

Town of Jasper
Since 1820

JASPER, TENNESSEE STANDARD SPECIFICATIONS FOR WATER AND SEWER PROJECTS

LAST REVISION: JANUARY 2023

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Part 1 General

1.01 Scope

- A. These specifications shall apply to all sewer and water utility construction which is, or which will become a part of Jasper's water distribution and wastewater collection systems. These specifications shall also apply to private water and wastewater systems that are under Owner's jurisdictions for inspection. Any failure to comply with these specifications shall be cause for the Owner to refuse acceptance of such distribution or collection lines for operation and maintenance
- B. The project consists of providing all material, labor, tools, equipment, and incidentals needed to complete construction, testing, and placing into service all water and sewer mains or other appurtenances shown and listed on the plans and contract documents.

1.02 Definitions

- A. Owner: Jasper, TN
- B. Contractor: Person, firm or corporation with whom the Owner has entered into the Agreement.
- C. Resident Project Representative (RPR): Authorized representative of the Owner who is assigned to the site or any part thereof.

1.03 Contractor's Responsibilities

- A. Protection of Lives and Health
 - a. In accordance with generally accepted construction practices, the Contractor will be solely and completely responsible for conditions at the job site, including the safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Contractor shall follow all applicable OSHA Standards and provide documentation of OSHA compliance upon request of the Owner, RPR, or TOSHA.
 - b. Pipe and materials shall be stored in a safe location, away from roadways, and properly barricaded for the safety of vehicular and pedestrian traffic. No smoking, fire, or use of any fire- or explosion-producing tools or equipment will be permitted on the properties of oil companies or other concerns prohibiting same on their premises or at any locations where such may endanger said premises of the current operations thereon.
 - c. No discharge of wastewater to waterways will be allowed during construction unless a schedule has been approved by the Tennessee Division of Water

Pollution Control and the U.S. Environmental Protection Agency pursuant to the terms of the NPDES permit prior to commencing the Work.

- d. Under no circumstances will spent oil wastes be discharged anywhere on the site.
- e. Contractor shall comply with all applicable laws, regulations, and requirements which may or may not be included in these technical specifications, including, but not limited to, Contractor Licensing Act of 1994, as amended, and the Tennessee State Safety, Health, and Labor Standards.
- f. Contractor shall provide proof he holds a valid Contractor's license in the state of Tennessee with a Municipal and Utility Construction (MU) classification of sufficient monetary limit to bid on and/or perform water distribution and wastewater collection system installation and construction for Jasper, TN. The license number shall be provided to Owner prior to construction.
- g. Contractor shall obtain all licenses and permits prior to the start of work. Copies of each permit shall be submitted to Jasper, TN. Contractor shall be responsible for obtaining permission to work in the right-of-way from the following agencies, including, but not limited to the City or County Engineering or Highway Department having jurisdiction and the Tennessee Department of Transportation.

1.04 Rights-of-Way and Easements

- A. All work on water and wastewater mains to be dedicated to the Owner shall be on public rights-of-way and/or on easements secured by the Owner or by Contractor/developer and transferred to the Owner. Easement areas shall be restored to as near original condition as possible, and to the satisfaction of Owner.

1.05 Protection of Public and Private Property

- A. Take special care in working areas to protect public and private property. The Contractor shall immediately notify the Owner and/or RPR, and the property owner when damage property occurs. At Owner's discretion, Contractor shall replace or repair in a timely manner at his own expense any damaged water or sewer mains, power and communication lines, or other public utilities, roads, curbs, gutters, sidewalks, fences, drain pipes, and drainage ditches. It shall be the responsibility of Contractor to replace damaged vegetation or to compensate the property owner for replacement value for those areas located outside the easement limits. Leave the site in a condition satisfactory to Owner.
- B. Take reasonable care during construction to avoid damage to vegetation. Take special precautions (including the provision of barricades and the temporary tying back of shrubbery and tree branches) for the protection and preservation of such vegetation throughout all stages of construction. Where the area to be excavated is occupied by trees, brush, or other uncultivated vegetable growth, clear such growth from the area, and dispose of it in a lawful and satisfactory manner. Trim any limbs or branches of trees broken during construction operations with a clean cut, and paint with an approved tree pruning compound. Treat damaged tree trunks with appropriate tree dressing.

- C. Contractor shall examine the site and become familiar with any construction requirements, such as work related to drainage ways, erosion control, and easements. Any such work shall be considered incidental to the Work, and no additional payment will be allowed. Sodding, fabric mats, or other methods of re-establishing vegetation may be required by Owner if difficulty persists in reestablishing vegetation, and shall be considered incidental to construction.

1.06 Obstructions Encountered During Construction

- A. The locations of existing utilities, public or private, are approximate only. Contractor is to contact owners of all underground utilities through Tennessee One-Call, Underground Utility Damage Prevention Act, Protection of Utilities.
- B. Carefully protect from damage all utilities in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility in order to complete the work properly; do so in compliance with the rules and regulations of the particular utility involved. Any such work shall be considered incidental to the construction repairs of utility lines, and no additional payment will be allowed.
- C. Contractor shall report damages to the Owner at 423.942.3180 and proceed as directed and report to other utility owners as required.

1.07 Substitutions

- A. The contract is based on the standards of quality established in the contract documents.
- B. All products proposed for use, including those specified by required attributes and performance shall require approval by Owner before being incorporated into the work.
- C. Do not substitute materials, equipment, or methods unless such substitution has been specifically approved for this work by Owner. Where the phrase "or equal" or "or approved equal" occurs in the plans or specifications, do not assume that materials, equipment, or methods will be approved as equal unless the item has been specifically approved for this work by Owner. The decision of Owner shall be final.

1.08 Construction Clearing

- A. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage. Dispose of all materials in accordance with all applicable laws and regulations and, when applicable.
- B. Maintain the site in a neat and orderly condition at all times.

1.09 Warranty

- A. Contractor shall warranty all materials, equipment, and workmanship for a period of one year from the date of Substantial Completion of the Work as determined by the Certificate of Substantial completion issued by the Owner. If during this time period any material, equipment, or item of construction proves defective, Contractor shall make the repairs at his own expense to the satisfaction of Owner. If Owner must perform emergency repairs during the guarantee period, Contractor shall be liable for the costs incurred by Owner, including labor, equipment and materials. Guarantees shall be covered by Contractor's performance bond where applicable. Neither the final acceptance, final payment, nor other provision relieves Contractor of the responsibility for faulty material, equipment or workmanship.

1.010 Owner's Representation During Construction

- A. The Resident Project Representative (RPR), who is the Owner's agent at the site, will act as directed by and under the supervision of Owner and will confer with Owner regarding RPR's actions. The RPR's dealings in matters pertaining to the on-site work shall, in general, be with Owner and Contractor, keeping Owner advised as necessary. The RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor.

Part 2 Products

2.01 General

- A. All products and materials utilized in the execution of the work described herein shall meet or exceed the specified characteristics provided herein.

Part 3 Execution

(NOT USED)

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Clearing and grubbing.
- B. Excavation and disposal of all wet and dry materials (including rock) encountered that must be removed for construction purposes.
- C. Sheeting, shoring, bracing, and timbering.
- D. Dewatering of trenches and other excavations.
- E. Pipe bedding.
- F. Backfilling and tamping of trenches, foundations, and other structures.

1.2 Definitions

- A. Degree of Compaction: Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698, for general soil types, abbreviated as percent laboratory maximum density.
- B. Hard Materials: Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- C. Rock: Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement.

1.3 Submittals

- A. The following shall be submitted to Owner before construction of work:
 - 1. Flowable Fill: Certified mix design and test results; including types and weight per cubic yard for each component of mix.
 - 2. Should the Contractor excavate twenty feet or greater in depth, a protective system designed by a registered professional engineer shall be submitted prior to the start of work. The Contractor shall provide a drawing which identifies the type of location and protective system to be used with supporting data as necessary.
 - 3. Dewatering work plan.

4. Blasting work plan as prior approved by the Owner.
- B. Test Reports – Submit copies of all laboratory and field test reports within 24 hours of the completion of the test.
1. Borrow Site Testing: Fill and backfill test.
 2. Select material test.
 3. Porous fill test for capillary water barrier.
 4. Density test.

1.4 Delivery, Storage, and Handling

- A. Perform in a manner to prevent contamination or segregation of materials.

1.5 Requirements for Off Site Soil

- A. Soils brought in from off site for use as backfill shall be tested for petroleum hydrocarbons, BTEX, PCBs and HW characteristics (including toxicity, ignitability, corrosivity, and reactivity). Backfill shall not contain concentrations of these analytes above the appropriate State and/or EPA criteria, and shall pass the tests for HW characteristics. Determine petroleum hydrocarbon concentrations by using appropriate State protocols. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5035/8260B. Perform complete TCLP in accordance with EPA SW-846.3-3 Method 1311. Perform HW characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for petroleum hydrocarbons and BTEX from a grab sample of material from the area most likely to be contaminated at the borrow site (as indicated by visual or olfactory evidence), with at least one test from each borrow site. For each borrow site, provide borrow site testing for HW characteristics from a composite sample of material, collected in accordance with standard soil sampling techniques. Do not bring material onsite until tests results have been received and approved by the Owner.

1.6 Field Measurements

- A. Verify that survey bench mark and intended elevations for the Work are as shown on the drawings.

1.7 Coordination

- A. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

1.8 Quality Assurance

- A. Shoring and Sheeting Plan: Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.
 - 1. The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contractor and Owner of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems.
- B. Dewatering Work Plan: Submit procedures for accomplishing dewatering work.
- C. Utilities: Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Report damage to utility lines or subsurface construction immediately to the Engineer.

Part 2 Products

2.1 Trench Stabilization Material

- A. Base Rock: TDOT Mineral Aggregate Base Class A, Aggregate Grading D as specified in Section 903.05 of the TDOT Standard Specifications for Road and Bridge Construction.
- B. Granular Backfill: TDOT #57 stone as specified in Section 903.22 of the TDOT Standard Specifications for Road and Bridge Construction.

2.2 Pipe Zone Material

- A. Crushed stone, TDOT #7 as specified in Section 903.22 –Sizes of Coarse Aggregate AASHTO M 43, of the TDOT Standard Specifications for Road and Bridge Construction; Class B aggregate.
- B. Excavated materials suitable for use shall consist of sand, clay, or soil free from large rocks, silt, roots, organic matter, or trash. Excavated materials shall be approved by the OWNER (see Part 3, Execution, Section 3.10, Pipe Zone).

2.3 Earth Backfill

- A. Soil, clay, or other excavated material suitable for use as backfill.

- B. Free from roots or organic matter, refuse, boulders and material larger than 6 inches in diameter, or other deleterious materials.

2.4 Flowable Fill

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150, Type I or Type II.
 - 2. Aggregate: ASTM C33, Size 7.
 - 3. Fly Ash (if used): ASTM C618, Class C.
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.5 Source Quality Control

- A. Perform gradation analysis in accordance with ASTM C136 for:
 - 1. Imported earth backfill, including specified class.
 - 2. Trench stabilization material.
 - 3. Pipe zone material.
- B. Certify Laboratory Performance of Mix Designs: Flowable fill.

Part 3 Execution

3.1 Protection

- A. Shoring and Sheeting
 - 1. Take special care to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the excavation work.
 - 2. Wherever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5 feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than 5 feet deep when examination of the ground indicates

hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.

3. Trench excavation safety protection shall be accomplished as required by the most recent provisions of Part 1926, Subpart P - Excavations, Trenching, and Shoring of the Occupational Safety and Health Administration (OSHA) Standards and Interpretations, as may be amended. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done. The sheeting, shoring, and bracing system shall be designed by a professional engineer licensed in the State of Tennessee and shall be subject to approval by the Engineer. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of sheeting, shoring, and bracing.
4. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the Engineer.
5. Do not leave sheeting, shoring, or bracing materials in place unless this is called for by the Drawings, ordered by the Engineer, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.
6. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.
7. The Contractor may use a trench box, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.
8. A "Qualified Person", as defined by OSHA regulations, shall be on-site at all times during activities requiring trench safety provisions.

B. Drainage and Dewatering

1. Provide for the collection and disposal of surface and subsurface water encountered during construction.
2. Drainage: So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. Where applicable, the Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary

ditches, dikes, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3. Dewatering:

- a. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 2 feet below the working level.
- b. Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly.

C. Underground Utilities

1. Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of all existing utilities prior to starting construction. The Contractor shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered.

- D. Machinery and Equipment: Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.2 Surface Preparation

- A. Identify required lines, levels, contours, and datum.
- B. Protect plant life, lawns, and other features remaining as part of final landscaping.
- C. Maintain and protect above and below grade utilities which are to remain.

3.3 Excavation

- A. Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material.
1. **Blasting:** Where permitted and allowed by the Owner and Engineer as an acceptable trenching option, blasting shall be performed in accordance with appropriate criteria established by the National Fire Protection Association and all Local, County, State, and Federal codes and ordinances. The Contractor shall be responsible for obtaining all permits at no cost to the Owner. Blasting for utility excavation must be done in such a manner as to minimize the fracturing of rock beyond the required excavation. The Contractor shall consider the elevation of utilities in relation to the blasting charge and the relative alignment of existing and proposed trenches. Blasting within such areas shall be accomplished only by qualified Contractors who hold blasting licenses from a qualified agency. Any damage to existing utilities resulting from blasting shall be repaired at the Contractor's expense. Sand shall not be used for bedding for backfill in trenches that have been blasted.
- B. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed of in the manner described below. Then refill the areas excavated for this reason with 1 inch to 2 inch sized crushed stone up to the level of the lines, grades, and/or cross sections shown on the Drawings. The top 6 inches of this refill shall be No. 67 TDOT crushed stone for bedding
- C. Unless specified otherwise, refill excavations cut below indicated depth with bedding material and compact to 95 percent of ASTM D698 maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Engineer, shall be replaced with satisfactory materials to the indicated excavation grade. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Engineer.
- D. **Pipe Trenches:**
1. Unless the construction of lines by tunneling, jacking, or boring is called for by the Drawings or specifically authorized by the Engineer, make excavation for pipelines in open cut and true to the lines and grades shown on the Drawings or established by the Engineer on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: $4/3d + 15$ inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the Engineer, the banks of trenches

from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula $4/3d + 15$ inches shall be at the expense of the Contractor and may be cause for the Engineer to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

2. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.
3. Excavate bell holes for bell and spigot pipe at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than 2 joints ahead of pipe laying.
4. Provide minimum depths of "Bedding Material" as defined in Tables 1, 2, and 3.
5. Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Engineer deems necessary to maintain vehicular or pedestrian traffic.
6. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.

E. Hard Material and Rock

1. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made therefor.
2. Should rock be encountered in the excavation, remove it by blasting or other methods. Where blasts are made, cover the excavation with enough excavation material and/or timber or steel matting to prevent danger to life and property. The Contractor shall secure, at his own expense, all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable laws and ordinances pertaining to blasting operations.

3. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the bottom of pipe up to 30 inches in diameter and not less than 12 inches below the bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 67 (TDOT) crushed stone or other approved material, tamp to the proper grade, and make ready for construction.

F. Excavated Materials

1. Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

3.4 Filling and Backfilling

- A. Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

B. Backfill and Fill Material Placement For Utilities

1. Begin backfilling after the line construction is completed and then inspected and approved by the Engineer. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than 4 inches deep. Thoroughly and completely tamp each layer into place before placing additional layers.

- C. At locations of improvements subject to damage by displacement, tamp and thoroughly compact the backfill in layers that, before compaction, are 6 inches deep. In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

- D. If earth material for backfill is, in the opinion of the Engineer, too dry to allow thorough compaction, then add enough water so that the backfill can be properly compacted. Do not place earth material that the Engineer considers too wet or otherwise unsuitable.

- E. Wherever excavation has been made within easements across private property, the top 1 foot of backfill material shall consist of topsoil, as defined in Section 32 92 19 - Seeding.

- F. Wherever trenches have been cut across or along existing pavement and driveways, including gravel or dirt drives, temporarily pave the backfill of such trenches by placing mineral aggregate (TDOT) crushed stone as the top 12 inches of the backfill. Maintain this temporary pavement either until the permanent pavement is restored or until the project is accepted by the Owner.

- G. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary

to prevent damage to the utility structure.

- H. Do not use power operated tampers to tamp that portion of the backfill around the pipe within 1 foot above the pipe.
- I. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary, whenever directed to do so by the Engineer.
- J. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the Engineer's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.
- K. Compaction Requirements: Under buildings and 2 times the depth of pipe beyond, and under roads and 2 times the depth beyond the shoulder, compact to 100 percent maximum density in accordance with ASTM D698. In all other locations, compact to 95 percent maximum density.

3.5 Borrow

- A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, then obtain additional material from other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and suitability of its material shall be approved by the Engineer.
- B. Excavate borrow pits in such a way that the remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave the sides of borrow pit cuts at a maximum slope of 2:1 unless otherwise directed by the Engineer.
- C. Properly clear and grub borrow pits and remove all objectionable matter from the borrow pit material before placing it in the backfill.
- D. The taking of materials from borrow pits for use in the construction of backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

3.6 Finish Operations

- A. Grading: Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

- B. Protection of Surfaces: Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.7 Disposition of Surplus Material

- A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the Drawings or directed by the Engineer shall be used for these purposes. Any materials not so used shall be considered waste materials and disposed of by the Contractor as specified below.
- B. Once any part of the work is completed, properly dispose of all surplus or unused materials (including waste materials) left within the construction limits of that work. The Contractor shall dispose of these surplus and waste materials off-site in an appropriate manner in conformity with pertinent codes and ordinances. Leave the surface of the work in a neat and workmanlike condition, as described below.
- C. The disposal of waste materials shall be considered an integral part of the excavation work and one for which no separate payment shall be allowed.

3.8 Field Quality Control

- A. Sampling: Take the number and size of samples required to perform the following tests.
- B. Testing: Perform one of each of the following tests for each material used. Provide additional tests for each source change.
 - 1. Bedding Material and Fill and Backfill Material Testing: Test fill and backfill material in accordance with ASTM C136 for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D4318 for liquid limit and for plastic limit; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.
 - 2. Density Tests: Test density in accordance with ASTM D1556, or ASTM D6938. When ASTM D6938 density tests are used, verify density test results by performing an ASTM D1556 density test at a location already ASTM D6938 tested as specified herein. Perform an ASTM D1556 density test at the start of the job, and for every 10 ASTM D6938 density tests thereafter. Test each lift at randomly selected locations with one test per 200 linear feet in each lift.

Table 1: Backfilling and Compaction of Trenches for Pressure Pipes in Unimproved Areas

| Layer* | Depth | | | Material** | | | |
|-----------|--------|----------|---------|------------|------|------|------|
| | ≤15"Ø | 18"-38"Ø | >38"Ø | DIP | PVC | HDPE | Conc |
| A | 4" min | 6" min | 12" min | I B | II | II | I B |
| B1 | ½ OD | | | III | II | II | III |
| B2 | ½ OD | | | III | II | II | III |
| C | 6" | | | III | II | II | III |
| D | 6" | | | IV A | II | II | IV A |
| E | Varies | | | IV A | IV A | IV A | IV A |

*See Figure 1.

**Bedding material to be used in wet conditions for all layers.

Table 2: Backfilling and Compaction of Trenches for Gravity Lines in Unimproved Areas

| Layer* | Depth | | | Material** | | | |
|-----------|--------|----------|---------|------------|------|------|------|
| | ≤15"Ø | 18"-38"Ø | >38"Ø | DIP | PVC | HDPE | Conc |
| A | 4" min | 6" min | 12" min | I B | II | II | I B |
| B1 | ½ OD | | | I B | II | II | I B |
| B2 | ½ OD | | | III | II | II | III |
| C | 6" | | | III | II | II | III |
| D | 6" | | | IV A | II | II | IV A |
| E | Varies | | | IV A | IV A | IV A | IV A |

*See Figure 1.

**Bedding material to be used in wet conditions for all layers.

Table 3: Backfilling and Compaction of Trenches in Paved Areas

| Layer* | Depth | | | Material | | | |
|-----------|--------|----------|---------|----------|-----|------|------|
| | ≤15"Ø | 18"-38"Ø | >38"Ø | DIP | PVC | HDPE | Conc |
| A | 4" min | 6" min | 12" min | I B | II | II | I B |
| B1 | ½ OD | | | I B | II | II | I B |
| B2 | ½ OD | | | I B | II | II | I B |
| C | 6" | | | I B | II | II | I B |
| D | 6" | | | I B | II | II | I B |
| E | Varies | | | I B | II | II | I B |

*See Figure 1.

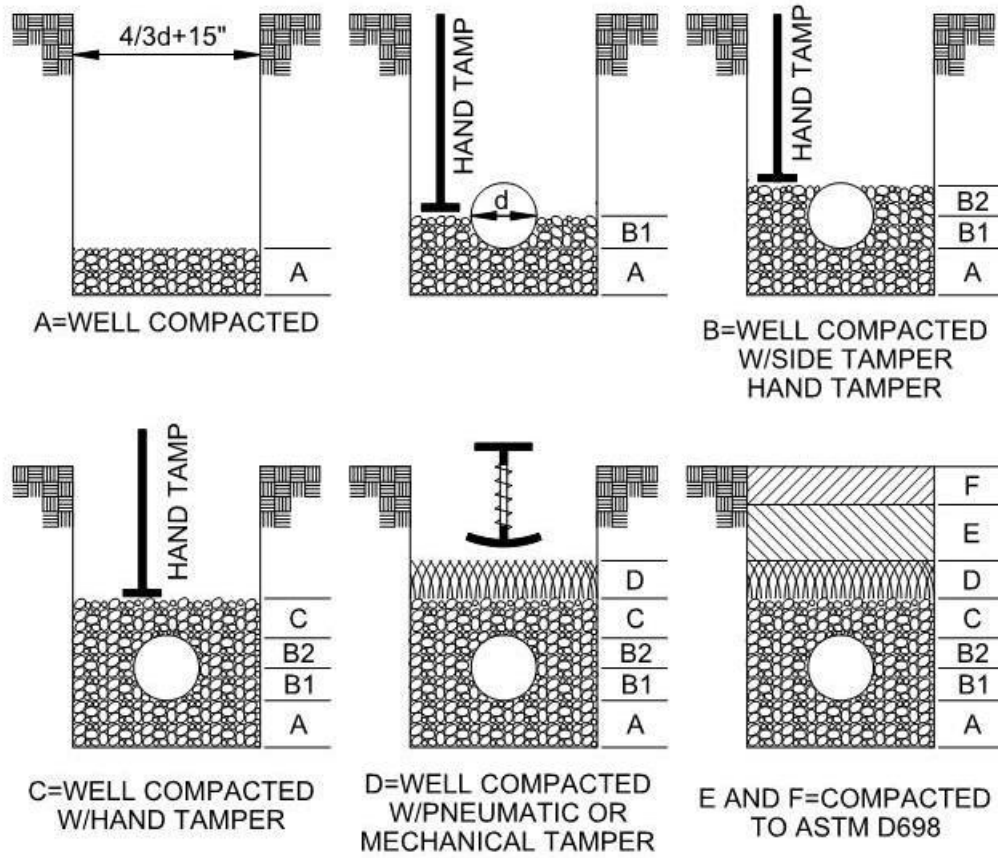


Figure 1: Backfilling and Compaction of Trenches

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Seeding of disturbed areas.
- B. Fertilizing and soil amendments, as necessary.
- C. Maintenance.

1.2 References

- A. U.S. Department of Agriculture (USDA)
 - 1. AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act.
 - 2. DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0.

1.3 Definitions

- A. Acceptable Stand of Turf: An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representative of the seed mixture.

1.4 Submittals

- 1. Product Data:
 - a. Wood cellulose fiber mulch.
 - b. Fertilizer: Include physical characteristics, and recommendations.
- 2. Certificates:
 - a. Contractor shall furnish labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this section.
- 3. Test Results:
 - a. The Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Service or other certified testing laboratory.

1.5 System Description

- A. This work shall be performed in all disturbed areas not receiving such site improvements as buildings, roads, walks, sod, planting, etc., and shall include, but not necessarily be limited to, all seed bed preparation; the supplying and placing of soil additives, seed, and mulch wherever required by the Drawings or directed by the A/E; and maintenance.
- B. All existing lawns encountered shall be replaced with topsoil and seeding of the same type and quality as that existing prior to construction and shall be restored to original condition or better.
- C. Unless otherwise approved in writing by the A/E, seeding operations shall be limited to the following planting periods:
 - 1. Spring - March 1 through May 30.
 - 2. Fall - August 15 through October 31.
- D. Refer to the Tennessee Erosion and Sediment Control Handbook, latest edition for seeding requirements.
- E. Refer to other sections for items affecting seeding. Coordinate this work with that specified by other sections for timely execution.

1.6 Delivery, Storage, and Handling

- A. Delivery
 - 1. Seed Protection: Protect from drying out and from contamination during delivery, on-site storage, and handling.
 - 2. Fertilizer and Other Agricultural Chemicals Delivery: Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.
- B. Storage
 - 1. Seed Storage: Store in cool, dry locations away from contaminants.
 - 2. Topsoil: Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.
- C. Handling: Do not drop or dump materials from vehicles.

Part 2 Products

2.1 Topsoil

- A. On-Site Topsoil: Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition."
- B. Off-Site Topsoil: Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.
- C. Composition: Containing from 5 to 20 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

| | |
|---------------|-----------------|
| Silt | 25-50 percent |
| Clay | 10-30 percent |
| Sand | 20-35 percent |
| pH | 5.5 to 7.5 |
| Soluble Salts | 600 ppm maximum |

2.2 Grass Seed

- A. Seed shall be delivered in new bags or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.
- B. All seed shall be from the last crop available at time of purchase and shall not be moldy, wet, or otherwise damaged in transit or storage.
- C. Seed shall bear the growers analysis testing to 98% for purity and 90% for germination. At the discretion of the Engineer, samples of seed may be taken for check against the grower's analysis.
- D. Species, rate of seeding, fertilization, and other requirements shall conform to the Tennessee Erosion and Sediment Control Handbook, latest edition.

2.3 Fertilizer Materials

- A. Fertilizer materials shall comply with applicable state, local, and federal laws concerned with their production and use.
- B. Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in the Seeding Requirements Table. Container bags shall have the name and address of the manufacturer, the brand name, net weight, and chemical composition.

2.4 Agricultural Limestone

- A. Containing a minimum of 85 percent calcium carbonate and magnesium carbonate combined, 85 percent of which passes a No. 10 mesh sieve, and 40 percent passing a No. 40 mesh sieve.

2.5 Mulch

- A. Mulch shall be free from noxious weeds, mold, and other deleterious materials.
- B. Straw: Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

2.6 Mulch Binder

- A. Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non-toxic to plant life and shall be acceptable to the Engineer.
- B. Emulsified asphalt binder shall be Grade SS-1, ASTM D 977. Cut-back asphalt binder shall be Grade RC 70 or RC 250.

2.7 Inoculants for Legumes

- A. All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen-fixing bacteria that is adapted to the particular seed involved.

2.8 Water

- A. Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the Contractor.

Part 3 Execution

3.1 Preparation

- A. Extent of Work: Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.
- B. Topsoil: Provide 4 inches of off-site topsoil to meet indicated finish grade. Over rock, provide minimum of 12 inches of topsoil. After areas have been brought to indicated finish grade, incorporate fertilizer, pH adjusters, and soil conditioners into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Engineer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in

finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

- C. Before beginning seeding operations in any area, complete the placing of topsoil and final grading, and have the work approved by the Owner's Representative.

3.2 Seeding

A. Seed Application and Conditions

1. Immediately before seeding, restore soil to proper grade.
2. Do not seed when ground is muddy, frozen, or in an unsatisfactory condition for seeding.
3. Apply seed within twenty-four hours after seedbed preparation.
4. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

- B. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in the Tennessee Erosion and Sediment Control Handbook, latest edition seeding requirements. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation.

- C. Seeds shall be uniformly sown by any approved mechanical method to suit the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder, or approved mechanical power drawn seed drills. Hydro-seeding and hydro-mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seeding at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.

- D. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8 inch by a cultipacker or suitable roller.

- E. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculated in accordance with the manufacturer's mixing instructions.

3.3 Mulching

- A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion, and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.

- B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:

- | | |
|-------------------------|-----------------|
| 1. Wood Cellulose Fiber | 1,400 lbs./acre |
| 2. Stalks | 4,000 lbs./acre |
| 3. Straw | 4,000 lbs./acre |

These rates may be adjusted at the discretion of the Engineer at no additional cost to the Owner, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

- C. Mulch on slopes greater than 3 to 1 ratio shall be held in place by the use of an approved mulch binder. Binder shall be thoroughly mixed and applied with the mulch. Emulsified asphalt or cutback asphalt shall be applied at the approximate rate of 5 gallons per 1,000 square feet as required to hold the mulch in place.
- D. The Contractor shall cover structures, poles, fence, and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.
- E. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates.

3.4 Watering

- A. Contractor shall be responsible for maintaining the proper moisture content of the soil to ensure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain adequate water content in the soil.
- B. Watering shall be accomplished by hoses, tank trucks, or sprinklers in such a way to prevent erosion, excessive runoff, and overwatered spots.

3.5 Maintenance and Bond

- A. Upon completion of seeding operations, the Contractor shall clear the area of all equipment, debris, and excess material and the premises shall be left in a neat and orderly condition.
- B. No equipment, material storage, construction traffic, etc., will be permitted on newly seeded ground.
- C. The Contractor shall maintain all seeded areas without additional payment until final acceptance of the work by the Owner. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gullies, washouts, or other causes shall be repaired by filling with topsoil, compacting, and repeating the seeding work at contractor's expense.

- D. A grassing bond will be required to cover all grassed area, solid sod areas, and erosion control for one year after the time of planting seed or placing sod.

3.6 Field Quality Control

- A. The Owner's Representative shall inspect the seeding within 60 days after planting and determine if an acceptable stand of grass has been produced.
- B. If an acceptable growth is not obtained on the first planting, reseeding and remulching will be required.
- C. If the planting is less than 50 percent successful, rework the ground, refertilize, reseed, and remulch.

END OF SECTION

Part 1 General

1.01 Scope of Work

- A. The Contractor shall furnish all equipment, labor, and materials (unless otherwise agreed upon in writing) necessary to construct water mains and appurtenances and perform all work specified or indicated on the Standard Details. The work shall include all necessary trenching, backfilling, soil erosion and sedimentation control, and testing. These specifications cover water and mains and service connections complete.
- B. The Contractor shall arrange his work so as to minimize interference with pedestrian and vehicular traffic, and to avoid interruption of service of any existing utilities. The Contractor shall furnish and maintain suitable bridges, footways, or other means of access to or across intercepted streets, alleys, driveways and walkways, where necessary.
- C. The Contractor shall be responsible for removing all water from excavations and trenches whether from surface or ground sources.
- D. The Contractor shall guarantee all material and workmanship on year from the date of final acceptance of the work. If during this period any material or workmanship, etc., proves defective, the Contractor shall repair same at his own cost and expense and to the satisfaction of the Owner.
- E. In addition to the responsibility of the Contractor for remedying observed defects in his work during the guarantee period, the Contractor shall also reimburse the Owner for all expenses incurred in investigations to assure the Owner that the completed work is in accordance with these specifications.

1.02 Inspection

- A. All materials to be installed shall be inspected by the Owner for compliance with these Specifications.

1.03 Connection to Work By Others or Existing Lines

- A. For existing lines or lines installed to which piping must connect, the Contractor shall expose buried lines to confirm or determine pipe material and diameter, furnish and install appropriate piping, and make proper connections. Such investigation is subject to the prior notification and coordination requirements specified elsewhere herein.

1.04 Applicable Specifications and Standards

- A. The latest editions of the following specifications, standards and publications setting the minimum requirements for quality, safety and performance of work and materials form a part of these Regulations as though fully repeated herein:
 - 1. ASTM American Society of Testing Materials
 - 2. ANSI American National Standards Institute
 - 3. AWWA American Water Works Association
 - 4. OSHA Occupational Safety and Health Administration

Part 2 Materials

2.01 General

- A. Materials to be incorporated into the work shall be new and unused and shall conform to all applicable requirements of these specifications. Submittal and approval of all materials, shop Standard Details, or samples shall be in conformance with these specifications. Any materials installed prior to approval by the Department will be subject to rejection, and will be removed at the Contractor's expense.
- B. Acceptance will be on the basis of inspection and the manufacturer's written certification that the pipe, fittings and appurtenances were manufactured and tested in accordance with the applicable standards.
- C. Any pipe, fittings and appurtenances used in the installation or repair of water mains or services shall be lead-free pipe and fittings by an all-American manufacturer.
- D. Water distribution piping shall be ductile iron pipe unless approved by Owner.

2.02 Ductile Iron Pipe (DIP)

- A. Ductile iron pipe from an approved manufacturer such as U.S. Pipe or an approved equal shall conform to AWWA C151 (ANSI A21.51) and shall be a minimum of pressure Class 350 or thickness Class 52 unless otherwise specified or shown on the Standard Details. Pipe sizes will be as shown on all plans and details. All pipes shall be furnished in minimum lengths of 18 feet. Pipe and fittings shall be cement lined in accordance with AWWA C104. Fittings shall be mechanical joint compact ductile iron and conform to AWWA C153 with rated working pressure of 350 psi or AWWA C110 with rated working pressure of 250 psi. Pipe and fittings shall be furnished with a bituminous outside coating.
- B. Joints shall be push-on type for pipe and standard mechanical joints for fittings with the exception of hydrant fittings. Fittings for bends shall be mechanical joint with retainer glands. Joints shall conform to AWWA C111. Provide and install the

appropriate gaskets, nuts and bolts for mechanical joints. Nuts shall be steel with American Standard Regular hexagonal dimensions, all as specified in ANSI B17.2.

1. All bolts and all nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A and 2B fit.
 2. When flanged joints are indicated provide gaskets for flange joints made of 1/8 inch thick cloth reinforced rubber. Gaskets may be ring type or full-face type.
 3. Provide bolts for flange connections. Bolts shall be steel with American Regular unfinished square or hexagon heads. Nuts shall be steel with American Standard Regular hexagonal dimensions, all as specified in ANSI B17.2. All bolts and all nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A and 2B fit.
- C. Field lock gaskets are required on two pipe joints up and downstream from any fitting, in addition to megalugs on each fitting.

2.03 Plastic Pipe (PVC)

A. Materials:

1. Pipe, polyvinyl chloride (PVC) C900, DR21 or greater. Shall conform to ASTM D2241. Lay lengths shall be minimum of 20 feet. Pipe joints shall conform to ASTM D3139.
2. Fittings. Socket type, DR21 polyvinyl chloride (PVC).
3. Unions. Socket type, DR21 polyvinyl chloride (PVC).
4. Flanges. Flat face, socket type, DR21 polyvinyl chloride (PVC).
5. Gaskets. 1/8 inch thick, EPDM low torque, full face gaskets with concentric, convex rings between center hole and bolt hole circle. Shall conform to Standard ASTM F477.
6. Bolts and Nuts. Stainless Steel, hex head bolts (Grade B) with heavy, buff finish, cold punched nuts
7. Pipe color must be White NSF 14 and 61.

2.04 High Density Polyethylene (HDPE)

- A. HDPE pipe shall be HDPE 3408 and have a heat indented print line containing information required in ASTM D3035. All HDPE pipe shall be in compliance with NSF 61 and must be made by a pipe manufacturer that must be approved by the Owner before pipe installation. HDPE pipe must be designated for potable water use by having a minimum of three blue stripes extruded along the entire length of the pipe and also being equally spaced around the outside diameter of the pipe. Pipes larger than 2 inch shall be Ductile Iron Pipe Size (DIPS)) in compliance with AWWA C906 and ASTM F 714. Pipes 2 inch and less shall be Iron Pipe Size (IPS)

in compliance with AWWA C901 and ASTM D3035. HDPE pipe 2 inch and larger shall be SDR 11 and pipe smaller than 2 inches shall be SDR 9.

2.05 Service Tubing

- A. Service lines shall be crosslinked polyethylene (PEX) pressure tubing conforming to AWWA C904, latest revision.
- B. Where required, adapters shall be brass ANSI B 16.18. Unions shall be cast bronzes. Joints shall be compression type.

2.06 Gate Valves

- A. Gate valves size 3 inches and larger shall be resilient seat wedge type and shall conform with the specifications of the American Water Works Association, Designation C509, latest edition rated for 200 psi minimum working pressure. Gate valves shall be equipped with "O" ring stem seals above and below stem thrust collar. Gate valves for use on mechanical joint ductile iron pipe and slip joint ductile iron pipe shall have manufacturer's standardized mechanical joint ends. Gate valve body and bonnet shall be ductile or cast iron and shall be fusion bonded, interior and exterior, with epoxy coating which conforms to AWWA C550, latest edition.
- B. Water mains in which the valves are installed shall be tested as specified and the valve must remain water tight under this pressure in each direction.
- C. Valves shall open counter clockwise (no exceptions will be allowed); shall be designed for vertical installation; and shall be the non-rising stem type.
- D. Valves shall be equipped with valve boxes. Provide extension stem where required to bring the operating nut to within 36 inches of ground surface and shall have a 24" x 24" x 10" concrete collar poured in place. Trowel level with ground surface.
- E. All gate valves shall be manufactured by Mueller or pre-approved equal.
- F. Gate valves 2-1/2 inches in diameter and smaller shall be bronze, heavy duty, rising stem (2-1/2 inches and smaller only), rated for 200 psi WSP. Valves shall conform to Federal Specification WW-V-54, Class A, Type II.
- G. Gate valves shall be installed on all fire lines and distribution lines smaller than 16-inches.

2.07 Valve Operators

- A. All valve operators shall be suitable for buried service.
- B. Where indicated buried service valves shall be equipped with a standard two-inch operator nut (open left), valve box and concrete collar place flush with the finished ground surface.
- C. Above ground operators shall have:

1. Riser stem and operator mechanism;
2. Min. of 2 foot by 2 foot by six inch thick concrete pad at the finished ground surface;
3. Standard pattern non-rising stem support stand for the above ground operator, either hand-wheel or electrical valve operator. The support stand shall be such design as to support a multi-turn hand-wheel operator or an electrical valve operator with hand-wheel.

2.08 Valve Boxes

- A. Valve Boxes: Valve boxes shall be cast iron two-piece screw type with drop covers. Valve boxes shall have a 5.25 inch inside diameter. Valve box covers shall weigh a minimum of 13 pounds. The valve boxes shall be adjustable to 6 inches up or down from the nominal required cover over the pipe. Valve boxes shall be of sufficient length that bottom flange of the lower belled portion of the box is below the valve operating nut. Ductile or cast iron extensions shall be provided as necessary. Covers shall have "WATER", "SEWER" or "REUSE", as appropriate, cast into them.
 1. Only after the valve has been completely installed, test before backfilling the excavation. Following the installation of the valve box, carefully backfill the ground, and tamp so that the top surface, after completion, will be no more than 2 inches above the ground surface or exactly even with paved surfaces. In its final position, the box shall not touch the valve or stem at any point.

2.09 Tapping Valves and Sleeves

- A. Tapping valves 12-inches and smaller shall conform to AWWA C509 latest revision or AWWA C515. Tapping sleeves shall be cast or ductile iron of the split-sleeve, mechanical joint type. Valves shall be resilient seat gate valves sizes 6" - 10".
- B. Tapping valves shall be Mueller Model H-687 sizes 4" - 10", H-667 sizes 12" - 20", M&H Style 3751-NRS sizes 4" - 10" or Style 751 sizes 12" - 20". Sleeves shall be Mueller Model H-615 or US Pipe MJ T-9.
- C. Connections to water mains may use Tapping Sleeve and Valve as permitted according to the table below. Where not specifically permitted for Tapping Sleeve and Valves, connections are to be made by cut-in to the existing line. No taps are permitted to 6 inch and smaller lines.

Tapping Schedule

| Existing Pipe Size | Largest Tap Permitted* |
|--------------------|------------------------|
| 6 inch | not permitted |
| 8 inch | 6 inch |
| 10 inch | 8 inch |
| 12 inch | 10 inch |

*Next smallest pipe size is largest tap permitted.

2.10 Fire Hydrants

- A. Primary fire hydrants shall be M&H Valve Company, or equal and shall conform to ANSI/AWWA C502-05. Fire hydrants shall be of the compression type, with the main valve opening against the pressure and closing with the pressure. The main valve opening shall be 5 ¼" in diameter. Fire Hydrant shall be of a dry barrel, dry top design.
- B. Hydrants shall have two 2.5 inch nozzles and one 4.5 inch pumper nozzle all on the same elevation. The nozzle threads shall be National Standard Fire Hose Coupling Screw Thread as described in Appendix A of ANSI/AWWA C502-05.
- C. Hydrants shall be painted yellow. Bonnet and top shall be painted per below requirements:
 - a. Light Blue top =1500 gpm or higher
 - b. Green top = 1000-1499 gpm
 - c. Orange top= 500-999 gpm
 - d. Red top= LESS than 500 gpm,
 - e. Violet BARREL= Non-potable water
 - f. Black BARREL = OUT OF SERVICE
- D. Operating nut shall be 1.5 inch point to flat and Open Left. Breakaway type flange is required.
- E. Any construction of water distribution system that has demand greater than 50 gpm or more than two houses shall incorporate iHydrant feature on at least one fire hydrant.

2.11 Air Valves

- A. Air valves shall be Air valves for water lines shall be in accordance with the Materials specifications and as shown on the Standard Drawings.
- B. Air valves shall be 1-inch size on pipelines 12 inches in diameter and smaller. For larger pipes, the air valves shall be 2-inch size.
- C. Air valves shall be located at all high points on the pipeline or as directed by the Owner.
- D. Air valves shall be installed in precast concrete or brick manhole as shown on drawings.
- E. A tapping saddle shall be used on all air valve installations.

- F. Air valves shall be ARI D-040, Crispin UL model, APCO or approved equal.

2.12 Double Check Backflow Preventers.

- G. Double check backflow preventers shall conform to the following standards: A.S.S.E. No. 1015, A.W.W.A., C506, C.S.A. B64.5, FCCCHR of USC Manual - Section 10, U.L. Classified File No. EX3185, and be accepted by IAPMO (UPC), SBCCI (Basic Plumbing Code).
- H. Shut-off valves for backflow preventers in sizes 2 inch and smaller shall be full-port ball-type, with threaded connections and bronze bodies with copper content not less than 80 percent. Shut-off valves for backflow preventers in sizes 2-1/2 inches and larger shall be full-port ball-type, or resilient-wedge gate-type, with flanged connections, and iron bodies with FDA-approved fusion bonded epoxy coating inside and out.
- I. Double check backflow preventers shall be Ford or approved equal.

2.13 Double Detector Check Valve Assembly.

- A. Double detector check valve assemblies shall conform to the following standards:
 - 1. A.S.S.E. Standard No. 1015, AWWA Standard C 506; FCCCHR of USC Manual Section 10., U.L. Classified File No. EX 3185, and be listed under CSA B.64 Standard.
 - 2. All assemblies shall be standard equipped with epoxy coated UL/FM listed OS&Y resilient seat gate valves. Check valve bodies shall be epoxy-coated cast iron. The bypass line unit shall consist of an approved double check backflow preventer and water meter that reads in gallons.
- B. Double detector check assemblies shall be Watts 709DDC or approved equal.

2.14 Valve Markers.

- A. Valve markers shall be 4 feet long concrete posts. They shall have "WATER" imprinted on one side. A brass disc shall be cast into the marker immediately below the imprint indicating the distance to the valve. The upper 12 inches of marker shall be painted blue to indicate water. Valve locations shall be clearly marked by an arrow painted on the nearest curb or pavement using blue paint.

2.15 Corporation Cocks and Curb Stops.

- A. All $\frac{3}{4}$ inch and 1 inch corporation cocks shall be Mueller or approved equal. All 1-1/2 inches and 2 inches corporation cocks shall be Mueller or Ford or approved equal.

- B. Curb stops for 2 inch blow-off assemblies shall have inside I.P.T. on both ends. They shall be Mueller or approved equal.

2.16 Retainer Glands

- A. Retainer Glands shall be ductile iron and shall be manufactured in the United States.
- B. Retainer glands shall be provided at all mechanical joints, including fittings, valves, and other locations as shown on the standard details or as directed by the Department.
- C. Retainer glands shall be the following types: Set Screw Type- Set screw type retainer glands shall be ACIPCO, EBAA Iron, Union Foundry, or Tyler. Compact/lightweight retainer glands shall not be allowed. The minimum working pressure and minimum weight, excluding set screws and gasket material, shall be as follows:

| Retainer Gland Size (Inches) | Minimum Working Pressure (PSI) | Minimum Weight (Pounds) |
|---|---|------------------------------------|
| 4 | 350 | 6.0 |
| 6 | 350 | 11.8 |
| 8 | 250 | 16.0 |
| 12 | 250 | 24.8 |
| 16 | 200 | 50.0 |
| 20 | 200 | 72.5 |
| 24 | 150 | 85.0 |

- D. Wedge Type: Wedge type retainer glands shall be MEGALUG, Series 1100 as manufactured by EBAA Iron, Inc.

2.17 Locator Wire

Locator wire shall be Number 14 AWG solid THHN plastic coated copper wire with purple insulation. Locator wire shall be extended above ground 3 to 4 feet in a valve box as directed by the Owner. Locator wire shall be laid 6 inches above the pipe and should not come in direct contact with the pipe. Locator wire shall be used on all installations of non-metallic pipe (AWWA C9).

2.18 Casing Pipe

- A. Steel casing pipe shall be manufactured from steel conforming to ASTM A 139, Grade B and shall be new and unused. Minimum size and thickness shall be as follows:

Casing Pipe Under Roadways

| Pipe Diameter (inches) | Casing Diameter (inches) | Wall Thickness (inches) |
|-----------------------------------|-------------------------------------|------------------------------------|
| 6 | 12 | 0.250 |
| 8 | 16 | 0.250 |
| 10 | 16 | 0.250 |

| | | |
|----|----|-------|
| 12 | 18 | 0.250 |
| 14 | 22 | 0.375 |
| 16 | 24 | 0.375 |
| 18 | 30 | 0.375 |
| 20 | 30 | 0.375 |
| 24 | 36 | 0.375 |
| 30 | 42 | 0.375 |

The materials for casings under State Highways shall be in accordance with the Tennessee Department of Transportation Standard Specifications for the Construction of Roads and Bridges, latest edition. It shall be the Contractor's responsibility to determine the exact requirements of the Tennessee Department of Transportation. If there is a conflict between these Regulations and the Tennessee Department of Transportation Specifications, the latter shall take precedent.

| Pipe Diameter (inches) | Casing Diameter (inches) | Wall Thickness (inches) |
|-----------------------------------|-------------------------------------|------------------------------------|
| 6 | 14 | 0.250 |
| 8 | 18 | 0.250 |
| 10 | 20 | 0.281 |
| 12 | 22 | 0.375 |
| 14 | 24 | 0.375 |
| 16 | 30 | 0.406 |
| 18 | 30 | 0.406 |
| 20 | 32 | 0.469 |
| 24 | 32 | 0.469 |
| 30 | 42 | 0.500 |

2.19 Concrete Thrust Block/ Thrust Restraint

- A. Thrust blocks shall be installed on ductile iron pipe wherever the water main changes direction (at tees and bends), at dead ends, or at any other point recommended by the manufacturer or required by the Owner. Thrust blocks shall be considered an integral part of the water line work. Where thrust blocking is inadequate or inappropriate, tie rods shall be installed. Non-fusion type HDPE joints shall be restrained using approved mechanical joint adapters listed in the approved materials for HDPE installations. Compaction standards shall be strictly enforced near HDPE fittings. Backfill material near HDPE fittings shall be crushed stone, Class A Aggregate Grading D, as specified in Section 903.05 of the Tennessee Department of Highways' Standard Specifications for Road and Bridge Construction, March 1, 1995 (pug mix), placed in 8-inch lifts and compacted to 100 percent of the Standard Proctor density at 2 percent less than the optimum moisture content as determined by AASHTO T99-81.
- a. All pipe and fittings in contact with concrete thrust restraint blocks should be wrapped in plastic sheeting, minimum 6-mil thickness.

- b. Concrete thrust restraints for HDPE pipe shall be installed when transitioning from HDPE pipe to sections of unrestrained slip joint pipe as shown on the project drawings or as directed by the Owner.
- B. Megalugs and restraint joint gaskets with an Owner approved manufacturer design may be used in place of, or in addition to concrete thrust restraints with prior approval of the Owner.

2.20 Meter Boxes

- C. Meter boxes and covers shall be constructed of cast iron for paved areas or plastic for outside of roadways. Construction of box and cover shall match in any installation. In the case of subdivision installation, all meter boxes for a single development shall be of the same type unless otherwise specifically approved by the Owner.
- D. Meter boxes for 2-inch meter assemblies shall be polymer concrete meter well with lid.
- E. Meter boxes and covers shall be colored to indicate water service. Plastic boxes shall be impregnated such that the color is consistent throughout the structure of the box. Cast Iron boxes shall be shop-painted interior and exterior prior to delivery using an approved two part epoxy paint.
- F. If plastic boxes are provided, they shall be high-density polyethylene.
- G. Meter boxes and covers shall be manufactured in the USA only.

Part 3 Execution

3.01 Pipeline Installation

- A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Great care shall be taken to prevent the pipe coating from being damaged particularly cement linings on the inside of the pipes and fittings. Any damage shall be remedied as directed.
- B. All pipe and fittings shall be carefully examined by the Contractor for defects just before laying and no pipe or fitting shall be laid which is defective. If any defective pipe or fitting is discovered after having been laid, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the Contractor at his own expense.
- C. No pipe shall be laid in water. The Contractor will be required to operate pumps, if necessary, to remove water (whether from ground or surface sources) from the trench while pipe is being laid and joints are being made. When work is not in progress the ends of the pipe shall be closed to prevent water or other foreign material from entering the pipe. Valves installed on existing mains shall be kept closed until after the line is tested, disinfected, and accepted for service.

- D. Pipe laid in trenches shall be laid true to line and grade on a firm and even bearing for its full length at depths and grades as indicated. Adequate precautions shall be taken to prevent floatation of pipelines prior to backfilling. Installation of ductile iron pipe in underground pressure piping systems shall conform to the requirements of AWWA C600. Excavation of trenches and backfilling around pipes shall conform to the requirements of the section entitled "Excavation, Trenching and Backfilling" of these Specifications.
- E. Unless otherwise indicated on the drawings, all water lines shall have at least 36 inches of cover from the top of the pipe. The Owner shall approve all exceptions.
- F. The maximum trench width for water line installations shall be 24 inches for 6- and 8-inch lines and 30 inches for 10- and 12-inch lines. Trench widths for larger sizes shall be approved by the Owner. Minimum trench widths must be achieved to ensure proper backfilling around pipe.
- G. Whenever pipe laying is not in progress, the open ends of the pipe shall be closed either with a watertight plug or by other means approved by the Owner.
- H. Wherever pipe must be deflected from a straight line, (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever along radius curves are permitted, the amount of deflection shall neither exceed that necessary for the joint to be satisfactorily made, nor exceed that recommended by the pipe manufacturer and shall be approved by the Owner. Bend fittings shall be used when the pipe deflections are inadequate, according to manufacturer's recommendations, or as directed by the Owner.
- I. Horizontal Separation: Water mains and service lines shall maintain a minimum of 10 feet edge-to-edge horizontal separation from sanitary sewer lines or sanitary force mains.
- J. Vertical Separation: If the water main or service line cannot be installed with the above-described horizontal separation, the following vertical separation shall apply. Where water mains are within 3 feet horizontally or cross sanitary sewers or sanitary force mains the water main shall have a minimum of 18 inches edge-to-edge vertical separation from sanitary sewers or sanitary force mains as follows.
- K. All elbows, tees, branches, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust. Underground pressure piping containing un-harnessed push-on or mechanical joints or expansion joints shall be restrained by thrust blocks. The Contractor may use forms or earth walls to mold the thrust blocks. When earth walls are used, they shall be cut true to shape and all excess earth removed. The work shall be conducted so that no loose earth will become mixed with the concrete. At the end of 24 hours, damp earth may be placed over the concrete to retain moisture.
- L. All lumps, blisters, excess coating, dirt and other objectionable substances shall be removed from the bells and spigots. Bells and spigots shall be wiped clean and dry. Bells shall be centered in the trench and spigots driven home.

- M. The Contractor shall keep a transit and appurtenances on the job to be used for laying out the angles required for making bends and other works of this nature. shall be removed before backfilling. All stress points and ends of mains shall be inspected before backfilling.
- N. Provide casing pipe where water lines cross roads. Casings are required at all roads, unless ductile iron pipe is used and the Owner grants a waiver. Such waiver shall be approved during the plan review process and recorded on the construction plans.
- O. All water distribution mains shall be flushed prior to inspection as specified below to assure complete removal of all debris and foreign material.
- P. Bends, valves and other points where deemed necessary shall be blocked and harnessed to resist thrust. This shall be accomplished by methods and means approved by the Department. All forms used to form concrete for blocking
- Q. Blow-off valves shall be installed at terminus of all dead end mains. Method of installation shall be approved by Jasper. Refer to Standard Details for 2 inch blow-off details.
- R. Mechanical joints and restrained joints shall be made in strict accordance with the pipe manufacturer's instructions. The gaskets and follower rings shall be kept clean and carefully centered in the bell with the bolts and bolt holes always parallel with the centerline of the pipe. The coating and lining of the pipe shall not be damaged. The nuts on all bolts shall be started and tightened evenly around the entire circumference of the pipe. No one nut shall be tightened more than ½ turn tighter than the remainder of the nuts of the joint. When the joint is complete, the follower ring shall be equal distance from (parallel with) the face of the bell. Bolts shall not be over-stressed and shall be tightened just enough to compress the gasket sufficient to prevent leakage. Just prior to assembly, the gasket shall be cleaned of all foreign material and shall be brushed with soapy water just before slipping the gasket over the spigot and into the bell of the pipes. The joint shall be in straight alignment during assembly. Any deflection required shall be made after assembly but before tightening bolts. Bolts shall be tightened with torque wrenches with the following torque loads applied:

Range of Torque

| Bolt Size(inches) | Foot Pounds |
|--------------------------|--------------------|
| 5/8 | 45 – 60 |
| 3/4 | 75 – 90 |
| 1 | 100 – 120 |
| 1-1/4 | 120 - 150 |

- S. Push-on type joints shall be made in strict accordance with the pipe manufacturer's instructions. All joints shall be completely "belled-up" and all spigots shall be "home". The gasket seat in the socket, the gasket and the plain end of the pipe to be entered shall be wiped clean before assembly. After the gasket has been inserted into the gasket recess, a thin film of lubricant shall be applied to the inside surface of the gasket and to the outside surface of the spigot end of the pipe to be

jointed. After lubricating, the end of the pipe shall not be allowed to touch the bottom or side of the trench causing dirt to adhere to the joint surface. When pipe is cut in the field, the cut end of the pipe shall be beveled with a file or grinder. The joint shall be in straight alignment while pushing the pipe to make assembly. Any deflection required shall be made after the joint is assembled.

- T. Set screw type retainer glands shall be installed in strict accordance with the fitting manufacturer's instructions. After making up the mechanical joint as previously specified, the set screws shall be run down until they are in firm contact with the pipe. The set screws shall then be tightened once completely around the joint to approximately 40 foot-pounds torque. Finally, the set screws shall be tightened twice completely around the joint to the following torques, unless a "break-away" torque is used: 3" through 12" glands - 80 foot – pounds 14" through 24" glands - 65 foot – pounds
- U. Wedge type retainer glands shall be installed in strict accordance with the manufacturer's instructions. Impact wrenches shall be prohibited for used with "break-away" nuts for final tightening.
- V. Retainer gland joints shall be made in straight alignment and any deflection required shall be made before tightening the joint bolts or set screws.

3.02 Ductile Iron and PVC Mains

- A. After a length of ductile iron or PVC pipe has been placed in the trench, the spigot end shall be centered in the bell of the adjacent pipe and then inserted to the depth specified by the manufacturer.
- B. Bell holes, when required, shall be big enough so that there is ample room for the pipe joints to be properly made. The trench shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length. Pipe shall be laid and continuously supported on undisturbed or well-compacted soil. Pipe shall not be supported by blocks or allowed to rest on rocks or any other material that could cause shearing stresses on the pipe during backfill. All backfilling shall be in accordance with specification herein.
- C. Pipe shall be cut so that valves, fittings, or closure pieces can be inserted in a neat and workman-like manner and without any damage to the pipe. The manufacturer's recommendations shall be followed to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipes axis. For cast iron pipe, hydraulic cutters or a carborundum saw shall be used. A carborundum saw shall be used for ductile iron pipe. The Owner may consider other methods for 12-inch diameter and larger pipe.
- D. Pipe shall be installed with the bell ends facing in the direction of laying unless otherwise directed by the Owner.

3.03 High Density Polyethylene (HDPE)

- A. Prior to installing pipe through a bored hole, ensure that the size of the hole is sufficient diameter to prevent pipe stress during installation. The leading end of the pipe to be inserted shall be closed to prevent the entrance of dirt and debris. After insertion, the leading end of the pipe shall be examined in the exit bell hole to ensure that the pipe has not been damaged during insertion. Damaged pipe shall be replaced after corrective measures have been taken to prevent damage to the replacement pipe.
- B. HDPE pipe shall be handled using canvas or nylon slings. If a forklift is to come in direct contact with HDPE pipe, the forks shall be padded. HDPE pipe shall be stored in a manner, which minimizes crushing or bending. HDPE pipe should lay flat and be stacked no higher than 84 inches. HDPE pipe coils shall not be stored in a vertical position. HDPE pipe shall be transported and stored so that it does not come in contact with debris or materials that could cause damage to the pipe.
- C. Any pipes placed along the route of the proposed lines before the actual installation of the lines shall not be lowered into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. Pipe shall be placed along the route a maximum of one day ahead of pipe laying. All unnecessary material shall be removed from the bell and spigot end of each pipe. Before any pipe is laid, the outside of its spigot end and the inside of its bell shall be cleaned and left dry and oil free. HDPE pipe shall be inspected prior to fusion and prior to lowering the pipe into the trench to ensure that the pipe does not contain any debris. The pipe shall be cleaned if necessary to remove debris.
- D. Pipe shall be inspected prior to and after lowering into the trench for any damage. HDPE pipe shall be carefully inspected for cuts, gouges, deep scratches, or other defects. Any segment containing defects shall be removed and replaced. HDPE pipe shall not be used if gouges or cuts are greater than 10 percent of the wall thickness. When lowering HDPE pipe into the trench, the pipe shall not be subjected to excessive twisting and bending stresses. Allow for contraction of small diameter HDPE pipe by “snaking” the pipe from side to side in the trench.
- E. All pipe shall be joined in the exact manner specified by the manufacturers of the pipe and joining materials.
- F. HDPE fusion joints shall be allowed to cool for the required time. The Contractor shall be qualified to perform HDPE fusion by the product manufacturer and shall provide proof of qualification prior to beginning work.
- G. HDPE pipe must be joined using a qualified joining procedure and by persons qualified on that procedure.
- H. HDPE shall be joined using butt fusion, unless otherwise approved by owner. All mains and services shall be butt fused, unless otherwise approved by owner. Fusion shall take place in weather conditions acceptable to the Owner.

- I. Procedure Qualification - all joining methods for polyethylene pipe be qualified. The polyethylene pipe manufacturers have developed qualified procedures for heat fusion of HDPE pipe. Jasper has adopted the Plexco Pipe procedure for all saddle and butt fusion of polyethylene pipe and fittings. Jasper has adopted Central Plastics Procedures for electrofusion. All heat fusion joints will be visually inspected to determine if they have the same appearance as a joint properly made under the qualified procedure.
- J. Joiner Qualification - persons making either heat fusion or mechanical joints shall be qualified using applicable joining procedures mentioned above. Each person will be required to qualify for each of the joints they are expected to make. The qualifying procedure for polyethylene pipe joiners will consist of:
 - a. Training and experience with the qualified procedure.
 - b. Making a specimen joint according to the qualified procedure.
 - c. Visual inspection of the specimen joint to determine if it has the same appearance as a joint properly made under the qualified procedure.
 - d. For heat fusion joints, three longitudinal straps, 1 inch wide, cut from the joint will be examined for defects and then deformed by back bend, root bend, or torque. If failure indicates outside the joined area, the joint is acceptable.
 - e. For service saddle tee fusion, the test specimen will be secured and struck with a 3 lb. hammer.
- K. Qualification of persons making joints for each procedure will remain effective for 1 year from the date of testing, unless the Owner requires more frequent retraining due to quality of joints completed.
- L. Contractor fusion training shall be completed by a manufacturer or manufacturer representative acceptable to the Owner. Contractor shall provide proof of training acceptable to the Owner.
- M. All personnel performing plastic pipe fusion shall at all times while performing the fusion have readily available on the job site proof of qualification from the manufacturer or other acceptable training company.
- N. Mechanical couplings designed for use in HDPE piping systems have qualified installation procedures developed by the manufacturers. These procedures shall be followed for installation. All field mechanical joints will be visually inspected to determine if they have the same appearance as a joint properly made under the qualified procedure. All mechanical couplings used in plastic piping systems shall be designed to resist pullout.
- O. Aqua-grip or other Owner approved fittings shall be used for wet tie-ins.

3.04 Tapping Sleeves

- A. Prior to attaching the sleeve, the pipe shall be thoroughly cleaned, utilizing a brush and rag, as required.

- B. Before performing field machine cut, the water tightness of the sleeve assembly shall be pressure tested. The interior of the assembly shall be filled with water. An air compressor shall be attached, which will induce a test pressure as specified in this Article. No leakage shall be permitted for a period of five minutes.
- C. After attaching the sleeve to an existing main, but prior to making the tap, the interior of the assembly shall be disinfected.

3.05 Connecting to Existing Side Street Mains

- A. Before taking existing side street mains out of service, taps for air removal shall be made at each high point along the section of existing main to be temporarily taken out of service. With the Department's approval at each location, existing service lines may be used to expel air.
- B. Close service line curb stops along the section or sections that will be dewatered and close all connecting main valves.
- C. Take existing main out of service, cut and complete connection as detailed on the Standard Details.
- D. Open appropriate valve and after expelling all air, return existing main to Service and re-open all service line curb stops.
- E. At all taps to remove air, install brass cap on corporation stop, backfill, and replace pavement where required.

3.06 Valve and Fitting Installation

- A. Prior to installation, valves shall be inspected for direction of opening, number of turns to open, freedom of operation, tightness of pressure-containing bolting and test plugs, cleanliness of valve ports and especially seating surfaces, handling damage and cracks. Defective valves shall be corrected or held for inspection by the Department. Valves shall be closed before being installed.
- B. Valves, fittings, plugs and caps shall be set and joined to the pipe except that 12 inch and larger valves shall be provided with special support, such as treated timbers, crushed stone, concrete pads or a sufficiently tamped trench bottom so that the pipe will not be required to support the weight of the valve. Valves shall be installed in the closed position.
- C. A valve box shall be provided on each underground valve. They shall be carefully set, centered exactly over the operating nut and truly plumbed. The valve box shall not transmit shock or stress to the valve. The bottom flange of the lower belled portion of the box shall be placed below the valve operating nut. This flange shall be set on brick, so arranged that the weight of the valve box

and superimposed loads will bear on the base and not on the valve or pipe. Extension stems shall be installed where depth of bury places the operating nut in excess of 30 inches beneath finished grade so as to set the top of the operating nut 30 inches below finished grade. The valve box be flush with the surface of the finished area or such other level as directed by the Department.

- D. If valve boxes are installed concurrently with valves, the Contractor shall be responsible for maintaining valve boxes until the warranty period expires. All lost or damaged valve boxes shall be replaced by the Contractor, at the Contractor's own expense.
- E. A concrete pad shall be required around each valve box, the top flush with the cover as detailed on the Standard Details. Pre-cast valve pads will only be allowed where approved by the Department and specifically noted on the construction plans. Pre-cast pads shall not be used on slopes or in ditches.
- F. In no case shall valves be used to bring misaligned pipe into alignment during installation. Pipe shall be supported in such a manner as to prevent stress on the valve.
- G. Where main valves are shown on the Standard Details adjacent to intersection tees, install the valves no more than four feet from the tee unless shown or specified otherwise.
- H. Non-restrained and push-on joints shall not be installed within 15-feet of restrained joints at valves or fittings, unless shown otherwise on the Standard Details or approved by the Department.

3.07 Jack and Bore

- A. The Contractor shall provide to the Department, for approval, a detailed plan for the methods proposed for the construction of the casing. These plans shall include the methods proposed for groundwater control and face protection.
- B. In general, jack and bore operations shall conform to the requirements of the Tennessee Department of Transportation as presented in their *Standard Specifications for the Construction of Roads and Bridges*, latest edition. If a conflict between these Regulations and the Tennessee Department of Transportation Specifications exists, the more stringent Specifications shall govern.
- C. Install the steel casing pipe by the dry boring method. Bore the hole and install the casing through the soil simultaneously by a cutting head on a continuous auger mounted inside the casing pipe. Fully weld lengths of casing pipe to the preceding section in accordance with AWS recommended procedures. After the boring and installation of the casing is complete, install a cleaning plug on the rig and clean the casing.

- D. After construction of the casing is complete, and has been accepted, install the pipeline in accordance with the detailed Standard Details and/or these Regulations.
- E. Check the alignment and grade of the casing and prepare plan for approval to set the carrier pipe at proper alignment, grade and elevation. The carrier pipe shall be supported by stainless steel casing spacers to preclude movement within the casing. One spacer shall be placed not more than two feet from each end of the casing. Subsequent spacers shall be placed at 6 feet - 10 feet intervals within the casing.
- F. Provide all necessary bracing, bulkheads, and shields to ensure complete safety to all traffic at all times during the work. Perform the work in such a manner as to not permanently damage the roadbed or interfere with normal traffic over it.
- G. Begin the boring operation in a pit, sheeted and shored as necessary and begin at and proceed from one end. Observe all applicable requirements of Tennessee Department of Transportation regulations or City/County Transportation Department, as applicable.
- H. Conduct the operations in such a manner that all work will be performed below the level of the roadbed. Coordinate and schedule all of the work with Tennessee Department of Transportation or City/County Transportation Department, as applicable.
- I. Complete all boring work at one particular location before boring work is started at another location.
- J. If the casing installation work is being conducted in an unsafe manner or in a manner detrimental to the overpassing roadway or to the safety of the traveling public, all operations of boring shall cease until the necessary corrections have been made. In the event that distress occurs to the roadway due to the boring, the Contractor shall be required to submit a plan to repair the roadway. The plan must be acceptable to the Tennessee Department of Transportation or City/County Transportation Department, as applicable.

3.08 Free Boring

- A. The Contractor may construct a driveway crossing by the free bore method, in lieu of making a pavement cut, where indicated on the Standard Details and approved by the Department. The free bore method shall be accomplished by the dry auger boring method without jetting, sluicing, or wet boring.
- B. The diameter of the free bore shall not exceed the pipe bell outside diameter or the pipe barrel outside diameter plus 1 inch, whichever is greater.
- C. Free boring is allowable only under residential driveways. Free boring is not allowed under commercial driveways or any roadway.

- D. The Contractor shall be responsible for any settlement of the driveway caused by the free bore construction activities.
- E. If the Contractor elects to free bore and an acceptable installation does not result for any reason, the Contractor shall install a casing pipe by the bore and jack method.

3.09 Double Check Backflow Preventers

- A. Double check backflow preventer may be required at specific locations as directed by the Department. When required, the backflow preventer shall be housed in a meter box or vault as per the detail.
- B. One and one-half inch and smaller backflow preventers require a minimum of 6 - inches below, 8 inches behind, 8 inches in front of, and 3 inches above the highest point on the device or its valves.
- C. Two inch and larger backflow preventers require a minimum of 12 inches below, 12 inches behind, 24 inches in front of and 3 inches above the highest point on the device or its shut off valves.
- D. A minimum of 6 inches between the pit walls and the large device's valves and 3 inches between the pit walls and the valves on the small devices is required.
- E. The dimensions given above assume a standard "shallow" installation. If the depth exceeds 12 inches to the top of the device the other dimensions will need to be increased accordingly and be approved by the Department.

3.10 Locator Wire

- A. A continuous or properly spliced Number 14 AWG THHN solid plastic coated copper wire shall be placed along all HDPE pipeline installations (AWWA C906 pipe or AWWA C901 tubing).
- B. Care shall be taken during backfilling to prevent damaging or cutting of the locator wire.
- C. All splices shall be made by using copper wire "U" bolt assemblies and then wrapping with electrical tape.
- D. Wire shall be wrapped around pipe such that at least four (4) "wraps" are produced per length of pipe.
- E. In lieu of "wrapping", the tracer wire may be strung along the top of pipe provided it is taped to the pipe every five (5) feet to ensure proper positioning during backfilling.

- F. Locator wire shall be brought up to ground surface at all valve boxes and service connections. At service connections, a length of at least 12 inches of locator wire shall be coiled inside the meter vault. At valve boxes, a length of at least 12 inches of locator wire shall be coiled in a sealed opening at each valve pad. Locator wire from each side of valve shall terminate in the valve pad. Locator wires from each side of valve shall be bridged underground at the valve level to form a continuous conductor.

3.11 Valve Markers

- A. Markers shall be installed with the top of the marker protruding 36 inches above the ground surface. Valve markers shall be located in a suitable location approved by the Department's Inspector during construction.
- B. A marker shall be located within 20 feet or less from all in-line valves and/or tapping valves. One marker may be used to reference the location of more than one valve provided the valves are within 20 feet of the marker. No marker is to be installed within three feet of direct line of operation of a fire hydrant. Valve marker shall be installed in ditch line being in direct line with water main.
- C. The brass disc shall be stamped with the distance between the valve(s) and marker. The marker shall be installed such that the disc faces the valve.

3.12 Field Pressure Testing

- A. After the pipe has been installed, the complete pipeline shall be subjected to a hydrostatic pressure test.
- B. All testing shall be scheduled with the Owner.
- C. Mains and services shall be pressure tested as a complete system or as directed by the Owner.
- D. All pressure and leakage testing of water mains and appurtenances shall be in conformance with the latest revision of AWWA Standard C600 for DIP and AWWA C605 for PVC.
- E. All newly installed and backfilled pipe or any valved section thereof shall be subjected to a hydrostatic pressure test, conducted in the presence of the OWNER. If testing against a previously existing valve and the valve leaks, the CONTRACTOR shall be responsible for the valve. However, the OWNER shall not be liable for costs or lost time incurred by the CONTRACTOR when attempting to test a line against a faulty valve.
- F. Water used to conduct the hydrostatic testing shall be of the same quality required for KUB tap water.
- G. Hydrostatic Pressure Test – DIP

- a. Each valved section of pipe shall be slowly filled with water, and a test pressure equal to the 1.5 times the normal working pressure (but not less than 200 psi) shall be applied for a minimum of 2 hours. Test pressure shall be based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge. A pump shall be connected to the pipe in a manner satisfactory to the OWNER. The CONTRACTOR shall furnish the labor and equipment, including the pump pipe, connections, gauges, and all necessary apparatus.
- b. The hydrostatic pressure test shall be conducted by measuring, through a calibrated meter, the amount of water, which enters the test section under 200 psi or normal working pressures (whichever is greater) for a period or at least 2 hours. No installation will be accepted until the hydrostatic testing allowance is less than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148,000}$$

L = allowable leakage gallons/hour
S = length of pipeline tested, in feet
D = nominal diameter at the pipe, inches
P = average test pressure during the leakage test, psig

- c. The following table has been developed for the commonly used sizes of ductile iron pipe with the nominal laying length of 20 feet, under a test pressure of 200 psi. The hydrostatic testing allowance formula above may be used when conditions differ from those stated parameters.

| Pipe Diameter (inches) | Allowable Leakage per 1000 feet (gallons/hr) |
|---------------------------|---|
| 8 | 0.66 |
| 12 | 0.99 |
| 16 | 1.32 |
| 20 | 1.66 |
| 24 | 1.99 |
| 30 | 2.48 |
| 36 | 2.98 |

- d. Cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this hydrostatic pressure test shall be replaced with sound material in the manner specified at no cost to the OWNER. The test shall be repeated until the results are satisfactory to the OWNER. A recording chart shall be used to document the results of the test if requested by the OWNER.

H. Hydrostatic Pressure Test – HDPE

- a. Water lines installed using HDPE pipe shall pass a hydrostatic pressure test pressure equal to the 1.5 times the normal working pressure (but not less than 200 psi) for a period of 2 hours minimum and 4 hours maximum.
- b. The total test time including initial pressurization, initial expansion and time at test pressure shall not exceed eight hours. If the pressure test is not completed within 8 hours, the test section shall be depressurized, and allowed to relax for at least 8 hours before reapplying the test pressure.
- c. Hydrostatic pressure test shall be conducted following manufacturer and accepted industry recommendations.
- d. The OWNER shall be notified at least 24 hours prior to beginning any testing and shall be present during the test procedure. Test results shall be recorded in the as built drawings for the project including date, name of CONTRACTOR, name and signature of CONTRACTOR’s employee responsible for testing, test pressure, and test duration. A recording chart shall be used to document the results of the test if requested by the OWNER.
- e. Monitored make-up water test shall consist of an initial expansion and test phase. During the initial expansion phase, the test section is pressurized to the test pressure and sufficient make-up water is added each hour for three hours to return to the test pressure.

Make-up Water Allowance (gallons per 100 feet of pipe)

| Nominal Pipe Size | 1 Hour Test | 2 Hour Test | 3 Hour Test |
|-------------------|-------------|-------------|-------------|
| 2” | 0.07 | 0.11 | 0.19 |
| 6” | 0.3 | 0.6 | 0.9 |
| 8” | 0.5 | 1.0 | 1.5 |
| 12” | 1.1 | 2.3 | 3.4 |

- f. After the initial expansion phase, about four hours after pressurization, the test phase begins. The test phase may be two or three hours after which a measured amount of make-up water is added to return to the test pressure. The amount of make-up water added shall not exceed the allowable make-up water allowance.

I. Hydrostatic Pressure Test – PVC

- a. Submit detailed test procedures and methods for Engineer’s review. Testing shall be conducted in accordance with AWWA C605.
- b. The specified pressure test shall not exceed pipe or thrust restraint design pressures.

- c. Water lines installed using PVC pipe shall pass a pressure test equal to 1.5 times the normal working pressure (but not less than 200 psi) for a period of 2 hours minimum and 4 hours maximum.
- d. Hydrostatic testing allowances shall not exceed those indicated in AWWA C605. Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified.
- e. Leakage shall be defined as the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi of the specified leakage-test pressure after the pipe has been filled with water and the air in the pipeline has been expelled. No installation will be accepted if the leakage is greater than that determined values in AWWA C605.

3.13 Final Cleaning

- A. Interim Cleaning: Prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.
- B. Flushing: Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.
- C. Disinfection: Disinfect all pipelines which will carry potable water, non-potable water, or hot water. Before acceptance of piping system operation, each section of completed pipeline shall be disinfected in accordance with AWWA C651. After pressure tests have been made, the piping section to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be liquid chlorine, calcium hypochlorite, or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the piping in an approved manner. PVC pipe lines shall be chlorinated using only the above specified chlorinating material in solution. In no case shall the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine

residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each outlet on the line shall be opened and closed several times. From several points in the pipeline section, Contractor personnel, approved by the Engineer, shall take samples in sterilized containers and have a bacterial examination performed by a commercial laboratory in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until the piping system passes the bacterial examination for 2 consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.14 Waste Water Disposal

- A. The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Engineer prior to performing any testing, cleaning, flushing and disinfection activities.

END OF SECTION

Part 1 General

1.1 Work Included

- A. Construction of gravity sanitary utility piping, including piping, manholes, and appurtenances.
- B. Testing and inspection

1.2 Submittals

- A. Shop Drawings
 - 1. Detailed pipe drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information
 - 2. Detailed manhole drawings showing details, connections, dimensions, castings, anti-flotation provisions and other pertinent information
- B. Product Data
 - 1. Pipe data, including pressure class, wall thickness, reinforcing, and strength calculations.
 - 2. Manufacturer's data for couplings, saddles, gaskets and other pipe accessories.
 - 3. Manhole data, including wall thickness, reinforcing, and strength calculations.

1.3 Quality Assurance

- A. Installer Qualifications: Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.
- B. For PVC pipe, furnish a certificate from the pipe manufacturer indicating that the pipe meets all applicable requirements of these specifications.
 - 1. The minimum pipe stiffness for PVC pipe at 5 percent deflection shall be 46 for all sizes when tested in accordance with ASTM D2412; external loading properties of plastic pipe shall be by parallel plate loading.
 - 2. A specimen of PVC pipe 6 inches long shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is complete in 2 to 5 minutes.

3. After being immersed for 2 hours in a sealed container of anhydrous acetone (99.5 percent pure), a sample ring of PVC pipe shall show no visible spalling or cracking when tested in accordance with ASTM D2152 (swelling or softening is not considered a failure).

C. Drawings

1. Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.
2. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.

1.4 Delivery, Storage, and Handling

A. Delivery and Storage

1. Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
2. Metal Items: Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

- B. Handling: Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Carry, do not drag, pipe to trench.

Part 2 Products

2.1 Pipe

A. Polyvinyl Chloride (PVC)

1. To meet and/or exceed the requirements of ASTM D3034, SDR 26; suitable for use as a gravity sewer conduit with provisions for contraction and expansion at each joint; with a rubber ring and standard lengths of 20 feet and 12.5 feet plus or minus 1 inch; designed to pass all tests at 73 degrees F (plus or minus 3 degrees F); 6 inches long sections of pipe to be subjected to impact from a free falling type (20 pounds, Type A) in accordance with ASTM D2444 with no evident splitting or shattering (denting not considered a failure); and with a minimum envelope of 4 inches of granular material around the pipe, but with all other bedding and backfilling requirements remaining the same as for other pipe material.

2. PVC Plastic Gravity Joints and Jointing Material: Joints shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.

B. Ductile Iron Pipe

1. Pipe shall conform to ASTM A746 and be of push on type. Rubber gaskets shall conform to AWWA C111. Lubricant for joint pipe as approved by pipe manufacturer. Ceramic epoxy lined and coated outside with asphaltic coating. Pipe shall be US Pipe or equal.
2. Fittings: Ductile iron conforming to AWWA C110, lined and coated same as pipe.

2.2 Manholes

- A. General: Manholes shall be cylindrical, with a 48" minimum inside diameter. Increase diameter as indicated on drawings. Provide eccentric cone top sections.

B. Precast Concrete Manholes

1. Precast concrete manhole risers, base sections, and tops shall conform to ASTM C478.
2. Base and first riser shall be monolithic.
3. The manhole sidewall shall be of a length such that a minimum of one course and a maximum of 2 courses of bricks shall be placed on top of the unit to bring the casting to grade. A precast concrete adjusting ring may be used for this purpose, conforming to the height ranges specified for brick.
4. Xypex Admix C-1000 or approved equal shall be used for all manholes. Xypex Admix or approved equal shall be added to the concrete mix at time of batching. The manhole manufacturer shall submit specifications and the procedures for adding the Admix to the concrete. The admix shall have a red-tinted coloring.
5. Coat interior with corrosion resistant coating. The coating shall be SewperCoat, Strong-Seal, SpectraShield or approved equal. Coating shall be field applied in accordance with the manufacturer's recommendations, by qualified and experienced personnel.
6. Precast manholes are to be manufactured by Cloud, Forterra or approved equal.
7. Plastic Gasket For Precast Manholes: Preformed plastic gasket shall meet or exceed all requirements of FS SS-S- 210-A, "Sealing Compound, Preformed Plastic for Pipe Joints," Type I, and ASTM C990, rope formed. It shall be supplied in extruded rope form of suitable cross section and in such sizes as to seal the joint space when the manhole sections are installed. The sealing compound shall be protected by a suitable removable 2 piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing

the other half in order to facilitate application of the sealing compound. The flexible plastic gasket shall also meet the requirements of the following table:

| Property | Test Method | Minimum | Maximum |
|--|-------------|---------|---------|
| Specific Gravity @ 77°F | ASTM D71 | 1.20 | 1.30 |
| Ductility @ 77°F (5 cm/min) | ASTM D113 | 5.0 | -- |
| Softening Point (°F) | ASTM D36 | 320 | -- |
| Penetration @ 77°F (cm) (150 g-5 secs.) | ASTM D217 | 50 | 120 |

- C. Throat Rings: Adjustment throat rings shall be precast non-reinforced concrete rings having a maximum thickness of two inches (2"). The internal diameter shall not be less than twenty-four inches (24"), and the width shall be a minimum of five inches (5"). No more than six throat rings shall be used on any manhole.
- D. Gaskets and Connectors: Gaskets for joints between manhole sections shall conform to ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C923, and shall be Pelleborg Kor-N-Seal I with Korband Expander, or approved equal.
- E. External Preformed Rubber Joint Seals: An external preformed rubber joint seal shall be an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" shall be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal shall be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit shall consist of a top and bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be a non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections shall cover up to two more adjusting rings. Properties and values are listed in the following tables:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals

| Physical Properties | Test Methods | EPDM | Neoprene | Butyl Mastic |
|-----------------------|-------------------|------|----------|--------------|
| Tensile, psi | ASTM D412 | 1840 | 2195 | |
| Elongation, % | ASTM D412 | 553 | 295 | 350 |
| Tear Resistance, ppi | ASTM D624 (Die B) | 280 | 160 | |
| Rebound, %, 5 minutes | ASTM C972 (mod.) | | | 11 |
| Rebound, %, 2 hours | ASTM C972 | | | 12 |

2.3 Metal Items

- A. Frames, Covers, and Gratings for Manholes: Frames and covers shall be ASTM A48, Class 35B cast iron or ductile iron, made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or

otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and before rusting begins; and with the actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint. Castings shall be Vulcan 1480-1 or Neenah R-1642 for traffic rated areas and Vulcan 1480-1 or Neenah R-1642 for non-traffic rated areas. Watertight castings shall be Neenah R-1916-F1 or Vulcan V-2358. Refer to Standard Drawing. The frames and covers shall have a combined weight of not less than 270 pounds. Watertight covers shall be bolt-down type and shall be equipped with four 1/2 -inch stainless steel bolts and 1/8-inch red rubber or rubber O-ring gasket. Covers shall be rotatable and interchangeable. Bolt holes shall be bored through so that debris entering the bolt hole will fall into the manhole. Bolt holes shall have the full 360 degree circle within the cover's radius when bored through the cover.

- B. Manhole Steps: Zinc-coated steel conforming to 29 CFR 1910.27. As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to ASTM D4101, copolymer polypropylene. Rubber shall conform to ASTM C443M ASTM C443, except shore A durometer hardness shall be 70 plus or minus 5. Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

2.4 Compression Couplings

- A. When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM C425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size. Ductile iron couplings shall be Romac 501 fitting or approved equal.

Part 3 Execution

3.1 Protection

- A. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structure in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other sections of these specifications. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed therefore.
- B. Water service connections that are damaged shall be repaired or replaced by the Contractor, in accordance with the Owner's Specifications.

- C. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor, in accordance with the Owner's Specifications.

3.2 Pipe Separation

- A. Lay sewers at least 10 feet horizontally from any existing or proposed water main. If this is not practical, the sewer may be laid closer than 10 feet to a water main provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.
- B. Where a sewer crosses under water mains, the top of the sewer shall be at least 18 inches below the bottom of the water main. If the elevation of the sewer 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 10 feet on each side of the sewer with a full joint of the water main centered over the sewer.
- C. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.

3.3 Pipe Laying

- A. Lay no pipe except in the presence of Engineer or project representative representing the Owner.
- B. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting or trench boxes as provided in Section – Trenching and Backfilling.
- C. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the Drawings. Cradles shall be of concrete and conform to the dimensions shown on the Drawings. Concrete placed outside the dimensions shown shall be at the Contractor's expense.
- D. Lasers shall be used to set line and grade, after the type and procedures are approved by the Engineer. Set reference points for both line and grade at each manhole. Where grades are 0.6 percent or less, check the elevation of the beam each 100 feet with an offset point or engineer's level.
- E. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.
- F. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with compacted earth or stone as necessary.
- G. Special Requirements:

1. Installation of PVC Plastic Piping: Install pipe and fittings in accordance with this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
- H. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.
- I. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out the bell holes no more than 2 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.
- J. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.
- K. After the joints have been completed, they shall be inspected, tested, and accepted by the Owner's Representative before being covered. The pipe shall meet the test requirements for watertightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe relaid at the Contractor's expense. Carefully protect all pipe in place from damage until backfilling operations are completed.
- L. Do not begin the backfilling of trenches until the pipe in place has been reviewed and approved by the Owner's Representative.
- M. Make connections to all existing active sewer lines as shown on the Drawings. Make connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or by constructing a manhole, junction box, regulator chamber, or other structure as shown on the Drawings.
- N. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of sewer pipe into the hole, filling around the pipe with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.
- O. Joint dissimilar pipe by using suitable compression couplings. If compression couplings are not available, make jointing with a special fabricated coupling approved by the Owner.

- P. Provide concrete protection or concrete cap as for pipe sewers that, when completed, have less than 2.5 feet of covering in nontraffic areas and 4 feet of cover in traffic areas.
- Q. Existing water service connections which are damaged by the Contractor will be repaired or replaced at his expense as an incidental part of the work.
- R. Existing service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.

3.4 Concrete Work

- A. Pipe shall be supported on a concrete cradle, or encased in concrete where indicated on the drawings or directed by the Engineer.

3.5 Manhole Construction – General

- A. Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.
- B. Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected sewers or as directed by the Engineer. Wherever water is encountered at the site, place all cast-in-place bases on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.
- C. Carefully set the cast iron frame and cover at the required elevation, and properly bond it to the masonry with preformed plastic gasket or cement grout. Wherever manholes are constructed in paved areas, tilt the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the existing adjacent pavement. Wherever manholes are constructed in new subdivision streets, set the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the proposed finished surface.
- D. Where the difference in the invert elevation of two or more sewers intersecting in one manhole is 24 inches or more, construct a drop manhole. Drop manholes shall be similar in construction to standard manholes except that a drop connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 4,000 psi concrete as indicated by the Standard Drawing 110.

3.6 Concrete/precast Manhole Construction

- A. Construct base slab of cast-in-place concrete or use precast concrete base sections. For cast-in-place manhole bases, carefully block the lower barrel section above the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipe can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. For monolithic manhole bases, carefully level the base stone and place

the base section on this prepared base so it is fully and uniformly supported in true alignment and elevation.

- B. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit.
- C. No parging will be permitted on interior manhole walls.
- D. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes.
- E. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section.
- F. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer.
- G. Thoroughly wet and then completely fill all lift holes with mortar. Trim all protruding mastic between precast elements and between the manhole casting and the manhole riser on the inside of the manhole and smooth over these joints with mortar.
- H. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.
- I. Place backfill by hand around the manhole and to a distance of at least one pipe length into each trench, and tamp the downstream side with clean 1/2 inch to 3/4 inch crushed stone up to an elevation of 12 inches above the crown on all entering pipes. Continue backfilling in accordance with the requirements for trench backfilling.

3.7 Field Quality Control – Sewer Lines

- A. Before constructing or placing any joints, demonstrate to the Owner's Representative, by completing at least 1 sample joint, that the methods to be used conform to the specifications and will provide a watertight joint and further that the workmen to be involved in this phase of work are thoroughly familiar with experienced with the type of joint proposed.
- B. No other type of joint may be used unless authorized in writing by the Owner.
- C. Testing Of Gravity Sewers
 - 1. Visual Tests

- a. Upon completion of the construction or earlier if the Owner's Representative deems advisable, the Owner's Representative will make a visual inspection of the sewer and construction site. Immediately repair all leaks and defects found by such inspection.
 - b. In addition to general cleanup and leakage, the following standard shall be used to determine failure or defects of this project. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that no remaining puddle of water is deeper than 1/2 inch on pipe 36 inches internal diameter or smaller and 3/4 inch on pipe larger than 36 inches internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or relaid at the Contractor's expense.
 - c. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If defects develop in the pipe within 1 year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the Drawings, specifications, and local conditioning at the site of the work.
2. Leakage Tests: Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.
- a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C969. Make calculations in accordance with the Appendix to ASTM C969.
 - b. Low pressure air tests: Perform low pressure air testing as follows:
 - 1) Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by a representative of the Owner.
 - 2) Perform the first series of air tests after 2,000 LF but before 4,000 LF of sewer has been laid. The purpose of this first series of tests is to assure both the Contractor and the Owner that the materials and method of installation meet the intent of these specifications. Conduct the remainder of the tests after approximately each 10,000 LF has been laid.

- 3) Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
 - 4) Prior to testing, check the pipe to see that it is clean. If not, clean it by passing a full-gauge squeegee through the pipe. It shall be the Contractor's responsibility to have the pipe cleaned.
 - 5) PVC plastic pipelines. Test in accordance with UBPPA Uni-B-6. Allowable pressure drop shall be as given in UBPPA Uni-B-6. Make calculations in accordance with the Appendix to UBPPA Uni-B-6.
- c. Water for testing shall be obtained from an Owner supplied fire hydrant nearby. The cost of water for testing shall be borne by the Owner.
3. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of the pipe. Determine whether the allowable deflection has been exceeded by the use of a pull-through device or a deflection measuring device.
- a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:
- 1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
 - 2) Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 40 degrees F, and shall have a surface Brinell hardness of not less than 150.
 - 3) Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.
 - 4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

- b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.
 - c. Pull-through device procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.
 - d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.
- D. Visual Inspection Of Miscellaneous Materials: All material used on this project are subject to visual inspection by the Owner’s Representative at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the Owner’s Representative may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

3.8 Field Quality Control - Manholes

- A. All manholes are to be vacuum tested immediately after assembly or construction and before backfilling. No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test.
- B. All pipe and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is pulled. Service lines at manholes may be vacuum tested in lieu of air testing at the option of the Contractor.
- C. The Contractor is required to furnish all equipment necessary for these tests including the manhole sealing apparatus, gauges, pump plugs, and personnel shall be in accordance with equipment specifications and instructions provided by the manufacturer.
- D. The test head shall be placed in the cone section of the manhole.
- E. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.
- F. Acceptance for 4 foot diameter manholes shall be defined as when the time to drop to 9 inches of mercury meets or exceeds the following:

| Manhole Depth | Diameter | Time to Drop 1” HG |
|-------------------|----------|--------------------|
| 1. 10 ft. or less | 4 ft. | 75 seconds |

- | | | | |
|----|------------------|-------|-------------|
| 2. | 10 ft. to 15 ft. | 4 ft. | 90 seconds |
| 3. | 15 ft. to 25 ft. | 2 ft. | 105 seconds |
- G. For manholes 5 foot in diameter, add an additional 15 seconds and for manholes 6 foot in diameter, add an additional 30 seconds to the time requirements for 4 foot diameter manholes.
- H. If the manhole fails the test, necessary repairs shall be made and the vacuum test repeated until the manhole passes the test.
- I. If the manhole joint mastic is displaced enough to leave a void between the sections during the vacuum test, the manhole shall be disassembled and the seal replaced.
- J. A second vacuum test will be required after the manhole casting has been set and the binder placed around it.
- K. Regardless of the outcome of the vacuum tests, any visual or audio defects are to be repaired.

3.9 Cleanup

- A. After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

END OF SECTION

Part 1 General

1.1 Section Includes

- A. Pipe and fittings for underground force mains.
- B. Valves and appurtenances

1.2 Related Sections

- A. Trenching and Backfilling

1.3 Submittals

- A. Product Data: Submit manufacturer's standard drawings or catalog cuts. Include information concerning gaskets with submittals for joints and couplings. Provide data on:
 - 1. Pipe materials
 - 2. Pipe fittings, joints, valves, couplings and accessories.
 - 3. Valve boxes.
- B. Manufacturer's Certificates:
 - 1. Certify that pipe, fittings, and valves meet or exceed specified requirements.
- C. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. For all valves and fittings, provide either GPS coordinates (to centimeter accuracy) or provide field ties to two permanent above-ground locations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 Delivery, Storage, and Handling

- A. Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Do not store materials directly on the ground. Store PVC pipe away from heat or direct sunlight.
- B. Deliver and store valves in shipping containers with labeling in place.
- C. Keep the interiors of all piping, fittings and other accessories free from dirt and foreign matter at all times.
- D. Handle pipe, fittings, valves and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to

coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Owner. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight. Under no circumstances shall pipe be dropped or dumped from delivery trucks to the ground or into the trench.

Part 2 Products

2.1 General

- A. All materials of the same type shall be the product of the same manufacturer.
- B. Unless otherwise shown on drawings, piping for force mains less than 4 inches in diameter shall be polyvinyl chloride (PVC) plastic. Piping for force mains 4 inches in diameter and larger shall be ductile iron, PVC plastic or HDPE as shown on drawings. Pipe shall conform to the respective specifications and other requirements specified below.

2.2 Ductile Iron Pipe

- A. Ductile Iron Pipe: Push-on, single gasket joint with rubber gasket in accordance with AWWA C151/A21.51. The design thickness shall be that specified by ANSI A21.50/AWWA C150 with a wall thickness of Pressure Class 350. Pipe and fittings shall be lined with Protecto 401, Tnemec Series 431, or Engineer-approved equal. The outside coating shall be manufacturer's standard asphaltic coating.
 - 1. Fittings: Ductile iron, mechanical joint ANSI A21.10/AWW/A C110, standard body, lined with same material as pipe.
 - 2. Joints: Joints for pipe and fittings shall be push-on joints unless otherwise indicated.
 - a. Push-On Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly, per AWWA C111/A21.11.
 - b. Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets, AWWA C111/A21.11.
 - c. Flanged Joints: Bolts, nuts, and gaskets for flanged connections as recommended in the Appendix to AWWA C115/A21.15. Flange for setscrewed flanges shall be of ductile iron, ASTM A536, Grade 65-45-12, and conform to the applicable requirements of ASME B16.1, Class 250. Setscrews for setscrewed flanges shall be 190,000 psi tensile

strength, heat treated and zinc-coated steel. Gasket and lubricants for setscrewed flanges, in accordance with applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

- d. Sleeve-Type Mechanical Coupled Joints: As specified in paragraph entitled "Sleeve-Type Mechanical Couplings."
 - e. Grooved and Shouldered Type Joints: Grooved and shouldered pipe ends and couplings, AWWA C606. Joint dimension shall be as specified in AWWA C606 for rigid joints, except that where joints are indicated to be flexible, joint dimensions shall be as specified for flexible joints.
- 3. Restrained Pipe Joints (where indicated on the drawings): push-on joints with American Ductile Iron Pipe Fast-Grip gaskets, Flex Ring, Lok-Ring, or approved equal.
 - 4. Restrained Fitting Joints (where indicated on the drawings): Mechanical Joints with Ebaa Iron Megalug Series 1100 joint restraints, or approved equal.

B. Manufacturers:

- 1. Ductile Iron Pipe
 - a. American Cast Iron Pipe Company
 - b. McWane Ductile
 - c. U. S. Pipe and Foundry Company
- 2. Push-On Single Gasket Joints
 - a. "Fastite" by American Cast Iron Pipe Company
 - b. "Tyton" by U. S. Pipe and Foundry Company
- 3. Ductile Iron Fittings, mechanical joint
 - a. American Cast Iron Pipe Company
 - b. Tyler Union
 - c. U. S. Pipe and Foundry Company
- 4. Substitutions: Not permitted.

2.3 Polyvinyl Chloride (PVC) Plastic Piping - AWWA Type

A. Pipe and Fittings, 4" and Larger:

1. PVC Pipe 3" to 12" shall be AWWA C900, with gasket bell end, Pressure Class 200 (DR 14) with cast-iron-pipe-equivalent OD. Each length of pipe furnished shall bear identification markings in conformance with Section 2.6 of AWWA Standard C900.
2. Fittings for PVC pipe: Fittings shall be gray iron or ductile iron, mechanical joint, AWWA C110/A21.10 or AWWA C153/A21.53, and have cement-mortar lining.
3. Joints and Jointing Material: Joints for pipe shall be push-on joints, ASTM D3139. Joints between pipe and metal fittings, valves, and other accessories shall be mechanical joints, ASTM D3139 and AWWA C111/A21.11. Provide each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe, shall comply with ASTM F477. Gaskets for mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, shall comply with AWWA C111/A21.11.
4. Restrained Pipe Joints (where indicated on the drawings): push-on joints with Ebaa Iron Megalug Series 1900/2800 joint restraints, or approved equal.
5. Restrained Fitting Joints (where indicated on the drawings): Mechanical Joints with Ebaa Iron Megalug Series 2000PV joint restraints, or approved equal.

B. Manufacturers:

1. PVC Pipe
 - a. NAPCO
 - b. Vulcan
 - c. Hawk
 - d. Columbia Plastics
2. Substitutions: Not permitted

2.4 Polyethylene (PE) Plastic Piping

- A. Pipe, tubing, and heat-fusion fittings shall conform to AWWA C906. High Density Polyethylene Pipe (HDPE) and fittings shall be made of high density extra high molecular weight (EHMW) polyethylene with a standard thermoplastic material designation code of PE3408 and having a cell classification of 345464E per ASTM D3350. The molecular weight category shall be extra high (250,000 to 1,500,000) as per the Gel Permeation Chromatography determination procedure with a typical value of 300,000 to 330,000.
- B. All HDPE piping must have identifiable green striping (dual) every 120°. The pipe will be color grey or black and shall meet the Utility Location and Coordination

Council, "Uniform Color Code," for sewer lines per APWA/ULCC Standards Committee.

- C. The pipe and fittings shall have product traceability. The manufacturer shall include a print line on the pipe. This shall notate the manufacturer's name, date of manufacture, the lot and supplier of raw material, plant location, and production shift. The ASTM standard shall also appear as ASTM F714 with the material designation as PE3408.
- D. The polyethylene pipe manufacturer shall provide certification that the stress regression testing has been performed on the specific product. The said certification shall include a stress life curve per ASTM D2837. The stress regression testing shall have been performed in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined by ASTM D2837.
- E. The material shall be listed by the Plastics Pipe Institute (PPI), a division of The Society of the Plastics Industry in PPI TR-4. The pipe material shall have a Hydrostatic Design Basis of 1600 psi at 730F and 800 psi at 1400F. The PPI listing shall be in the name of the pipe manufacturer and testing and validation of samples of the pipe manufacturer's production pipe shall be based upon ASTM D2837 and PPI TR-3.
- F. The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications and that the pipe complies with AWWA Standards and NSF Standard 61. The certificate shall state the specific resin used and its source.
- G. HDPE pipe manufactured from materials meeting the specifications of this section shall have an Environmental Stress Crack Resistance of no failures in 10,000 hrs. (ESCR: FO>10,000) when tested in accordance with ASTM F1248.
- H. Pipe and fittings shall be manufactured from material meeting the requirements of this section. Pipe supplied under this specification shall have a nominal DIP (Ductile Iron Pipe) outside diameter unless otherwise specified. The Dimension Ratio (DR) and pressure rating of the pipe at 73* shall be selected for 200 psi pressure rating.

2.5 Trace Tape Or Wire

- A. Tracer wire shall be a #12 AWG (minimum) copper conductor, insulated with a minimum 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet APWA color code standard for buried utilities.

2.6 Valves

- A. General:
 - 1. Provide manufacturer's name and pressure rating marked on valve body.

2. All exterior bolting, fasteners, etc., shall be stainless steel.
- B. Ball Valves Up To 2 Inches:
1. Ball valves, 2 inch and smaller, shall be end entry type with bronze bodies and threaded, in accordance with ASME B1.20.1, regular ports. Valves shall have polytetrafluoroethylene (PTFE) seats and packing, hard chrome plated brass balls and hand lever operators, or be pre-drilled for control rod. Valves shall be rated for 600 psig WOG, and shall conform to MSS SP-110. A union shall be installed adjacent to the valves to provide access to the seat.
 2. Acceptable Manufacturers and Products:
 - a. Threaded:
 - 1) Conbraco Apollo 70-100
 - 2) Nibco T-580-70
 3. Substitutions: Not permitted.
- C. Swing Check Valves From 2 Inches to 24 Inches:
1. AWWA C508, Swing check valves, 2 inch through 36 inch, shall conform to AWWA C508, and have ASME B16.1 Class 125 flanged or grooved end connections. Valves shall have a cast iron or ductile iron body, stainless steel body seat, stainless steel-mounted cast or ductile iron disc, and a stainless steel hinge shaft. Valves 2 inch through 12 inch shall be rated for 175 psig service and valves 14 through 36 inch shall be rated for 150 psig service at 140 degrees F. Valves shall not slam shut on pump shutdown. Valves shall be outside spring and lever type. Valves shall be of the globe design with ANSI 125 pound flanges.
 2. Manufacturer/Product:
 - a. Apco
 - b. Valmatic
 - c. G.A. Industries
 3. Substitutions: Not permitted.
- D. Plug Valves:
1. Nonlubricated type eccentric valves, 3 inch thru 12 inch, shall be rated for 175 psig service at 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and cast iron bodies. Exposed service valves shall have flanged ends in accordance with ASME B16.1 flanged or AWWA C606 grooved end connections. Buried service valves shall have mechanical joint ends, unless otherwise noted.

2. Plug shall be all metal, matching body with round or rectangular port with no less than 80% of connecting pipe area and coated with Buna-N, welded nickel seats, self-lubricating stainless steel stem bearings, and stem seal multiple V-rings or U-cups with O-rings of nitrile rubber, with grit seals on both upper and lower bearings. Valves to 6" shall be provided with lever operator (exposed) or operating nut (buried). Larger valves shall be equipped with totally enclosed, geared, manual operator with handwheel or 2-inch nut. Size operator for 1.5 times the maximum shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
3. Manufacturers and Products:
 - a. DeZurik
 - b. Keystone
 - c. Or approved equal.

2.7 Accessories

- A. Concrete for Thrust Restraints: Use concrete, ASTM C94/C94M, having a minimum compressive strength of 3,000 psi at 28 days.
- B. Rods for Restraint: Stainless Steel
- C. Tapping Sleeves
 1. Wide body, ASTM A285 Grade C Steel
 2. Corrosion resistant, high strength, low alloy bolts (AWWA C111, ANSI A21.11) provided by manufacturer
 3. Recessed, roll resistant type, Buna-N gasket around outlet
 4. 12" and smaller; hydrostatic test pressure of 250 psi
 5. Larger than 12", hydrostatic test pressure of 200 psi
 6. Fusion bonded epoxy coating, average minimum thickness 12 mils
 7. 3/4" NPT test plug on the outlet throat required
- D. Tapping Valves
 1. 12 inches and smaller: AWWA C509
 2. Tapping sleeve side: ANSI B16.1; flanges with male pilots for centering; outlet side mechanical joint (AWWA C111).
 3. Flange and mechanical accessories supplied by valve manufacturer.

E. Repair Sleeves

1. Manufacturer/Product: Mueller H785
2. MJ ends, iron body

F. Combination Air Release Valves

1. Automatic Combination Air Release Valve: Automatic combination air release valves shall have a 316 stainless steel body with a 1 ½-inch reinforced nylon top outlet and shall have an operating pressure range of 1-150 psi. The air valve shall have a threaded inlet. The air valve shall have a removable 316 stainless steel clamp center-ring for ease of cleaning. Automatic combination air release valve shall be ARI Model D025-ST.

G. Sleeve-Type Mechanical Couplings

1. Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. For ductile iron and PVC plastic pipe, the middle ring shall be of cast-iron or steel; and the follower rings shall be of malleable or ductile iron. Cast iron, ASTM A48/A48M not less than Class 25. Malleable and ductile iron shall, conform to ASTM A47/A47M and ASTM A536, respectively. Steel shall have a strength not less than that of the pipe. Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type, ASTM A307, Grade A, with nuts, ASTM A563, Grade A. Bolts shall be 5/8 inch in diameter; minimum number of bolts for each coupling shall be 4 for 4 inch pipe. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Mechanically coupled joints using a sleeve-type mechanical coupling shall not be used except where pipeline is adequately anchored to resist tension pull across the joint. Mechanical couplings shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

H. Joint Tape: ASTM D3308.

I. Pressure and vacuum gauges

1. Pressure and vacuum gauges shall be stem mounted, with stainless steel cases equipped with safety pressure blowout backs and glycerine dials. The gauge sensors shall be C-Type Bourdon tube actuated and constructed of stainless steel. The gauges shall be equipped with TP316L stainless steel

threaded 0.25 inch male connections. The dials of the gauges shall be minimum 4.5-inches in diameter with scale readings in psig and inches of mercury ranging from zero to approximately twice the anticipated process operating or equipment pressure. A slotted adjustable pointer shall be provided with accuracy to conform to ASME B40.100, Grade A. A lever handled gauge cock and filter type snubber shall be provided. The gauges shall be isolated from the process fluids using remote corrosion resistant diaphragm seals where indicated. The housing of the corrosion resistant seals shall be constructed of stainless steel. Seals shall be composed of polytetrafluoroethylene (PTFE).

2. Manufacturers and Products:

- a. Ashcroft
- b. Wikal

Part 3 Execution

3.1 Examination

- A. Verify that municipal utility force main size, location, and invert are as indicated on the drawings. Report any discrepancies to the Engineer before proceeding with the work.
- B. Examine all pipe, fittings, valves, and other appurtenances carefully for damage and other defects immediately before installation. Mark defective materials and hold for final disposition.

3.2 Preparation

- A. Cut pipe ends square and beveled, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges, unions or threaded.

3.3 Trenching

- A. Hand trim excavation for accurate placement of pipe to elevations indicated. Bell holes shall be big enough so that there is ample room for 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.
- B. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Install thrust restraints in the sizes indicated on the Drawings.
- C. Restrained Joints. Restrained Joints shall be installed as shown on the plans or as

directed by the Engineer. Installation shall conform to the manufacturer's recommendation.

- D. The standard laying conditions shall be completed in accordance with ANSI/AWWA C150/A21.50 and as required by the specifications.

3.4 Installation - Pipe

A. Separation of Water Mains from Sanitary Sewer Mains

1. Parallel Installation

- a. Normal conditions - Water mains shall be laid at least 10 feet horizontally from any sanitary sewer, storm sewer or sewer manhole, whenever possible; the distance shall be measured edge-to-edge.
- b. Unusual conditions - When local conditions prevent a horizontal separation of 10 feet, a water main may be laid closer to a storm or sanitary sewer provided that:
 - 1) The bottom of the water main is at least 18 inches above the top of the sewer;
 - 2) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

2. Crossings

- a. Normal conditions - Water mains crossing house sewers, storm sewers or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer, whenever possible.
- b. Unusual conditions - when local conditions prevent a vertical separation as described in 2.a. above, the following construction shall be used:
 - 1) Sewers passing over or under water mains should be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.
 - 2) Water mains passing under sewers shall, in addition, be protected by providing:
 - 3) Provide a vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;
 - 4) Provide adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the

water mains;

- 5) The length of water pipe shall be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.
 - 6) Both the sewer and the water main shall be constructed of water pipe materials and tested in accordance with this specification.
- B. Lay force main lines to and maintain at the lines and grades required by the drawings. All fittings and valves shall be at the required locations, the spigots centered in the bells, and all valve stems plumb. Establish elevations of buried piping to ensure not less than 48 inches of cover unless otherwise indicated on the drawings.
- C. Install ductile iron piping and fittings in accordance with AWWA C600 and manufacturer's recommendations.
1. Jointing: Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11. Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions. Use setscrewed flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the setscrewed flange manufacturer. Allowable Deflection: The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.
- D. Install PVC water lines in accordance with AWWA C605 and manufacturer's recommendations for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."
1. Jointing:
 - a. Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joint shall be tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than 2 threads past hand-tight.

- b. Push-on joints: The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. The gasket shall remain in proper position in the bell or coupling while the joint is made.
 - c. Solvent-weld joints shall comply with the manufacturer's instructions.
 - d. Make mechanical joints with the gaskets, glands, bolts, and nuts previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for mechanical-joint connections and do not re-bevel.
2. Offset: Maximum offset in alignment between adjacent pipe joints shall no more than 75% of value recommended by the manufacturer and approved by the Engineer, but shall not exceed 5 degrees.
 3. Fittings: Install in accordance with AWWA C605.

E. Thrust Restraint

1. Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, shall be provided with thrust restraint. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Unless noted otherwise, thrust restraints shall be either thrust blocks or restrained joints.
2. Thrust Blocks: Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.
3. Restrained Joints: Restrained joints shall utilize joint restraints as indicated above. Where restrained lengths are not shown on the drawings, restraint shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD.

F. Install concrete pressure pipe in accordance with manufacturer's instructions.

1. The manufacturer's instructions shall be followed when lubricating and installing rubber gaskets. Joints shall comply with the manufacturer's instructions. The external annular space shall be filled with cement mortar or

with a portland cement-filled polyurethane loop. For pipe 24 inch diameter and larger, the internal annular space shall be filled with cement mortar and struck off to ensure a smooth and continuous surface between pipe sections. Pipe less than 24 inch diameter shall have a rope or trowelable mastic affixed to the concrete face of the bell socket before joining the sections of pipe. The mastic shall not be detrimental to the rubber gasket and shall fill the interior annular space when the pipe sections are pushed together.

2. Grout for exterior joint protection on concrete pipes shall be a mix of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to flow into the joint recess beneath the diaper. Grout for interior joint protection shall be a mix of 1 part portland cement and 1 part sand. A polyurethane foam loop, impregnated with portland cement, may be substituted for grout for exterior joints.
- G. Route pipe as shown on the Drawings. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed 75% of the maximum deflection allowed by the pipe manufacturer, and shall be approved by the Engineer.
- H. Lay pipe with the bell ends facing in the direction of laying unless otherwise directed by the Engineer.
- I. Close the open ends of pipes with a watertight plug whenever pipe laying is not in progress. No debris, tools, clothing or other material shall be placed in the pipe at any time. If the joints of any pipe in the trench cannot be completed until a later time, caulk them with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, leave this seal in place until the trench has been pumped completely dry.
- J. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations. Loop wire up in all valve boxes to provide a minimum 24" loop.
- K. Lay no pipe in water or when it is the Engineer's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project, and no separate payment will be made for its use.
- L. When crossing water courses which are greater than 15 feet in width:
1. The pipe shall be of special construction, having flexible, watertight joints.
 2. Valves shall be provided at both ends of water crossing and the valves shall be easily accessible and not subject to flooding.
 3. Two 3/4-inch taps should be made for sampling and testing.

- M. For installations requiring other forms of corrosion protection, see AWWA Manual M27.

3.5 Installation - Valves

- A. Prior to installation, valves shall be cleaned of all foreign matter and inspected for damage. Valves shall be fully opened and closed to ensure that all parts are properly operating. Valves shall be installed with the stem in the vertical position.
- B. Set valves on solid bearing. Set valves so that operators are plumb.
- C. Center and plumb valve box over valve. Set box cover flush with finished grade. Install valve boxes so that no vehicle loads are transmitted from the valve box to the valve.
- D. Provide support such as crushed stone, concrete pads or sufficiently tarped trench bottom, so pipe is not carrying weight of the valve.

3.6 Field Quality Control

- A. Hydrostatic Testing
 - 1. Pressure test
 - a. Test restrictions. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section.
 - b. Test pressure shall not exceed pipe or thrust-restraint design pressures.
 - c. The hydrostatic test shall be of at least 1-hour duration.
 - d. Valves shall not be operated in either direction at a differential pressure exceeding the rated valve working pressure. For tests at these pressures, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or the valve can be fully opened if desired.
 - e. The test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed valves.
 - 2. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.5 times the working pressure at the point of testing. Each valved section of pipe shall be slowly filled with water, and the specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied using a pump connected to the pipe. The system should be allowed to stabilize at the test pressure before conducting the hydrostatic test.

3. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at these points to expel the air as the line is filled with water. After the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and the pipe plugged or left in place as required by Engineer.
4. Any exposed pipe, fittings, valves, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves or joints that are discovered following the pressure test shall be repaired or replaced with reliable material, and the test shall be repeated until satisfactory results are obtained.

B. Leakage Test

1. Leakage shall be defined as the quantity of makeup water that must be supplied into the newly laid pipe or any valved section thereof to maintain the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall be measured by a drop in pressure in a test section over a period of time.
2. The leakage test shall be of at least a 2 hour duration. Contractor to furnish the pump, pipe, connections, measuring devices, and all other necessary apparatus as well as all necessary assistance to conduct the test. The leakage test shall be conducted in the presence of the Owner's representative.
3. No pipe installation will be accepted if the amount by Table 3 of makeup water is greater than that listed.
4. Should any test of laid pipe disclose leakage greater than that specified, the Contractor shall, at his own expense, locate and repair or replace the defective joints until leakage is within the specified allowance.
5. All visible leaks are to be repaired regardless of the allowance used for testing.

Table 3 Leakage testing allowance per 1,000 ft of pipeline*-gph^t

| Avg. Test Pressure psi | Pipe Size (inches) | | | | |
|---------------------------|--------------------|------|------|------|------|
| | 4 | 6 | 8 | 10 | 12 |
| 250 | 0.43 | 0.64 | 0.85 | 1.07 | 1.28 |
| 225 | 0.41 | 0.61 | 0.81 | 1.01 | 1.22 |
| 200 | 0.38 | 0.57 | 0.76 | 0.96 | 1.15 |
| 150 | 0.33 | 0.50 | 0.66 | 0.83 | 0.99 |

*If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

- C. If tests indicate that the Work does not meet specified requirements, repair the Work until it meets the requirements or remove the Work, replace and retest at no cost to the Owner.

- D. After each section of pipe is successfully tested, remove all debris and construction materials from the work site. Grade all areas to the elevations required by the drawings, or to the pre-construction elevations if no grade changes are required by the drawings. Seed and sod all areas disturbed by the construction.
- E. ¹Water for testing shall be obtained from the fire hydrant depicted in Exhibit A and the water supply shall be protected. The cost of water for testing shall be borne by the Owner.

END OF SECTION