SECTION 43 21 10 WATER MAIN INSTALLATION

PART 1 - General

1.1 SCOPE OF WORK

A. In general, work included in this Manual covers all aspects of the water system construction required to bring water service to any improvement located within the area of development as described within the Development Plan or the Main Extension Agreement. The design of any on-site private system will follow the guidelines as established in the PADEP Water Supply Manual for the Construction of Public Water Supply Systems to ensure adequate water service and fire protection. This manual specifies a minimum standard of quality and workmanship for materials and construction methods. This includes but is not limited to the furnishing and installing of all materials, goods and services needed to bring public water to any proposed structure or proposed facility to include:

1. All public and private water main,
2. All service line materials, and
3. All valves, hydrants, brass goods, fittings and all accessories and all appurtenances needed for a complete and proper installation of a public water system.

1.2 STANDARDS AND CODES

A. Work shall be in accordance with standards and codes listed below except as modified by the Contract Documents:

1. ACI Building Code Requirements for Reinforced Concrete (ACI 318)
2. AISC Manual of Steel Construction
3. ANSI Applicable Volumes
4. ASTM Applicable Volumes
5. AWS Applicable Codes
6. AWWA Applicable Volumes
7. OSHA Regulations
8. Federal State, and Local Regulations

B. Reference herein and in other attached documents to these and other standards and codes are to editions thereof in effect as to the date of the contract.

C. The following terms are defined as follows, unless another meaning is clearly intended.

1. Authority: The North Penn Water Authority.
2. Developer: The company, partnership, corporation or individual desiring to enter into a Main Extension Agreement with Authority for the purpose of obtaining public water for the Developer's project.
3. Contractor: Any company, partnership, corporation or individual hired by the developer or general contractor, its subcontractors and representatives assigned to complete or construct any aspect of the water system.

D. Related Documents: The general provisions of the Developer Main Extension Agreement, The NPWA Standard Details Sheet, The PA DEP Water Supply Manual--Chapter 8, Municipal Development and Subdivision Plan approvals and local fire and plumbing codes may apply in the execution of the work associated with this manual. It is the Contractor's responsibility to ensure that construction is in compliance with all applicable rules, codes, regulations and stipulations.

E. Report any conflict between the various codes or between any code and Specification to North Penn Water Authority (NPWA) for interpretation and consultation, prior to proceeding with the work. Report any conflict between the NPWA Standard Details Sheet and this Manual to NPWA for interpretation and decision. In general, the materials and methods specified in this Manual are to be used for the installation of all appurtenances of the water system.

F. The Contractor shall provide all the labor, supervision, materials, plant, tools and equipment necessary or desirable for properly performing and completing the work as described and specified in the plans and these specifications. All water system work by the Contractor is subject to the review, inspection and approval of the Authority.

G. Where this Manual refers to NPWA, the Authority or Authority's representative, it is defined as the NPWA Construction Inspector or its authorized representative.

H. Materials and Workmanship -- All materials, fixtures, fittings and supplies furnished under this Main Extension Agreement, unless otherwise specified, shall be of standard first grade quality and of the best workmanship and design. Where the characteristics of any materials are not particularly specified, such approved materials shall be used as is customary in first-class work of the nature for which the material is employed. No inferior or low grade materials will be either approved or accepted, and all work of assembly and construction shall be done in a neat, first- class and workmanlike manner. Authority shall have sole discretion in accepting or rejecting all materials and work associated with this Main Extension.

1.3 EXCAVATION AND BACKFILL

A. In general, the Contractor shall conform with all local and state road opening permit requirements for excavating and backfilling.

B. This item includes removal of all material encountered in excavating, backfilling and compaction of backfill necessary for the installation of water main. It includes all clearing and grubbing, barricades, sheeting and bracing, removal of water, disposal of surplus materials and debris and other precautions required for the safe and proper conduct of the work.

C. Trench excavation for pipe installation shall be to the depth shown on the drawings. Depth in unpaved area shall be measured from edge of nearest pavement.

D. Trench excavation in existing pavement shall be performed in a manner that will prevent fracture or disturbance of the pavement beyond reasonable working limits.

E. Topsoil, or other suitable materials removed from excavations shall be stored separately for further use as backfill, if approved by Authority's representative for use as backfill. Topsoil shall be used only for finished surface grading and shall be spread uniformly over the areas designated to a compacted depth of six (6) inches unless otherwise specified.

F. All materials not needed for backfill or deemed unsuitable for backfill by the Authority's Representative shall be disposed of by the Contractor at Contractor's dumpsite.

G. Suitable Material

1. Excavated material used as backfill shall contain no frozen material, ashes, rubbish, combustible or decomposable material, topsoil nor any other material which the Authority's Representative deems unsuitable for this purpose. Contractor shall replace any excavated material unsuitable for use as backfill with proper material obtained from other sources as approved by the Authority's Representative.

H. Select Fill

1. Backfill shall conform to PennDOT specifications and the drawings and more commonly known as 2A Modified.

I. Trench Backfill

1. Backfill from the trench bottom to 12 inches above the top of pipe shall be made with specified material. The material shall be placed in uniform layers a maximum of 4 inches thick and compacted alternately on both sides of the pipe by hand tamping.
2. Backfill from 6 inches under and 12 inches above the pipe to rough grade shall be made with suitable material in unpaved areas as defined in 1.2.7 and select fill in paved areas as defined in 1.2.8, unless trench detail states otherwise, including driveways. The material shall be placed and compacted in 4-inch layers for hand tamping and 12-inch layers for mechanical tamping.

J. Gravel Cradle

1. The Contractor shall install a gravel cradle by Authority's Representative or inspector due to rock protrusion or unstable trench bottom, the Contractor shall furnish and install a minimum of a 6-inch thick layer of compacted select fill prior to placing the water main or appurtenances. The limits of the gravel cradle will be determined by the Authority.

1.4 ROCK EXCAVATION

A. Wherever "rock" is used as the name of an excavated material, it shall mean boulders or pieces of rock, concrete or masonry, measuring one-half (1/2) cubic yard or more, hard shale or solid ledge rock and masonry which, in the opinion of the Authority's Representative, requires for its removal the continuous use of pneumatic tools or drilling and blasting. Material which can be loosened and removed by normal job equipment and material which is outside the limits of measurement allowed shall not be measured or classified as rock excavation.

B. In areas where blasting is necessary, such blasting shall be performed only by a person or persons showing proper credentials to be fully qualified to handle blasting materials and perform blasting. The local municipality must approve all proposed blasting prior to proceeding. The Contractor shall assume the risk of and be responsible for all blasting by him or under his supervision.

1.5 TRENCH EXCAVATION

A. Sheeting, Bracing and Shoring -- Wherever it is necessary to prevent injuries or to avoid damage to existing structures, pavement or foundations, or to prevent trench loads in the pipe due to caving or sliding of banks or excavations, the Developer shall sheet, brace or shore such excavations.

B. In open trench operations on State highways, the Developer shall be governed by the conditions, restrictions and regulations made by the Pennsylvania Department of Transportation (PENNDOT). The Developer shall comply with all applicable standards as published by the Occupational Safety and Health Administration (OSHA). If the Developer fails or neglects to meet these requirements, Authority may order any or all of the work to be stopped until the requirements are met.

C. All sheeting, sheet piling, bracing and shoring shall be installed by personnel skilled in such work. Timber or steel members used shall be sound, straight and free from defects. Sheeting and piling shall remain in place within the pipe zone which is the area of trench from the top of the pipe to the subgrade.

D. Sheeting, sheet piling, bracing and shoring above the pipe zone shall be withdrawn and removed as the trench is being backfilled except where and to such extent as Authority shall order in writing that the same shall be left in place, or where Authority shall permit the Developer to leave the same in place, at the request and expense of the Developer.

E. In withdrawing sheeting and sheet piling, special care shall be taken to ensure that all voids or holes are filled with satisfactory material and thoroughly compacted so as to prevent injury to the pipe and its appurtenances and injury or settlement of adjacent structures and pavement.

F. The neglect, failure or refusal of Authority to order the use of sheeting or sheet piling, or to order better quality or larger sizes of timber or steel members, or to order sheeting, sheet piling, bracing or shoring to be left in place, or the failure to give any orders or directions to the manner or methods of driving or placing sheeting, sheet piling, bracing or shoring shall not in any way or to any extent relieve the Developer of any or all obligations under this Main Extension Agreement. Such sheeting, sheet piling, bracing or shoring shall be provided at the sole expense of the Developer.

G. Width and Depth of Trenches

1. Trench Widths -- Sides of trenches shall be kept as nearly vertical as possible, and the trenches shall be excavated true to line so that a clear space as shown on details is provided on each side of the barrel of the pipe. If sheeting is required at the level of the pipe, the dimensions in the foregoing sentence shall be applicable to the inside faces of the sheeting.

2. Trench Depths -- The depth of the excavation for the pipe and appurtenances shall be so constructed to provide a minimum of four feet of cover. Stream crossings shall be excavated to provide a minimum of three feet of cover in the stream bed. The subgrade shall be excavated to fit the outside periphery of the lower quarter of the pipe with depressions being formed for bells or couplings. The pipe shall be bedded as shown on the details throughout the entire length of the pipe. If the trench is not excavated neatly or is excavated beyond the specified subgrade, the trench shall be backfilled to the proper subgrade with crushed stone or concrete if encasement is required so that the lower third of the pipe is supported for its entire length. The Developer shall have no claim for additional compensation for such bedding.

3. Unstable Subgrade -- When Authority determines that the material encountered at subgrade is unstable, the material shall be removed from under and from each side of the pipe for a distance of one diameter of the pipe or as otherwise ordered by Authority. The trench shall then be backfilled to the proper subgrade as required in these specifications.

4. Unyielding Subgrade -- When any unyielding material such as rock is encountered at subgrade, such material shall be removed to the depths below the bottom of the pipe as shown on the drawings, and the trench shall be backfilled to the proper subgrade with crushed stone so that the pipe is supported along its entire length. If trenches are shattered by blasting below or beyond the lines of excavation specified herein, the trench shall be refilled to specified lines of excavation with crushed stone, as directed by Authority. The Developer shall pay for all additional excavation and bedding as required by this specification.

H. Length of Open Trench

1. Authority shall have the right to limit the amount of trench opened in advance of pipe-laying and the amount of pipe laid in advance of backfilling, but in no case shall more than 400 feet of trench be opened at any one place in advance of the completed pipe. The trench shall not be opened for a distance of more than 500 feet at any one time.

2. Trench excavation shall be fully completed, except for the forming of trench subgrade, at least 20 feet in advance of the pipe placement and shall be kept free from obstructions except at the close of the work day, or at the discontinuance of work, the pipe laying may be completed to within 5 feet of the end of the opened trench. The amount of pipe laid in advance of backfilling shall not exceed 200 feet.

3. Authority may, at any time, require backfilling of open trenches over completed pipelines and the Developer shall have no claim for compensation even though, to accomplish said backfilling, excavation or other work at any place must be discontinued temporarily. If work is discontinued on any trench, except by order of Authority, and the excavation remains open for an unreasonable time, in the opinion of Authority, the Developer shall backfill the trench if so directed by Authority.

I. Trench Consolidation, Backfill, Cleanup and Traffic Maintenance

1. Trench backfill shall be completed expeditiously upon completion of pipe- laying. Trench backfill material shall be as specified in the appropriate section of these specifications. All excess trench excavation shall be removed from the site daily, and, where applicable, each street shall be broom-swept to afford a clean pavement surface. The Developer shall maintain affected streets in a clean condition and shall make daily inspections to examine all water main trenches. Where settlement occurs, the trench shall be repaired immediately to bring the trench up to grade. The Developer shall conform to all applicable PENNDOT and local codes and standards, as a minimum, for all backfill work.

1.6 BACKFILLING MATERIALS

A. Description

1. The Developer shall perform all backfill operations of every description for trenches and roads, with the materials and procedures and to the dimensions and levels shown on the drawings, or as required by Authority and in accordance with these specifications. This section shall include the backfilling, consolidation and compaction of all pipe trenches in roadways and shoulders and other areas with select or suitable materials to the levels and tolerances specified.

2. In open trench operations on State highways, the Developer shall be governed by the conditions, restrictions and regulations made by the Pennsylvania Department of Transportation (PENNDOT). All such regulations shall be in addition to those set forth in these specifications.

B. Related Work Specified Elsewhere

1. Excavation
2. Maintenance of Work Site
3. Erosion Control
4. Paving Restoration
5. Ductile Iron Pipe and Appurtenances
6. Service Line Materials and Brass Goods

C. References -- The following references are to be consulted for the applicable work items.

1. PENNDOT 408 - Pennsylvania Department of Transportation Publication 408 - Specifications - Sections 601.3 and 703.3.

2. Standard Detail Drawings

3. ANSI/ASTM D1557 - Test Methods for Moisture-density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 kg) Rammer and 18 Inch (457 mm) Drop.

D. Regulatory Requirements -- Backfill operations shall conform to the applicable PENNDOT and local codes and standards for all backfill work.

E. Backfill Material

1. Select Material Stone Backfill -- Select material stone backfill shall be crushed stone or gravel aggregate with suitable soil filler materials conforming to Select Granular Material (2A modified) - Section 703.3, Publication 408 - Specifications - PENNDOT. Select material stone backfill shall be placed from the top of pipe bedding material to subgrade elevation in roadways and shoulder or as directed by Authority. Refer to the appropriate Standard Details in these Specifications for an illustration of proper backfill placement.

2. Suitable Backfill Material for Use in Pipe Trenches other than in Roadways and Shoulders – Select Material Stone Backfill shall be used up to 12 inches below finished grade. The trench may be topped off using suitable backfill material excavated from the trench, if free of stones larger than eight (8) inches in maximum dimension and free from waste, objectionable organic matter, rubbish, boggy or other unsuitable materials as determined by Authority. No frozen material shall be used for backfilling.

3. Imported Backfill Material -- Imported fill soils, if required, shall be predominantly granular, well-graded, non-plastic soils with a maximum particle size of two (2) inches, with not more than ten (10) percent fines passing the

4. U.S. Standard Sieve No. 200, such as AASHTO Coarse Aggregate No. 2A or equivalent. If first approved in writing by Authority, imported backfill material may be material meeting the requirements of Section 4.2.1.2 above when imported from a local, nearby excavation.

5. Structural Backfill Material -- Structural backfill material shall be designated as Class B Fill and shall be used around structures for the width of the excavation or as directed by Authority. Class B fill shall be the deeper, courser- grained residual soil materials of low plasticity properties which are excavated as part of the proposed construction, or material meeting the requirements for Class A Fill, and shall be used for structural fill unless otherwise first approved in writing by Authority. The surficial higher plasticity, clayey soils, the decomposed shale bedrock (i.e., predominantly shale rock fragments with a much smaller fraction of intermixed coarse and fine-grained soils), and intact fragmented shale bedrock from blasting work shall not be used for compacted structural fill construction.

1.7 BACKFILLING OPERATIONS

A. General Procedures -- All trenches and excavation shall be backfilled and compacted in accordance with this Section, to the original line and grade or to such other line and grade as may be shown on the Drawings or as directed by Authority. Excavation shall be backfilled as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade
2. Inspection, testing, approval and location of underground utilities have been performed and recorded.
3. Removal of concrete form work.
4. Removal of shoring and bracing and backfilling of voids with satisfactory materials.
5. Removal of trash and debris from excavation.
6. Removal of all water, mud and slough.
7. Placement of permanent or temporary horizontal bracing on horizontally- supported trench walls.

B. All pipe shall have been bedded as shown on the Standard Details or as directed by Authority. Select backfill material shall be placed in uniform horizontal lifts not to exceed six (6) inches using hand tamping equipment and twelve (12) inches using a mechanical head shaker or similar equipment. Frozen material shall not be placed as backfill, nor shall backfill be placed upon frozen material. Previously frozen material shall be removed or otherwise treated as directed by Authority before new backfill is placed.

C. A bulldozer or other blade shall not be used to place select material backfill. However, mechanical equipment with various types of buckets may be used. The work shall be performed in such a way as to prevent dropping material directly on top of the pipe through a vertical distance greater than 5 feet. Care shall be taken to compact the material under the haunches of the pipe, to place the select material backfill evenly on each side, and to avoid displacing the pipe during backfill operations.

D. Where Authority determines that backfill material, whether it be material removed from the trench or imported to the site, is unsuitable and rejects all or a part thereof due to conditions prevailing at the time of construction, the Developer shall remove the unsuitable material and replace it with select material stone backfill or suitable foreign backfill material.

E. Compaction by water-jetting shall not be permitted.

F. The Developer shall permit Authority to visually inspect backfill and compaction operations at all times and if backfill material or the degree of compaction is determined by Authority to be inadequate, then the Developer shall remove backfill as specified above or shall re-compact material until, in the opinion of Authority, compaction is adequate.

G. Backfilling in Roadways -- After the pipe is installed, select material backfill shall be placed along the pipe in horizontal layers in maximum lifts of one (1) foot loose thickness and shall be compacted with approved tamping equipment to 95 percent density at optimum moisture as determined by the Modified Proctor Moisture Density Relationship (ASTM D 1557-78). Lift thickness limitations and compaction requirements specified for State highways, shoulders or embankments govern over these specifications when working in State highway rights-of-way.

H. Backfilling Around Structures -- No backfill shall be placed against concrete until the concrete has obtained sufficient strength to withstand the earth pressure placed upon it and in no case less than seven (7) days, nor before carrying out and satisfactorily completing the tests specified in the applicable section of the "Concrete" specifications.

I. Backfilling in Open Trench -- As soon as practicable after the pipe has been placed, as specified elsewhere, and the pipe joints have been properly made, the backfilling shall begin and shall continue without delay. In placing the material, care shall be taken that stones do not strike the pipe and correct pipe alignment shall be maintained by the Developer at all times. Pipe bedding material shall be placed in accordance with the Standard Details or as directed by Authority. Care shall be taken in the use of mechanical or other tampers not to injure or move the pipe or to cause the pipe to be supported unevenly.

1. The backfill in the remainder of the excavation from the top of the pipe bedding material to grade, or above the top of the concrete envelope, if used, shall be placed in lifts of 2 feet loose thickness and promptly compacted with appropriate compaction equipment until dense and stable. Refer to Standard Details for specific conditions and operations.

2. No stone or rock fragments shall be placed into the trench nor shall large masses of backfill material be dropped into the tamped layers of backfill until two (2) feet of earth backfill has been placed over the top of the pipe bedding material. Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with backfill material.

3. No compacting shall be done when the material is too wet to be compacted properly. At such times, the compacting work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compacting, or such other precautions shall be taken as may be necessary to obtain proper compacting. Authority shall be the sole judge of when conditions are proper for compacting backfill. All backfilled trenches shall be thoroughly surface-tamped with a hydraulic tamping machine approved by Authority.

J. Tests and Testing

1. Prior to accepting any material for use as backfill around structures or as select material stone backfill, Authority will visit the proposed borrow source area(s) to inspect the material proposed for use as structural fill material or as select material backfill stone backfill. Upon inspection and acceptance by Authority, a minimum of two (2) 100-pound samples of each borrow source will be obtained by Authority and transported to a qualified soils testing laboratory for testing. The Developer shall select the soils testing laboratory and pay the associated costs for testing.

2. A complete series of tests will be conducted on each selected sample and shall consist of determinations of moisture content, grain-size distribution, specific gravity and the Modified Proctor Moisture-Density Relationship (ASTM D1557-80). The data shall be used in determining field moisture and density acceptability of compacted structural backfill or compacted select material backfill.

3. The field moisture content of materials being compacted shall be determined by "Laboratory Determination of Moisture Content of Soil" (ASTM D2216-80), or by "Standard Test Methods for Water Content of Soil and Rocks in Place by Nuclear Methods (Shallow Depth) (ASTM D3017-88). The field density of compacted material shall be determined by either "Test for Density of Soil in Place by the Sand-cone Method" (ASTM D 1556-82), or "Test Method" (ASTM D2167-84) or by "Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth)" (ASTM D2922-81).

4. Authority shall perform field density and field moisture content tests on each lift of material in 100-foot intervals, or as deemed necessary by Authority, to ensure that the Developer is complying with the compaction requirements of this Section of the Specifications. Authority shall have the right at all times to test each lift of material to ensure that the compaction requirements of this Section of the Specifications are met.

K. Protection of Finished Work -- The Developer shall protect finished work with temporary barriers, structures, signs and traffic regulation as required by Authority or the State or local governmental agency having jurisdiction. The Developer shall reshape and re-compact fills subjected to vehicular traffic, as necessary, to maintain original line and grade.

1.8 REMOVAL OF WATER

A. The Contractor shall at all times during construction provide and maintain ample means and devices with which to promptly remove and properly dispose of all water entering the excavations and trenches. The Contractor shall take whatever means are necessary protect drainage areas and storm sewers from silt loading due to runoff or pumping from trenches. The Contractor shall use sediment bags and other sediment control devices as approved by the Authority's representative to ensure the control all runoff from the site.

1.9 TRAFFIC CONTROL

A. The Contractor shall supply and maintain all traffic control devices as shown on the development plans and as required by PennDOT or other agencies having jurisdiction. Traffic control devices shall be in accordance with the Manual of Uniform Traffic Control Devices, latest edition.

PART 2 - Water Distribution System Specifications

2.1 GENERAL

A. Related Documents: The general provisions of the Developer Main Extension Agreement, PA DEP Water Supply Manual, Chapter 8, Township approvals and local fire and plumbing codes may apply in the execution of the work under this section.

B. Description of Work: The work of this section includes furnishing all labor, materials, equipment to install, and test all pipe and tubing and related items required for this project. The pipe and related items shall be installed by the Contractor as indicated on the plans and as further specified in the specifications.

C. Submittals: For materials furnished by the Contractor, submittals shall be given to NPWA for approval for any material that differs from the specifications. As a minimum the information shall consist of catalog data and manufacturer's specification and engineering data.

D. Standards: All the products used in the construction that come in contact with drinking water shall meet the American Water Works Association (AWWA) Standards* and applicable Pennsylvania Department of Environmental Protection (PADEP) and National Sanitation Foundation (NSF) Standards. The primary focus of the NSF standards is on contaminants or impurities which may be imparted indirectly to drinking water. The products and/or materials covered include, but are not limited to, protective materials (coatings, linings, liners, etc.), joining and sealing materials (solvent cements, welding materials, gaskets, etc.), pipes and related products (pipes, tanks, fittings, etc.), and mechanical devices used in transmission and distribution systems (valves, etc.).

*AWWA Standard C600 and C651, latest revisions are incorporated into and considered a part of this Section.

2.2 STEEL PRODUCTS PROCUREMENT ACT

A. **ONLY STEEL PRODUCTS AS DEFINED IN THE STEEL PRODUCTS PROCUREMENT ACT, ACT NO. 3 OF 1978 73 P.S. § 1881 ET. SEQ., SHALL BE USED OR SUPPLIED IN THE PERFORMANCE OF THIS MAIN EXTENSION AGREEMENT OR ANY RELATED CONTRACT OR ANY SUBCONTRACT HEREUNDER, WHERE IRON OR STEEL PRODUCTS ARE SPECIFIED**.

2.3 DUCTILE IRON PIPE AND APPURTENANCES

A. Ductile Iron Pipe (Underground / Exterior):

1. All pipe greater than 2 inches in diameter shall be ductile iron pipe, Class 52 and manufactured in accordance with ANSI/AWWA specifications C151/A21.51, latest revision in nominal laying lengths of approximately 18 feet. Joints are to be Tyton joint, single rubber push-on gasket, made in accordance with ANSI/AWWA specifications C111/A21.11, latest revision.

2. All pipe and fittings furnished shall be cement lined and either bituminous or epoxy coated in accordance with ANSI/AWWA specifications C104/A21.4, latest revision. The minimum thickness of the cement lining shall be 3/32”.

3. In accordance with ANSI/AWWA specifications C151/A21.51, Section 51-15, latest revision, Ductile Iron Pipe shall be tested for ductility by an approved method such as ball impression test, punch test, or approved equal test method and the manufacturer shall furnish certification.

4. Polyethylene encasement for ductile iron pipe and fittings shall be used in corrosive soils, locations of potential stray current influence, gas line and stream crossings or in locations that may be impacted by future changes in condition, at the direction of the Authority. Consideration should be given to normally using polyethylene encasement in environments that have in the past posed external corrosion problems. Class C (black) polyethylene encasement shall be in accordance with the latest revision of AWWA C105, latest revision. Class B (colors) may be used if prolonged exposure (more than one month) to sunlight is precluded. Both low-density and high-density cross-laminated films are approved. For assistance in performing a soil survey and measurements for stray current influence, DIPRA can generally be called upon for assistance.

B. FITTINGS: All fittings shall be mechanical joint, Class 350, manufactured in accordance with AWWA specifications C-153/A21.53, latest revision (Compact Fittings) and furnished complete with all joint accessories. All fittings are to be bituminous coated or epoxy coated in accordance with applicable AWWA specifications. Fittings shall be of United States manufacture.

C. ACCESSORIES: Accessories such as gaskets, glands, bolts, nuts, etc., shall be furnished by the Manufacturer as required to make all piping systems complete.

D. Mega-Lugs will be used on all fittings and on all fire hydrant assemblies.

E. Field-Lock Gaskets – shall be used as determined by the NPWA inspector

F. VALVES:

1. GATE VALVES: All valves smaller than 24 inches shall be gate valves of the resilient seat wedge gate valve design, meeting or exceeding all requirements of the latest revision of AWWA C 509 & C-550. The wedge shall consist of a ductile iron casting encased in a bonded-in-place nitrile elastomer covering which forms the resilient sealing surfaces. The valves shall be of the non-rising stem design with sealing accomplished by double "O" rings and shall open left. All gate valves shall be designed for a minimum of 150 psi working pressure. Valves shall have mechanical joints and shall be epoxy or bituminous coated. Valves shall be Mueller Model A2360-20 or approved equal

2. BUTTERFLY VALVES: All valves 24 inches and larger shall be butterfly valves and conform to AWWA C504, latest revision, except as modified herein. Valves shall be designed for tight shutoff against a differential pressure equal to a minimum 150 psi for the service indicated. The valve body shall be constructed of cast iron, ASTM A126, Class B. Two trunnions for shaft bearing shall be integral with the valve body. Discs shall be cast iron, ductile iron, Type 304 or 316 stainless steel Seats bonded on the discs are not acceptable. Seats shall be Buna-N for liquids. Stuffing boxes shall be constructed of cast iron, ASTM A126. Gland assemblies shall be of cast bronze, ASTM B132. The packing gland shall be housed in a solid walled cast iron, ASTM A48, Class 40 one piece structure, or approved equal. Valves shall be open left. Shaft seals shall be O-ring type. Valve body & vane shall be epoxy coated in accordance with AWWA Standard C-550, latest revision.

3. INSERTION VALVES: Linestops shall be JCM 440 epoxy coated with stainless steel bolts. The method of linestop shall be as shown on the NPWA standard detail sheet.

G. VALVE BOXES: Each exterior valve shall be provided with a valve box. Valve boxes shall be cast iron and of the adjustable, screw type. The heavy pattern type must be used in areas where vehicular traffic can be expected. They shall be so designed and constructed as to prevent the direct transmission of traffic loads to the pipe or valve and shall be made by Pioneer, Quality Water Products, or approved equal. The box shall be adjustable through at least 6” vertically without reduction of lap between sections to less than 4 in. The length shall be as necessary to suit the ground elevation. The inside diameter of the box shall be at least 5-1/4 in. Covers shall be close fitting and substantially dirt-tight. The top of the cover shall be flush with the top of the box rim.

H. FLANGED ADAPTOR: Flanged adaptor shall be Uniflange, manufactured by EBAA Iron Sales, Inc. of Eastland, Texas or similar type couplings as approved by NPWA. Interior couplings shall have retainer rods according to the following schedule:

Pipe Dia	No.of Rods	Rod Dia.
3	2	5/8”
4	2	5/8”
6	4	¾”
8	4	¾”
12	4	7/8”

I. HYDRANTS:

1. All material used in the production of fire hydrants for ordinary service shall conform to the specifications designated for each material listed in AWWA Standard C 502, latest revision.

2. All hydrants shall be Mueller or Kennedy and will be approved by NPWA and have the appropriate threads.

3. Installation shall be in accordance with Section 2.5.1 (G) of this Manual.

J. POLYETHYLENE ENCASEMENT TUBING: Eight (8) mil thick polyethylene encasement tubing and tape for water pipe shall conform to AWWA Standard C 105, latest revision.

K. CURB BOXES: All curb boxes shall be the extension type with arch pattern base. Inside diameter of the upper section is to be 1.0". Boxes will be provided complete with heavy cover. Cover shall have a solid brass pentagon headed plug with easy out thread. Boxes will be designed such that if a heavy weight is placed on the top of the box, the upper section will slide into the base without causing damage to the curb stop or service piping. All boxes shall be coated inside and out with a tar base or epoxy base enamel. Mueller H-10308 Quality Water Products type or equal shall be used. Bases shall fit 1" ball valves. Rods shall be stainless steel ends and be one piece units with integral end. Boxes shall be of domestic manufacture.

L. TAPPING SLEEVES AND TAPPING VALVES

1. Tapping Sleeves: Mechanical joint stainless steel tapping sleeve with Class 125 outlet flange shall be used. Sleeve working pressure shall be 150 psi. Neoprene gaskets to be included with each sleeve. Sleeve to be cast iron construction and furnished with COR 10 bolts and nuts.

Pipe Type	**Sleeve Type**	**U.S Pipe Type**
Class 150 Asbestos Cement	Mechanical Joint	Heavy Class
Ductile Iron	Mechanical Joint	M.J.
Class 150 Asbestos Cement	Mechanical Joint	M.J.
PVC Plastic pipe – AWWA C-900	Mechanical Joint	M.J.

U.S. Pipe, Atlantic States Pipe or approved equal

Tapping sleeves are to be used to make "Wet" taps.

a. Tapping Valves: Tapping valves shall be in accordance with AWWA C500, latest revision. Affidavit from manufacturer required that the valves furnished comply with all applicable provisions of AWWA C-500. Flanged valve ends - Inlet flange shall be Class 125 and the Outlet Flange shall be mechanical joint. Companion flanges shall be made from a corrosion resistant material and all mechanical joint bolts and nuts shall be COR-10. Stem seal to be "O" Ring type. Epoxy-coated resilient wedge gates. Valve to be Mueller type H-667, H-642, H-541 or approved equal. All valves shall be of domestic manufacture.

M. REPAIR CLAMPS: Repair clamps are not allowed for new installations. If existing pipe is damaged and replacement is not practical, the Authority may permit the use of a repair clamp. Only with Authority approval, clamps shall be split type repair sleeves for the repair of cast iron, asbestos cement, or ductile iron pipe. Repair sleeve shall hold a minimum of 200 psi at 150 degrees Fahrenheit hydrostatic test pressure. Sleeve to be caulked or mechanical joint as manufactured by Tyler or approved equal. Sleeve shall be of domestic manufacture.

N. WRAP AROUND TYPE: Repair clamps are not allowed for new installations. Double or single band clamp used for repair of steel pipe, cast iron pipe, asbestos cement pipe, ductile iron pipe or PVC pipe. Repair sleeve shall hold a minimum of 200 psi at 150 degrees Fahrenheit hydrostatic test pressure. Bands shall be stainless steel type 304 with 24 gauge minimum thickness. Lugs shall be of malleable iron ASTM A47 Grade 30510 with mutually supporting sliding fingers. Low alloy steel bolts and nuts shall meet AWWA C115, latest revision. Bolts shall have double radius heads and square necks. Gasket shall provide for water service at 150 degrees Fahrenheit, and be at least 3/16" thick. Manufacturers shall furnish a report of gasket material certification by ASTM for specific applications. Gaskets shall have tapered ends and stainless steel armor shall be vulcanized into gasket. Clamps to be Rockwell Model #245, 226, 227, 228 or approved equal. Clamps shall be of domestic manufacture.

O. COMPRESSION TYPE: Repair clamps are not allowed for new installations. Compression type repair coupling used for repair standard size steel, plastic or copper pipe through 2" diameter. End nut sleeves shall be mild steel or malleable iron (ASTM-A47), Grade 32150. Finish shall be galvanized with steel sleeve meeting AISI C1010-15, liberal clearance to accommodate deflection of up to 6 degrees. Repair sleeve shall hold a minimum of 300 psi at 150 degrees Fahrenheit hydrostatic test pressure. Coupling shall be Rockwell Model 521 or 522 or approved equal. Coupling shall be of domestic manufacture.

2.4 SERVICE LINE MATERIALS AND BRASS GOODS

A. Corporation Stops: Stops shall be manufactured and designed in accordance with AWWA C800, latest revision. Design working pressure shall be 300 psi ball valve compression. Outlet threads shall be tapered iron pipe thread as described in Table 7, AWWA C800, latest revision. Inlet threads shall be the standard corporation stop thread as described in Table 8, AWWA C800, latest revision. Corporation stops to be Mueller B-25008 or approved equal. Stops shall be of domestic manufacture.

B. Ball Valve Curb Stops: Curb stops shall be manufactured and designed in accordance with AWWA C800, latest revision. Design working pressure shall be 300 psi compression ball valves. Compression fitting equal or exceeding Ford pack joint with gasket material molded of synthetic rubber meeting ASTM D-2000. Body shall be three piece design with solid brass ball. Stem shall be locked on with brass ring. Curb stops to be Mueller B-25209 or approved equal. Valves shall be of domestic manufacture.

C. Couplings: Couplings shall be manufactured and designed in accordance with AWWA C800, latest revision. Design working pressure shall be 300 psi. Compression fitting equal or exceeding Ford pack joint with gasket material molded of synthetic rubber meeting ASTM D-2000. Couplings to be Mueller or approved equal. Couplings shall be of domestic manufacture.

D. Alternate for all Brass Goods: Brass goods meeting and manufactured in accordance with AWWA C800, latest revision and of the same or equal design to Mueller.

E. Copper tubing: All service lines 2 inches and smaller shall be copper tubing Type K conforming to ASTM B88 and meeting AWWA Standard C-901, latest revision. Service lines all be laid out in one continuous length whenever possible. Where couplings are needed, exterior pipe shall have compression fittings. All interior copper pipe shall be supported 5 feet on center by Grinnell Fig. CT-130 supports or equal.

2.5 EXECUTION

A. All materials shall be stored and handled in accordance with the manufacturer's recommendations. The Contractor is responsible for replacing at its cost, any pipe and/or material damaged, that is deemed unacceptable by the Authority's representative. during the course of unloading the pipe or during construction.

1. Pipe Unloading: It is the responsibility of the Contractor to unload and string pipe. Pipe shall be lifted off the truck and placed on the ground with care to prevent damage to the pipe and the cement lined interior of the pipe. Rolling the pipe off the truck or dropping the pipe is prohibited. Pipe may be stacked, but no more than three layers high and only with proper blocking in between layers.

2. Pipe Jointing: For exterior piping, all joints shall be made in a dry trench and in accordance with the manufacturer's recommendations and the best practices for class of pipe laid. The ends of the pipe shall be wiped clean with a dry cloth before making the joint.

3. Pipe Laying:

   a. Installation of ductile iron pipe shall be in accordance with the requirements of AWWA C 600 and AWWA C 605, latest revisions, respectively. The pipe shall be accurately laid to the line and grades to the satisfaction of the Authority's representative. The line and grade may be adjusted from what is shown on the drawings to meet field conditions, upon approval by the Authority's representative.

   b. All pipe shall be laid with a minimum of four feet of cover and a maximum of six feet of cover over the top of the pipe, where utility conflicts do not prevail.

   c. All pipe laid within 3 feet of a culvert or with less than 4.0 feet of cover shall be insulated with 2-inch 40 pound density styrofoam material. The insulation shall extend the width of the trench, a minimum of 4 feet above the pipe envelope and on the vertical sides of the trench bottom from the bottom to above the pipe envelope. No pipe shall be laid with less than 4.0 feet of cover without prior approval of the Authority.

   d. The deflection of alignment at a joint shall not exceed the appropriate permissible deflection, as specified in the tabulation titled PIPE DEFLECTION ALLOWANCES.

PIPE DEFLECTION ALLOWANCES
Push-on Joint Ductile Iron Pipe Maximum Permissible Deflection, in Inches*

Nominal Size of Pipe (in)	***Deflection Angle = θ* (deg)***	***Maximum offset (in)***	***Approximate Radius of Curve – R* Produced by succession of joints (ft)***
24	3	11	340
16	3	11	340
12	5	19	205
8	5	19	205
6	5	19	205
4	5	19	205

Mechanical Joint Ductile Iron Pipe Maximum Permissible Deflection, in Inches.*

Nominal Size of Pipe (in)	*Deflection Angle = θ* (deg)*	*Maximum offset* (in)*	*Approximate Radius of Curve – R* Produced by succession of joints (ft)*
24	2	9	450
16	3.5	13.5	285
12	5	20	195
8	5	20	195
6	7	27	145
4	8	31	140

*Maximum permissible deflection for 18-ft. length, maximum permissible deflections for other lengths shall be in accordance with AWWA and DIPRA standards.

e. When mechanical joint, push-on joint, or similar pipe is laid, the bell of the pipe shall be cleaned of excess tar or other obstruction and wiped out before the cleaned and prepared spigot of the next pipe is inserted into it. The gasket, bell, and spigot shall be lubricated with gasket lubricating compound compatible with potable water. The new pipe shall be shoved firmly into place until properly seated and held securely until the joint has been completed. All pipe shall be pushed home by a method that protects the driving end of the pipe.

f. No pipe laying will be allowed to begin at any point other than a stub end or other appurtenance without the expressed consent of the Authority's representative. If the Authority's representative requires it, the interior of each length of pipe will be swabbed and wiped clean before laying the next length. Whenever the work is stopped temporarily, or for any reason whatsoever, the end of the pipe shall be carefully protected against dirt, water, or other extraneous material. Bedding shall be as shown on the plans.

g. In areas where the Contractor's trenching operation exceeds the typical section, the Contractor may be required to use a higher strength class pipe in lieu of the designated class at no additional cost to the Authority.

4. Valve Installation: All valves shall be installed in accordance with the specifications for the pipe to which they are to be connected. Valve joints shall be made up in accordance with the Contract Drawings. The valves shall bear no stresses due to loads from the adjacent pipe. Valve shall be placed on solid concrete block with operating stem plumb. Wedges shall be used to prevent movement during backfill operation. The valve shall be operated completely before placement in the trench, and all factory installed bolts shall be checked for tightness. All valves shall be inspected before installation and they shall be cleaned and well lubricated before installed in the line.

5. Pipe Cutting:

a. Where required, sections of pipe may be cut to provide shorter sections of pipe necessary for the construction. The cutting of the pipe shall be done in accordance with the pipe manufacturer's recommendations and subject to the approval of the Authority Inspector.

b. In general the pipe material shall be cut by using a saw or milling process, approved by the pipe manufacturer. The pipe shall be cut, not broken. The cut end of the pipe shall be square to the axis of the pipe, any rough edges ground smooth, and beveled where being used for push-on joints.

6. Repair Clamps: Repair clamps are not considered as permanent repairs. If a section of main is found to be defective, it shall be cut out and a new section of ductile iron pipe shall be installed using solid cast couplings.

7. Hydrant Installation:

   a. The hydrant valve shall be installed using a hydrant tee with a ductile iron rotatable MJ gland.
   b. The hydrant shall be secured to the hydrant valve connecting piece with a ductile iron rotatable Mega-lug on one end.
   c. The MJ bolts shall be Corten.
   d. The hydrant shall be set in true vertical alignment and shall be braced against undisturbed trench walls with poured concrete. Hydrants shall not be encased in poured cement in such a way that the bolts cannot be removed. The hydrant base shall be wrapped in polyethylene. Concrete shall not plug up drain holes.
   e. No service connection shall be made between the distribution main and the hydrant along the hydrant lateral.
   f. All hydrant installations shall be inspected by the Authority's representative prior to backfilling.
   g. In unfavorable soil conditions and at my time when so designated by the Authority's representative, a concrete collar shall be placed below the surface around the hydrant barrel, as shown in

B. SPECIAL REQUIREMENTS:

1. Pressure Pipe - Ductile Iron: Valves shall bear no stresses due to loads from the adjacent pipe.

2. Vertical Separation from Sanitary and Storm Sewer: Utility separation must be in accordance with PADEP regulations of the Public Water Supply Manual—Chapter 8. Whenever water mains must cross sewers, the main shall be laid at such an elevation that the top of sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be buried to meet the above requirements protection shall be provided as follows:

   a. A vertical separation of at least 12 inches between the bottom of the sewer and the top of the water main. (Water main below sewer)
   b. Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the water main.
   c. That one full length of water pipe be centered at the point of crossing so that the joints will be equal distance and as far as possible from the sewer.

3. Parallel Separation from Sanitary and Storm Sewer Water mains shall be laid at least 10 feet horizontally, edge to edge from sewers or sewer manholes. When conditions do not permit a horizontal separation of 10 feet, a water main may be laid closer to a sewer provided that:

   a. The bottom of the water main is at least 18-inches above the top of the sewer and a minimum of 5 feet edge to edge horizontally.
   b. Where this 18-inch vertical separation and 5 foot horizontal separation cannot be obtained, field conditions will dictate the methods of pipe protection, to include use of concrete bridging, blocking, mechanical joints, or other methods as directed by the Authority's representative.

4. Assembling Mechanical Joints: Mechanical joints shall be assembled in accordance with manufacturer specifications, pipes shall be parallel in line with each other as joint is assembled. Surfaces against which the gasket will come in contact shall be thoroughly brushed with a wire brush prior to assembly of the joint. The gasket shall be cleaned. The gasket, bell, and spigot shall be lubricated by using gasket lubricating compound compatible with potable water. The spigot shall be inserted into the bell until it is correctly seated. The gasket shall then be seated evenly in the bell at all points, centering the spigot, and the gland shall be pressed firmly against the gasket. After all bolts have been inserted and the nuts have been made up finger- tight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint to the proper tension by means of a torque wrench. Mechanical joints shall be assembled with mechanical joint restraint glands, megalugs or approved equal.

   The correct range of torque as indicated by a torque wrench and the length of wrench, shall not exceed the values specified in the tabulation titled TORQUE RANGE VALUES.

   TORQUE RANGE VALUES
   Range of torque 75-90 ft. - lb.

   Mechanical joint bolts shall be re-torqued to a range of 75 to 90 ft- lb. after waiting a period of two hours.

   If effective sealing of the joint is not attained at the maximum torque indicated above, the joint shall be disassembled and thoroughly cleaned, then reassembled. Bolts shall not be overstressed to tighten a leaking joint.

5. THRUST BLOCKS: Thrust blocks of concrete of adequate size and weight shall be used on all pressure piping for all bends including and in excess of 11 1/4 degrees.

   Minimum thrust blocking size shall be as shown on the standard details or shall be determined by the soil characteristics and bearing capacities as shown on the following table, whichever is larger:

   Horizontal Bearing Strengtrf5hs

Soil	*Bearing Strength S_b(lb/ft^2)
Soil Muck	0
Soft Clay	1,000
Silt	1,500
Sandy Silt	3,000
Sand	4,000
Sand Clay	6,000
Hard Clay	9,000

   *Although the above bearing strength values have been used successfully in the design of thrust blocks and are considered to be conservative, their accuracy is totally dependent on accurate soil identification and evaluation. The ultimate responsibility for selecting the proper bearing strength of a particular soil type must rest with the design engineer,

6. POLYETHYLENE ENCASEMENT TUBING: Eight (8) mil thick polyethylene encasement tubing shall be installed when appropriate on all ductile iron water pipe as set forth in the instruction in AWWA C105, latest revision and recommended by DIPRA. All valves, fittings and appurtenance shall also be wrapped and taped in a similar fashion.

C. HYDROSTATIC PRESSURE TEST:

1. The Contractor shall perform pressure and leakage tests under Authority supervision, according to the requirements set forth below.

2. All water lines shall be tested in the field in the presence of the Authority or an authorized representative in the manner prescribed. All test procedures must be reviewed and approved by the Authority prior to proceeding. Pipe shall be tested in stages so that unacceptable leakage can be more easily pinpointed and as part of the flushing water disposal management plan.

3. The pipe shall be filled slowly with water and tested at a pressure of 50 percent above the normal working pressure, as determined by the Authority, but in no case less than 200 psi. The pipe shall be filled in such a way as to evacuate all air from the line. The test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Authority. A meter to measure makeup water shall also be installed. Makeup water shall be potable water in a disinfected container made of material NSF-approved for contact with potable water. The pump, pipe connections, pipe taps, and all necessary apparatus shall be furnished by the Contractor at no additional cost.

4. The allowable leakage for ductile iron pipe may be determined by the formula:

$$\frac{L = SD\,p\,1/2}{133{,}200}$$

Where L is the allowable leakage in gallons per hour, S is the length of pipe in feet, D is the nominal diameter in inches, and P is the average test pressure in psi. For convenience, the following Table 1 may be used to estimate allowable leakage for ductile iron pipeline installations:

Table 1
DIPRA RECOMMENDED ALLOWABLE LEAKAGE PER 1000' OF PIPELINE*
(GALLONS PER HOUR)

Avg. Test Pressure (PSI)	**NOMINAL PIPE DIAMETER (INCHES)**				
	6	***8***	***12***	***16***	***24***
450	0.95	1.27	1.91	2.55	3.82
400	0.90	1.20	1.80	2.40	3.60
350	0.84	1.12	1.69	2.25	3.37
300	0.78	1.04	1.56	2.08	3.12
275	0.75	1.00	1.49	1.99	2.99
250	0.71	0.95	1.42	1.90	2.85
225	0.68	0.90	1.35	1.80	2.70
200	0.64	0.85	1.28	1.70	2.55
175	0.59	0.80	1.19	1.59	2.38
150	0.55	0.74	1.10	1.47	2.21
125	0.50	0.67	1.01	1.34	2.01
100	0.45	0.60	0.90	1.20	1.80

* For mechanical or push-on joint pipe with 18-ft. nominal lengths. To obtain the recommended allowable leakage for pipe with 20-ft. nominal lengths, multiply the leakage calculated from the above table by 0.9.

If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

D. DISINFECTION OF WATER MAINS (Refer to AWWA Standard C651)

1. Disinfection: The disinfection and hydrostatic testing operation can be combined provided that the following procedure is followed:

   Dry HTH (calcium hypochlorite) tablets are to be placed in each section of pipe and also one such tablet shall be placed in each hydrant, hydrant branch, and other appurtenance. The number of HTH tablets required per length of pipe is as noted in Table 2 below. The tablets shall be attached by an FDA-approved adhesive such as Poly Grip or equal. There shall be no adhesive on the tablet except on the broad side attached to the surface of the pipe. Attach all tablets inside and at the top of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section so it can be readily determined that the pipe is installed with the tablets at the top.

Table 2
Quantity of 5g HTH Tablets Needed Per Section of Pipe

Length of Section (feet)	**Diameter of Pipe (inches)**				
	6	**8**	**12**	**16**	**24**
13 or less	1	1	3	4	8
18	1	2	4	6	12
20	1	2	4	7	14

After a satisfactory hydrostatic test and allowing the chlorinated water to remain in the pipe for at least 24 hours, the line shall be flushed as described below, if the water temperature is less than 41□F (5□C), the water shall remain in the pipe for at least 48 hours. During this test period, all newly installed valves and hydrants shall be operated to thoroughly disinfect all moving internal parts.

2. Flushing Procedures: After the chlorinated water has been retained for the required time, the treated water shall then be thoroughly flushed from the newly laid pipeline at its extremities until the replacement water throughout its length shall, upon test show a residual chlorine content of not more than 1 ppm as tested by the Water Authority.

Water samples taken from the test section following completion of the disinfection procedure described above shall show no coliform count in 2 consecutive 100 ml samples. The Authority shall take all required bacteriological tests and perform this testing for the Contractor. Test results will be furnished to the Contractor at the earliest possible time. Should the initial treatment fail to result in the conditions specified in the above paragraphs, an alternate disinfection procedure shall be used as directed by the Water Authority.

Disposal of flushing waters

The environment to which dechlorinated water is to be discharged shall be inspected. The Contractor shall take proper precautions to dispose of all dechlorinated water in an environmentally acceptable manner. It is the Contractor's responsibility to ensure that all flushing water is retained, treated and free of chlorine residual prior to discharge to the environment.

The chlorine residual of water being disposed must be neutralized using one of the chemicals listed in Table 3. If a sanitary sewer system is unavailable for disposal of the chlorinated water, then an alternate disposal site must be located by the Contractor. The proposed alternative site to which the dechlorinated water is to be discharged shall be reviewed and approved by the Authority. The reducing agent shall be applied to the water to completely neutralize the chlorine residual (see Table 3 for neutralizing chemicals). Where necessary, the appropriate local and state authorities should be contacted by the Contractor regarding disposal to public waterways.

Table 3
Neutralizing Chemicals for Disposal of Flushing Water (lbs/100,000 gallons)

Chlorine residual concentration (mg/L)	Sulfur Dioxide (SO_2)	Sodium Bisulfate ($NaHSO_3$)	Sodium Sulfite ($NaSO_3$)	Sodium Thiosulfate ($NaS_2O_35H_2O$)
1	0.8	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
10	8.3	12.5	14.6	12.0
50	41.7	62.6	73.0	60.0

All expenses and costs incurred in carrying out the specified disinfection work, including furnishing the calcium hypochlorite granules and tablets, shall be borne by the Contractor at no extra cost to the Authority.

3. ACCEPTANCE:

   a. The Authority reserves the right to allow the mains to be placed into service in sections after the satisfactory tests have been made and approved, and to make full use of any part or parts of the system after acceptance of those parts.
   b. Until such time as the entire work has been accepted by the Authority, the Contractor shall be held responsible to rectify any leaks, errors, or other poor workmanship which may be discovered and shall make any necessary repairs, alterations, or adjustments as may be required to properly complete the work, as directed by the Authority's representative at Contractor's own expense.

2.6 RESTORATION OF OFF-SITE UNPAVED AREAS

A. The Contractor shall restore all disturbed unpaved grassed areas with topsoil, seed and mulching, and be responsible for the re-vegetation of said areas.

B. The topsoil shall be applied to a uniform depth of six (6) inches. Immediately prior to topsoil distribution, the surface shall be scarified to provide a good bond with the topsoil. Topsoil shall contain no stones, lumps, roots or similar objects larger than one (1) inch in any dimension and shall have a pH value of not less than 5.0 and no more than 7.5.

C. All seeds shall be certified blends (blue tag). No annual ryegrass will be permitted under any circumstances. Bluegrass blends may be added for residential lawns as needed. Cultivars are as follows: Kentucky Bluegrass, Quantum Leap Kentucky Bluegrass, Rugby 2 Kentucky Bluegrass and Alpine Kentucky Bluegrass.

D. Seeding shall consist of the following blend and be applied at the following rate:

SEED TYPE*	**MINIMUM GERMINATION ALLOWED**	**RATE**
Manhattan II Perennial Ryegrass	95-100	1 lb./200 sq. ft.
Catalina Perennial Ryegrass	95-100	1 lb./200 sq. ft.
Quickstart Perennial Ryegrass	95-100	1 lb./200 sq. ft.
Brightstar 2 Perennial Ryegrass	95-100	1 lb./200 sq. ft.
Kentucky Bluegrasses per 4.7.3	95-100	2 lb/1000 sq. ft.

* alternate seed selections may be used, only if cultivars are listed as top performers in the National Turfgrass Evaluation Program. All alternates must be approved by the Authority prior to application.

E. Fertilizing and mulching shall be applied to assure the proper growth of the seed. Fertilizer shall be a starter blend (18-24-5) applied at 1 lb/1,000 sq. ft. Mulch shall be a quality straw material and shall be applied at a uniform rate to ensure good coverage. If acceptable growth does not occur due to planting season, inadequate fertilization or mulching, poor topsoil or other related aspects, the Contractor will be responsible for reseeding until acceptable growth has occurred.

F. For optimum germination, straw should be secured using tackifier or netting. In the latter, netting shall be removed by Contractor after germination. No mulch or hay will be permitted as securing for seed.

G. In the event tree roots are damaged during excavation, all roots over ½" diameter shall be cut cleanly with pruning shears.

H. The Contractor will be responsible for the replacement of any shrubbery or ornamental landscaping that is irreparably disturbed by the Contractor and replace any plantings or Shrubbery with equivalent or superior plant material. The Contractor will guarantee and replace any disturbed planting which die within one year of completion of this project.

2.7 RESTORATION OF PAVED AREAS

A. Description: The work in this Section includes, but is not limited to, temporary paving, permanent paving and shoulder restoration. The work in this Section is also referenced or specified in Sections specifying Excavation, Backfilling and Maintenance of Work Site.

B. References - Quality Assurance:

1. The following publications of the Pennsylvania Department of Transportation (PENNDOT) are referenced throughout this Section.

   a. Publication 408 Specifications
   b. Publication 27 - Specification for Bituminous Mixtures (Bulletin 27)
   c. Publication 37 - Specification for Bituminous Materials (Bulletin 25)
   d. Publication 203 - Work Zone Traffic Control
   e. Publication 72 - Standards for Roadway Construction Submittals

   The Developer shall submit certification from bituminous and aggregate suppliers attesting that materials conform to the applicable State specifications, shall obtain materials from the same source throughout the life of the project, and shall maintain two (2) copies of each delivery document on site.

C. Job Conditions: The Developer shall take appropriate measures to control traffic during paving operations and shall not allow traffic to damage newly-placed paving. The Developer shall employ traffic control measures in accordance with Publication 203 - "Work Zone Traffic Control." The Developer shall, at his expense, restore to its original condition existing paving outside the limits of the work that was damaged by the Developer's operations.

D. Bituminous Concrete Materials

1. Bituminous concrete used for paving or repaving under this Main Extension Agreement shall conform to the applicable requirements listed below:

   a. Bituminous Base Course - PENNDOT 408, Sections 305 and 700.
   b. Bituminous Binder Course ID-2 - PENNDOT 408, Sections 401 and 421.
   c. Bituminous Wearing (Surface) Course ID-2 - PENNDOT 408, Sections 401 and 420.
   d. Emulsified Asphalt Seal - PENNDOT 408, Section 401.3(g).

E. Temporary Paving: The Developer shall place temporary paving, when directed by Authority, immediately upon completion of trench backfilling. Unpaved trenches shall not remain unpaved longer than three (3) working days after backfilling unless approved by Authority. The subgrade material shall be properly shaped and compacted. and the crushed stone base course shall then be placed and compacted to the required thickness and density. The temporary paving material shall then be placed and compacted to required minimum thickness using a trench roller having a minimum compaction roll of 300 pounds per inch-width. The Developer shall continuously maintain temporary paving material to the satisfaction of Authority and State and local road departments. Cold patch or 1-1/2” fo 1- D2 may be used.

F. Permanent Paving: The Developer shall saw cut existing paving to remove damaged areas, where applicable, and shall cut straight joint lines and right angle offsets using a 1 foot cut back. If temporary paving was placed, then such temporary paving shall be removed and disposed of in accordance with applicable State and local requirements. The permanent base course and surface course shall be placed to the required compactions and thicknesses in accordance with the specifications contained in Publication 408. Upon completion of the permanent paving, the Developer shall continuously maintain permanent paving throughout the contract maintenance period.

G. Bituminous Concrete Base Course: The bituminous concrete base course shall be placed in accordance with PENNDOT 408 - Section 305 Specifications. The base course shall be placed to the specified thickness after compaction which shall be accomplished by rolling. Pavement shall not be displaced or extruded from position and shall be compacted by hand with mechanical tamping equipment in areas which are inaccessible to rolling equipment.

H. Bituminous Concrete Surface Courses: Bituminous concrete surface courses shall only be placed after the binder course has been placed and compacted to the required thickness. The wearing course shall be placed to the required compacted thickness and shall conform to the gradient and surface cross-section of abutting pavement, where applicable, or to the required line and grade as specified. Pavement shall be compacted by rolling and shall not be displaced or extruded from position. Pavement shall be hand-compacted in areas which are inaccessible to rollers. Rolling shall be performed in connective passes to achieve an even and smooth finish without roller marks.

I. Shoulder Restoration: The Developer shall restore shoulders to the specifications and to the satisfaction of the local road departments and/or PENNDOT, whichever has jurisdiction.

J. Driveways: Driveways shall be trimmed to remove damaged areas and shall be saw cut with straight joint lines parallel to the centerline of the trench. Offsets shall be cut at right angles to the trench centerline. Existing concrete driveways shall be restored with a six (6) inch layer of concrete reinforced with 6x6 10/10 wire mesh. Existing asphalt driveways shall be restored with a minimum 1-1/2 inch layer wearing course over a six (6) inch layer of 2A modified stone backfill. Stone or gravel driveways shall be restored with a six (6) inch layer of 2A modified stone backfill.

K. Emulsified Asphalt Seal: A twelve (12) inch wide wearing surface seal shall be applied adjacent to curbs, inlets and other structures on the finished wearing course and on pavement joints. The seal shall be applied per PENNDOT Specification 408 - Section 401.3(g).

L. Field Quality Control: Authority will conduct field inspections as applicable. The standard nuclear method for testing the density of bituminous concrete in place shall be performed, as required during construction, at the expense of the Developer and in accordance with ASTM Designation D2950-82. Where applicable, all equipment and materials necessary for such testing shall be maintained on-site during the period of construction.

M. Protection: Immediately after placement, pavement shall be protected from traffic or loads until the pavement has attained adequate stability and adhesion.

N. As a minimum, the Contractor shall restore all pavement removed or disturbed during construction to a condition which is equal to or superior to the appearance and quality that existed before the work began.

O. The restoration of the roadway shall be constructed in accordance with all permitting agencies having jurisdiction in the vicinity of the road openings.

P. The Contractor shall be responsible for any sinking of the finished grade of the trench and for the pavement restoration for a period of one (1) year following the completion of the work.

2.8 RESTORATION OF OFF-SITE PRIVATELY OWNED IMPROVEMENTS

A. The Contractor shall restore all privately owned improvements such as driveways, sidewalks, curbing and landscaping to a condition that existed prior to construction.

B. The materials used will be equal to those that existed prior to construction unless otherwise directed by the Authority's Representative, in which case the Contractor shall place whatever the authorized governing body requires.

C. The finished product shall have workmanship equal to or superior to that which existed prior to construction.

D. The Contractor shall be responsible for any sinking of the finished grade of the trench and restoration work for a period of one (1) year following the completion of the work, in accordance with all requirements as set forth by the local governing agency and NPWA, where applicable.

2.9 RESTORATION IN EASEMENT AREA (IF APPLICABLE)

A. In off-site easement areas, the Contractor shall restore the area to a condition equal or superior to what existed prior to construction. No change in pre-existing grade will be allowed.

B. The Contractor shall, during the backfilling operation and if required by the Authority, bury a pipeline marker tape along the entire trench within the easement 12" to 18" below finished grade.

C. The Contractor shall install pipeline markers at locations shown on the plans.

END OF SECTION