials shall be used to protect the pipe and fitting ends from pry bars, chains, etc. with particular care taken with plastic materials. Pipe shall be pushed closed to the "home" position and if joints do not remain tightly closed, the pipes shall be replaced.
- (2) Final Line and Grade: After the pipe is laid, care in backfilling and other operations shall be taken so as not to disturb its line, grade, or joint. Misalignment shall be cause for rejection of the sewer.
- E. Pipe Bedding and Backfill Materials: Shall conform to the Michigan Department of Transportation Standard Plan R-83 (Series), Utility Trenches.
- F. Pipe Encasement: In areas of aggressive soils, such as peat, ductile iron pipe shall be encased in a polyethylene encasement.
- G. Connections to Live Sewers: When connections are made with sewers carrying sewage or water, special care must be taken that no part of the work is built underwater; a flume or dam must be installed and pumping maintained if necessary and the new work kept dry until completed and any concrete or grout has set.
2. Manhole Installation: Shall be in accordance with the plans and the standard specifications.
3. Service Lateral Installation:
- A. General : Shall be installed to the property line or length as shown on the construction drawings. The location of the service lateral shall be as shown, or when serving an existing building, to the location designated by the building owner. Where an existing service lead is to be connected, the Contractor shall locate the lead.
- B. Marking: The Contractor shall mark the end of each service lateral with a 4 x 4 of sufficient length to extend from the service lateral to 12 inches above grade, unless otherwise noted on the plans.

- C. Record of Locations: The Contractor shall record and submit to the Owner and the Engineer a location sketch of the service lateral fitting measured upstream from the nearest manhole and shall record the location of the terminus of the service lateral with a minimum of two witness measurements to permanent physical features, building corners, etc. Any services not readily located within one year after date of final payment due to inaccurate as-built measurements shall be field located by the Contractor at no expense to the Owner.
 - D. Risers: Where sanitary sewers are constructed deeper than 12 feet, service risers shall be constructed as shown in the standard detail. Risers shall be constructed such that the service lateral is 11 feet deep at the property line. When main sanitary sewers are less than 12 feet deep, no riser is required and the lateral shall be constructed at a slope such that the service lead is 11 feet deep at the property line, if feasible. The six inch service laterals shall be constructed at a minimum slope of 0.60%. Lateral fittings shall be installed with the branch connection tilted up 45 degrees.
 - E. Service Lateral Inspection: All service lateral pipes shall be left with at least the top of the pipe exposed until inspected by the Owner or his representative and authorization for backfill given.
4. Removal of Unsuitable Material: Whenever any pipe section, fitting or appurtenance is found to be unsuitable for installation due to specification non-conformance, poor workmanship, damage, or any other reason, it shall be removed from the construction site during that working day by the Contractor. Any material not so removed shall be painted or otherwise marked by the Engineer to prevent its subsequent use.
5. Sanitary Sewer Testing:
- A. General: Upon completion of installation of the sanitary sewer and appurtenances, the Contractor shall furnish all apparatus, materials, and labor required to perform the pressure tests in accordance with the following.
 - (1) Pre-test Procedures: Contractor shall clean the sanitary sewers.
 - (2) Preliminary Tests: Preliminary test(s) shall be accomplished by the Contractor. Any defects shall be corrected and the test(s) shall be rerun until the results are satisfactory.
 - (3) Final Tests: Shall be conducted in the presence of the Engineer, who shall receive 24 hours notice prior to testing. If it is necessary for the Engineer to observe more than one test on any section of sanitary sewer, the Contractor shall be liable for the additional cost involved for observation of subsequent tests.
 - B. Air Testing: Shall be the Time-Pressure Drop Method in accordance with the following.
 - (1) Polyvinyl Chloride (PVC): ASTM F1417
 - (2) Ductile-Iron (D.I.):

- (3) If the section of sanitary sewer to be tested includes more than one pipe size (i.e.. lateral connections), calculate the test time for each size and add the test times to arrive at the total test time for the section.
- C. PVC Deflection Test: The completed installation of PVC sewers shall at no point have out-of-round pipe deflections greater than 5.0%. Deflectometer or go-no-go gauging tests shall be performed prior to acceptance of sewers. The test shall be conducted after the final backfill has been in place at least 30 days.
- D. TV Inspection: All new sanitary sewers shall be visually inspected in accordance with the Special Provision for Video Taping Sanitary Sewers after all services leads are hooked up, manhole flow channels are poured, manhole castings are adjusted to final grade, and all other work which connects to the sewer is completed. The inspection shall verify that the sewer is clear of all debris and that no damage has occurred to the sewer. All debris shall be removed by the Contractor and the reach shall be inspected again at no additional cost to the Owner.
- E. Correction of Defective Work: Whenever any of the above test or inspections indicate defective material or installation, the Contractor shall repair and retest the section to the satisfaction of the Engineer at no cost to the Owner. The use of chemical grouts shall be limited to the repair of minor joint leaks and shall not be used without the specific written approval of the Engineer. Any pipe or fitting having structural damage shall be removed and replaced. Any PVC sewer with deflection in excess of the 5.0% limitation shall be re-excavated, inspected for structural damage, and then rebedded and backfilled and retested.
6. Sanitary Sewer Spot Repairs:
- A. General: Shall be as shown on the plans and/or specified herein. Sawcutting the existing pipe at the removal limits, as well as removal of the existing pipe shall be included in the spot repair.
- B. Bedding for Spot Repairs: Shall be pea-stone from 6 inches below the pipe invert to the pipe spring line.
- C. Connection of the repair to the existing sanitary sewer shall be constructed such that the joint is not offset by more than 1 inch in the horizontal and vertical direction and the joint gap is less than 1 inch. Care shall be used in placing the bedding and backfill to prevent displacement of the pipe outside of the noted tolerances.

SPECIAL PROVISION
FOR
WATER MAIN

CC

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4/25/02

a. Description. The work of **Water Mains** shall consist of furnishing all labor, equipment, and materials required for the installation of all water mains and appurtenances as shown on the plans and specified herein, including testing and disinfection.

b. Materials

1. Detailed material lists and specifications for all water system materials shall be submitted to the Engineer for review. All water system materials shall be new and shall meet the requirements of AWWA, the standard specifications, and the following.
2. Water Main: Shall be Ductile-Iron (D.I.) in accordance with ANSI/AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids and the following:
 - A. Class and Size: Pipe wall thickness shall be minimum pressure Class 52, unless otherwise noted on the plans.
 - B. Pipe Markings: All pipes delivered to the job site shall bear the marks required by ANSI/AWWA C151/A21.51.
 - C. Exterior Coating: Shall be bituminous, 1 mil thick.
 - D. Cement-Mortar Lining: Shall be in accordance with ANSI/AWWA C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - E. Polyethylene Encasement: Shall be in accordance with ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - F. Mechanical Joints and Push-on Joints: Shall be in accordance with ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. Bolts and nuts shall be high strength corrosion resistant alloy with hex head nuts.
 - G. Fittings: Shall be in accordance with ANSI/AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
 - H. Electrical Continuity: Shall be bronze wedges or continuity straps.
3. Valves and Valve Boxes
 - A. General Requirements
 - (1) Working Pressure: 150 psi minimum.

- (2) Joints: Shall be mechanical joints in accordance with ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, unless otherwise noted on the plans or in the valve schedule. End flanges, if specified, shall be ANSI B16.1 Class 125.
- (3) Direction of Opening: Left.
- B. Resilient Seated Gate Valves: Shall be in accordance with ANSI/AWWA C509 Resilient-Seated Gate Valves for Water Supply Service and the following:
 - (1) Body Construction: ASTM A126 Class B, cast iron.
 - (2) Operator: Hex nut, unless otherwise noted on the plans or in the valve schedule.
 - (3) Manufacturer: Refer to Table of Standard Materials.
- C. Valve Boxes: Cast iron, screw type, three piece; cover shall be furnished marked "Water".
- 4. Hydrants: Shall be in accordance with ANSI/AWWA C502 Dry-Barrel Fire Hydrants and the following:
 - A. Type and Size: Breakaway traffic flange; 6 inch main valve seat.
 - B. Connections: Two 2-1/2 inch hose connections and one 4 inch pumper connection; National Standard threads, 4 threads per inch.
 - C. Direction of Opening: Left.
 - D. Operating Nut: 1-1/2 inch pentagon.
 - E. Manufacturer: Refer to Table of Standard Materials.
- 5. Service Lead Pipe, Corporation Stop, Curb Valve, Curb Box
 - A. Service Lead Pipe: ASTM B88 type K annealed seamless copper water tube. Fittings shall be compression type.
 - B. Corporation Stop: Refer to Table of Standard Materials.
 - C. Curb Valve: Refer to Table of Standard Materials.
 - D. Curb Box: Refer to Table of Standard Materials.

c. Methods of Construction

- 1. Water System Installation, including water mains and their appurtenances, shall be in accordance with ANSI/AWWA C600 Installation of Ductile-Iron Water Mains and their Appurtenances and the following.

- A. Location, Grade and Alignment: Water main shall be constructed to maintain at least a ten feet separation from any sewer and to provide a minimum depth of cover of 6 feet, unless otherwise noted on the plans.
- B. Laying Pipe: Pipe shall be laid with the bell ends facing the direction of laying, unless otherwise directed or allowed by the Engineer.
- C. Wet Trench Laying: When the trench contains water, open ends of the pipe shall be closed by a watertight plug. This provision shall apply during the noon hour as well as overnight.
- D. Pipe Bedding and Backfill: Shall be in accordance with the Michigan Department of Transportation Standard Plan R-83 (Series), Utility Trenches.
- E. Pipe Encasement: In areas of aggressive soils, such as peat, ductile iron pipe shall be encased in a polyethylene encasement.
- F. Electrical Continuity: Shall be provided for ductile iron pipe, unless otherwise noted on plans.
- G. Joint Resistant: Where water to air pressure exerts a disjoining force, at all pipe deflections over 20 degrees, and all tees and dead ends, joints shall be restrained, tied or harnessed in a manner approved by ENGINEER. The restraint shall be applied to joints in each direction from the deflection an adequate distance to resist the axial thrust of the test pressure as shown in Table 1: Pipe Restraint Schedule. Details of the proposed joint restraint, showing the type and location, shall be submitted to ENGINEER for approval. All pipe and fitting restrained joints shall be rated for a minimum of 250 psi.

**TABLE 1: PIPE RESTRAINT SCHEDULE
GROUND BURIED PRESSURE PIPE – DUCTILE IRON PIPE**

Pipe Diameter	Length (Ft) of Pipe Restraint for Each Direction from Fitting						
	Tee, 90° Bend	45° Bend	22-½° Bend	11-¼° Bend	Dead End	Reducer (One Size Reduction)	Reducer (Two Size Reduction)
4"	11	5	2	1	28	--	--
6"	16	7	3	2	41	21	--
8"	21	9	4	2	52	21	49
12"	30	12	6	3	75	40	81
16"	38	16	8	4	97	41	96
20"	46	19	9	5	118	42	94
24"	54	22	11	5	139	42	92
30"	65	27	13	6	169	59	117
36"	75	31	15	7	197	59	132

Based upon: Internal Pressure: 180 psi
 Pipe Depth: 5'
 Bedding Class: Type 4
 Soil Type: Good Sand
 Safety Factor: 2

For pipe diameter not listed, use next largest pipe diameter.

For pressure other than 180 psi, increase or decrease values proportionally.

For a tee, length of pipe restraint is for the branch/stem direction.

For tie rods, use four rods minimum and add 1/8-inch to bar diameter as corrosion allowance.

- (1) Retainer Glands: Mechanical joint pipe shall be restrained with EBAA Iron "Megalug Series" or Uni-Flange Block Buster 1400 retainers. Megalugs or Uni-Flange Block Buster 1400 retainers may also be used to restrain joints for unanticipated deflection points, or where connections require a mechanical joint. Push-on joint pipe shall be restrained with American Lok-Ring, Flex-ring or Fast-Grip Gaskets, U.S. Pipe TR Flex, Field Lok Gasket, or equal.
- (2) Thrust Blocks: Shall be constructed of Class B, poured-in-place concrete and installed at all bends, dead ends, tees, reducers, hydrants and valves. The area in square feet of concrete thrusting against undisturbed earth shall be computed by dividing the total thrust by the safe bearing load of the soil; refer to Tables 2 and 3. For larger sizes, details shall be shown on the plans.

TABLE 2: THRUST TABLE

Thrust Main Size	Total Thrust (Lbs)				
	Plug	90° Bend	45° Bend	22-½° Bend	11-¼° Bend
4"	2,840	4,000	2,100	1,100	600
6"	5,800	8,200	4,300	2,300	1,100
8"	8,900	14,000	7,400	3,900	2,000
10"	14,800	21,000	11,000	5,800	2,900
12"	20,900	30,000	15,500	8,200	4,100
14"	28,000	40,000	21,000	11,000	5,500
16"	36,200	51,000	27,000	14,200	7,100
18"	45,400	64,000	34,000	17,800	8,900
20"	55,800	79,000	37,500	21,800	11,000

TABLE 3: SAFE BEARING LOADS FOR SOILS (HORIZONTAL THRUST)

Type of Soil	Safe Bearing Load (Lbs/Sft)
Muck, Peak, etc.	0
Soft Clay	1,000
Sand	2,000
Sand	3,000
Sand and Gravel cemented w/clay	4,000
Hard compacted clay	5,000

- (3) Thrust blocks in unstable soil conditions: Thrust shall be resisted by piling driven to solid foundations or by removal of unstable soil material and replacement with ballast of sufficient stability to resist thrust. Thrust block size and method of thrust resistance shall be approved by the Engineer before construction.
 - (4) Special thrust containment: Use of joint ties, containing thrust within the pipe, will be considered by the Engineer upon a definite proposal of methods submitted by the Contractor. Only methods retaining the freedom of joint to bend will be considered.
2. Valve and Valve Box Installation: Shall be in accordance with ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings and ANSI/AWWA C509 Resilient-Seated Gate Valves for Water Supply Service.
3. Hydrant Installation
 - A. Hydrant: Shall be in accordance with ANSI/AWWA C502 Dry-Barrel Fire Hydrants and the detail shown on the plans.
 - B. Depth of Cover: Hydrant leads shall be installed to provide a minimum depth of cover of 6 feet, including crossings through ditch sections.
 - C. Hydrant Drain Ports: Shall remain plugged unless otherwise noted on the plans.
 - D. Hydrant Thrust Restraint: Shall be restrained from the main line to the hydrant in accordance with 1.G Joint Restraint.
4. Service Lead Installation
 - A. General: Open cutting of existing hard surfaced pavement will not be allowed. Service leads may be bored, drilled or jacked; jetting of water or air will not be allowed. Under normal conditions, casings will not be required except where probable damage to the roadbed or the service lead exists. Service leads shall be installed to provide a depth of cover of 6 feet.
 - B. Installation without Casing: In stable soils, the diameter of the auger head shall not exceed the diameter of the service lead by more than one inch. Service lead pipe shall be pushed or pulled through after the hole has been augured. Pipe ends shall be examined after installation for damage. If damaged, the service pipe shall be replaced.
 - C. Installation With Casing: In unstable soils, as determined by the Engineer, the combination of boring and jacking simultaneously shall be utilized providing the cutting edge of the auger does not advance ahead of the casing. Casing diameter shall not exceed the diameter of the service lead by more than one inch. Casing pipe may be removed at the Contractor's option.
 - D. Boring Installation: Shall be in accordance with the requirements of the local agency/utility.
 - E. Connection to Existing Services: Connections to existing water services with like material shall be made with standard couplings; connections of dissimilar materials shall be made with appropriate couplings complete with Nylon dielectric bushings.

5. Hydrostatic Testing Requirements

- A. General: Upon completion of installation of the water main and appurtenances, the Contractor shall furnish all apparatus, materials, labor and water required to perform the pressure tests in accordance with Section 4 - Hydrostatic Testing, ANSI/AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances and the following.
- B. Pre-Test Procedures: Contractor shall open all valves, including hydrant auxiliary valves, and completely fill the line with water to remove all air from the pipe, valves or hydrants. If necessary, the Contractor shall install additional corporation stops at high points to allow the air to be expelled.
- C. Preliminary Test: A preliminary pressure test shall be accomplished by the Contractor. Any leaks encountered shall be corrected and the test shall be rerun until results are satisfactory.
- D. Final Pressure and Leakage Test: Shall be conducted in the presence of the Engineer, who shall receive 24 hours notice prior to testing. If it is necessary for the Engineer to observe more than one test on any section of mainline, the Contractor shall be liable for the additional cost involved for observation of subsequent tests.
- E. Leak Repair: The Contractor shall provide all labor and materials, etc. as required to repair leaks, or otherwise required to meet these tests. Any leakage over the allowable design calculations in AWWA C600 shall be repaired. Water damage resulting from flushing or testing procedures shall be the responsibility of the Contractor.

6. Disinfection Requirements

- A. General: Shall be in accordance with ANSI/AWWA C651 Disinfecting Water Mains and the following.
- B. Preliminary Flushing: After the pressure test and before disinfection, the Contractor shall flush the new pipe until the water runs clear. Each valved section of the newly laid pipe shall be flushed separately with potable water from the public supply.
- C. Disinfection: The Contractor shall disinfect the new mains by flushing in approximate 1,000 foot intervals at a minimum velocity of 2.5 feet per second until the water runs clear. Sufficient chlorine should be applied for a 25 ppm chlorine residual and allowed to remain in the water main for 24 hours. Samples shall be taken from corporation stops only or location approved by the City. If mains dead end at hydrants, with no adjacent valve the Contractor shall install an additional corporation stop for sampling.
- D. Bacteriological Water Samples: Shall be collected by the Contractor, in the presence of an authorized Municipal Employee and in accordance with ANSI/AWWA C651 Disinfecting Water Mains. Two successive safe tests taken 24 hours apart are required; analysis shall be made by a State approved laboratory. Chlorine residuals are required to be tested with each bacteriological sample and must indicate less than 0.5 ppm to allow for a bacteriological test.
- E. Failing Tests: In the event of an unsafe test, the test shall be repeated as described above. The Contractor shall be responsible for the tests and shall be liable for any costs when more than one treatment or set of tests is necessary.