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SECTION 2

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work under this section includes, but is not limited to piping, valves, fire hydrants, water service line, and appurtenances for a complete potable water distribution system.

1.02 DESIGN CRITERIA AND PERMITTING

A. The design of all public water system improvements, that are to become a part of the City of Clinton's water distribution system, shall be in accordance with Title 15A Subchapter 18C of the North Carolina Administrative Code and the rules and policies of practice of the N.C. Department of Environmental Quality Public Water Supply Section. These rules and policies are consolidated in the publication "Engineering, Planning and Development Guidance Document".

B. Engineer/Developer shall prepare and submit all applicable permit applications required by federal, state and local authority. All fees are the responsibility of the Developer.

C. Water lines shall be installed in street rights-of-way or permanent easements. Minimum easement width shall be 20 feet with water line centered within the easement.

D. Main line valves shall have the following maximum spacing:

Main Size	Maximum Spacing
2-inches	400 feet
4-inches	500 feet
6-inches	600 feet
8-inches	800 feet
12-inches	1,200 feet
16-inches	1,600 feet

E. Air valves shall be located at all high points along the water lines and at a spacing of approximately 2,500 feet on horizontal pipelines. Final locations to be approved by the City.

1.03 REFERENCES

A. Publications are referred to in the text by basic designation only.

1. American Society of Sanitary Engineering (ASSE) Standards

   a. 1013 Reduced Pressure Principle Backflow Preventers
   b. 1015 Double Check Backflow Prevention Assembly
   c. 1069 Outdoor Enclosures for Backflow Prevention Assemblies

2. American Society for Testing and Materials (ASTM)
    a. A48 Standard Specification for Gray Iron Castings
    b. A536 Standard Specification for Ductile Iron Castings
    c. B88 Standard Specification for Seamless Copper Water Tube
    d. C443 Flexible Watertight Joints for Precast Manhole Sections
    e. C478 Precast Reinforced Concrete Manhole Sections
    f. C890 Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
    g. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
    h. D98 Standard Specification for Calcium Chloride
    i. D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
    j. D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
    k. D1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
    l. D2241 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
    m. D2466 Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
    n. D2467 Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
    o. D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
    p. D3350 Polyethylene Plastics Pipe and Fittings Materials
    q. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
3. American Water Works Association (AWWA)
    a. B300 Hypochlorites
    b. B301 Liquid Chlorine
    c. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
    d. C110 Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids
    e. C111 Rubber Gasket Joints for Ductile Iron Pressure Pipe & Fittings
    f. C115 Flanged Ductile-Iron Pipe with Threaded Flanges
    g. C150 Thickness Design of Ductile Iron Pipe
    h. C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
    i. C153 Ductile-Iron Compact Fittings, 3 inch through 16 inch, for Water and Other Liquids
    j. C502 Dry-Barrel Fire Hydrants
    k. C504 Rubber-Seated Butterfly Valves

l. C508 Swing-Check Valves for Waterworks Service, 2 inch Through 24 inch NPS

m. C509 Resilient-Seated Gate Valves for Water Supply Service

n. C510 Double Check Valve Backflow-Prevention Assembly

o. C511 Reduced-Pressure Principle Backflow-Prevention Assembly

p. C512 Air-Release, Air / Vacuum, and Combination Air Valves for Waterworks Service

q. C515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service

r. C550 Protective Epoxy Interior Coatings for Valves and Hydrants

s. C600 Standard for Installation of Ductile Iron Water Mains and Their Appurtenances

t. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

u. C651 Disinfecting Water Mains

v. C700 Cold Water Meters-Displacement Type, Bronze Main Case

w. C701 Cold Water Meters-Turbine Type, For Customer Service

x. C702 Cold Water Meters-Compound Type

y. C800 Underground Service Line Valves and Fittings

z. C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch, for Water Distribution

aa. C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch through 3 inch for Water Service

bb. C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, 14 inch through 36 inch, for Water Distribution

cc. C909

dd. M23 PVC Pipe - Design Installation

4. National Sanitation Foundation (NSF) Standards

a. 14 Plastic Piping Components and Related Materials

b. 60 Drinking Water Treatment Chemicals – Health Effects

c. 61 Drinking Water System Components - Health Effects

d. 372 Drinking Water System Components – Lead Content

1.04 SUBMITTALS

A. Submit the following to the City's Public Works Department prior to beginning work:

1. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that tests set forth in each applicable referenced publication have been performed and that test requirements have been met. Affidavits shall be provided for all pipe, fittings, valves, fire hydrants, service valves and fittings, pre-cast structures, encasement pipe and other items as requested by the City.

2. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for all pipe, fittings, valve fire hydrants, service valves and fittings, casting, tapping sleeves, valve boxes, fire hydrants, backflow prevention assemblies and other items as requested by the City.
3. Reports: Submit the following reports in booklet format (Note: Methods used must be specified on reports):
    a. Field test report for each section of pipe for the following:
        1) Measured free chlorine residual
        2) Bacteriological test; Total Coliform and E. coli, performed by NC certified laboratory
        3) Pressure test
    b. Field test report for each backflow prevention device.
    c. Other reports as requested by the City.
4. Operation and Maintenance Instructions: Submit manufacturer's complete operation and maintenance manuals for the following:
    a. Valves
    b. Fire hydrants
    c. Backflow prevention assembly
    d. Other items as requested by the City

1.05 DELIVERY, STORAGE, AND HANDLING

A. All materials and equipment shall be handled and stored in accordance with the manufacturer's recommendations.

1.06 QUALITY ASSURANCE

A. All parts and materials incorporated into a project shall be new and unused.

B. Contractors must be licensed by the N.C. Licensing Board for General Contractors and have a classification and a cost limitation appropriate for the work to be performed.

1.07 WARRANTY

A. Line Work

1. Unless otherwise required, all materials and workmanship shall have a one-year warranty from the date of final acceptance by the City. A warranty inspection will be made jointly by the City and Contractor/Developer approximately eleven (11) months after acceptance to identify needed repairs. All labor, equipment and materials needed to make these repairs shall be the responsibility of the Contractor.

PART 2 ALLOWABLE PRODUCTS AND MATERIALS

2.01 GENERAL

A. Products with surfaces intended to be in contact with the drinking water shall be certified and listed in accordance with NSF 61 for potable drinking water.

B. Any pipe , fitting or fixture (e.g., corp stops, curb valves, gate valves less than 2-inches in diameter, backflow prevention devices, water meters, hose bibs, etc.), solder and flux installed or requiring replacement as of January 4, 2014 must be "lead free". The Contractor shall be responsible for complying with the State, local laws, ordinances, codes, rules and regulations governing the Reduction of Lead in Drinking Water Act that may have additional limitations or requirements.

2.02 DUCTILE IRON PIPE

A. General

1. Pipe and fittings 3-inch to 64-inch shall conform to AWWA C150 and C151 and the following requirements:
    a. Minimum pipe pressure class shall be based on pipe size, depth of bury and laying conditions in accordance with AWWA C150 and C151.
    b. Pipe shall be designed for an operating pressure of 150 psi plus a surge allowance of 100 psi.
    c. Interior shall be lined with cement-mortar with seal coat in accordance with AWWA C104.

B. Ductile-iron pipe for below ground service shall have push-on joints, conforming to AWWA C150 and C151, and to the following requirements

1. Provide mechanical joint fittings.

C. Ductile-iron pipe for above ground service shall have flanged joints, unless noted otherwise on the Drawings, conforming to AWWA C115.

D. Fittings for ductile-iron pipe shall conform to AWWA C110, or C153 and to the following requirements:

1. Joint type shall be as specified above for the supplied ductile-iron pipe.
2. In lieu of exterior asphaltic coating and interior cement lining, fittings may be provided with a 6-8 mil nominal thickness fusion bonded epoxy coating inside and out in conformance with AWWA C550.
3. Fittings shall be made of ductile-iron.

E. Ductile iron pipe on piers shall have restrained joints as recommended by the pipe manufacturer.

F. Special Pipe Joints

1. Restrained.
    a. Provide restrained joint pipe at fittings and valves on water mains. Length of restrained pipe shall be as calculated by the Design Engineer and approved by the City. Restrained joints shall be Snap-Lok (Griffin Pipe), Flex Ring and Lok-Ring (American), TR Flex (U.S. Pipe) or approved equal.
    b. Restrained joint pipe and fittings shall meet all AWWA standards and other requirements as specified above for standard ductile iron pipe and fittings unless addressed herein.
    c. Field made joints are allowable but should be avoided where possible. Careful planning to locate field cuts in standard pipe sections is preferred. For field made joints in restrained piping, use field weldments or an insert

equal to TR Flex Gripper Rings or approved equal. Gasket type field made joints will not be allowed.

d. Restrained joint fittings shall be provided by the restrained joint pipe supplier where located within restrained joint pipe sections. Fittings shall be of the same model and type as the pipe supplied from the pipe manufacturer.

e. Restrained joint fittings may be push-on joint type.

f. Megalugs, Series 1100, as manufactured by EBAA Iron Sales or approved equal shall be allowable for restraint where approved by the City.

g. Tees for hydrants do not have to be restrained along the main line except where they are within required restrained length of nearby fittings or valves.

h. Contractor shall develop a field layout schedule and drawing for restrained joint pipe installations.

2.03 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. General

1. Pipe and fitting size shall be as indicated on the Drawings.
2. PVC materials shall comply with ASTM D1784 with a cell classification of 12454-B.
3. Pipe shall be certified and listed for potable water distribution products in accordance with NSF 14 or 61 and bear the NSF seal on each section of pipe.
4. Fusible PVC is an acceptable material for use.

B. AWWA C900: C900 PVC pipe 4-inch to 12-inch shall conform to AWWA C900 and the following requirements:

1. Outside diameter shall conform to ductile-iron pipe.
2. Pipe shall be a minimum pressure class of 150 with a standard dimension ratio of DR 18.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C110 or C153 and have mechanical joints. Fittings shall be made of ductile-iron. Interior of fittings shall be cement-mortar lined with seal coat in accordance with AWWA C104.

C. AWWA C905: C905 PVC pipe 14-inch to 48-inch shall conform to AWWA C905 and the following requirements:

1. Outside diameter shall conform to ductile-iron pipe.
2. Pipe shall have a pressure rating of 200 with a standard dimension ratio of DR 21.
3. Pipe shall have plain end and elastomeric-gasket bell ends.
4. Fittings shall conform to AWWA C110 or C153 and have mechanical joints. Fittings shall be made of ductile-iron. Interior of fittings shall be cement-mortar lined with seal coat in accordance with AWWA C104.

D. Pressure Rated: Pressure Rated (PR) PVC pipe 1-1/2-inch to 3-inch shall be used only if approved by the City for a specific application and shall conform to ASTM D2241 and the following requirements:

1. Pipe shall be pressure rated 200 with a standard dimension ratio of SDR 21.
2. Pipe shall have an integral elastomeric-gasket bell end. The joints and gaskets shall comply with ASTM D3139 and ASTM F477.
3. Fittings for 3-inch pipe shall conform to AWWA C110, or C153 and have mechanical joints with transition gaskets as required for the pipe outside diameter. Fittings shall be made of ductile-iron. Interior of fittings shall be cement-mortar lined with seal coat in accordance with AWWA C104.

2.04 FUSIBLE POLYVINYLCHLORIDE PIPE (FOR DIRECTIONAL DRILL)(WITH PRIOR CITY APPROVAL)

A. Fusible polyvinylchloride pipe shall conform to AWWA C900 or AWWA C905, as applicable. Testing shall be in accordance with AWWA standards for all of these pipe types.

B. Pipe shall be DIPS standard dimensions with a minimum pressure rating of 235 psi (DR18) and the size as indicated on the Drawings.

C. Piping shall be made from a PVC compound conforming to cell classification 12454 per ASTM D1784.

D. Fusible polyvinylchloride pipe may conform to ASTM D3034 or ASTM F679 for non-pressure use, as indicated in the drawings.

E. Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

F. Fusible polyvinylchloride pipe shall be manufactured in standard 40 foot nominal lengths.

G. Fusible polyvinylchloride pipe shall be blue in color for potable water use. Fusible polyvinylchloride pipe shall be purple in color for reclaim, reuse, or other non-potable distribution or conveyance. Fusible polyvinylchloride pipe shall be white in color for raw water collection and transmission, surface run-off, storm water use, or other non-potable resource or irrigation water uses, as indicated in the drawings. Fusible polyvinylchloride pipe shall be green in color for wastewater use.

H. Pipe generally shall be marked per industry standards, and shall include as a minimum:

1. Nominal pipe size
2. PVC
3. Dimension Ratio, Standard Dimension Ratio or Schedule
4. Pipe legend or stiffness designation, or AWWA pressure class, or standard pressure rating for non-AWWA pipe
5. AWWA Standard designation number or pipe type for non-AWWA pipe (omit for ASTM D3034 or ASTM F679 pipe)
6. Extrusion production-record code
7. Trademark or trade name
8. Cell Classification 12454 and/or PVC material code 1120 may also be included.

I. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

2.05 POLYETHYLENE (PE) PRESSURE PIPE (FOR DIRECTIONAL DRILL)(WITH PRIOR CITY APPROVAL):

A. The pipe shall conform to AWWA C906 and the following requirements:
   1. Pipe shall be certified and listed for potable water distribution products in accordance with NSF 61 and bear the NSF seal on each section of pipe.
   2. Outside diameter shall conform with ductile-iron pipe for pipes 20-inch and smaller and iron pipe size for 24-inch and above.
   3. Material for pipe manufacturing shall be PE 3408 high density polyethylene (HDPE) meeting ASTM D3350 cell classification of 345444C.
   4. Note: Select class and associated DR No. for Project requirements. Note that NCDOT requires pressure class 200 with a DR of 9.
   5. Pipe shall be pressure class 200 with a standard dimension ratio (DR) 9.
   6. Fittings shall be made of material meeting the same requirements as the pipe.

2.06 COPPER PIPE AND TUBING (WITH PRIOR CITY APPROVAL)

A. Copper pipe and tubing shall conform to ASTM B-88 Type K and Type L standard specification for seamless copper water tube with copper or brass fittings. Type K to be used underground. Type L to be used above ground.

B. Soldered joint fittings shall conform to NSI B-16.22. Fittings to be of same manufacturer as pipe.

C. Screw joint fittings to be provided where required.

D. Screw joint unions shall be provided at each in-line valve, pressure regulator, pressure reducer and/or where indicated.

2.07 CTS FLEXIBLE TUBING (WITH PRIOR CITY APPROVAL)

A. Polyethylene tubing, 1-inch through 3-inch, shall conform to ASTM D3350 , AWWA C901, NSF Standards 14 and 61, and the following requirements:
   1. The tubing shall be made from material having standard PE code designation PE 3408 and a cell classification of 345464E.
   2. The tubing shall have a minimum pressure class of 200 psi with a dimension ratio (DR) of DR-9.
   3. The minimum water service line size shall be 1-inch.

2.08 ENCASEMENT PIPE

A. Encasement pipe installed under City maintained and NCDOT maintained roadways shall be in accordance with NCDOT's "Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way".

B. Encasement pipe installed under railroads shall be in accordance with "Part 5.3, Specifications for Pipelines Conveying Non-Flammable Substances" as developed by the American Railway Engineering Association (AREA).

C. Pipe materials used for the carrier pipe shall be adjusted as needed to meet the requirements of the roadway or railroad owners.

D. Pipe supports used in the encasement pipe designed and manufactured for the support of the carrier pipe shall be as follows:

1. Band and Riser Material: 14 gauge steel for band and riser except if the riser is over 6-inches high, the steel shall be 10 gauge for riser. Riser shall be of the channel shape. Band with risers shall have a fusion bonded PVC coating of a minimum of 10-mil thickness. Band shall be bolted together with stainless steel bolts, nuts and washers.
2. Band Liner: Provide PVC liner a minimum of 0.09 inches.
3. Runners: Glass Reinforced Polyester of UHMW Polymer plastic. Runner shall be a minimum of 1-inch wide and not more than 1-inch shorter than the bandwidth. Provide 2 top and 2 bottom runners for pipe sizes through 12-inches and 2 top and 4 bottom runners for pipes over 12-inches.

E. End seals installed on the encasement pipe may be a wrap around or a pull-on type. Seal shall be made of 1/8-inch thick synthetic rubber and shall be secured with stainless steel banding straps with worm gear tightening device.

2.09 TAPPING SLEEVE

A. Tapping Sleeve: Tapping sleeves shall be 304 stainless steel, flanged for the tapping valve and manufactured for a working pressure of 150 psi. Sleeve shall have a full body 360-degree gasket. Sleeve shall have a 3/4-inch test plug. Bolts and nuts shall be stainless steel.

B. Stainless steel tapping sleeve shall be Mueller model number H-304ss, Romac Models SST-4 60 to SST 2650, Smith Blair models 662, 663, 664 and 665 and approved equals.

2.10 VALVES

A. General: Valves shall meet the following requirements:
1. 12-inch and smaller valves shall be suitable for a working pressure of not less than 200 psi, and a minimum of 150 psi for valves greater than 12-inch.
2. Open by **counterclockwise** rotation (**open left**).
3. Provide an interior protective epoxy coating in accordance with AWWA C550 on ferrous surfaces in contact with the liquid.
4. Components in contact with the liquid shall be in compliance with NSF 61.
5. Equip valves with a suitable means of operation to be approved by the City.
6. Ends shall be mechanical joint for underground location and flanged joint for above ground location/underground utility vaults.
7. For buried valves over 5 feet deep, provide extension stems of cold rolled steel to bring the operating nut to within 2 feet of the ground surface. Extension stems shall also be provided as required for floor stands and to floor valve box.
8. Provide valve accessories as required for proper valve operation for valve locations as recommended by valve manufacturer.
9. Similar valve types shall be of one manufacturer.

B. Gate Valves, Resilient-Seated: Gate valves 3-inch to 20-inch shall conform to AWWA C509 or AWWA C515 and to the following requirements:
1. O-ring stem seal on non-rising (NRS) stem valves.
2. Ends shall be mechanical joint for underground locations and flanged joint for above ground locations.

3. Valves shall be non-rising stem (NRS) with wrench nut for underground locations and Outside Screw and Yoke (OS&Y) with handwheel for above ground locations.
4. Valves 16-inch and larger shall be equipped with gearing to facilitate opening. Geared valves shall be equipped with indicators to show the position of the gate in relation to the water.
5. Valves 16-inch and larger shall be equipped with a by-pass if system pressures are high enough to warrant. Manufacturer's recommendations will be used to determine this.

C. Tapping Valves: Tapping valves shall conform to the specifications for the gate valves as indicated in this Section and the following:
1. Valve shall be specifically modified for the passage and clearance of the tapping machine cutter.
2. The mating end to the tapping sleeve shall be raised male surface to provide true alignment to the sleeve and tapping machine. The valve shall be compatible with the tapping sleeve.

D. Butterfly Valves: Butterfly valves may be allowed by the City for installations greater than 16-inch. Butterfly valves shall conform to AWWA C504 for potable water and to the following requirements:
1. Valve body shall be ductile iron and mechanical joint for below ground locations and flanged short body or long body in underground vaults and above ground locations. End mechanical joints shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. End flanges shall conform to ANSI B16.1, Class 125 and ANSI/AWWA C110/21.10.
2. Valves shall be AWWA Class 150B.
3. Rubber seats shall mate with stainless steel or nickel-copper alloy seat surfaces.
4. Valve shafts shall be one piece or the stub-shaft type. Shafts shall be type 304 stainless steel.
5. Valve discs shall be cast iron, ductile iron, or stainless steel.
6. Valve Actuator
    a. Manual Actuator: Manual actuator shall be of the traveling nut type. Valves for buried service shall have a standard AWWA nut. Valves for above ground shall have a handwheel, or chain wheel as indicated on the Drawings. Actuators shall be open-right (**counterclockwise**) only.

E. Swing-Check Valves: Swing-check valves 2 to 24-inch shall conform to AWWA C508 and to the following requirements:
1. Provide lever and weight for swing check control.
2. Metal to Metal seat construction.
3. Ends shall be flanged.

2.11 AIR VALVES

A. Provide air valves in conformance with AWWA C512 and the following:
   1. Valve type shall be an Air Release valve.
   2. Valves shall be sized based on flow capacity of line and pressure.
   3. Valve shall be designed for the following automatic operation:
      a. Release accumulated air while the main is in operation and under pressure.
   4. Provide threaded inlet.
   5. Provide stainless steel ball float and wetted internal parts.
   6. Provide isolating bronze ball valve for connection to main line.

2.12 MANHOLES

A. General
   1. Manholes shall be made of pre-cast concrete sections in conformance with ASTM C478, N.C. Department of Transportation and the following requirements:
      a. Standard manhole diameter shall be 4 feet unless an inside drop structure is installed or the depth exceeds 15 feet. In these cases the minimum diameter shall be 5 feet.
      b. Pre-cast concrete manholes shall be as manufactured by Adams Concrete, Carolina Precast Concrete, Inc., D&M Concrete Specialties, Inc., N.C. Products Corp., Stay Right Tank, Tindall Concrete Products, Inc. or approved substitute.

B. Pre-Cast Sections
   1. Minimum wall thickness shall be 5-inches.
   2. Base: Cast monolithically without construction joints or with an approved PVC waterstop in the cold joint between the base slab and the walls. The width of the base extensions on Extended Base Manholes shall be no less than the base slab thickness.
   3. Riser: Minimum lay length of 16-inches.
   4. Eccentric Cone: Top inside diameter shall be 24-inches. Width of the top ledge shall be no less than the wall thickness required for the cone section.
   5. Transition Cone: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Minimum slope angle for the cone wall shall be 45 degrees.
   6. Flat Slab Top: Designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the manhole ID and the top and bottom surfaces. Provide a float finish for exterior slab surface.
   7. Pre-Cast or Core Holes for Pipe Connections: Diameter of hole shall not exceed outside diameter of pipe by more than 3-inches.
   8. Grade Rings: May be used to adjust frame and cover to finished grade.
   9. Grade Rings shall be no less than 4-inches in height.

10. Lifting Devices: Devices for handling pre-cast components shall be provided by the pre-cast manufacturer and comply with OSHA Standard 1926.704.

C. Joints
   1. Manufacturer in accordance with tolerance requirements of ASTM C990 for butyl type joints.
   2. Minimize number of joints. Do not use riser section for manholes up to 6 feet tall and no more than one riser for each additional 4 feet in height.
   3. Flexible Joint Sealants: Preformed butyl rubber based sealant material conforming to Federal Specification SS-S-210A, Type B and ASTM C990.
   4. External Seal: Polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6-inches wide.

D. Flexible Pipe Connectors
   1. Provide flexible connectors for pipe to manhole that conform to ASTM C923.
   2. Provide stainless steel pipe clamp type band around flexible connection to sewer pipe.

E. Manhole Steps
   1. Steps shall be in accordance with ASTM C478 and made of 1/2-inch grade 60 steel encapsulated by co-polymer polypropylene and have serrated tread and tall end lugs.
   2. Secure steps to the wall with compression fit in tapered holes or cast-in-place. Align steps along a vertical wall and shall not be located over a pipe opening. First step shall be a maximum of 26 inches from the bottom.
   3. Steps shall be by American Step Co., Inc., Bowco Industries, Inc., M.A. Industries, Inc. or approved substitute.

2.13 CASTINGS

A. General
   1. Made of gray iron, ASTM A-48 - Class 30, or ductile iron, ASTM A536, grade 65-45-12.
   2. Castings shall be free from imperfections not true to pattern. Casting tolerances shall be plus or minus 1/16 inch per foot of dimension. Top shall set neatly in frame, with edges machined for even bearing and proper fit to prevent rattling and flush with the edge of frame.
   3. Castings shall be as manufactured by Neenah Foundry Co., U.S. Foundry & Manufacturing Corp., Vulcan Foundry, or approved equal.

B. Manhole Ring and Cover:
   1. Minimum clear opening shall be 22 inches.
   2. Minimum weight for frame and cover shall be 310 pounds and suitable for Heavy Duty Highway Traffic Loads of H-20.
   3. Frame shall have four 3/8-inch anchor bolt holes equally spaced.
   4. "Water" shall be cast on the cover as appropriate. Casting shall bear the name of the manufacturer and the part number.
   5. Provide solid cover.

2.14 HEAT TAPE AND INSULATION

A. Pipe Insulation
   1. All exposed valves and water piping located outdoors shall be insulated with 1-inch thickness of fiberglass insulation. The outside cover for the insulation shall be covered with an asphalt saturated weatherproof jacket for all weather protection with aluminum cover. Exposed piping 6-inch and larger shall have aluminum cladding over insulation.

B. Heat Tape
   1. All of the above piping and valves shall be wrapped with self-regulating, rapid trace heat tape rated 8 watts per foot, 120V. Heat tape for non-metallic piping shall be provided with tinned copper braid and fluoropolymer over coat. All heat tape shall be controlled by a thermostat, which is in direct contact with protected piping. Contractor installed heat tape shall provide power wiring from J-box to thermostat in liquid-tight, flexible conduit. Plug-in type heat tape will not be acceptable. Protect pipe to -5° F.

2.15 VALVE ACCESSORIES

A. Valve Box, Below Ground: Boxes shall be high strength cast iron of the telescopic type. Box shall consist of a flare base section, center extension as required, and a top section with the word "WATER" cast in the cover. Length of box shall be such that full extension of box is not required at the depth of water main cover.

B. Extension Stem (if necessary): Stem shall be sized so as to transmit full torque from the operating mechanism to the valve stem without binding, twisting, or bending. Stem shall be made from extra heavy steel pipe. Stem shall be complete with couplings for connection to valve and floor stand where required. When valve extension kits are used they must be as recommended by the valve manufacturer.

2.16 SERVICE VALVES AND FITTINGS

A. Water service valves and fittings shall conform NSF 61 and AWWA C800 for normal pressure and the following requirements:
   1. Service saddles shall be used for all other pipe materials.
   2. Brass nipples with female adapter to be used for all 2-inch taps.
   3. Service Saddle: Provide service saddle for service pipe connection to main pipe material. Saddles shall meet the following requirements:
      a. Brass body to conform to the outside dimension of the main. Confirm with City prior to project for main pipe to be tapped and saddle requirements.
      b. O-ring, Buna N rubber gasket to provide watertight connection.
      c. Hinged, double bottom strap design.
      d. Threaded outlet to match threads on corporation valve.
   4. Corporation Valve
      a. Stop size shall be the same as service line.
      b. Inlet thread shall be as per AWWA C800.
      c. Outlet thread shall be as required for the pipe material specified.

d. Corporation stops shall be manufactured by Mueller Company or the Ford Meter Box Company or approved equal.

5. Pressure Reducing Valve
   a. Shall meet ASSE 1003.
   b. Bronze body, renewable stainless steel seat.
   c. Suitable for reducing from an inlet pressure range of 100 – 150 psi to an outlet pressure of 40 psi.
6. Meter Boxes
   a. Boxes and cover shall be shall be the following or equivalent as approved by the City's Water and Sewer Superintendent:
      1) Ford Long Yokeboxes (for 5/8-inch to 1-inch meters)
      2) Mueller EZ-Vault with setter (2-inch service)
      3) Pre-cast vault per standard detail for services 3-inch and larger)
   b. Minimum 18 inches deep.
   c. Sized for required water meter.

2.17 FIRE HYDRANTS

A. Fire hydrants shall conform to AWWA C502 and to the following requirements:
   1. Nozzles: Two (2) 2-1/2-inch hose and One (1) 5-inch Storz connections.
   2. Nozzle threads: "Clinton Standard"
   3. Main valve diameter: 5-1/4 inch.
   4. Minimum depth of bury: 42-inches.
   5. Inlet connection: 6-inch mechanical joint.
   6. Open **counterclockwise** (**open left**).
   7. Close with water pressure.
   8. O-ring seals.
   9. Traffic model with frangible sections near the ground line designed to break on impact.
   10. Rodding is not allowed on hydrants. Restrained joints are required: AquaGrip, MegaLug, or Approved Equal.
   11. Provide extension for hydrant standpipe as required to set centerline of hydrant nozzle a minimum of 15-inches and a maximum of 24-inches above grade.
   12. Exterior color above ground line shall match Clinton's standard at the time of installation. Current color standard: Yellow.
   13. Hydrants shall be warranted by the manufacturer against defects in materials or workmanship for a period of ten (10) years from the date of manufacturer. The manufacturing facility shall have current ISO certification.
   14. Hydrants shall be Mueller Super Centurion 250 or Approved Equal, specific model to be specified by City Fire Department.

2.18 BACKFLOW PREVENTION ASSEMBLY

A. Refer to the City's Cross Connection Control Ordinance, Article VII of the City Code, for the full requirements.

B. General

1. All water services shall be provided with a means of backflow prevention. The type of device required for all applications is a Reduced Pressure Zone Assembly (RPZ) with test assembly and dump port, regardless of the Degree of Hazard posed by the customer being served. Examples of the various Degrees of Hazards and required backflow devices are as follows:

   a. Low Hazard: Any of the following or similar uses unless the use includes a use clearly identified as a higher hazard. These activities shall have a minimum of a Reduced Pressure Zone Assembly (RPZ) with test assembly and dump port installed at the meter service two (2) inches or less.

      1) Two-family residential homes (duplexes).
      2) Multi-family residential units.
      3) Duplexes that have a master meter.
      4) Office buildings.
      5) Retail stores with only one (1) meter under two (2") inches in diameter.
      6) Warehousing (detached and with only restrooms).
      7) Churches (with only restrooms).

   b. Moderate Hazard: Any of the following or similar uses unless the use includes a use clearly identified as a higher hazard. The following is a partial list of facilities, activities and processes which require the installation of an approved Reduced Pressure Zone Assembly (RPZ) with test assembly and dump port.

      1) A private water system or building, any portion of which is elevated less than 50 feet above any service connection between such private water system and the public water system.
      2) Beauty shops/barber shops.
      3) Fire sprinkler or standpipe systems without chemical additives without booster pumps. Fire lines shall also include a properly sized water meter with shut off valves.
      4) Gas stations (with no food preparation).
      5) Industrial or manufacturing facilities (that do not include a high hazard).
      6) Apartment houses or complexes that have a master meter.
      7) Mobile home parks/Manufactured home parks.
      8) Restaurants, bakeries, commercial kitchens or convenience stores with food service with no water supplied fire suppression system.
      9) Churches (with kitchen facilities).

c. High Hazard: Any of the following uses. The following is a partial list of facilities, activities and processes which require the installation of a Reduced Pressure Zone Assembly (RPZ) with test assembly and dump port.

1) Any private water system used or designed for use with a booster pump or which may become pressurized for any reason to the extent that backpressure may occur.
2) Any service connection having irrigation tied in (irrigation not on a separate tap) including residential irrigation systems.
3) Any private water system which contains water which has been or is being recirculated.
4) Connection of a non-potable water use (fire lines, fire suppression systems, irrigation systems, cooling towers, auxiliary water supplies, used water, etc.) to a potable water supply.
5) A private water system or building any portion of which is elevated 50 feet or more above any service connection between such private water system and the public water system.
6) Automotive plans and service bays.
7) Beverage bottling plants.
8) Breweries.
9) Campgrounds, RV parks.
10) Canneries, packing houses and other rendering houses.
11) Commercial carwashes.
12) Chemical plants.
13) Churches (containing a baptismal or operating a multi-functional facility).
14) Commercial greenhouses.
15) Commercial laundries.
16) Concrete/asphalt plants.
17) Dairies and cold storage plants.
18) Dentist offices.
19) Dry cleaning.
20) Dye works.
21) Morgues, mortuaries, and embalming facilities.
22) Film laboratories.
23) Fire sprinkler or standpipe systems with chemical additives.
24) Hospitals, clinics, medical buildings.
25) Hotels, apartment houses, public and private buildings or structures 50 feet or more in height.
26) Industrial facilities that utilize water in their industrial process.
27) In-ground irrigation systems, with or without chemical additives.
28) Laboratories.

29) Law care companies.
30) Malls, strip malls, or multi-tenant strip malls (frequent tenant change and photo labs, etc.) that are master metered.
31) Master metered buildings or facilities with multi-use tenants.
32) Metal processing plants.
33) Nursing homes
34) Oil and gas production, storage or transmission properties.
35) Paper and paper products plants.
36) Pest control (exterminating and fumigating).
37) Pharmaceutical plants.
38) Photo labs.
39) Plating plants.
40) Power plants.
41) Radioactive materials or substances, plants or facilities handling.
42) Restaurants, bakeries, commercial kitchens, convenience stores with food services, any of which have water-supplied fire suppression systems.
43) Rubber plants (natural or synthetic).
44) Sand and gravel plants.
45) Schools and colleges.
46) Swimming pools, spas, hot tubs, with fixed water lines.
47) Tanks or reservoirs filled by water from public water supply.
48) Tire manufacturers.
49) Truck wash facilities.
50) Veterinary hospitals, clinics, offices.
51) Wastewater treatment plants, lift stations, and storm drain facilities.
52) Waterfront facilities and industries.

C. Backflow prevention assemblies shall conform to USC Foundation for Cross Connection Control and Hydraulic Research and to the following requirements:
   1. Reduced Pressure Zone Assembly (RPZ) in conformance with AWWA C511 and ASSE 1013.
   2. Assembly unit shall include a flow Detector consisting of an auxiliary line with an approved backflow preventer and water meter. Flow detector assembly shall comply with ASSE 1047 or 1048.
   3. Service shall be for cold water.
   4. End connection shall be threaded or flanged.
   5. Assembly shut-off valves shall be:
      a. 2-inch and under: 1/4 turn, full port, resilient seated, bronze ball valve.
      b. Over 2-inch: OS&Y resilient seated gate valves.
   6. Valves shall be internally epoxy coated in accordance with AWWA C550.

2.19 BACKFLOW PREVENTER ENCLOSURES

A. Enclosures for backflow preventers (BFP) shall meet the following requirements:
   1. Aluminum or fiberglass reinforced construction sized to totally enclose “wet” portion of BFP.
   2. Provide access through lockable doors or hinged lid for testing of BFP.
   3. Shall be totally removable for maintenance of BFP.
   4. Lined with unicellular, non-wicking, insulation.
   5. Provide thermostatically controlled heat source within enclosure to provide freeze protection to minus 30 degrees F.
   6. For enclosure of reduced pressure zone BFP provide drain openings at each end to accommodate full port discharge form device. Openings shall be protected against intrusion of wind, debris, and animals.
   7. Provide means of permanent anchor to concrete pad.

2.20 METERS

A. General
   1. The type of meter used shall be determined on a case-by-case basis. Engineer/Developer shall coordinate with the City to determine specific requirements.
   2. Meters shall be installed on all service lines (including fire lines if required by City).
   3. Meters shall be installed by the City staff.

2.21 THRUST BLOCKING

A. Provide concrete thrust blocking in accordance with the Standard Detail.

B. Thrust blocking is still required where restrained joint fittings and equivalent length of restrained joint pipe are used unless otherwise required by the City.

2.22 DISINFECTANT

A. The following products may be used as the disinfectant:
   1. Chlorine, liquid: AWWA B301.
   2. Hypochlorite, calcium and sodium: AWWA B300.

PART 3 EXECUTION / INSTALLATION

3.01 PIPE AND ACCESSORIES

A. General
   1. Provide erosion control measures as required. Erosion control measures including seeding and mulching shall be designed, installed and maintained in accordance with the N.C. Department of Environmental Quality, Land Quality Section’s “Erosion and Sediment Control Planning and Design Manual”. The Developer/Engineer is responsible for securing all required permits.
   2. Pipe installation shall meet the following general guidelines:

a. Lay pipe in the presence of a representative of the City, unless specifically approved otherwise.

b. Handle pipe and accessories in accordance with manufacturer's recommendations. Take particular care not to damage pipe coatings.

c. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.

d. Lay pipe to design grade and alignment.

e. Provide proper equipment for lowering pipe into trench.

f. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.

g. Provide tight closure pipe ends when work is not in progress.

h. Keep pipe interior free of foreign materials.

i. Clean bell and spigots before joining. Make joints and lubricate gasket in accordance with pipe manufacturer recommendation.

j. Block fittings with concrete or restrain as required to prevent movement.

B. Trenching for Underground Pipe Installation

1. Definitions

a. Backfill: A specified material used in filling the excavated trench and placed at a specified degree of compaction.

1) Materials: Materials listed herein include processed materials plus the soil classifications listed under the Unified Soil Classification System, (USCS) (Method D2487 and Practice D2488). The soil materials are grouped into five broad categories according to their suitability for this application.

i. Class I: Angular, 6 to 40-mm (1/4 to 1-1/2-in.), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shell.

ii. Class II: Coarse sands and gravels with maximum particle size of 40 mm (1-1/2 in.), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

iii. Class III: Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

iv. Class IV: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials shall not be used for bedding, haunching, or initial backfill.

v. Class V: This class includes the organic soils OL, OH, and PT as well as soils containing frozen earth, debris, rock larger than 40 mm (1 1/2 in.) in diameter, and other foreign

materials. These materials shall not be used for bedding, haunching, or initial backfill.

2) Backfill Zones: Each backfill zone shall extend the full width of the trench bottom.

i. Foundation: Extending down from the bottom of bedding zone as defined below.

ii. Pipe Embedment

1. Bedding: Extending from 4 inches below the pipe bottom to the pipe bottom for 30-inch diameter and smaller and 6 inches below the pipe bottom for pipes larger than 30 inches in diameter.

2. Haunching: Extending from the bedding (bottom of the pipe) to the pipe spring line.

3. Initial Backfill: Extending from the haunching (pipe spring line) to 1 foot above the top of the pipe.

iii. Final Backfill: Extending from the initial backfill to the finish ground elevation.

b. Laying Conditions:

1) Type 1: Flat bottom trench with loose backfill.

2) Type 2: Flat bottom trench with backfill lightly consolidated to centerline of pipe.

3) Type 3: Pipe bedded in 4 inches minimum of loose soil and backfill lightly consolidated to top of pipe.

4) Type 4: Pipe bedded on Class I material to 1/8 pipe diameter (4 inch minimum) Backfill compacted to top of pipe a minimum of 80 percent of standard proctor.

5) Type 5: Pipe bedded in compacted Class I material to pipe centerline with 4-inch minimum under pipe. Backfill to top of pipe with Class I, II, or III and compact to 90 percent of standard proctor.

c. Compaction: Process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of compaction" shall be expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698 (Standard Proctor).

d. Excavation: The removal of soil or rock to obtain a specified depth or elevation.

e. Hard Material: Solid, homogeneous material which is not included in the definition of "rock" but which may require the use of heavy excavation equipment with ripper teeth. Amount must exceed 1 cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 between 60 and 150 blows per foot is defined as "hard material."

f. Lift: Layer of soil placed on top of a previously prepared or placed soil.

g. Rock: Solid, homogeneous material which cannot be removed without the systematic drilling and blasting exceeding 1 cubic yard in volume. Material having a standard penetration resistance as determined by

ASTM D1586 greater than 150 blows per foot is defined as "rock." Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

h. Pipe Springline: A line running horizontally through the center of the pipe.

i. Topsoil: Natural, friable soil, representative of productive soils in the vicinity of the site. Topsoil shall be free from roots, stones larger than 1 inch, objectionable weed seeds, toxic substances, and materials that hinder grading, planting, and maintenance operations.

2. Products

a. Stone

1) Class I material shall be #67 or #78M stone in accordance with NCDOT specifications Section 1005, General Requirements for Aggregate.

b. Warning and Identification Tape

1) Tape shall be a minimum 3-inch wide polyethylene plastic tape manufactured specifically for identification of buried utilities with means of enabling detection by a metal detector to a minimum depth of 3 feet. Tape shall be color coded and continuously imprinted with warning and identification markings in bold black letters to read "CAUTION - BURIED (utility) LINE BELOW." Color and printing shall be permanent, unaffected by moisture or soil and shall be as follows:

UTILITY	COLOR	MARKING
Water	Blue	Caution - Buried Water Line Below
Gravity Sewer	Green	Caution - Buried Sewer Line Below
Force Main	Green	Caution - Buried Force Main Below
Electric	Red	Caution - Buried Electric Line Below
Gas	Yellow	Caution - Buried Gas Line Below
Telephone	Orange	Caution - Buried Telephone Line Below
SCADA	Orange	Caution - Buried SCADA Line Below

2) Tape shall be by Blackburn Manufacturing, Joseph G. Pollard Co., or Reef Industries Inc.

c. Tracer Wire

1) Tracer wire shall be #12 solid copper wire. All connections shall be by wire nuts and taped.

2) Splices in tracer wire are to be kept to a minimum and joined with copper split nuts of appropriate size.

3. Project Safety

a. Contractor is responsible for Project safety.

b. Perform work in conformance with applicable State and Federal safety regulations including, but not limited, to the following:
    1) North Carolina Safety and Health Standards for the Construction Industry (29CFR 1926 Subpart P).
    2) NC OSHA Industry Guide No. 14, Excavations.
    3) NC OSHA Industry Guide No. 20, Crane Safety.
c. Provide barriers, warning lights, and other protective devices at excavations as necessary for safety of workers and the public.
d. Provide sloping of bank, shoring, sheeting, or other means of maintaining the stability of the trench in accordance with the requirements of the Associated Contractor's Manual of Accident Prevention OSHA, Part 1926.P.

4. Protection of Underground Facilities
    a. Investigate underground facility location prior to start of construction.
    b. Installer is required to contact North Carolina 811 prior to start of construction.
    c. Repair damage to any existing facilities.
5. Water Control
    a. Prevent surface water from entering the trench.
    b. When trench bottom is below the existing ground water table, install a dewatering system to maintain water table 1 (one) foot below trench bottom. Provide a man experienced in dewatering work at the job site.
    c. Maintain dewatering until backfilling has proceeded above the existing ground water level.
    d. Dispose of water from dewatering operations in accordance with the North Carolina Sedimentation Pollution Control Act.
6. Use of Explosives
    a. Explosives may not be used on any excavation unless specifically approved by the City.
7. Excavating
    a. Excavation shall be by open cut method. Short sections of trench may be tunneled or direct bored with the approval of the City.
    b. Stockpile excavated material in such a manner that it will not obstruct the flow of runoff, streams, endanger Work, impair the use or appearance of existing facilities, or be detrimental to the completed Work.
    c. Contractor shall segregate excavated material so as to maintain material suitable for backfill separate from material that is unsuitable.
    d. Trench dimensions at the pipe embedment and foundation zone unless noted otherwise shall be as follows:
        1) Minimum width: Pipe outside diameter plus 18 inches.
        2) Maximum width: Pipe outside diameter plus 24 inches.
        3) Sides shall be vertical to a minimum of one foot above the top of pipe.

e. Shape trench bedding to provide uniform bearing for the full pipe length. Bottom shall be free of protrusions that could cause point loading on pipe. Provide bell holes as required for properly making pipe joint.

f. Do not over excavate. Excavation below grade shall be backfilled with Class I material at no cost to the City.

g. Undercut soils that become unsatisfactory by construction activity or by being left exposed to the weather and backfill with Class I material.

h. Remove shoring, bracing, and sheeting, unless otherwise noted, as the trench is backfilled.

i. Excavation of trench shall not advance more than 200 feet ahead of the installation. In no case should the excavation extend beyond that which can be backfilled by the end of the workday.

j. Correct unstable soil conditions encountered at trench foundation by one of the following methods:

    1) Excavate below grade as approved by Engineer and backfill with Class I material or approved substitute material.

k. Rock and Hard Material

    1) Excavate rock and hard material to a minimum depth of 4 inches below the pipe for pipes smaller than 30 inches and 6 inches for pipes 30 inches and larger.

l. Pressure Lines:

    1) Provide a minimum 3 feet of cover.

    2) Excavate trenches to provide vertical curve chords that will not exceed the pipe manufacturer's recommended joint deflection.

    3) Provide concrete thrust blocks having a compressive strength of 3,000 psi at 28 days at change in horizontal and vertical direction and reduction in the pipe size, unless other restraint systems are approved. Cut trench sides vertical and square to receive concrete. Provide bearing area against trench wall as indicated in the Standard Detail.

8. Backfilling

a. General

    1) Temperature must be above freezing and rising.

    2) In windy, hot, or arid conditions with a high rate of evaporation add moisture to the material to maintain the optimum moisture content.

    3) Do not proceed in rain or on saturated subgrade.

    4) Do not place material on surfaces that are muddy, frozen, or contain frost.

    5) Maintain backfill operation within 200 feet from pipe laying operation.

    6) Backfill trench to existing ground surface with select excavated material at the specified compaction.

    7) If excavated material is unsuitable to obtain specified compaction, provide suitable off-site borrow material for backfill.

8) Re-excavate trenches improperly compacted. Backfill and compact as specified.

9) Provide appropriate tamping equipment, and water to obtain proper moisture content, to achieve specified compaction of backfill.

10) Conduct operation of heavy equipment above pipe installation as to prevent damage to pipe.

11) Install warning / identification tape over utilities. Bury tape one foot below finished grade above the utility.

12) Install tracer wire for non-metallic pressure pipe. Bury tracer wire with pipe. Wire shall be looped into valve boxes to allow access for direct contact location.

b. Backfill in pipe embedment zone (bedding, haunching, and initial backfill).

1) General

i) Backfill with material as specified below. Material shall be free from objects larger than 2 inches.

ii) Where rock and hard material has been excavated below pipe bottom, backfill and compact bedding with Class I material. Class II or III material may be used for bedding with Engineer's approval.

iii) Place backfill material to assure placement of material under pipe haunches.

iv) Take care during placement and compacting of material to avoid movement of pipe.

2) Place backfill in bedding and haunching zones in 6 inch maximum lifts and compact to 90 percent density. Place initial backfill in one lift do not compact. Provide backfill material in pipe embedment zone as specified below.

i) Pressure Lines (Flexible and Rigid Pipe)

1. Excavation in Class I, Class II, and Class III soils suitable for bedding, the bedding surface shall provide a firm foundation of uniform density. Backfill with select excavated material.

2. Excavation in Class IV or Class V, running water, and other unstable soil conditions, excavate a minimum of 4 inches below pipe bottom and provide Class I material for bedding and haunch zone. Backfill with Class I, II, or III material in initial backfill.

3. Ductile Iron over 16 inch

a) Depth 0 - 12 feet: Type 2 laying conditions same as for pressure pipe.

b) Depth over 12 feet: Provide Class I material for bedding and 4 inches up from bottom of pipe.

c. Final Backfill

1) Backfill with materials free of stones and free of debris larger than 6 inches in dimension. Place backfill in lifts not exceeding the thickness and compacted to the minimum density specified below.

2) Trench backfilled with non-cohesive materials may be compacted with water flooding; except under roadways, shoulders of roadways, and other areas subject to vehicular movement, provided the method of compaction is approved by the City and provides the degree of compaction required.

3) Lifts and density:

i) Undeveloped areas (i.e., forests, fields, and, croplands): Trench may be filled with bulldozer blade provided material fall will not damage pipe. Mound soil over the trench area sufficiently to settle level over time. Degree of compaction shall be 85 percent.

ii) Lawns: Backfill in 12-inch lifts and compact to 90 percent. Top 12 inches shall be free of material with a dimension over 2 inches.

iii) Roads (including Rights-of-way), drives, parking areas (including areas within 20 feet), and adjacent to existing utilities: Backfill in 6 inch lifts compact to 95 percent.

iv) Within 20 feet of foundations: Backfill in 6-inch lifts compacted to 95 percent.

d. Utility Structures: Bring backfill to grade in even lifts on all sides. Lift depths and compaction densities shall be as specified according to area of installation for pipe above. Backfill against cast-in-place concrete structure only after concrete has attained the specified 28-day compressive strength.

3.02 RELATION OF WATER MAINS TO SEWERS

A. Lateral Separation: Lay water mains at least 10 feet laterally from existing and proposed sewers. Where existing conditions prevent a 10-foot lateral separation, the following shall be followed with approval of the Engineer:

1. Lay water main in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

2. Lay water main in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

B. Crossing Separation: Lay bottom of water main at least 18-inches above the top of the sewer. Where existing conditions prevent an 18-inch vertical separation, construct both the water main and sewer of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.

C. Crossing a Water Main Under a Sewer: When it is necessary for a water main to cross under a sewer, construct both the water main and the sewer of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing. Both the water and sewer lines must be pressure tested to 150 psi to insure water tightness.

3.03 WATER SERVICE

A. Water service lines shall extend from the main distribution line to a meter box located at the right-of-way.

B. Taps shall be located at 10 or 2 o'clock on the circumference of the pipe.

C. Service taps shall be staggered, alternating from one side of the water main to the other and at least 12 inches apart.

D. Taps on the same side of the main shall be a minimum of 24 inches apart.

E. Install meter boxes and water service components so top of meter will be within 6 inches of the surface.

3.04 DUCTILE IRON PIPE

A. Install pipe in conformance with AWWA C600 and the following:

1. For laying pipe in a vertical or horizontal curve, each full length pipe may be deflected by the following offset distance:
    a. Push-on joint
        1) 3 to 12-inch pipe: 14-inch offset
        2) 14 to 36-inch pipe: 8-inch offset
    b. Mechanical joint
        1) 3 to 6-inch pipe: 20-inch offset
        2) 8 to 12-inch pipe: 15-inch offset
        3) 14 to 20-inch pipe: 8-inch offset
        4) 24 to 36-inch pipe: 6-inch offset
2. For laying restrained joint pipe in a vertical or horizontal curve, except for horizontal directional drills (HDD), each full length pipe may be deflected by the following offset distance:
    a. 6 to 12-inch pipe: 11-inch offset
    b. 16 to 20-inch pipe: 7-inch offset
    c. 24 to 30-inch pipe: 5-inch offset
    d. 36-inch pipe: 4-inch offset
    e. 42 to 48-inch pipe: 1 ¼ -inch offset

3.05 PVC PRESSURE PIPE

A. Install PVC C900 pipe in conformance with AWWA C605.

B. Bell and Spigot Joints: Clean bell and spigot ends prior to jointing. Ends of field cut pipe shall be beveled with file. Gasket shall be clean and lightly lubricated. Joint shall be made as recommended by the manufacturer.

C. Fusible PVC shall be fused only by certified technicians that have been certified and trained by the fusible pipe manufacturer.

3.06 DIRECTIONAL DRILLING

A. General
   1. Investigate the subsurface conditions at the crossing location.
   2. Provide water for the drilling process.
   3. Handle pipe in accordance with manufacturer's recommendation.
   4. Utilize pipe rollers during layout and pull-back operations to prevent excess sagging of the pipe. Pipe rollers shall be of sufficient size to fully support the weight of the pipe while being hydro-tested before installation and during pull-back operations.
   5. Directional drilling procedure shall include provisions to guard against electrical shock such as ground mats, ground cables, hot boots and gloves. Drilling equipment shall include an alarm system capable of detecting electrical current as it nears electrical lines.
   6. Maintain log sheets for drilling fluid pressure, flow rate, drill thrust pressure, pull-back pressure, drill head torque and drill head location plots at 20 foot intervals.
   7. Drilling fluids shall be inert and of no risk to the environment. No fluid will be utilized that does not comply with permit requirements and environmental regulations. Drilling fluid should remain in the bore hole to increase the stability of the surrounding soil and to reduce the drag on the pulled pipe.
   8. Drill pilot hole along the path shown on the Drawings to the following tolerances:
      a. Vertical Location - Plus or minus 0.5 feet
      b. Horizontal Location - Plus or minus 3 feet.
   9. At the completion of the pilot hole drilling, provide a tabulation of coordinates referenced to the drilled entry point which accurately describes the location of the pilot hole.
   10. Perform reaming diameter to 1.25 to 1.5 times the outside diameter of the pipe being installed. Prepare pipe to facilitate connection to the remainder of the pipeline being installed.

B. Fusible Polyvinylchloride (FPVC) pipe
   1. General
      a. Installation guidelines from the pipe supplier shall be followed for all installations.
      b. The fusible polyvinylchloride pipe will be installed in a manner so as not to exceed the recommended bending radius guidelines.
      c. Where fusible polyvinylchloride pipe is installed by pulling in tension, the recommended maximum safe pulling force, established by the pipe supplier, shall not be exceeded
   2. Handling and Storage
      a. Pipe shall be offloaded, loaded, installed, handled, stored and stacked per the pipe supplier's guidelines. These guidelines include compliance with

the minimum recommended bend radius and maximum safe pull force for the specific pipe being used.

b. The general best practices of the industry per AWWA M23 shall also be observed.

3. Fusion Joints
   a. Fusible polyvinylchloride pipe lengths shall be assembled in the field with butt-fused joints. The fusion technician shall follow the pipe supplier's guidelines for this procedure. All fusion joints shall be completed as described in this specification.
4. Fusion Process
   a. Fusible polyvinylchloride pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
   b. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier.
   c. Pipe supplier's procedures shall be followed at all times during fusion operations.
   d. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine, which utilizes a current version of the pipe supplier's recommended and compatible software.
   e. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. This includes requirements for safety, maintenance, and operation with minor modifications made for PVC.
5. Installation:
   a. Pull heads for use with FPVCP
      1) Pipe pull heads shall be utilized that employ a positive through-bolt design assuring a smooth wall against the pipe cross-section at all times.
      2) Pipe pull heads shall be specifically designed for use with fusible polyvinylchloride pipe, and shall be as recommended by the pipe supplier.
   b. Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous length.
   c. Contractor shall handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not bend past the pipe supplier's minimum allowable bend radius, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.
   d. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
      1) The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.
      2) The fusible polyvinylchloride pipe may be continuously or partially supported on rollers or other Owner and Engineer approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.
      3) A swivel shall be used between the reaming head and the fusible polyvinylchloride pipe to minimize torsion stress on the pipe assembly.

e. Buoyancy modification shall be at the sole discretion of the Contractor, and shall not exceed the pipe supplier's guidelines in regards to maximum pull force or minimum bend radius of the pipe. Damage caused by buoyancy modifications shall be the responsibility of the Contractor.
f. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.
g. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, or movement and distortion of surface features. Any damages caused by the Contractor's operations shall be corrected by the Contractor.
h. Once installed, the contractor shall make connections to the open cut pipe by means of mechanical joint fittings, taking care to correct horizontal or vertical alignment with the fittings rather than the Fusible PVC.

C. Polyethylene (PE) Pressure Pipe
1. Joints at the ends of directionally drilled runs shall be fusion bonded to the adjacent pipe section. Mechanical couplings are not permitted. Fusion bonding may be accomplished through the use of butt fusion or electrofusion coupling techniques as specified.
2. Use care to protect the pipe from scarring, gouging, or excessive abrasion.
3. Method of connection between HDPE pipe and other pipe materials shall be as indicated on the Drawings
4. Pipe shall be deflected within the tolerances as provided by the pipe manufacturer.
5. Allow one week from the time of installation for pipe to be connected other piping systems to allow tensional stresses to relax.

D. Clean Up
1. Upon completion of the pipe installation, backfill the drilling pit and receiving pit as specified.
2. Properly remove and dispose of drilling fluid and spoil material in compliance with relative environmental regulations, right-of-way and work space agreements under permit requirements. Drilling fluid returns at locations other than the entry and exit points shall be minimized. Immediately clean up drilling fluid that inadvertently surfaces.
3. Prior to Installation Contractor may elect, at his expense, to hydrostatically test or perform a low pressure air test on the pipe line to determine the integrity of the joints. This shall not be considered an alternative to the testing required after installation.
4. Following installation, test pipe in accordance with pressure testing in Section 3.16.

3.07 VALVES AND FITTINGS

A. Maximum spacing between line valves shall be as follows:

B. Install buried valves on top of an 18-inch square, 3-inch thick, solid concrete pad (minimum dimensions). The concrete pad may be provided by a pre-cast manufacturer or cast-in-place in the field above grade. Concrete used for the pads shall be a minimum 3,000 psi mix. The pads may not be cast-in-place in the pipe trench. Connection to pipe shall be such that there shall be no stress at the joint caused by misalignment or inadequate support of pipe or valve.

C. Valve Box: Set a valve box over each buried valve. Support box so that no stress shall be transmitted to the valve or pipe line. Install box plumb and set top flush with finished grade. Operating nut shall be centered in box. Provide a 24-inch x 24-inch wide by 6-inch thick concrete pad at top of valve boxes outside paved areas.

D. Valve operation nut shall be within 30 inches of the top of box. Provide stem extension if necessary to bring operating nut to within 30 inches of the top of box.

E. Install fittings as recommended by the manufacturer. Fittings shall be blocked or otherwise restrained from movement.

F. Install valves, gates, and accessories in complete accordance with the manufacturer's recommendations.

G. Install air / vacuum valve inside a manhole as per Standard Detail.

3.08 AIR VALVES

A. Installation shall be in accordance with the manufacturer's recommendations and the Standard Detail.

3.09 ENCASEMENT AND CARRIER PIPE

A. Verify the subsurface conditions at each boring site.

B. Stabilize and maintain bore pit bottom to provide proper equipment support and maintain pipe alignment. Dewater as necessary for site. Excavate bore pit in accordance with OSHA regulations. Provide adequate barricades, railings, and warning lights throughout the boring operation. Conduct operation in such a manner so as not to create a hazard to, nor impede the flow of traffic.

C. Install encasement pipe by dry boring and jacking.

D. Boring auger diameter shall not be greater than the outside diameter of the encasement pipe and shall not extend more than 6-inches ahead of the cutting edge of the encasement pipe. Fill voids that are formed during the operation with a 1:3 portland cement grout pumped at 50 psi to ensure that there will be no settlement of the roadway.

E. As the boring operation progresses, butt weld each new section of the encasement pipe to the section previously jacked into place. Maintain proper alignment. Confirm the grade of the encasement pipe as the Work progresses.

F. If an obstruction is encountered during the boring operation, efforts should be made to remove the obstruction. If obstruction cannot be removed, withdraw the encasement pipe and fill the void with 1:3 portland cement grout at 50 psi. If the encasement pipe cannot be withdrawn, seal ends before moving to another bore site. City shall approve location of new bore site.

G. Provide seals at each end of encasement pipe.

H. Install carrier pipe in the encasement pipe using manufactured pipe supports. Supports shall prevent movement of the carrier pipe within the encasement. Space supports as specified.

3.10 MANHOLES

A. Provide 12 inches of No. 67 stone base to extend a minimum of 6 inches beyond the manhole base.

B. Set base plumb and level. Align manhole invert with pipe invert.

C. Secure pipe connectors to pipe in accordance with manufacturer's recommendation.

D. Clean bells and spigots of foreign material that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Do not stretch.

E. Set precast components so that steps align.

F. Plug lift holes using a non-shrink grout. Cover with a butyl sealant sheet on the outside and seal on the inside with an application of an epoxy gel 1/8-inch thick extending 2 inches beyond the opening.

G. Set manhole frames to grade with grade rings. Seal joints between cone, adjusting rings, and manhole frame with butyl sealant rope and sheet.

H. Finish the interior by filling fractures greater than 1/2 inch in length, width or depth with a sand cement mortar. Do not fill the joints between the precast components.

I. Clean the interior of the manhole of foreign matter.

3.11 METERS

A. Install meter boxes and water service components so top of meter will be within 6 inches of the surface.

B. Install meter box assembly in accordance with manufacturer's recommendations.

C. Meter installation must be performed by a City representative.

3.12 HYDRANT

A. Set hydrant in accordance with manufacturer's recommendations and Standard Detail.

B. All hydrants to be installed on 6-inch or larger mains.

C. Coordinate the location of fire hydrants with the City. Generally hydrants will be located as follows:

1. At least one hydrant at each street intersection.
2. In residential areas the maximum spacing of hydrants, as measured along street centerlines, shall be 500 feet.
3. In business, commercial and industrial areas, the maximum spacing between hydrants, as measured along street centerline, shall be 300 feet.

3.13 PAVEMENT PATCHING

A. Repair damaged pavement structure.

B. Cut existing pavement for utility installation in straight lines generally parallel to the utility. Properly dispose of removed pavement structure.

C. Extend pavement patch 1 foot beyond each side of trench on firm subgrade. Slope new surface to drain.

D. Asphalt Pavements: Replace asphalt pavement with a pavement structure no less than as shown on the Standard Details. For roadways under NC Division of Highways jurisdiction, pavement shall be replaced in accordance with their requirements.

E. Concrete Pavements: Replace concrete pavement with pavement structure equal to existing but no less than 6 inches. Concrete shall be minimum 3,000 psi. When existing concrete joint is within 5 feet of trench remove existing concrete to joint. Provide expansion joint at edge of existing concrete. Surface treatment shall match existing.

F. If existing pavements are found to be in thicknesses greater than the Standard Details or NC Division of Highways' requirements, the repair shall be made to match the thickness of the existing pavement.

G. Curbs, Gutters, and Sidewalks: Replace curbs and gutters, and sidewalks removed or damaged with similar sections to match the existing. Remove to nearest existing joint.

H. Approval of Other Authorities: Pavements under the jurisdiction of the NC Division of Highways shall be subject to the approval of a representative of that Division.

3.14 GRADING AND CLEAN-UP

A. Provide for testing and clean-up as soon as practical, so these operations do not lag far behind the pipe installation. Perform preliminary clean-up and grading as soon as backfill is complete.

B. Provide positive drainage of finished grade and drain away from structures. Finished grade shall be reasonably smooth, compacted, free from irregular surface changes and comparable to the adjacent existing ground surface.

C. Seed and mulch disturbed areas.

D. Upon completion of backfilling, remove and properly dispose of excess material and waste.

3.15 BACKFLOW PREVENTION TESTING

A. Install and test Backflow prevention devices in accordance with the manufacturer's requirements in the presence of a representative of the City.

B. Refer to the City's Cross Connection Control Ordinance, Article VII of the City Code for full requirements on installation, testing, and reporting.

3.16 PRESSURE TESTING

A. Prior to pressure testing, the City reserves the right to require the line to be pigged. If pigging of the line is required, City staff shall be notified at least 48 hours prior to pigging of the line. City staff must be present to witness and verify the insertion of the pig and additionally to be present to witness and verify the successful removal of the pig for each section pigged.

B. Pressure test in accordance with AWWA C600 for ductile iron pipe and AWWA C605 and M23 for PVC pipe and as specified herein

C. General:

1. The Engineer shall approve the source, quality, and method of disposal of water to be used in test procedures.
2. Obtain City's permission 48 hours prior to filling or flushing of pipe system with water from City's water system. City shall operate valves connected to the existing water system. Where large quantities of water may be required for

flushing, City reserves the right to require that flushing be done at periods of low demand.

3. Clean and flush pipe system of foreign matter prior to testing.
4. Provide air vents at the high points in the line section to be tested for releasing of air during filling. Service corporation stops may be used for air vent when located at a high point. Leave corporation stops in place after testing and note locations on As-Built Drawings.
5. Allow concrete blocking to reach design strength prior to pressure testing.
6. Test main prior to installation of service taps.
7. Repair defects in the pipe system. Make repairs to the same standard as specified for the pipe system.
8. Retest repaired sections until acceptance.
9. Repair visible leaks regardless of the test results.
10. Pipe sections shall not be accepted and placed into service until specified test limits have been met and appropriate certifications made to the permitting agencies.

D. Testing

1. Notify City a minimum of 48 hours prior to testing.
2. Perform tests in the presence of a representative of the City.
3. Make pressure tests between valves. Furnish suitable test plugs where line ends in "free flow."
4. Upon completing a section of pipe between valves, test pipe by maintaining for a two hour period a hydrostatic pressure of 150 psig.
5. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
6. No length of line shall be accepted if the leakage is greater than that determined by the following formula based on the appropriate test pressure:

   L = Allowable leakage per 1,000 feet of pipe in gallons per hour.

   D = Nominal diameter of the pipe in inches.

   100 psi: L = D x 0.07

   150 psi: L = D x 0.08

   200 psi: L = D x 0.09

   250 psi: L = D x 0.10

3.17 DISINFECTION

A. After satisfactory completion of the pressure test, disinfect new potable water mains and existing mains that have required repair in accordance with AWWA C651 and as specified herein.

B. General:

1. Provide a superintendent experienced in the required procedures for disinfecting with chlorine.
2. Obtain City's permission 48 hours prior to filling, flushing, and chlorinating of the water mains. City shall operate valves connected to the existing water system.

3. Do not allow highly chlorinated water into the existing distribution system.
4. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize the residual chlorine. Federal, state, or local environmental regulations may require special provisions or permits prior to disposal of highly chlorinated water.
5. Perform disinfection and testing in presence of a representative of the City.

C. Connection to Existing System:
   1. Notify City 48 hours prior to making connections to the existing system. Thoroughly clean the existing water main exterior prior to the installation of tapping sleeves and corporation stops. Lightly dust with calcium hypochlorite powder the water main exterior and the interior surface of the tapping sleeve, and corporation stops.

D. After satisfactory flushing of the main, disinfect by the injection of a chlorine solution. Induce chlorine in sufficient quantity to maintain a chlorine residual of at least 50 ppm throughout the system to be tested. Maintain the chlorine solution in the system for at least 24 hours.

E. Valves and Fire Hydrants:
   1. Open and close valves on the mains being disinfected a minimum of three times during the chlorine contact period and a minimum of three times during flushing. Fire hydrants and other appurtenances should receive special attention to insure proper disinfection.

F. For Cut-In Construction:
   1. Use the following procedures for disinfecting of the new installation and the existing main at the cut-in point in accordance with AWWA C651, Section 9:
      a. Apply liberal quantities of hypochlorite, in the form of tablets, to the open trench.
      b. Interior of new pipe and fittings and the ends of the existing mains shall be swabbed or sprayed with a one percent hypochlorite solution before installation.
      c. Install a 2-inch tap downstream of the work area. Tap shall be used for blowing off the main, or use the next fire hydrant downstream of the work area for blowing off the main.
      d. Install a 2-inch tap just upstream of the new installation. Control Water from the existing system so as to flow slowly into the work area during the application of chlorine. After the line is thoroughly flushed, add chlorine solution at a concentration of 100 ppm by the continuous feed method and hold in the main for one (1) hour.
      e. Coordinate all cut-in work with the City.

G. Prior to flushing, the free chlorine residual shall be a minimum of 10 ppm. Flushing of the lines shall proceed until the lines contain the normal chlorine residual of the system.

H. Test in the field for free chlorine residual:
   1. Sample location shall be the same as required for the bacteriological test samples.

2. Immediately after injection of the chlorine solution. Sample shall have a chlorine residual as specified.
3. Prior to flushing of the highly chlorinated water from the potable water system and a minimum of 24-hours after the initial injection of the chlorine. Sample shall have a minimum chlorine residual as specified.

3.18 BACTERIOLOGICAL TESTING

A. Required location for obtaining water samples:
   1. Every 2,000 lf.
   2. End of each main.
   3. A minimum of one from each branch.
   4. Mains at cut-in locations: Each side of work area. Time between samples to be determined by Engineer in field.

B. A laboratory, certified for the required testing by the State of North Carolina, shall collect the sample and perform the testing. The laboratory shall be the same for both sampling and testing.

C. Obtain two water samples at each specified location for the bacteriological testing. Take the first sample immediately after flushing of the chlorinated water and again in 24-hours.

D. Recommended additional samples. During the required sampling of water from the new system, it is recommended that samples be taken from the existing potable water source to determine if coliforms are present.

E. Care in sampling. No hose or fire hydrant shall be used for the collection of samples. Take samples from an approved sample tap consisting of a corporation stop installed in the main with a copper tube gooseneck assembly. Operation shall be such as to ensure that the sample collected is actually from water that has been in the new system. Copper tube gooseneck assembly shall be removed and sample tap corporation stop shut off upon completion of testing bacteriological testing is requirements.

F. Test samples for the presence of coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater. Testing method used shall be the multiple-tube fermentation technique, the membrane-filter technique, or presence/absence.

G. Test for odor. The water in the new system should also be tested to assure that no offensive odor exists due to chlorine reactions or excess chlorine residual.

H. If samples show the presence of coliform, procedure 1 or 2 described below shall be followed, with the approval of the City, before placing the unit or facility in service.
   1. Take repeat samples at least 24 hours apart until consecutive samples do not show the presence of coliform.
   2. Again subject the system to chlorination and sampling as described in this section.

I. If samples are free of coliform, and with the approval of the City and with the proper certification being submitted to and accepted by the State's Public Water Supply Section, the potable water system may be placed in service.

J. Contamination of Existing System:

If, in the opinion of the City, possible contaminants have entered the existing water system, or water samples show the water in the existing system to be unsafe on completion of the work, the existing water system shall be disinfected as specified herein and shall include all contaminated components. Disinfection of the existing system shall be coordinated with the City.

3.19 VALVE OPERATION

A. Prior to final acceptance provide competent personnel to operate each valve in presence of Engineer. Verify that valves are left in the open position.

3.20 "AS-CONSTRUCTED" DRAWINGS

A. General

1. Maintain on-site a full set of project drawings for purpose of recording as-constructed conditions.
2. Information should be legibly recorded as construction progresses.
3. Clearly and completely identify any field changes from the original drawings.
4. The depth of the installed waterline shall be recorded at all roadways, waterway crossings, utilities crossings, connections to new or existing waterlines, and all other areas as needed to accurately define the vertical location of the waterline. A minimum of one depth shall be recorded on each 100 feet of pipe installed. Depth shall be referenced to finished surface grades.
5. Show horizontal and vertical location of any existing underground utilities encountered during construction.
6. Submit document to the City prior to final acceptance.
7. All new features shall be surveyed utilizing survey grade GPS equipment and digital file with all surveyed information shall be provided to the City.
8. A digital CADD file and a field mark-up PDF version shall be provided to the City. The file shall contain all the features constructed with the updated as-built information along with survey data.
9. The City shall have the right to employ an independent survey firm to verify the "As-Constructed" Drawings submitted by the Contractor/Developer/Engineer at the end of the project. If components or the drawings are determined to be incorrect, the Contractor/Developer/Engineer shall have all items corrected to obtain final approval by the City. Contractor/Developer/Engineer will also be responsible for reimbursing the City for all associated costs related to verification, review, and other costs arising from any corrections having to be made in order to provide correct plans and files to the City.

END OF SECTION