

SECTION 02724

SEWAGE FORCE MAIN

PART 1 – GENERAL

1.1 SCOPE OF WORK

The work covered by this Section relates to sanitary sewer force mains including type materials permitted, installation, testing, and cleanup.

1.2 TYPE MATERIAL PERMITTED

Pipe material for all sanitary sewer force mains eight (8") inches and larger shall be ductile iron. PVC pipe, GREEN in color, will be permitted for force mains six (6") inches in diameter or smaller unless special or unusual construction conditions are encountered.

1.3 DELIVERY, STORAGE, AND HANDLING

It shall be the Contractor's responsibility to insure that all necessary materials are furnished, and that those found to be defective in manufacture are replaced at no extra cost to the Owner. Materials damaged in handling after being delivered by the manufacturer shall be replaced at the Contractor's own expense. If installed material is found to be defective before the final acceptance of the work, the cost of both the material and labor needed to replace it shall not be passed on to the Owner.

The Contractor shall be responsible for safely storing materials until they have been incorporated into the completed project. Keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.

1.4 STANDARDS

Where materials and methods are indicated in the following specifications as being in conformance with a standard specification, it shall refer in all cases to the latest edition of the standard specification and shall include all interim revisions. Listing of a standard specification without further reference indicates that the particular material or method shall conform with such listed specification.

All materials to be incorporated in this project shall be first quality, new, and undamaged material conforming to all applicable portions of these specifications. Where deviation from the specifications is necessary because of changes in manufacturing procedures, inability to obtain the specified product, or other extenuating circumstances, a request for the proposed substitution shall be submitted to the Engineer in writing for consideration. Materials failing to conform to these specifications shall not be delivered to the job site unless the Contractor has written approval from the Engineer covering the substitute materials.

The supplier must provide and deliver pipe manufactured by one company per project/job only. The mixing of different pipe manufacturers will no longer be accepted. Jobs can be broken into separate sections and/or phases as approved by the Murfreesboro Water & Sewer Department.

1.5 RELATED WORK SPECIFIED ELSEWHERE

Refer to following Sections of these Specifications for work related to this Section:

- A. Section 02221W – Trenching, Bedding and Backfilling for Water Lines, Sewage Force Mains and Repurified Water Lines
- B. Section 02600 – Manholes
- C. Section 03303 – Concrete for Water Lines, Sanitary Sewer Mains and Repurified Water Lines and Appurtenances

PART 2 – PRODUCTS

2.1 GENERAL PIPE REQUIREMENTS

A. QUALITY AND INSPECTION

Latitudes in workmanship and finish allowed by ASTM Specifications notwithstanding, all pipe shall be first quality, of smooth exterior and interior surfaces, free from cracks, blisters, and other imperfections, and true to theoretical shapes and forms throughout each length. All pipe, independent of laboratory tests, shall be subject to the inspection of the Engineer at the pipe plant, trench, or other point of delivery for the purpose of culling and rejecting pipe which does not conform to the requirements of these Specifications. Pipe which does not conform shall be marked as such by the Engineer and shall not be delivered or used in the work. Repairing of rejected pipe will not be permitted.

B. EXPERIENCE OF MANUFACTURER

The manufacturer of the pipe shall submit evidence, if requested by the Engineer, of having consistently produced both pipe and joints of specified quality and satisfactory performance results in service over a period of at least two years. The manufacturing process shall be subject to the approval of the Engineer.

2.2 DUCTILE IRON PIPE

A. MATERIAL

Ductile iron pipe shall conform to ANSI/AWWA/C151/A21.51, latest revisions for ductile iron pipe centrifugally cast in metal or sand lined molds. Pipe shall have asphaltic coating on the exterior. Pipe shall have an interior lining of coal tar epoxy, amine cured novalac epoxy containing ceramic quartz pigment, or polyethylene lining. Pipe shall be made with 60-42-10 grade ductile iron, or

stronger, and pressure Class 350 shall be used unless noted otherwise on the Plans.

B. JOINTS

Joints shall be push-on type compression joints unless otherwise indicated, and shall conform to ANSI/AWWA/C111/A21.11, latest revisions. Gaskets and lubricant shall be furnished with the pipe. Where shown on the Plans or required, joints shall be designed and factory fabricated for extra deflection to the maximum for various pipe sizes as shown in published tables supplied by the pipe manufacturer.

C. TESTING

Testing of ductile iron pipe and joints shall be performed in accordance with ANSI/AWWA/C151/A21.51, latest revisions and ANSI/AWWA/C151/A21.11, latest revisions.

D. MARKING

The weight, class, manufacturer's mark, year of manufacture, and letters "DI" or "DUCTILE" shall be cast or stamped on pipe.

E. CERTIFICATIONS

Manufacturer shall furnish certifications as follows:

1. That the pipe and joints have been manufactured in accordance with ANSI/AWWA/C151/A21.51, latest revisions and ANSI/AWWA/C111/A21.11, latest revisions.
2. The pipe and joints have been tested in accordance with the procedures as outlined in ANSI/AWWA/C151/A21.51, latest revisions, and ANSI/AWWA/C111/A21.11, latest revisions.

F. LENGTHS

Pipe shall be furnished in lengths of eighteen (18') feet or twenty (20') feet long, except for special construction conditions.

G. INTERIOR COATING FOR DUCTILE IRON PIPE

The pipe manufacturer shall submit complete information on the proposed coating system, method of application and application personnel to the Engineer and shall receive the Engineer's approval before undertaking any pipe coating. Certified

copies of the manufacturer testing results shall also be submitted to the Engineer by the pipe manufacturer.

In addition to the certifications to be provided by the pipe manufacturer, the Owner may retain an independent Testing Laboratory to inspect and label the pipe before the coating application begins. If so directed, the independent Testing Laboratory provided by the Owner will make random selections of up to one (1%) percent of the coated pipe sections which will be visually inspected, checked for holidays, and tested for dry film thickness. Any patching or recoating of the test sections shall be done by the Applicator at no additional cost. Any changes in procedure or any recoating necessary to correct defective coating systems shall be carried out promptly upon notification of such deficiencies.

1. Interior coating for ductile iron pipe shall consist of a coal tar epoxy lining system applied in strict accordance with the coating manufacturer's recommendations and these Specifications. The coating shall be equivalent to Kopcoat 300-M or Tnemec 46H-413 Hi Build Tnemec – Tar.
2. Cured novalac epoxy lining for ductile iron pipe shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Lining shall be forty (40) mils nominal thickness.
3. Polyethylene lining for ductile iron pipe shall be of virgin polyethylene complying with ASTM D-1248 compounded with sufficient lamp black to resist ultraviolet rays during above ground storage of the pipe. Lining shall be heat fused to the interior of the pipe and shall be approximately forty (40) mils thick.

H. MANUFACTURER

Ductile iron pipe shall be as manufactured by U.S. Pipe/Griffin Pipe and Foundry Company, American Cast Iron Pipe Company, McWane Pipe/James B. Clow and Sons, or an approved equal.

2.3 POLYVINYL CHLORIDE (PVC) PIPE

A. MATERIAL

PVC pipe shall conform to the requirements of AWWA C900 "Standard for Polyvinyl Chloride (PVC) Pressure Pipe, four (4") inches through twelve (12") inches for Water Distribution" and furnished in cast iron pipe equivalent outside diameters of DR 18 with integral wall thickened bell ends and pressure Class 150, unless directed otherwise by the Engineer. In all cases the pipe must be "GREEN" in color.

B. JOINTS

Provision must be made for contraction and expansion of each joint with flexible ring gaskets from rubber or other suitable material. Gasket materials shall meet the requirements established in ASTM F477. Joints for pipe shall be manufactured in accordance with ASTM D 3139. Lubricant shall be nontoxic and shall not promote biological growth. Solvent cemented joints in the field are not permitted.

C. TESTING

The following tests shall be run for each machine on each size and type of pipe being produced as specified.

1. FLATTENING TEST

Once per shift in accordance with ASTM D2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.

2. ACETONE TEST (Extrusion Quality Test)

Once per shift in accordance with ASTM D2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.

3. QUICK BURST TEST

Once per twenty-four (24) hours in accordance with ASTM 1599.

4. WALL THICKNESS AND OUTSIDE DIMENSIONS TEST

Once per hour in accordance with ASTM D2122.

5. BELL DIMENSIONS TEST

Once per hour in accordance with ASTM D3139.

If any specimen fails to meet any of the above mentioned tests, all pipe of that size and type measured between the test periods must be scrapped and a full set of tests rerun.

D. MARKING

Certain information shall be applied to each piece of pipe. At the least, this shall consist of:

1. Nominal size
2. Type of material
3. SDR or class
4. Manufacturer

5. NSF Seal of Approval

E. CERTIFICATIONS

The manufacturer shall furnish certifications as follows:

1. That the pipe and joints have been manufactured in accordance with AWWA C900 “Standard for Polyvinyl Chloride (PVC) Pressure Pipe, four (4”) inches through twelve (12”) inches, for Water Distribution”.
2. That the pipe and joints have been tested in accordance with the ASTM designations for the respective tests designated in C.

F. LENGTHS

Pipe shall be furnished in lengths of twenty (20) feet, except for special construction conditions.

G. DETECTION WIRE

Pipe shall have a twenty-four (24) TW solid copper wire with a white coating installed in such manner that detection with electronic equipment is possible. The detection wire shall be continuous and shall be installed at the side of the trench adjacent to the pipe.

H. MANUFACTURER

Pipe shall be as manufactured by JM-Eagle Manufacturing, National, North American Pipe, Pipelife Jet Stream Inc., Diamond Plastics, Royal Building Products or an approved equal.

2.4 PIPE FITTINGS

Fittings furnished for use with PVC or ductile iron pipe shall be fittings conforming to ANSI/AWWA/C110/A21.10, latest revisions. Unless otherwise indicated, ends shall be mechanical joint. Fittings shall have interior lining and exterior coating as specified for pipe. Fittings shall be of ductile iron. Ductile iron compact fittings shall conform to ANSI/AWWA/C153/A21.53. Fittings shall have a pressure rating of 350 psi.

Fittings shall be in accordance with standard mechanical joint fittings as manufactured by the U.S./Griffin Pipe and Foundry Company, American Cast Iron Pipe Company, McWane/James B. Clow and Sons, , Tyler/Union, Sigma, Star or an approved equal.

2.5 CASING PIPE

The minimum material requirements for casing pipe used in highway and railroad crossings shall be steel conforming to ASTM A 139, Grade B. Minimum yield strength shall be 35,000 psi. All casing pipe used must meet the approval of the permitting authority. If the casing pipe is being used in a bore situation within the City's rights-of-way, the bore must extend to 10 feet beyond the toe of the slope and/or the back of the ditch and at minimum from right-of-way to right-of-way. Nominal casing diameter shall be as indicated on the plans as determined by the Department, but shall be 2 times larger than the diameter of the carrier pipe minimum. Joints shall be continuously welded. Casing pipe and joints shall be leakproof and capable of withstanding Cooper E-80 loading. Casing pipe shall be coated as specified herein.

The minimum wall thickness of casing pipe shall be as shown in the table below.

Nominal Diameter <u>(Inches)</u>	Minimum Wall Thickness (Inches)	
	<u>With Coating</u>	<u>Without Coating</u>
Under 14	0.188	0.251
14 and 16	0.219	0.282
18	0.250	0.313
20	0.281	0.344
22	0.312	0.375
24	0.344	0.407
26	0.375	0.438
28 and 30	0.406	0.469
32	0.438	0.501
34 and 36	0.469	0.532
38, 40, 42	0.500	0.563

Where specified, coating for steel casing pipe shall be a two component, self-priming, chemically cured coal tar epoxy-polyamide protective coating. Minimum dry film thickness of completed coating shall be sixteen (16) mils. Material shall be Kopcoat 300 M, Tnemec 46H-413 Hi Build Tneme – Tar or equal. Preparation shall be SP6 commercial blast.

2.6 VALVES AND VALVE BOXES

A. CHECK VALVES

Check valves shall be Dresser (M&H) or equal, and shall match existing check valves in size and laying length.

B. GATE VALVES

Gate valves three (3") inches through twelve (12") inches shall be resilient seated, solid wedge, manufactured to meet or exceed the requirements of AWWA C-509 or C515 of latest revision. Each valve shall have the manufactures name, pressure rating, and year in which it was manufactured cast in the body. The body, bonnet and the o-ring plate shall be fusion bonded epoxy coated inside and out in

accordance with AWWA C550 and shall be NSF 61 Certified. Gate valves fourteen (14") inches in diameter and larger shall be resilient seated, solid wedge type and shall be similar to AWWA C-500 latest revision, but may be furnished for 150 psi working pressure. Double disc valves having not more than four internal parts, excluding the valve stem, and with discs and wedging mechanism free from pockets, pins, lugs, or ribs which would trap solids and interfere with operations may be furnished, with cleanouts in lieu of solid wedge gates. Cleanouts shall be of such design that valve may be cleaned or flushed while the valve is in service in the closed position. All gate valves shall be of such design that valves may be installed in either a horizontal or vertical position.

Buried valves shall be mechanical joint, equipped with a two (2") inch square operating nut and shall be housed in valve boxes as specified herein. The valves are to be non-rising stem. Two stem seals shall be provided and shall be of the O-ring type. Valves shall open to the left.

Valve supplier shall furnish two standard stem iron wrenches for turning nut-operated valves.

Iron body gate valves shall be American Flow Control, Mueller, M&H, U.S. Pipe Company, or equal.

C. VALVE BOXES

Valve boxes shall consist of precast concrete sections with cast iron frames and covers. The precast concrete sections are each approximately six (6") inches high with a minimum inside opening of eleven by thirteen (11" x 13") inches. Manufacturer shall be Hula Concrete Products of Hickman, TN, or Thomas Holton of Christiana, TN or approved equal.

The cast iron frame and lid shall be roadway type, Bouchard No. 8006, or equal having inside dimensions of eleven by thirteen and one-fourth (11" x 13¹/₄") inches and a height of six and one-half (6¹/₂") inches. The combined weight of frame and cover shall be one hundred ninety-five (195) pounds.

D. COMBINATION AIR RELEASE VALVES

Sewage combination automatic air release/air and vacuum valves shall be APCO, or equal, sized and installed in a manhole as shown on the Standard Detail Drawing.

2.7 CONCRETE

A. CLASS "A" CONCRETE

Class "A" concrete shall have a minimum compressive strength of four-thousand (4,000) pounds per square inch in twenty-eight (28) days and shall contain not less than six-hundred (600) pounds of cement per cubic yard.

B. CLASS "B" CONCRETE

Class "B" concrete shall have a minimum compressive strength of three-thousand (3,000) pounds per square inch in twenty-eight (28) days and shall contain not less than five-hundred-fifty (550) pounds of cement per cubic yard.

PART 3 – EXECUTION

3.1 GENERAL

The Contractor will be held completely responsible for any damage to pavement, sidewalks, curbs, gutters, meter or valve boxes, street inlets, or other structures or appurtenances as a result of construction operations. It should be specifically noted that the Contractor shall be responsible for damage even though the character or nature of the original pavement or structure was such that it was not capable of carrying the load of the construction equipment regardless of the construction methods used.

The Contractor shall take precautions as may be necessary to avoid endangering personnel, pavement, adjacent utilities, or structures through cave-ins, slides, settlement, or other soil disturbance resulting from construction operations. The Contractor shall furnish and maintain barricades, signs, flashing lights, and other warning devices as necessary for public safety and as required by the Manual on Uniform Traffic Control Devices, Part 6.

The Contractor shall plan construction operations so as to cause a minimum of inconvenience to property owners and to traffic. Flaggers shall be provided as required on heavily traveled streets to avoid traffic jams or accidents. No road, street, or alley may be closed unless absolutely necessary, and then only if the following conditions are met:

- A. Permit is secured from appropriate State, County, or Municipal authorities having jurisdiction.
- B. Fire and Police Departments and other emergency services are notified before road is closed.
- C. Suitable detours are provided and are clearly marked.

No driveways shall be cut or blocked without giving twenty-four (24) hour notice to the occupant of the property. Every effort shall be made to schedule the blocking of drives to suit the occupant's convenience, and except in case of emergency, drives shall not be blocked without an alternative access being provided.

Whenever pipe laying operations are to be discontinued for an extended period of time, the end of the pipe shall be carefully secured to avoid displacement or misalignment, and a tight fitting plug or stopper shall be placed in the line. Upon resumption of laying

operations, the plug or stopper shall not be removed from the line until any water, mud, or other debris has been removed to avoid entry into the completed section of the force main.

Installation of force main shall conform to provisions of these specifications and recommendations of the pipe manufacturer. Installation instructions provided by the pipe manufacturer shall be available at all times at the location of the work.

The proper gaskets and lubricants shall be furnished by the pipe manufacturer, and lubricants shall be delivered to the job site in properly labeled, unopened containers.

When force mains are to be constructed near water mains, horizontal and vertical separation shall be maintained as described as follows:

Horizontal Separation: Whenever possible, force mains should be separated horizontally from water mains a minimum of ten (10') feet. If this is not possible, the lines may be laid closer provided they are in separate trenches, and if the elevation of the top of the force main is at least eighteen (18") inches below the bottom of the water main.

Vertical Separation: When a force main must cross a water main, the top of the force main should be at least eighteen (18") inches below the bottom of the water main.

If the elevation of the force main cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of ten (10') feet on each side of the force main with a full joint of the water main centered on the sewer. If it is impossible to obtain proper horizontal and vertical separation as stipulated herein, construct both the water main and the force main of mechanical joint ductile iron pipe and pressure test each.

The Contractor shall submit a proposed construction schedule for the Engineer's approval before construction begins. If the sewer is to be installed in a proposed road, the road shall be graded to subgrade before the force main is installed. The normal requirement will be to begin pipelaying at the lower end of any proposed line and continue laying upstream until the line is completed. Construction will begin at points where proposed force mains tie into existing or proposed pump stations.

3.2 EXCAVATION AND BEDDING

The trench excavation for force mains and the excavation for manholes and other structures, including excavation in solid rock, and any necessary foundation stabilization, dewatering, sheeting or shoring, and the disposal of materials shall be done in accordance with Section 02221W, Trenching, Bedding and Backfilling for Water Lines, Sewage Force Mains and Repurified Water Lines.

In wet or mucky areas where the subgrade or the trench walls have insufficient stability to support the installed force main, the Contractor will be directed to remove such unstable material and replace same with crushed stone size No. 67 as given in Section 903 of the latest Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction. Where the wet or mucky condition is caused by the Contractor's failure or neglect to properly handle ground water or protect against the entrance of storm water, the Contractor will be required to remove and replace the unstable material at no expense to the Owner.

Unless otherwise indicated by the Plans, all force mains shall have at least forty-two (42") inches of cover. The pipe shall slope continuously between high and low points and have a minimum of sixty (60") inches cover at the high points. No departure from this policy shall be made except by order of the Engineer.

3.3 PIPE INSTALLATION

The Contractor shall exercise care in the storage and handling of pipe, both on the storage yard and at the site of laying operations. Suitable clamps, slings, or other lifting devices shall be provided for handling pipe and fittings. Pipe and fittings shall be carefully lowered into the trench piece by piece. Pipe and fittings shall be inspected for defects and for dirt or other foreign material immediately before placing them in the trench. Suitable swabs shall be available at the site of laying operations, and any dirt or foreign material shall be removed from the pipe before it is lowered into the trench. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside it, then place a heavy, tightly woven canvas bag of suitable size over each end of the pipe and leave it there until it is time to connect that pipe to the one adjacent to it.

After a length of pipe has been placed in the trench, center the spigot end of the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer, and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.

Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.

Whenever pipe laying operations are to be discontinued for an extended period of time, the end of the pipe shall be carefully secured to avoid displacement or misalignment, and a tight fitting plug or stopper shall be placed in the line. Upon resumption of laying operations, the plug or stopper shall not be removed from the line until any water, mud, or other debris has been removed to avoid entry into the completed section of pipe.

Installation of force mains shall conform to provisions of these specifications and recommendations of the pipe manufacturer. Installation instructions provided by the pipe manufacturer shall be available at all times at the location of the work.

The trench for the force main, including the bottom, bedding, sides, backfilling, and any necessary foundation stabilization, dewatering, sheeting or shoring, and the disposal of materials shall be prepared or done in accordance with Section 02221W, Trenching, Bedding and Backfilling for Waterlines and Sewage Force Mains.

The Contractor will be required to exercise care to maintain satisfactory grades and alignments and avoid unnecessary kinks, sags, or high points. Exact grades or centerline elevations where not indicated on the drawings are not required, but grades shall be such as to provide a continuous upward slope to discharge point or other summit point where facilities for release of air shall be provided.

Unless otherwise indicated, pipe shall be laid with slip type compression joints, equal to the manufacturer's standard for pressure water pipe, and assembly of the joints shall be in accordance with the manufacturer's recommendations using lubricant and accessories as provided by the pipe manufacturer.

Changes in grade or alignment may be made by means of deflection in pipe joints provided that the recommended deflection, as shown in published tables supplied by the pipe manufacturer, are not exceeded. The Contractor shall have on hand at the site of the work a table showing the permissible deflections whenever the pipe laying is in progress.

Whenever it is necessary to cut a joint of pipe in order to fit the trench conditions, the cutting shall be done using the equipment as recommended by the manufacturer for the specific type of pipe involved. The cut shall be made so as to leave a smooth end at right angles to the axis of the bore, and the end shall be bevelled or finished as required to make the joint without risk of damage to gasket.

3.4 THRUST BLOCKS OR RESTRAINT

Poured in place concrete thrust blocks must be provided at all points of unbalanced pressure where the pipeline could pull apart. Thrust blocks shall conform to details and minimum bearing areas as shown on the Standard Detail Drawings, and shall bear against the undisturbed trench face. Care shall be taken to avoid pouring concrete over or around pipe joints and to protect bolts, glands, or other component parts of the joint while the thrust block is being poured.

Where over bends (downward bends) cannot be avoided, the fittings must be held in place by one of the following methods:

- A. Steel rods and clamps extending for two (2) full pipe lengths on each side of bend as designed by the Engineer and approved by the Department.
- B. Steel rods anchored for at least eighteen (18") inches in solid rock.
- C. Poured concrete under pipe of sufficient volume to counteract unbalanced force, with steel clamp and anchor bolts to hold fitting to concrete.

Rods and bolts shall have a minimum diameter of three-quarter ($\frac{3}{4}$ ") inch, and clamps or straps shall be of steel having at least one-fourth ($\frac{1}{4}$ ") inch thickness. Steel rods, bolts, clamps, etc. shall be coated with coal tar epoxy. Concrete used in thrust blocks shall be Class "B".

3.5 BACKFILLING

Backfilling shall be carried out as expeditiously as possible, but shall not be undertaken until the Engineer has been given the opportunity to inspect the work. The Contractor must carry out all backfilling operations with due regard for the protection of pipe, structures, and appurtenances, and procedures to obtain the desired degree of compaction.

The Contractor shall be responsible for and shall protect all sewers, storm sewers, and electric, telephone, water, or other pipes or conduits against danger or damage while excavated areas are being backfilled and from future settlement of the backfill. In all instances sufficient care must be exercised to avoid leaving any holes or voids over, around, or under stones, boulders, or other backfill material which may later be filled by leaching or settlement of surrounding material, thereby causing future trench settlement. Where damage should occur as a result of the Contractor's backfilling operations or from trench settlement, he shall repair such damage promptly at no cost to the Owner.

The three classes of acceptable backfill material and placement procedures are as described in Section 02221W Trenching, Bedding and Backfilling for Water Lines, Sewage Force Mains and Repurified Water Lines and as shown on the Standard Detail Drawings.

3.6 CLEANING, TESTING, AND ACCEPTANCE

A. GENERAL

Upon completion of construction, the Contractor shall remove all sand, dirt, brick, and other foreign materials from the force main and shall conduct an inspection to locate any defects and determine when the force main is ready for testing and acceptance by the Engineer. After all apparent defects have been corrected, the Contractor shall notify the Engineer and request a final inspection.

No final inspection will be scheduled by the Engineer until the Contractor advises that he has conducted an inspection and believes the project to be ready for such final inspection. Should the Engineer begin a final inspection at the request of the Contractor and find that the force main has not been cleaned or defects have not been corrected, the inspection will be terminated and will not be rescheduled until the Contractor again advises that the project is ready for inspection.

Acceptance of the project shall involve both a visual inspection and a leakage test. The procedures shall be as outlined hereinafter. The work will not be accepted until both the visual inspection and leakage test results are satisfactory.

B. VISUAL INSPECTION

The Engineer will, as a part of the final inspection, make the necessary visual inspections to verify the quality of workmanship. Such inspections shall include observation of cleanup, pavement replacement, etc.

Any defects such as visible leaks, obstructions, cracked or broken pipe, or failure to restore the surface to a satisfactory condition must be corrected to the Engineer's satisfaction before acceptance.

C. TESTING FORCE MAINS

Before final acceptance, the force main shall be pressure tested by suitably closing the end of the main with a test plug of approved design suitably braced against the internal pressure to prevent blowout and possible injury to personnel.

Contractor shall furnish all labor, materials, and equipment for testing the force main, including but not limited to water for testing, test pump, pressure gauges, test plugs, etc. Test shall be performed by Contractor and witnessed by the Engineer.

The force main shall be filled with water taking care to eliminate air from the high points. A positive displacement test pump shall be used to pump clean water into the main to build up a test pressure equal to the normal system pressure plus 50 psi. Maximum required test pressure will be 150 psi. The test pump shall be valved off from the system and the pressure shall be observed over a period of one hour. A drop in pressure of 5 psi or more during the one-hour test period shall be taken as an indication of leakage. In the event leaks are found and corrected, the Contractor shall repeat the pressure test using the same procedure described above. Should the Contractor be unable to obtain a satisfactory pressure test over a duration of one hour, he shall then be required to perform a leakage test using a water tap and standard water meter to measure the leakage in the test section at system pressure over a period of twenty-four (24) hours. Leakage during the twenty-four (24) hour period must not exceed the allowable leakage for mechanical or push-on joints as shown in AWWA C600-87. Leakage shall not exceed the quantity determined by the formula: $L = (SD \sqrt{P}) \div 133,200$ where L is allowable leakage in gallons per hour; S is length of pipeline tested in feet; D is nominal internal pipe diameter in inches; and P is the average test pressure during the leakage test, in pounds per square inch. Should the system fail to pass the leakage test, the Contractor will be required to locate and correct the leaks and to retest the system until satisfactory results can be obtained.

The Contractor shall provide suitable first quality pressure gauges with five (5) lb. or smaller graduations and a standard 3/4 x 5/8 water meter in the event the meter is required for the leakage test. Pressure gauges and water meter shall be in good condition and shall be subject to such tests for proof of accuracy as the Engineer may require.

D. ACCEPTANCE

Force mains and appurtenances will not be considered ready for acceptance until all provisions of these Specifications have been complied with, until all tests have been satisfactorily completed, and until final inspection of the work has been made. Sewage flows shall not be diverted into new force mains until after such time as final inspection of the lines has been made by the Engineer, and permission granted thereof.

3.7 CONNECTIONS, APPURTENANCES, AND SPECIAL CONDITIONS

A. CONNECTION TO EXISTING SYSTEM

No new force main shall be connected to the existing system until all new construction has been completed, is free of foreign materials, and obvious defects have been corrected. New force mains, then, must remain disconnected from the existing system by actual physical separation, by plugs of a type approved by the Engineer, or by other means approved by the Engineer.

The Contractor shall make connections to the existing or proposed pump station or the gravity sewer manhole in accordance with details as shown on the Plans or Standard Detail Drawings.

B. CONCRETE PIERS

Concrete piers for ductile iron force mains shall be constructed of Class "A" concrete and shall conform to the details shown on the Plans. A saddle conforming to the outside of the pipe shall be constructed in the top of all piers. Pipe shall be blocked to proper grade and then grouted in place in the saddle with 1:2 cement mortar. Pipe straps shall be installed on all piers.

Piers supporting pipelines across streams shall be anchored into rock in accordance with details shown on the Plans, so as to resist overturning during periods of flood stages in the stream. Holes shall be drilled two and one-half (2½") inches minimum diameter into the rock after excavation for the footing is complete, and reinforcing bars embedded in grout made with high-early strength cement poured into the holes. With wet holes, grout shall be deposited by means of a trowel. Straight bars shall be used and bent over for anchorage after the concrete has attained its full strength.

C. STATE HIGHWAY AND RAILROAD CROSSINGS

The installation of force mains along and across state highways shall be made in accordance with the details shown on the Plans, as specified herein, and with all requirements of the Tennessee Department of Transportation (TDOT) with reference to construction operations, safety, traffic control, road maintenance and repair, etc.

The installation of force mains along and across railroads shall be made in accordance with the details shown on the Plans, as specified herein, and with all requirements of the Railroad Company with reference to construction operations, safety, maintenance of service, etc.

Permits for such work will be obtained by the Owner/Developer. All costs for labor, materials, and supervisory personnel furnished by the TDOT and the Railroad Company in connection with the work, if any, shall be at the expense of the Contractor. The Contractor shall fully inform himself/herself of the conditions and insurance requirements of the permit and fully comply with those conditions and requirements.

The Contractor shall be responsible for fully informing himself with regard to all TDOT and Railroad Company regulations and conditions relating to pipeline crossings.

The Contractor shall be responsible for notifying TDOT and the Railroad Company when work is about to begin on the crossing.

D. STREAM CROSSINGS

Where indicated on the Plans, special construction shall be used at stream crossings. Details shall be as shown on the Plans. These stream crossings require special construction materials or procedures.

When required, the Owner/Developer will submit the appropriate permit applications and details to TDEC and the U.S. Army Corps of Engineers so that appropriate permits can be obtained for the stream crossings. The Contractor shall be required to adhere to the permit requirements from each agency for the force main crossing of the stream.

3.8 CLEANUP

The Contractor shall not, without the permission of the Engineer, Owner, and property owner, remove from the line of work any earth excavated therefrom which may be suitable for backfilling or surfacing until the excavation has been refilled and surfaced.

As soon as the backfilling of any excavation is completed, and when in areas of existing development, the Contractor must at once begin the removal of all surplus dirt except that actually necessary to provide for the settlement of the fill. He shall also remove all the pipe and other material placed or left on the street by him except material needed for the replacement of paving, and the street shall be opened up and made passable for traffic. Following the above work, the repairing and complete restoration of the street surfaces, bridges, crossings, and all places affected by the work shall be done as promptly as possible.

All excavated material shall be cleared from adjacent street surfaces, gutters, sidewalks, parkways, railroads, grass plots, yards, etc., and the whole work shall be left in tidy and acceptable condition.

The Engineer shall be sole authority in determining time in which rough and final cleanup shall be prosecuted. Rough cleanup shall consist of removal of rocks larger than one (1') foot in any dimension, grading of excess backfill material over pipeline or removal of said material, opening of any drainage device, restoration of any street or roadway to condition so that traffic may safely and conveniently use street or roadway, restoration of pedestrian ways to condition where pedestrians may safely and conveniently use same. Rough cleanup shall, in general be prosecuted no later than one (1) day after pipe laying and backfilling or no farther behind pipe laying operations than one thousand (1,000') feet; whichever time limit is shortest shall govern. Final cleanup consisting of pavement replacement, sidewalk replacement, removal of rocks, hand raking with seeding, strawing, etc. of lawns and neutral grounds, adjusting grade of ground over pipeline, property repairs, and other items shall, in general, be prosecuted no later than three (3) weeks after completion of backfilling.

END OF SECTION 02724