

Western Virginia Water Authority
Water and Sewer Design & Construction Standards

**2006 Revision to
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Legend: Straight line in right margin denotes change(s) in text |

Western Virginia Water Authority
Water and Sewer Design & Construction Standards

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REQUEST FOR WAIVER, MODIFICATION, OR FIELD CHANGE

WVWA Design & Construction Standards

Item/Standard: _____

Water and Sewer Section Number: _____

Project: _____

Station/Location: _____

Project Inspector: _____

Project Engineer: _____

Person Making Request: _____

Name & Title

Company Name

Telephone Number

Justification/Reason for Request:

WVWA Inspector Comments:

WVWA Utility Department Comments:

_____ APPROVED _____ DISAPPROVED _____

Utilities Engineer – WVWA

SECTION 100

DESIGN AND CONSTRUCTION STANDARDS FOR WATER FACILITIES

PART ONE - GENERAL REQUIREMENTS:

- A. The following standards represent the minimum requirements for all public water systems within the service area of the Western Virginia Water Authority, hereinafter "Authority" or "owner". Before construction is commenced, plans and specifications shall be reviewed and approved by the Authority, and all construction shall be in accordance with the approved plans.
- B. Water mains shall be located within public rights-of-way or waterline easements, and shall be located no closer than five (5) feet from the edge of the easement or right-of-way line unless otherwise approved by the Authority. Easements shall provide sufficient space for both installation and maintenance, and shall be a minimum of 20 feet in width. When it is deemed necessary for proper maintenance of the facilities, additional easement width may be required by the Authority. No other utility line shall be laid within a vertical area, which is parallel to, and within 12" of a waterline.
- C. Water supply systems, as described above, shall be designed by a Professional Engineer, licensed by the Commonwealth of Virginia whose seal and signature shall be placed on each plan sheet. A Land Surveyor licensed by the Commonwealth of Virginia may design such portions of a water supply system as provided by the Code of Virginia, Title 54, Section 54-17.1, 3(b).
- D. Systems shall be designed to provide adequate flow and pressure, both for domestic supply and fire flow, based on sound hydraulic analysis and good engineering practice. Domestic fire flows shall be analyzed and presented separately and pipes shall be sized to meet the calculated requirements of simultaneous peak domestic and fire flow.
- E. The Authority Design and Construction Standards Manual, approved by the Authority Board, of which these specifications are a part, shall be followed unless specified deviation therefore is authorized, in writing, by the Authority. When such deviations affect fire protection concurrent authorization by the Fire Marshal of the local jurisdiction shall also be obtained. All standards referenced in this Section shall refer to the latest revision or revised edition of the referenced manual.
- F. A preconstruction conference shall be held on all water projects by the Authority at least one day prior to any construction work being performed. The contractor's superintendent or foreman shall attend this meeting. If superintendent or foreman cannot attend, then the developer or contractor's representative shall submit a letter to the Authority that the superintendent or foreman has been informed of items discussed at this meeting. Prior to the start of construction, contractor must have an approved set of plans on-site.
- G. A minimum one-year maintenance warranty shall be required prior to Final Acceptance of any water facility.

PART TWO - WATER LINE DESIGN:

102.01 Minimum Water Main Sizes:

- A. Generally, the minimum water main size is twelve-inch (12") when located along a primary or other major roadway, and eight-inch (8") elsewhere. Eight-inch (8") mains may be used only when they are interconnected in a grid system no more than one thousand five hundred feet (1,500') apart. Twelve-inch (12") mains are required for all lines not interconnected. The minimum main size is six-inch (6"), which can be used in dead end or cul-de-sacs beyond the last fire hydrant, if the block is less than six hundred feet (600') in length.
- B. Fire hydrants shall not be installed on lines less than eight inches (8") in diameter, except that fire hydrants may be installed on a six-inch (6") line that is part of a well interconnected grid system. Unless specifically approved otherwise by the Fire Marshal, no plantings or erection of other obstructions shall be made within a four-foot (4') radius of any fire hydrant. The surface shall be level within this same radius.
- C. If approved by the Authority, six-inch (6") pipe may be used for the last 600 feet of line, located beyond the last fire hydrant, on streets in which the water line cannot be extended.
- D. In lieu of the above, and for residential districts only, detailed design calculations may be submitted for review and concurrence by the Authority to substantiate line sizes other than those specified above. In any case, the minimum line size acceptable shall be six-inch (6"). For all design, the published "C" factor shall be reduced to new pipe "C" factor minus 10. This reduced "C" factor shall be used to reflect more accurately the future flow in aged pipe.

102.02 Fire Hydrant Locations:

- A. In residential areas, at street intersections and at intermediate locations where necessary, as determined by the Fire Marshal's Office. In no case shall the distance between fire hydrants, measured along the centerline of accessible streets, be greater than one thousand feet (1,000').
- B. Within one hundred feet (100') of any standpipe or sprinkler system fire-department connection, where those systems are required in buildings.
- C. As required by the following schedule as given by use group, the distance shall be measured to the most remote part of the structure the hydrant will serve.

Industrial buildings	250 feet
School buildings	300 feet
Commercial, Churches & Office Buildings	350 feet
Apartments, Multi-family & Townhouses	250 feet
Single family detached dwellings	500 feet*

* Measured along centerline of street to the center of front property line for single-family detached dwellings only.

- D. All hydrants shall be a minimum of fifty feet (50') away from buildings other than single-family detached dwellings. The location of all new and existing hydrants that are to serve the property shall be shown on the plans.

102.03 Water System Design:

Water systems shall be designed to adequately supply normal and peak demands for all customers, maintaining a pressure of not less than twenty-five (25) pounds per square inch at all points of delivery, without reducing the service to existing customers below the foregoing requirement, and shall have adequate capacity to deliver not less than the fire flows listed below, for a minimum of two hours, with a residual pressure of not less than twenty (20) pounds per square inch to at least one (1) point within two hundred fifty feet (250') of each building to be served or proposed to be served by an extension. In those cases where the existing source of supply cannot deliver fire flows at adequate pressures, the design engineer shall submit a request for waiver.

A. Peaking Factors and Demands for Design:

1. Peak Hour Factor: 4
2. Maximum Day Factor: 2.5
3. Average Day Factor: 1
4. Residential Demand per Equivalent Residential Customer (ERC) : 0.5 gallon per minute
5. Industrial or commercial demands shall be based upon Best Engineering Judgment.

B. Fire Flow Requirements Based on Flow from one two and ½ inch (2 ½") Nozzle

1. Fire flow requirements shown below are for guidance only, the jurisdictional Fire Marshal shall determine required fire flows.
2. Residential single-family/duplex:
 - a. A static pressure and modeled fire flow (based on existing mains) shall be shown on plans at each fire hydrant location.
 - b. Normal residential property with over 100' between buildings - 500 GPM.
 - c. Normal residential property with 31'-100' between buildings - 750 GPM.
 - d. Normal residential property with 11'-30' between buildings - 1,000 GPM.
 - e. Story and one-half residential - 1,000 GPM.
 - f. Two-story residential, congested area - 1,500 GPM.
 - g. Normal residential property with 10' or less between buildings - 1,500 GPM.

3. Multi-family/Commercial/Industrial:
 - a. Apartments, townhouses up to 2-1/2 stories -1,500 GPM.
 - b. Minor mercantile and congested apartments, 2 to 3 stories - 2,000 GPM.
 - c. High value industrial, shopping centers, and mercantile districts - 2,500 GPM.

In areas of mixed-use development, higher fire flow shall govern. Fire flows indicated above are for new development. Where size and scope of the development exceeds these requirements, additional flow shall be provided in accordance with ISO (Insurance Services Organization) requirements as reviewed by the Fire Marshal.

- C. In order to properly evaluate water systems and hydraulic conditions, all submitted plans shall be based upon actual USGS Datum and not assumed topographical elevations.

102.04 Location:

Water lines shall be located outside pavement whenever possible. Water lines shall be laid with a minimum parallel offset of 4 feet from centerline of the pipe to either face of concrete curbing.

102.05 Valves:

Whenever possible, all valves shall be located outside the pavement area. Valve boxes located within paved areas shall be set with the covers exposed and flush with street surface, to the satisfaction of VDOT or the local jurisdiction. If street surfaces are renewed or replaced by developer or owner after water system has been approved and accepted by the Authority, but while such streets are still the obligation of the developer or owner, valve vaults shall be readjusted by developer. Valve vaults located in sodded or other off-street areas shall be so set with the covers exposed and flush with finished surface elevation. Valves shall be installed at the intersection of water lines. Generally, four (4) valves will be used at crosses and three (3) valves at tees. A valve shall also be installed at least every one thousand feet (1,000') on distribution mains. A valve shall be installed between the last service and the terminus of any water main that can be extended in the future.

102.06 Dead-End Mains:

- A. Dead-end waterlines shall be eliminated wherever possible by looping of water mains. Any dead-end water main that can be extended at a future date must have a valve within thirty-six feet (36') of the end of the main. Any water main that can be extended across an adjoining street shall be extended across that street as part of the initial construction. The termination point shall be designed to insure minimal surface destruction when extension is constructed. In no case shall the end of a pipeline terminate in a paved area, or under concrete curb or gutter. No service or fire hydrant shall be installed between gate valve and end of line that can be extended.

- B. Developers are required to extend on-site water mains to the limits of their developments, for existing or possible future system looping and/or additional supply sources for the development.

102.07 Minimum Cover:

All pipes shall be laid to a minimum depth of thirty-six inches (36") from established final grade to the top of the pipe. Water pipe shall not be laid at depths exceeding ten (10') feet unless specifically approved by the Authority.

102.08 Blow-offs:

A means to blow-off dead-end lines shall be provided as indicated in the standard details. All transmission mains will be provided with blow-off valves at strategic low points in the line. The point of connection to the water main shall be rotated downward to facilitate removal of accumulated sediment. Fire hydrants may be used at low points in place of blowoffs where it is demonstrated that a minimum flushing velocity of 4 feet per second is provided.

102.09 Air Release Valves:

Automatic air release valves and/or hydrants shall be placed at strategic high points in the system to provide for the release of trapped air.

102.10 Cross Connections:

Cross connection and backflow prevention shall be designed and reviewed to insure compliance with the adopted cross-connection and backflow ordinances.

102.11 Easements:

- A. All water easements shall be a separate dedicated water easement and shall not be included in a Public Utility Easement.
- B. Water mains may be installed on private property if a waterline easement with a minimum width of twenty feet (20') is duly recorded. The easement width may be reduced in certain areas with written approval of the Authority, when the twenty-foot (20') easement would constitute a significant hardship for the development. In no case will an easement of less than twenty feet (20') be allowed for lines twelve inches (12") in diameter or larger.
- C. Increased easement widths may be required by the Authority when determined necessary due to large mains or excessive depths which will require special trench excavation in order to comply with applicable State and Federal safety regulations. Any water meter located on private property, shall require a waterline easement giving the Authority the right of access to water service connection, water meter, and associated appurtenances, for the purpose of maintenance and operation.
- D. No permanent structure, including fences, trees or shrubbery, shall be placed or constructed within an easement. Additional easements shall be provided across property under the owners/developers control that may be required to extend

water facilities in the future or to provide convenient access to easements for construction and maintenance purposes.

PART THREE - SURFACE WATER CROSSINGS

Surface water crossings, both over and under water, present special problems and should be discussed with the Authority before final plans are prepared.

A. Above Water Crossings - The pipe above water crossings shall be:

1. Adequately supported;
2. Protected from damage from freezing;
3. Accessible for repair or replacement; and
4. Above 100 year flood level or sufficiently protected from floatable debris.
5. Minimum class 350 DIP.

B. Under Water Crossing:

1. Pipe shall be of special construction, having flexible watertight joints; i.e. ball and socket, lock-joint, and shall be Class 300 or 350. In lieu of the above, Class 250 DI pipe may be used with a minimum of one foot on all sides being concrete encased within the one hundred (100) year floodway limits;
2. Valves shall be provided at both ends of the water crossing so that the section can be isolated for tests or repair; the valves shall be easily accessible and not subject to flooding by the 100-year storm event;
3. Permanent sample taps shall be installed on each end of the crossing and at reasonable distance from each side of the crossing to facilitate testing.

PART FOUR - WATER STORAGE FACILITIES

Water storage facilities shall be designed and constructed to meet the requirements of AWWA D100 for "Welded Steel Tanks" or AWWA D103 for "Factory Coated Bolted Steel Tanks" for water storage, latest edition Standard except as hereafter specified otherwise. Precast concrete water storage reservoirs may be required by the Authority under specific conditions that require below ground reservoirs. All precast concrete water storage reservoirs will be designed by the Authority using applicable standards.

A. Steel Standpipe, Reservoirs and Accessories

1. Supplemental Information to both AWWA D100 and AWWA D103.
 - a. Earthquake Design: Seismic Zone 2 using fixed percentage method of 5%.
 - b. Electric Power: Developer/Contractor's obligation
 - c. Compressed Air: Developer/Contractor's obligation

- d. Concrete Work: Comply with all requirements of ACI 301.
2. Supplemental Information to AWWA D100.
- a. Corrosion Allowances: 1/16-inch for parts in contact with water.
 - b. Submit written report certifying work inspected as set forth in AWWA D100, Sec. 11.2.1. Mill and shop inspection by commercial inspection agency is required.
 - c. Submit details of all welded joints referenced on design drawings in accordance with AWWA D100, Sec. 1.4.
 - d. Mill Scale: Completely remove by blast cleaning or pickling. (SSPC-SP10 or SSPC-SP8)
 - e. Butt-joint welds subject to secondary stress where thickness is greater than 3/8 inch (3/8") shall have complete joint penetration welds.
 - f. Radiographic tests shall be required and film shall become property of the Authority.
 - g. Protective Coatings:
 - 1. Surface preparation and coating systems specifications will be provided by the Authority at the time of plan preparation.
 - 2. First anniversary inspection in compliance with AWWA D102 will be required.
 - 3. Paint Color shall be as selected by the Authority from the manufacturers available colors.
3. Supplemental Information to AWWA D103.
- a. Tank Bottom: Concrete slab and steel base setting ring is required.
 - b. Full five (5) year manufacturers warranty on factory coating is required.
4. The following accessories, in addition to those required by either AWWA D100 or AWWA D103, shall be provided and installed.
- a. Exterior safety cage, rest platform and roof ladder, handrails to accessories in conformance with OSHA. A fall prevention system, which complies with applicable OSHA regulations, is acceptable as a substitute for the cage and rest platform.

- b. Overflow to ground, 1,000 GPM minimum, located near roof opening. Provide coarse screen and concrete splash pad and erosion protected channel from overflow to drainage system or natural channel.
- c. Screen vent against insects, provide special vent to insure fail-safe operation in event insect screens frost over.
- d. Removable silt stop.
- e. Separate drain line to drainage system or natural channel with erosion protection.

B. Disinfection

1. After all painting and coating schedules have been completed and the specified drying times have elapsed; the Developer/Contractor shall proceed to disinfect the interior surfaces of the standpipe structure utilizing one of the following disinfection methods.
 - a. Tank shall be filled to overflow level with potable water to which enough chlorine has been added to produce an initial chlorine concentration of 50 mg/l in the full tank. The full tank should stand for 24 hours; however, in no case, shall it stand less than 6 hours. At the end of the holding period, the highly chlorinated water shall be drained to waste, the tank refilled with potable water and tested for bacteriological quality.
 - b. All interior surfaces of the tank shall have applied to them a strong chlorine solution containing at least 200 mg/l of free available chlorine. The chlorine solution shall be applied with either spray equipment or brushes. Any equipment used to apply the chlorine solution shall either be new or previously used only for disinfection purposes. Strong chlorine solution shall remain in contact with tank surfaces for at least 30 minutes. Tank shall then be filled with potable water to overflow level and tested for bacteriological quality.
 - c. Potable water containing a free chlorine residual 50 mg/l shall be placed in the tank to such a depth that when the tank is filled, the resulting chlorine concentration in the water will be at least 2 mg/l. The water containing 50 mg/l of chlorine shall stand in the tank for 24 hours. The tank shall then be filled with potable water and allowed to stand for 24 hours. At the end of the second 24-hour period, the chlorine residual shall be at least 2 mg/l. After bacteriological analysis of the water for quality, the tank may be placed in service without draining the water used to disinfect it.
2. Two consecutive bacteriological samples collected at 24-hour intervals shall be obtained from the standpipe structure before the tank is placed into service. The bacteriological test form shall be marked "CONSTRUCTION SAMPLE". Analysis of the samples shall be performed by a laboratory certified by the VA State Health Department. If

contamination is indicated in the bacteriological samples, the disinfection procedure shall be repeated at the Developer/Contractor's expense.

PART FIVE - WATER PUMP STATIONS

Water pump stations shall be designed and constructed to meet the Standards of the Virginia Department of Health, and in addition to meet the following:

- A. All pump stations shall be designed with three pumps, each capable of pumping 50% of the peak day design flow. Hydraulic or electrically actuated pump control valves shall be provided for each pump unless otherwise approved by the Authority.
- B. Pump stations shall be controlled by pressure devices installed on a separate sensing line at the point of storage. For pump stations not located at storage facilities, pump control information shall be transmitted to pump station via telephone lines or radio transmission.
- C. Pump controllers shall include provisions for alternating plus backup control of pumps.
- D. Electrical Requirements:
 - 1. Pumps 5 horsepower and above shall be 3 phase. Where 3 phase is available, pumps larger than 3 horsepower shall be 3 phase. **Variable Frequency Drives (VFD) shall be provided for all pumps 5 horsepower and greater where 3 phase is not available.**
 - 2. Three phase pumps shall have phase protection on individual phases which also protect when running, as manufactured by Square D, Allen-Bradley or equal as approved by the Authority.
 - 3. Three phase pumps shall each have an individual poly-phase starter.
 - 4. All pumps shall be controlled by starters with individual HOA switches.
 - 5. Starters shall be sized one size larger than horsepower required. Heaters shall be sized for actual current load.
 - 6. All control circuits shall be 120 volt.
 - 7. Electrical service shall be provided with lightning arresters.
 - 8. Electrical panel shall have a minimum of 20 circuits.
 - 9. All electrical wiring shall be placed in conduit.
 - 10. Water pump stations shall be considered a wet location for interpretation of the National Electric Code requirements.
 - 11. All receptacles and switches shall have a minimum 20-amp rating.

12. At least one 20-amp circuit equipped with GFI protection shall be provided.
 13. All electrical equipment and panels shall be manufactured units with UL listing and shall include the manufacturer's warranty.
 14. A non-automatic transfer switch shall be installed on load side of service disconnect. Switch shall be rated same as or higher than service disconnect.
- E. Hour run meters shall be required for each pump motor.
 - F. A Master Water Meter shall be provided with 4/20mA output register.
 - G. All pump stations installed above ground shall be of masonry construction with masonry or frame roof with 50-year life expectancy. Exterior shall be brick faced or washed pebble and shall have zero-maintenance fascia, soffit and trim. Pre-hung insulated steel doors with minimum size 3-0 x 6-8 shall be used.
 - H. Pump houses shall have adequate insulation to protect equipment and reduce heating cost.
 - I. Adequate lighting, heating, ventilation, and drainage shall be provided for pump stations.
 - J. Below or in-ground pump stations may be approved by the Authority for special application on an individual basis. Such approval will only be given when such design meets all the above requirements and adequate provisions are made for the prevention of flooding, safe working conditions, efficient access system and adequate area for maintenance and operation of the pump station.
 - K. Minimum size structures to house a pump station shall be 8 foot x 10 foot x 8 foot high.
 - L. All pump stations shall comply with applicable BOCA Codes and applicable jurisdictional permits shall be secured.
 - M. All pump station piping and fittings shall be flanged copper unless otherwise approved by the Authority.
 - N. Isolation valves shall be installed at the intake and discharge of all pump stations. Isolation valves shall be required between the connection to the piping and all gauges and all other smaller diameter taps.
 - O. Bleeder valves (petcocks) shall be provided on all pump discharge lines.
 - P. Pump shutoff controls (high level pressure switch) with manual reset is required for each pump when discharge pressure exceeds 85 psi unless otherwise approved by the Authority.

- END OF SECTION -

SECTION 2665

WATER DISTRIBUTION LINES

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide all labor, material and equipment to excavate pipe trenches and backfill after the installation of the pipe, all in accordance with the Drawings and as specified herein.
- B. Related work specified elsewhere
1. General Water and Sewer Specifications – Section 2000
 2. Site Preparation - Section 2110
 3. Rock Excavation – Section 2230
 4. Erosion and Sediment Control – Section 2270
 5. Stream and/or Highway Crossings – Section 2310
 6. Horizontal Directional Drilling (HDD) Methodology – Section 2670
 7. Seeding and Mulching – Section 2900
- C. General Conditions - Any reference to General Conditions refers to the EJCDC C-700 Standard General Conditions of the Construction Contract (latest edition).

1.2 APPLICABLE AWWA STANDARDS

The following AWWA Standards (latest revision) are hereby incorporated by reference. Where a conflict exists between these written standards, and the standards incorporated by reference, the Utility Engineer will determine which standard shall apply. In general, the Utility Engineer will select the Standard that gives a final product that is in best interest of the Authority. Applicant shall provide the Authority with manufacturer's certification that materials meet these standards.

- A100 Standard for water wells.
- C104 Standard for cement-mortar lined for ductile-iron and gray-iron pipe and fittings.
- C110 Standard for ductile-iron and gray-iron fittings.
- C111 Standard for rubber gasket joints for ductile-iron and gray-iron pipe and fittings.
- C115 Standard for flanged ductile-iron and gray-iron pipe with threaded flanges.
- C150 Standard for thickness design of ductile-iron pipe
- C151 Standard for ductile-iron pipe
- C502 Standard for dry-barrel fire hydrants
- C504 Standard for rubber-seated butterfly valves
(approved for 14 inch or larger)
- C506 Standard for backflow prevention devices
- C508 Standard for swing-check valves
- C509 Standard for resilient-seated gate valves
- C550 Standard for protective interior coatings for valves and hydrants
- C600 Standard for installation and testing of ductile-iron
water mains and their appurtenances
- C651 Standard for disinfecting water mains
- C602 Standard for cement-mortar lining of water pipe lines
- C652 Standard for disinfection of water storage facilities

- C900 Polyvinyl chloride (PVC) pressure pipe, for water (DR-14 minimum class to be considered).
- C906 Polyethylene (PE) pressure pipe, for water (DR-11 minimum class to be considered).
- C909 Molecularly oriented polyvinyl chloride (PVCO) pressure pipe, for water (Minimum class 200 to be considered).
- D100 Standard for welded steel tanks for water storage
- D102 Standard for painting steel water storage tanks
- D103 Standard for factory-coated bolted water storage tanks

PART TWO – PRODUCTS

2.1 WATER PIPE AND APPURTENANCES

A. General:

All pipe for water main construction shall be one of the following or as directed by the Utility Engineer:

1. Ductile cast iron pressure pipe of the push-on joint or "mechanical joint" variety, conforming to AWWA C151, latest revision. **THIS IS THE ONLY PIPE MATERIAL APPROVED FOR USE IN THE TOWN OF VINTON** or where working pressures exceed 100 psi. Thickness class shall be minimum of Class 350 for all pipe twelve inches (12") in diameter or less. Water mains larger than 12" diameter in size, shall have thickness class as determined by thickness design of ductile-iron pipe AWWA C150, or;
2. Polyvinyl chloride (PVC) conforming to AWWA C900 with ductile iron O. D. Dimension Ratio (DR) 14 shall be minimum for PVC pipe. (SDR PVC pipe shall not be used as part of any water system). Water mains larger than 12-inch diameter in size shall meet requirements, Uni-Bell-B-11 for DR-18, PR 235 and have integral bell with bonded in ring and spigot joint. On specific authorization of the Authority, transmission lines may be PVC meeting Uni-Bell-B-11 with DR-25, PR-165 rating, or:
3. Polyethylene (PE) conforming to AWWA C906, with outside dimension Ratio (DR) 11 shall be minimum for PE pipe. PE pipe shall be assembled and joined using the butt-fusion method in strict compliance with the manufacturer's recommendations, or:
4. Molecularly oriented polyvinyl chloride (PVCO) conforming to AWWA C909 with class 200 shall be minimum for PVCO pipe. This material is only acceptable for water mains up to 12-inch diameter in size.

B. Ductile Cast Iron Standard Mechanical Joint Pipe:

1. All ductile cast iron standard mechanical joint water pipe shall conform to ANSI Specification A21.51 and shall be lined with cement mortar and have a protective exterior coating. Linings and protective coatings equal to "Enameline" with tar coating in the exterior will be considered as a satisfactory lining for water pipe, however, any substitution in pipe lining and/or coating from ANSI A21.4 shall be specifically approved by the Utility Engineer.

Joints of standard mechanical joint pipe shall conform to ANSI Specifications A21.11.

2. High strength cast iron tee head bolts, hex nuts, cast or ductile iron glands and rubber gaskets shall be as furnished by the pipe manufacturer. All tee bolts and nuts shall be constructed of same size and type material as head bolts and hex nuts.
3. In making connections of ductile cast iron pipe using standard mechanical joint, the gland followed by the rubber gasket shall be placed over plain end of the pipe, which shall be carefully inserted and aligned into socket end of pipe line. Gasket shall then be pushed into position so that it is evenly seated in the socket. Gland shall then be moved into position against face of the gasket, bolts inserted and made finger tight. Bolts shall then be tightened in accordance with AWWA C600 Table 3 (75-90 FT-LB Torque for pipe size 4-12"). All other requirements concerning bedding, alignment, and cleaning of pipe before making joint shall be followed.

C. Ductile Cast Iron Pipe - "Push-On Joint".

1. All "push-on" or "slip" joint pipe shall conform to requirements of standard mechanical joint pipe in regard to strength, class, protective coatings, etc.

D. Restrained Joint Pipe Systems:

1. Approved restrained joint pipe systems shall include the following:
 - a. Mechanical joint pipe with use of joint restraint gland such as EBAA Iron "Mega-Lug", Ford "Uni-Flange", Romac Industries "Grip Ring" or other restraint gland as approved by the Utility Engineer.
 - b. Ductile iron pipe push-on joint with use of U. S. Pipe "Field LOK" gaskets or American Ductile Iron Pipe "Fast Grip."
 - c. Restrained joint pipe such as U. S. Pipe "TR FLEX" pipe, Griffin Pipe "Snap-LOK" pipe, American Ductile Iron Pipe "Flex Ring" or other restraint joint pipe as approved by the Utility Engineer.
 - d. Ductile iron, PE, or PVC pipe push-on joints, valves or hydrants with use of Mueller Company "AquaGrip" system.

E. PVC Plastic Bell and Spigot Joint:

1. PVC pipe meeting the AWWA Specification C900 for dimension ratio (DR) 14, pressure Class 200, may be used for water lines. DR-18 or DR-25 may be used as noted above for pressure pipe larger than 12" in diameter.
2. PVC pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions. To facilitate future locating of PVC water pipe, a 12 gauge solid copper wire shall be laid with pipe using manholes, valve vaults or boxes, water meters and fire hydrants as access points. Wire splices shall be made with a 3M Direct Bury Splice Kit (DBY) or equivalent. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.

3. All service line connections to PVC pipe shall be made using a stainless steel service saddle and full port, Teflon coated ball valve corporation stop. Service saddle shall be of the extra wide or double-band type and manufactured specifically for PVC pipe. No direct tap to PVC pipe shall be permitted.
4. Only bell and spigot with elastomeric gasket joints shall be used. Solvent-cement joints or use of couplings shall not be allowed.

F. PE Pipe:

1. PE pipe shall be high density polyethylene meeting the AWWA Specification C906 for dimension ratio (DR) 11, ductile iron O.D., and applicable requirements of ASTM D3350, may be used for water lines.
2. PE pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions. To facilitate future locating of PE water pipe, a 12 gauge solid copper wire shall be laid with pipe using manholes, valve vaults or boxes, water meters and fire hydrants as access points. Wire splices shall be made with a 3M Direct Bury Splice Kit (DBY) or equivalent. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.
3. All service line connections to PE pipe shall be made using a fused service saddle and full port, Teflon coated ball valve corporation stop. No direct tap to PE pipe shall be permitted.
4. PE pipe shall be assembled and joined at the site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections shall not be permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations.
5. Qualifications of Personnel: HDPE pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the HDPE pipe. Training shall be performed by a qualified representative
6. Butt-fused joint shall be true alignment and shall have uniform roll-back bead resulting from the use of proper temperature and pressure. Joint shall be allowed adequate cooling time before removal of pressure. Fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the OWNER and/or his representative prior to insertion. All defective joints shall be cut out and replaced at no cost to the Authority.

Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above.

In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the OWNER and/or his representative shall be discarded and not used.

7. Terminal sections of pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp or equal. Butt gap between pipe ends shall not exceed one-half (½) inch. Also Unicore Plastic Fusion System, Unicore can be used to butt fuse the sewer pipe material.

G. PVCO Plastic Bell and Spigot Joint:

1. PVCO pipe meeting the AWWA Specification C909 for pressure Class 200, may be used for water lines up to 12" in diameter.
2. PVCO pipe shall be installed, embedded and backfilled according to the manufacturer's written instructions. To facilitate future locating of PVCO water pipe, a 12 gauge solid copper wire shall be laid with pipe using manholes, valve vaults or boxes, water meters and fire hydrants as access points. Wire splices shall be made with a 3M Direct Bury Splice Kit (DBY) or equivalent. Where water lines are greater than six (6) feet in depth, wire shall be brought to the surface every one hundred (100) feet and placed in a standard water meter box or approved junction box.
3. All service line connections to PVCO pipe shall be made using a stainless steel service saddle and full port, Teflon coated ball valve corporation stop. Service saddle shall be of the extra wide or double-band type and manufactured specifically for PVCO pipe. No direct tap to PVCO pipe shall be permitted.
4. Only bell and spigot with elastomeric gasket joints shall be used. Solvent-cement joints or use of couplings shall not be allowed.

H. Ductile Cast Iron Pipe Fittings:

1. Ductile iron water pipe fittings shall conform with ANSI/AWWA C-153/A-21.53 or ANSI/AWWA C-110/A-21.10, A21.11 for flange fittings. Specs. for ductile iron compact fittings shall be considered as meeting the requirements of this Specification.
2. One Bolt, Incorporated "One Bolt" fittings may be used for ductile iron and PVC pipe.
3. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint fittings, valves and hydrant connections.

I. Gate Valve:

1. All gate valves shall be of superior quality ductile iron body with resilient seat and full bronze mount or stainless steel stem. All gate valves shall withstand a working pressure of 250 psi and shall be in strict conformance to applicable AWWA Standards. Wrench nut shall turn to the left (counterclockwise) to open valve. Valves shall be so arranged to fit into pipe lines having standardized mechanical joints or slip joints. All gate

valves shall be resilient seat type valves meeting AWWA C515 latest revision Standards.

2. On valves fourteen inches (14") or larger, butterfly valves conforming to AWWA C504 may be used.
3. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint fittings, valves and hydrant connections.

J. Fire Hydrants:

1. Hydrants shall be traffic model, dry-barrel type, meeting AWWA C502 latest revision standard; AFC Model B-84-B, AVK Model 2780, Mueller Centurion A423, Kennedy K81D or approved equal.
2. Hydrants shall be of compression type with main valve openings not less than four and one-half inches (4-1/2") in diameter. Hydrants shall have cast or ductile iron body with full, bronze trim, and shall withstand a hydrostatic test pressure of 300 psi. Hydrants shall have a six-inch (6") connection base for setting with a minimum of thirty-six inch (36") cover on connection pipe. Hydrants shall be equipped with hose connections as follows:

Two each 2-1/2", N.S.T. hose connections

One each 4-1/2", N.S.T. pumper connections

3. Hydrant shall be operated by a National Standard 1-1/2 inch (1-1/2") pentagon shaped, operating nut, opening counterclockwise. Direction of opening shall be clearly marked by an arrow cast on outside of hydrant. Hydrants shall be connected to the main with a six-inch (6") pipe and shall be controlled by an independent six-inch (6") gate valve. Six-inch (6") gate valve shall be located as near to service main as practical, and connected to the tee with tie rods. A gravel dry well shall be provided for hydrant drain.
4. All hydrant barrels shall be painted silver, and the bonnet of the hydrant painted with red reflective paint. (Fire Marshal will color code caps after flow testing).
5. Hydrant assembly shall be restrained from connection to distribution main to hydrant. Approved restraint methods shall include threaded "Corten" rodding between hydrant, hydrant valve and connection to water distribution main with concrete thrust blocks behind hydrant and distribution main tee fitting. Approved mechanical joint gland restraint ("Mega-Lug", "Grip Ring" or "Uni-Flange") may be used in lieu of concrete thrust blocking.
6. Infact Corporation's "Foster Adaptor" may be used to connect between mechanical joint valves, fittings and hydrant connections.

K. Valve Vaults:

1. Valve vaults shall be used for all main line valves unless otherwise approved in writing by the Authority. All vaults shall be precast manhole cone sections with water manhole covers as shown in the Detail Drawings.

L. Valve Boxes:

1. All valve boxes, base extensions, head and cover shall be of cast or ductile iron. Valve boxes shall be of the Mueller sliding type, round head marked "Water". Shaft diameter shall not be less than five inches (5"). Valve boxes shall have a minimum range of extension to fit two inch (2") to twelve inch (12") valves inclusive, placed on mains at depths of three feet, (3') to five feet (5') of cover in order that cover of the valve box is set to finished grade. Valve boxes shall be Mueller Company 10364, or approved equal. Valve boxes shall be centered over valve screw and set plumb. Valve boxes shall only be allowed on fire hydrant valves or on other installations approved in writing by the Authority.

M. Water Service Connection – Type "A":

1. Type "A" meter connection shall be installed when main line pressure is less than 80 PSI.
2. Water meter box and accessories therein necessary for Type "A" meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
3. All water services pipe from main connections to the meter box assembly shall be "K" type copper. All connections shall use approved CTS compression connection fittings. The minimum size service connection shall be 1 inch (1") I.D. "K" type copper for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.

N. Water Service Connection – Type "B":

1. Type "B" meter connection shall be installed when main line pressure is 80 to 120 PSI. Type "B" connection incorporates an individual ¾-inch pressure reducing valve installed in a standard meter setter and box situated on the customer side of the meter.
2. Water meter box and accessories therein necessary for Type "B" meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
3. Pressure reducing valve and accessories shall be furnished and installed by CONTRACTOR on private property side of pressure reducing valve box and valve setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
4. All water services pipe from main connections to the meter box assembly

shall be "K" type copper. All connections shall use approved CTS compression connection fittings. The minimum size service connection shall be 1 inch (1") I.D. "K" type copper for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.

O. Water Service Connection – Type “C”:

1. Type “C” meter connection shall be installed when main line pressure is greater than 120 PSI. Type “C” connection incorporates installation of water meter and individual ¾-inch pressure reducing valve in a standard double meter setter and box situated, just within right-of-way/easement at the property line as shown on construction plans.
2. Water meter, ¾-inch pressure reducing valve, connecting S-bar with integral pressure relief valve and accessories therein necessary for Type “C” meter installation shall be furnished and installed by CONTRACTOR just within right-of-way/easement at the property line as shown on construction plans. Water meter box and double meter setter shall be furnished and installed as shown in the Detail Drawings. All meter setters shall be equipped with an integral lockable valve and check valve.
3. All water services pipe from main connections to the meter box assembly shall be "K" type copper. All connections shall use approved CTS compression connection fittings. The minimum size service connection shall be "K" type copper, 1 inch (1") I.D. for both single and double setters. Fittings for service lines shall meet AWWA Specification C800. Solder connection shall not be used for underground service.

P. 1” to 3” Water Services: All service pipes from 1” to 3” in diameter shall be "K" type copper.

Q. Water Meters: All water meters shall be installed by the Authority per the current Basic Connection Fee schedule.

R. Wet Taps: All taps to the Authority water system shall be made by the Authority.

S. Pipeline Bedding Materials: Where pipeline installation requires granular bedding materials, they shall meet requirements of VDOT gradation 21-A, No. 57 or No. 68.

T. Special Conditions: The Authority may require special material and/or construction be used where normal water pressure exceeds pressure rating used in these standards and where design will not permit reducing pressures to acceptable levels.

PART THREE - EXECUTION

3.1 WATER LINE CONSTRUCTION

A. General:

1. Except as specifically modified below, water line construction shall meet requirements of AWWA C600 latest edition Standards. Pipe, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting

with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped.

Pipe shall be so handled that any coating or lining is not damaged.

2. The water main shall be laid and maintained to the required lines and grades with fittings, valves, hydrants and accessories set at the required locations as indicated on the approved plans for the project. All valve and hydrant stems shall be set plumb. Whenever obstructions not shown on the plans are encountered during progress of the work and interfere to such an extent that alteration in plans is required, the Authority approval shall be given before such alterations are put into effect. Any such alternative design shall be designed or approved by the Engineer of record for the original design.
3. No pipe shall be laid in water or when, in the opinion of the Authority, trench conditions are unsuitable. If the Authority is of the opinion that trench bottom consists of wet, washable material or is otherwise incapable of properly supporting the pipe or structures, such material shall be removed and replaced with proper bedding material in addition to the standard bedding required.
4. All construction of water mains and appurtenances in the Authority shall be in strict accordance with plans and specifications prepared as part of the Contract Documents and as approved by the Authority. All materials shall be new and unused. Prior to construction of the approved water main, Contractor shall provide horizontal field stakeout in order that water line and appurtenances may be constructed in accordance with Contract Drawings.

B. Installation of Pipe and Fittings:

1. When installing pipe in trench, proper implements, tools, and facilities satisfactory to the Authority and as recommended by material manufacturer shall be provided and used by contractor for safe and convenient prosecution of the work. All pipe, valves, fittings, hydrants and accessories shall be carefully lowered into trench, piece by piece, by means of a derrick, ropes, slings or other suitable tools or equipment in such a manner as to prevent damage to water main material and any protective coatings and linings.
Under no circumstances shall water main materials be dropped or dumped into trench. Pipe and fittings shall be inspected for defects, and while suspended above grade, be rung with a light hammer to detect cracks.
2. All lumps, blisters and excess coal tar coatings shall be removed from ends of ductile iron pipe, and outside of the spigot and inside of the bell shall be wiped clean and dry and free from oil and greases before the pipe is laid.
3. Every precaution shall be taken to prevent foreign material including nonpotable water from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, a heavy tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe. At the end of each day a watertight plug shall be placed in the end of all pipe opening.

4. After placing a length of pipe in the trench, the spigot end shall be centered in the open bell of the pipe line and the pipe pushed home so that the face of the spigot is in close contact with the shoulder of the bell. Water pipe shall be laid with the bell facing the direction of the laying.
5. No stub of any water main shall terminate with a capped or plugged valve. Where a valve is required to be installed near a stub end, not less than 36 feet of pipe shall be installed between valve and plugged stub end of pipe for adequate anchoring.
6. Cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to axis of the pipe.
7. When machine cutting is not available for cutting metal pipe twenty inches (20") in diameter or larger, the electric-arc cutting method will be permitted using a carbon or steel rod. Only qualified and experienced workmen shall be used for this work. Flame cutting of metal pipe by means of oxyacetylene torch will not be allowed.
8. Whenever it is necessary to deflect pipe from a straight line, either in vertical or horizontal plane, to avoid obstructions or plumb stems, or where long-radius curves are approved, the amount of deflection allowed shall not exceed the maximum required, for satisfactory joining of the pipe, as specified in this manual. Maximum deflection permitted per joint shall be in accordance AWWA C600 Table 4 for push-on joint and Table 5 for mechanical joint pipe. C900 PVC pipe deflection may not exceed 75% of manufacturer's recommendation.

INSTALLATION OF DUCTILE-IRON WATER MAINS

TABLE 4

Maximum Joint Deflection Full-Length Pipe – Push-On Type Joint

Nominal Pipe Size (Inches)	Deflection Angle	Maximum Offset – S* Inches (Meters)		Approximate Radius of Curve – R* Produced by Succession of Joints	
		Joint Length 18-Foot (5.5 Meters)	Joint Length 20-Foot (6.1 Meters)	Joint Length 18-Foot (5.5 Meters)	Joint Length 20-Foot (6.1 Meters)
3	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
4	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
6	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
8	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
10	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
12	5°	19 (0.48)	21 (0.53)	205 (62)	230 (70)
14	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)
16	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)
18	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)

20	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)
24	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)
30	3°	11 (0.28)	12 (0.30)	340 (104)	380 (115)

* See Figure 4.

* For 14-in. and larger push-on joints, maximum deflection angle may be larger than shown above. Consult manufacturer.

TABLE 5

Maximum Joint Deflection Full-Length Pipe -- Mechanical Joint Pipe

Nominal Pipe Size (Inches)	Deflection Angle	Maximum Offset – S* Inches (Meters)		Approximate Radius of Curve – R* Produced by Succession of Joints	
		Joint Length 18-Foot (5.5 Meters)	Joint Length 20-Foot (6.1 Meters)	Joint Length 18-Foot (5.5 Meters)	Joint Length 20-Foot (6.1 Meters)
3	8° - 18"	31 (0.79)	31 (0.89)	125 (38)	140 (43)
4	8° - 18"	31 (0.79)	31 (0.89)	125 (38)	140 (43)
6	7° - 07"	27 (0.69)	30 (0.76)	145 (44)	160 (49)
8	5° - 21"	20 (0.51)	22 (0.56)	195 (59)	220 (67)
10	5° - 21"	20 (0.51)	22 (0.56)	195 (59)	220 (67)
12	5° - 21"	20 (0.51)	22 (0.56)	195 (59)	220 (67)
16	3° - 35"	13½ (0.34)	15 (0.38)	285 (87)	320 (98)
18	3° - 00"	11 (0.28)	12 (0.30)	340 (104)	380 (116)
24	2° - 23"	9 (0.23)	10 (0.25)	450 (137)	500 (152)
30	2° - 23"	9 (0.23)	10 (0.25)	450 (137)	500 (152)

* See Figure 4.

9. All tees, bends, plugs, caps, and fire hydrants shall be substantially braced, blocked and/or strapped to prevent any movements by providing adequate reaction backing and/or tie rods. Reaction backing shall be designed and installed as indicated in the Detail Drawings. Hydrants shall be set to established finished grade as follows:
 - a. Bottom of the four and one-half inch (4-1/2") nozzle shall be between eighteen inches (18") and twenty-four inches (24") above finish elevation, and at a minimum of 6' or maximum of 12' from edge of the shoulder on streets without curb and gutter and between eighteen and twenty-four inches (18")-(24") above elevation of the curb on streets with curb and gutter and at a minimum of 2' and maximum of 4' behind the curb as indicated in the Detail Drawings.
 - b. Two and one-half inch (2-1/2") hose connections shall have a minimum of four feet zero inches (4'0") clearance on all sides.
 - c. Surface shall be approximately level within a four-foot (4') radius of the hydrant.

10. Warning tape and locator wire are required for non-metallic pipe.

E. Installation of Valves, Air Relief Assemblies and Blow-Off Chambers

1. During construction, air and sediment accumulations may be removed through a standard fire hydrant. Compressed air and/or pumping may be used for dewatering mains through hydrants.
2. Chambers or pits containing valves, blow-offs, meters or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer.
3. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground in areas with a sufficiently deep water table.

3.2 HYDROSTATIC TESTS FOR LEAKAGE

A. General:

1. All new water mains shall be tested, after backfilling to a hydrostatic pressure of not less than 100 psi above design water pressure for the system or 150 psi, whichever is greater. Allowable leakage shall be calculated by the following formula and is shown in columnar form in Table 6:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where: L = allowable leakage in gallons per hour
 S = length of pipe tested in feet
 D = nominal diameter of pipe in inches
 P = average test pressure during leakage test in psi.

TABLE 6

Allowable Leakage per 1,000 ft. (305 m) of Pipeline*--gph[^]

Average Test Pressure PSI (Bars)	NOMINAL PIPE DIAMETER - Inches							
	3"	4"	6"	8"	10"	12"	14"	16"
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20

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

[^] To obtain leakage in liters/hour, multiply the values in the table by 3.785.

- B. No water line shall be placed in service until the leakage is less than the allowable leakage as indicated above. Testing of water mains shall only be done after installation of all valves, taps and service laterals are complete. All portions of the water system, including hydrants and service lines, shall be subject to hydrostatic pressure during the leakage test. Testing of water mains shall be observed and documented by an Authority Inspector/Engineer.
- C. All high points and service lines in portion of system under test shall be vented and all air expelled from system prior to beginning test. All fittings and hydrants shall be properly braced or blocked before applying pressure. Where concrete thrust blocks are used, they shall have attained their final set prior to testing.
- D. After section of system under test has reached required pressure as stated above, said pressure shall be maintained for two (2) hours. At conclusion of pressure test, volume of makeup water required to refill pipeline shall be determined by measurement with displacement meter or by pumping from vessel of known volume.
- E. All joints or fittings at which leakage occurs shall be reworked to insure tightness. All visible leaks shall be repaired regardless of amount of leakage. If measured amount of leakage exceeds values for the appropriate size as found in AWWA Specification C600, Hydrostatic Testing (Table 6), pipeline shall be repaired and retested until leakage is within limit set by the referenced specification. Methods of repair prior to retesting will be done with the Authority's approval and inspection. Repairs of new construction will be by adjustment or replacement of material only. The use of repair clamps or bell clamps will not be acceptable.

3.3 DISINFECTION OF WATER MAINS

- A. General - After testing and before final inspection of the completed systems, water mains and service laterals shall be flushed and disinfected in accordance with AWWA Specification C651 latest revision. Flushing shall be accomplished at a flow velocity of not less than 2.5 feet per second.
- B. Disinfection Procedures:
 1. Disinfection as described in AWWA C651 - "Placing of granular calcium hypochlorite tablets" shall be used. Five-gram (5g) calcium hypochlorite tablets with 3.25 gram available chlorine per tablet shall be attached at the inside top of the pipe by an adhesive such as Permatex No. 2 or equal. The following number of tablets for the given pipe size shall be used for an initial dose of twenty-five (25 mg/1 (ppm) chlorine:

<u>Pipe Diameter</u>	<u>Number Tablets Per 18-20 Ft. Pipe Section</u>
6"	1
8"	2
10"	3
12"	4

or the number of tablets equal to $0.0012d^2L$ rounded to the next higher integer, where d is the inside diameter, in inches, and L is the length of the pipe section, in feet. Use of the continuous feed or slug method of disinfecting may only be used to re-chlorinate a water pipe after the initial disinfection or in other specific cases approved by the Authority.

2. Disinfection solution shall remain in pipe line for not less than twenty-four (24) hours, after which time a chlorine residual of 10 ppm at all parts of line shall be required.
3. Following chlorination, piping shall be thoroughly flushed. Water in the new main shall be proven comparable in quality, by testing, to the existing public water supply. The Virginia Waterworks Regulations require at least two consecutive satisfactory bacteriological samples from distribution system for every 2,000 feet of pipe before system can be placed in service. the Authority will pay the cost of lab testing for first set of bacteriological samples. Developer/Contractor shall pay all costs associated with disinfection and testing of installed facilities and any additional bacteriological samples required after first set.

- END OF SECTION -

SECTION 200

DESIGN AND CONSTRUCTION STANDARDS FOR SANITARY SEWER FACILITIES

PART ONE - GENERAL

- A. The following standards represent the minimum requirements for all public sanitary sewer systems within the service area of the Western Virginia Water Authority, hereinafter "Authority" or "owner". Before construction is commenced, plans and specifications shall be reviewed and approved by the Authority, and/or the Virginia Department of Environmental Quality (DEQ) if required. All subsequent work shall be constructed in accordance with the approved plans.
- B. Additional requirements for private building sewers (service connections) are contained in the "Wastewater Rules and Regulations for the Western Virginia Water Authority".
- C. Public sewer shall be extended to serve new and existing development in accordance with the ordinances, resolutions and codes of the local jurisdiction, and the policies of the Authority.
- D. If public sewer is not available, the owner shall acquire necessary VDH approval prior to a building permit being issued.
- E. Sanitary sewers shall be designed to serve all lots, including lateral connections between the sewer main and the property line being served.
- F. Any plan approval required by the local jurisdiction, shall be obtained by the developer prior to plan approval by the Authority.
- G. DEQ approval is required for projects involving any sewer pump station discharging into a gravity collector or interceptor sewer line.
- H. A preconstruction conference shall be held on all sewer projects within the Authority, at least one day prior to the start of construction. The contractor's superintendent or foreman shall attend this meeting. If superintendent or foreman cannot attend, then the developer or contractor's representative shall submit a letter to the Authority stating that the superintendent or foreman has been informed of items discussed at this meeting. Prior to the start of construction, contractor must have an approved set of plans on-site.
- I. A minimum one-year maintenance warranty shall be required prior to Final Acceptance of any sewer facility.

PART TWO – DESIGN CRITERIA

- A. Non Sanitary Sewer Flows Prohibited
 - 1. The Authority sanitary sewer system is designed to provide conveyance with total containment. New sewers, extensions, or replacements, not designed to provide total containment for the design period shall not be permitted.

2. Under no circumstances shall storm water, surface water, ground water, roof runoff, subsurface drainage or untreated industrial process water be discharged into any public sanitary sewer system.
- B. This criteria established herein is required in order for the Authority to comply with the Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation authorizing the discharge of pollutants, under prescribed conditions, to State waters pursuant to the Virginia Department of Environmental Quality (VDEQ), Regulation 9 VAC-25-31.
 - C. All sanitary sewer design shall comply with the approved latest edition of Local Government Compliance Plan, and Commonwealth of Virginia Sewage and Treatment Regulations as applicable.
 - D. The adequacy of the existing sanitary sewer system receiving flows from the proposed project shall be determined at the preliminary stage to preclude unnecessary revisions to construction plans. The designer shall provide calculations for the sanitary sewer system (on-site and off-site for both existing and proposed conditions as required) to the points of connection to the Authority's sanitary sewer system when requested.
 - E. Tributary Population

Sewerage facilities shall be designed for the estimated ultimate tributary population. Consideration shall be given to domestic, commercial, institutional, and industrial wastes in determining the capacity of the system. The design shall be based on approved estimates of anticipated populations and flows for a period of 50 years hence, or the entire sewershed shall be assumed to be completely developed according to the Comprehensive Plan and/or sewer master plan, whichever provides the greater sewerage flow, unless the Authority approves otherwise.
 - F. Sewage Flow
 1. Determining the average design flow shall be the first step in the sizing of sanitary sewerage systems. Peak factors and average daily flow rates shall be in accordance with DEQ Sewage Collection and Treatment Regulations (SCAT). Actual design quantities may be substituted for the average design flows, provided supporting data is furnished to and approved by the Authority.
 2. Sewers shall be designed to carry a peak flow when full as determined by applying the appropriate peak flow factor to the average design flow.
 3. Ventilation of gravity sewer systems shall be provided where continuous watertight sections greater than 1,000 feet in length occur.
 4. All sanitary sewer plans submitted to the Authority for review shall provide all detailed calculations and include a separate sheet with the following information:
 - a. Date
 - b. Project title
 - c. Project location
 - d. Design flows (both average and peak)

- e. Pipe material
- f. Diameter
- g. Length

G. Location of Sewers and Manholes

1. Sewer lines and manholes shall be located within public streets or right-of-way wherever possible. If sewers cannot be located within public streets or right-of-way, then access easements to all manholes, sewer line and laterals shall be provided.
 - a. Manholes within the pavement area of streets should be located at the center of the travel lanes.
 - b. Sanitary sewer pipe and manholes shall not be located within the paved portion of privately owned and maintained streets or common driveways without the prior written approval of the Authority. This provision does not preclude the crossing of these driveways at generally 90 degrees with a sanitary sewer pipe.
 - c. The horizontal and vertical separation between sewers and waterlines shall be in accordance with the requirements of Authority's Design and Construction Standards for Water facilities (see Section 2000 Item 3.4, Separation of Water Lines and Sanitary Sewers.)
 - d. Sanitary sewers shall be designed such that they do not create skewed crossings with other utilities with an acute angle of less than 45 degrees, 90 degrees is preferred. Where skewed crossings are unavoidable due to existing utilities and involves any pipe larger than 24 inches in diameter, the crossing must be specifically designed and construction details provided.
 - e. The engineer or surveyor shall supply cut-sheets for the installation of all sewer systems (see Section 2731, Item 3.1.B).
 - f. A plan and profile of the sanitary sewer system is required.
 - g. The deflection angle from the inflow pipe to the outflow pipe at any junction shall not be less than 90° unless approved in writing by the Authority. Where more than one (1) inflow line enters a manhole, the deflection angle shall be less than 90° between the inflow lines. (i.e. No inflow line shall direct flow up another inflow line.)
 - h. Lowest finished floor elevation shall be a minimum of three feet (3') above the top of the main at the point where the service lateral connects to the main. All design/construction plans shall include a table that lists each lowest finished floor elevation and the corresponding top of the main elevation.
2. Proposed sanitary sewers to be publicly maintained shall not be located within the plane of influence of the building footing and in no case closer than one-half the required easement width from an existing or proposed building.

3. Manholes for access to sewer lines shall be provided at:
 - a. At all intersections of differing size sewers.
 - b. At all points of change in horizontal alignment.
 - c. At all points of change in grade.
 - d. At the end of all sanitary sewer lines.
 - e. At intervals not exceeding 400 feet on all sewers 15 inches in diameter or less and not exceeding 600 feet on all sewers larger than 15 inches in diameter.
 - f. A sampling manhole will be required for all non-residential users. The sampling manhole may be used in lieu of the required cleanout at the property/easement line.
4. When it is necessary due to steep slopes, increased velocity or invert elevation differences equal to or greater than 24 inches, a drop connection shall be employed. The maximum difference in elevation between the influent and effluent flows within the manhole itself shall be six inches. The minimum diameter manhole for use with an inside drop connection shall be five feet (5'). Only one inside drop shall be installed per five-foot (5') diameter manhole. Two inside drop connections may be made in a six-foot (6') diameter manhole. These provisions apply for both sewer main and lateral connections. Refer to Detail Drawings.
5. Outside drop manhole connections are acceptable.
6. Manholes for sewers up to 16 inches in diameter shall not be less than four feet inside diameter (except inside drops). Manholes for sewers up to 36 inches shall have an inside diameter of not less than five feet. If hydraulic characteristics do not permit use of a four-foot inside diameter manhole, then a five-foot diameter manhole or special manhole detail must be provided.
7. When designing new sewers to tie into existing sewers, the connection shall be made by one of the following methods:
 - a. Connection to an existing manhole. Connection to the existing manhole must be configured so that the invert of the new tie-in is not established lower than the existing bench.
 - b. New in-line manhole. The new manhole shall be set after removal of the existing pipe and installation of proper bedding material. Refer to Detail Drawings. The invert of the base section shall match the slope of the removed pipe. Outlet pipe shall be connected to the manhole boot. Inlet connection shall be made with a 6-foot pipe stub connected to the manhole boot and to the existing pipe by a Fernco coupling or approved equal as per Detail Drawings. This method will require pumping of existing flows during installation. Testing shall be by the vacuum test method.
 - c. Straddle manhole. Straddle manholes may be used for installations

not suitable to the above two methods. Refer to Detail Drawings. Special care shall be taken to make the manhole watertight and to protect the integrity of the existing pipe. Outside of existing pipe shall be thoroughly cleaned and waterstops installed prior to placing of concrete. All concrete for invert shaping, bench, and base shall be of a single pour. Risers and other sections shall not be installed for a minimum of 24 hours after placing concrete. All existing concrete that comes in contact with new concrete shall be etched and have a bonding agent applied. An Authority inspector must be present during installation of all straddle manholes. Testing shall be by the vacuum test method.

8. All new sanitary sewer manholes shall be precast concrete in accordance with ASTM-C478 consisting of precast concentric riser reinforced sections, an eccentric conical or flat top section, and a base section conforming with the typical manhole as shown in Detail Drawings.
9. Sewers adjacent to or crossing streams, estuaries, lakes and reservoirs shall be designed, constructed and protected in accordance with requirements of the DEQ Sewerage Collection and Treatment Regulations, except that:
 - a. The connection of sanitary sewer lines shall be made only at manholes. The type of material must be the same from manhole to manhole. Connections to existing manholes shall be made by the Authority.
 - b. Sewer lines crossing streams shall be Class 350 Ductile Iron pipe, C900-DR 14 PVC, C906-DR 11 HDPE or equivalent and concrete encased. Reference Detail Drawings. Pipe shall be provided with a minimum of one foot of cover over the concrete encasement where the stream is located in rock and three feet minimum cover where the stream is located in other materials. The cover requirements may be lessened with the approval of the Authority in an area that will not interfere with future improvements to the channel bottom.
 - c. Sewer lines shall not be located within stormwater management impoundment areas unless there is no alternative. The Authority may approve sewer lines within a stormwater management impoundment area only if such sewer lines are designed and constructed to site specific conditions that will protect the sewer line from future excavation and dredging.
 - d. Siphons are not allowed unless approved by the Authority. If allowed, inverted siphons shall not be less than two (2) barrels, with a minimum pipe size of six inches (6) and shall be provided with necessary appurtenances for convenient flushing and maintenance; the manholes shall be designed to facilitate cleaning; and, in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details shall be arranged so that normal flow is diverted to one (1) barrel so that either barrel may be removed for service or cleaning.

10. Sewer located in areas of unstable soil conditions or other special circumstances may need to be encased in concrete, relocated or redesigned as required by the Authority.

H. Sanitary Sewer Lateral Cleanouts

1. Sanitary sewer cleanouts will be:
 - a. Located at the property line or sanitary sewer easement line contiguous to the property. Refer to Detail Drawings.
 - b. A traffic bearing cleanout box is required if located in pavement areas. Refer to Detail Drawings.
 - c. Minimum slope for service lateral shall be 2.08 percent. Maximum slope of service lateral shall be 45 degrees within public easements or right-of-ways.
 - d. The horizontal angle of the lateral from the sewer main shall not exceed 45 degrees, and shall discharge in the direction of flow.

I. Minimum Sewer Size

No public sanitary sewer main shall be less than eight inches in diameter except for sewer force mains.

J. Hydraulic Criteria

The design and determination of sewer size shall be based on the following conditions:

1. Sewers shall have a uniform slope and alignment between manholes.
2. At all manholes where a smaller diameter sewer discharges into a larger one, the invert of the larger sewer shall be lowered so that the energy gradients of sewers at junction are at the same level. Generally, this condition will be met by placing the 0.8 depth of flow or diameter in each sewer at the same elevation.
3. Sewer shall be designed to be free-flowing with the hydraulic grade below the crown and with hydraulic slopes sufficient to provide an average velocity of not less than 2.0 feet per second when running full to maintain cleansing flow. Computations of velocity of flow shall be based on a PVC pipe coefficient of roughness "n" in the Manning formula of $n = 0.015$.
4. In no case shall terminal lines with less than 20 residential connections have a slope of less than one percent unless approved by the Authority.
5. The maximum permissible velocity occurring with average flow shall be 10 feet per second (before applying peak flow factor).
6. Where due to steep grades, velocity exceeds 10 feet per second, and/or where drop manholes are impractical for reduction of velocity, the sewer shall be designed with an abrasion resistant material meeting ASTM or

AWWA specifications approved by the Authority and shall be anchored where appropriate.

7. In general, the following are minimum slopes in feet per hundred feet to be provided for pipes flowing at full depth to one-half of full depth:

<u>Sewer Size</u>	<u>Minimum Slope in Feet per 100 Feet</u>
8 Inch	0.40
10 Inch	0.28
12 Inch	0.22
14 Inch	0.17
15 Inch	0.15
16 Inch	0.14
18 Inch	0.12
21 Inch	0.10
24 Inch	0.08
27 Inch	0.067
30 Inch	0.058
36 Inch	0.046

8. Benches in terminal manholes shall be built at a slope of not less than one inch per foot.

9. Minimum Permissible Depth

All sewer mains and service laterals shall have a minimum cover of three feet (See Section 2731, Item 3.4).

10. In general, the maximum allowable depths to inverts of various types and sizes of pipe is dependent on different types of bedding, earth loading and live loading. Pipes with less than minimum cover and pipe with cover greater than 18 feet require pipe strength calculations to be submitted with the design. The maximum depth for all types of pipe shall be in accordance with manufacturer's specifications and recommendations.

11. Slope Anchorage

Concrete anchors shall be placed on sanitary sewer lines with grades of 20 percent or greater. Minimum anchorage shall be provided such that anchors are not located over 36 feet center to center on grades from 20 to 35 percent. The maximum grade for sanitary sewers shall be 35 percent with anchorage unless otherwise approved in writing by the Authority. Refer to Detail Drawings.

12. In general, the pipe diameter of sewers shall increase continually with increase in tributary flow. Where steep slopes would permit the use of reduced pipe size and construction cost savings can be derived, the pipe size may be reduced one size at a manhole; however, appropriate hydraulic allowances shall be made for head loss of entry, increased velocity, and the effect of velocity retardation at the lower end where the flow will be on a flatter slope. Prior written approval of the Authority is required for reduction in line sizes.

K. Sanitary Sewer Force Mains

1. The minimum size for force mains shall be four inches except when using grinder pumps.
2. At pumping capacity, a minimum velocity of two feet per second shall be maintained.
3. An air relief shall be placed at the necessary high points in the force main to release trapped air.
4. Maximum velocity shall be eight feet per second.
5. All force mains shall connect to a cleanout with a drop stack connection at the right-of-way or easement line. From there the flow shall be gravity into the public system. See Detail Drawings.
6. All pipe used for force mains shall be pressure type with pressure type joints. (restrained joint PVC SDR 21, CL 200 minimal, HDPE DR 9, or Yellowmine SDR 21)
7. Anchorage shall be provided where deemed necessary by the Authority, refer to the Commonwealth of Virginia Sewage Collection and Treatment Regulations for testing and anchorage guidelines of force main sewers.
8. Receiving gravity flow sewage system shall be analyzed for adequacy to handle peak force main discharges.
9. Locator wire shall be installed with all force main non-metallic pipe. Refer to Detail Drawings. Minimum wire shall be U.S. standard gauge 12 solid copper, however Authority may require heavier gauge wire in depths of greater than 6'.

L. Private Sewage Pump Stations

1. Private sewage pump stations (i.e., those stations not accepted into the Authority sewer inventory and privately maintained) may be approved by the Authority under the following conditions.
 - a. Private sewer pump stations shall meet the construction requirements of the applicable building/plumbing code and may only accept flows from private sewer systems limited to:
 1. Building laterals
 2. Collector laterals
 3. Private sewer systems entirely on a single lot of record

M. Public Sewage Pump Stations

1. Public sewage pump stations shall meet the requirements of the Authority's Sewer Lift Station Design Standards.
2. Due to the excessive operation and maintenance cost of public sewer pump stations, these stations will only be accepted under a waiver request. These

requests must include all alternatives to the pump station including the cost to provide gravity sewer service to the property. The cost for the off-site gravity sewer extension must exceed the cost of the pump station by a factor of three (3). The inability to obtain off-site public easements for a gravity sewer extension will not in itself be justification to install a pump station.

N. Public Easements

1. All sanitary sewer easements shall be a separate dedicated sanitary sewer easement and shall not be included in a Public Utility Easement.
2. Sanitary sewer mains may be constructed on private property provided that the owner has duly recorded a public easement adequate for the proper installation, maintenance, operation or removal of the sewage facilities. The owner shall have recorded easements from all parties possessing or having legal interest in the property.
 - a. Public easement width shall be determined based on a one-to-one side slope measured from outside edge of pipe extending from invert of the pipe at its lowest point below proposed grade between manholes and rounded up to nearest foot. See Detail Drawings.
 - b. Minimum public easement width for sanitary sewers shall be 20 feet.
 - c. Increased/decreased public easement widths may be required by Authority for unusual situations or circumstances.
3. No privately owned permanent structure or landscaping other than shrubs shall be permitted within a public easement. Any damage to shrubs that are located within the easement that may be caused by the legal use of the easement by the Authority shall remain with the property owner.
4. Where deemed necessary by the Authority, and in order to ensure maximum utilization of public sanitary sewer systems, it will be required that appropriate public easements be provided to adjacent properties for access or extension of said public sewer system.

PART THREE - REPAIR GUIDELINES

- A. Prior approval of the Authority is required for repairing damaged concrete sanitary sewer pipe.
1. Maximum repairable size hole above the spring line shall be three inches in diameter. It shall be repaired using a repair coupling. Coupling shall extend a minimum of six inches beyond the edge of damage. Only one repair coupling is allowed between new manholes.
 2. All other damage (i.e., cracks, holes in pipe line, or crushed pipe) shall be repaired by replacement of the damaged section. To repair this type of damage, vertical plane cuts shall be made a minimum of one foot beyond the extremity of the damaged section. A replacement section shall then be installed such that the joint gap at either end shall be no more than one-eighth of an inch. Replacement section will then be clamped. If damage is in joint at manhole, then the entire joint shall be replaced.

3. All clamps shall be full circle and made of stainless steel and have a minimum width of 12 inches.
 4. All excavation shall be performed to afford proper protection to line while repair is made.
 5. Location of sanitary sewer pipe repairs will be made part of the as-built records.
 6. Location of each repair will be measured from the manhole on each side of repair.
 7. Type of repair situation will be noted.
 8. When pipe is required to be removed and replaced, the location of the repair clamps used will be noted on the as-built plans.
 9. Engineering Services shall be notified 48 hours in advance of making repairs so an inspector can be scheduled. Corrections made without notification will not be accepted.
- B. The Authority shall be responsible for informing owner/developer as to the approved method of repair.

PART THREE - STRUCTURAL

A. General

Structural design of sewers shall conform to methods set forth in the ASCE Manual No. 37, for the Design and Construction of Sanitary and Storm Sewers, except as modified hereafter.

- END OF SECTION -

SECTION 2731

SANITARY SEWER COLLECTOR LINES AND FORCE MAIN

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Furnish all labor, materials, tools and equipment necessary to install, backfill and test all sanitary sewer collector lines and associated structures in accordance with the Drawings and as specified herein.
- B. Related work specified elsewhere:
1. General Water and Sewer Specifications – Section 2000
 2. Clearing and Grubbing - Section 2110
 3. Rock Excavation - Section 2230
 4. Erosion and Sediment Control - Section 2270
 5. Stream and/or Highway Crossings – Section 2310
 6. Horizontal Directional Drilling (HDD) Methodology – Section 2670
 7. Seeding and Mulching - Section 2900
- C. General Conditions – Any reference to General Conditions refers to EJCDC C-700 Standard General Conditions of the Construction Contract (latest edition).

PART TWO - PRODUCTS

2.1 STRUCTURAL REQUIREMENTS

- A. Structural Design of Sewers: Structural design of sewers shall conform with the methods given in the ASCE Manual Number 37 - "Design and Construction of Sanitary and Storm Sewers". In the use of this manual, backfill weight shall equal 130 pounds per cubic feet and K_u shall be 0.130. The live load for sewers subject to traffic effect shall be determined from a minimum wheel load equivalent to an H-20 loading (16,000 pound wheel load). An allowance of fifty percent (50%) of the design wheel load shall be added for impact. A minimum wheel load of 10,000 pounds per wheel shall be applied to all other sewers not subject to traffic load. Ultimate lengths of rigid pipe shall be measured in terms of ultimate three-edge bearing strength divided by a safety factor of 1.5. Allowable load shall be working strength times a 2.5 load factor for concrete cradle or arch bedding and times a 1.9 load factor for Class B gravel bedding condition.

2.2 SEWER PIPE AND MATERIALS

- A. General: All sanitary sewer pipe installed on this project shall conform to the type, classification, and sizes as shown on the Drawings and as described in the Specifications. The pipe materials listed below have been approved for use by the Authority. However, the acceptability of specific pipe material for use within a specific soil type or condition shall be determined by the Utility Engineer on an individual basis at the time of design review of the Contract Documents. The type or types of pipe allowed for use on any specific project shall be shown on the approved construction drawings.

1. One type and class of pipe shall be used from manhole to manhole unless approved in writing by the Utility Engineer. Any changes in size, kind, type and class of pipe being installed shall be made at manholes only.
2. Pipe plugs shall be of the same material as the pipe. The cost of furnishing and placing pipe plugs shall be included in the unit prices bid for furnishing and installation of pipe and pipe stubs.

B. Pipe Material:

1. Ductile Iron Pipe: Ductile iron pipe shall be centrifugally cast manufactured in accordance with ANSI Specification A21.51, latest revision, and shall be cement mortar lined in accordance with ANSI Specification A21.4-80. Slip joint or mechanical joint pipe shall be used for gravity sewers. Slip joint pipe shall be designed in accordance with ANSI standard A21-50 and specified according to ANSI standard A21-11. Class 51 pipe shall be minimum strength used in all sewer applications. May only be used upon approval of Utility Engineer. Gaskets shall be furnished by the manufacturer and installed in accordance with his recommendations. Ductile iron pipe shall be used in exposed pipe installations, and where approved by the Utility Engineer when other pipe materials are subject to crushing.
2. Polyvinyl Chloride (PVC): PVC sewer pipe shall be manufactured in accordance with ASTM Designation 3034-77 (SDR 35). Gravity sewer pipe shall be unplasticized polyvinyl chloride with integral rubber ring wall bell and spigot joints furnished in 12.5' and 20' nominal lengths. Installation of PVC gravity sewer pipe and fittings shall be in accordance with ASTM Designation 2321 and manufacturer's recommendations.
 - a. PVC sewer pipe shall be stored in accordance with manufacturer's recommendations on flat, even surfaces and shall remain racked on the pallets as delivered to the job site until such time as the trench is ready for placement of the pipe; i.e., PVC pipe shall not be strung out on the job site in excess of one day's work.
 - b. The Utility Engineer may require additional strength PVC pipe including SDR-26, SDR-21, DR-18 or concrete encasement of SDR-35, or both where depth exceeds twelve feet (12') and where additional protection is required for the pipe.
3. PVC (Ribbed Pipe): Ultra-Rib pipe meeting ASTM F-794 with a stiffness factor of 46 may be used on Authority projects. Installation shall be in strict compliance with manufacturer's written instructions. All fittings used shall be designed specifically for pipe used and be approved for use by same manufacturer of pipe. Connections to manholes shall be made by manufacturer's recommended methods and approved by Utility Engineer.
4. PE Pipe: Polyethylene plastic pipe shall be high density polyethylene pipe which meets the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on Outside Diameter, and ASTM D3350 cell classification 345464E.

- a. All pipes shall be made of virgin material. No rework except that obtained from manufacturer's own production of the same formulation shall be used.
- b. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
- c. Dimension Ratios: The minimum wall thickness of the polyethylene pipe used as gravity sewer line shall be a minimum of SDR 17. Additional strength pipe material may be required for deep sewer lines.
- d. For sewer installations pipe material color shall be white, black or whatever is specified with interior of pipe having a light reflective color to enhance viewing for television inspection.
- e. PE pipe for sewer installations of four inch (4") diameter or larger shall be straight pipe sections of 40' or shorter. Rolled pipe is not approved for use by the Authority.
- f. All service line connections to PE pipe shall be made using a fused service saddle. No direct tap to PE pipe shall be permitted.
- g. PE pipe shall be assembled and joined at the site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections shall not be permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations.
- h. Qualifications of Personnel: HDPE pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the HDPE pipe. Training shall be performed by a qualified representative
- i. Butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. Joint shall be allowed adequate cooling time before removal of pressure. Fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the OWNER and/or his representative prior to insertion. All defective joints shall be cut out and replaced at no cost to the Authority. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the OWNER and/or his representative shall be discarded and not used.

5. Sanitary Sewer Force Main: Sanitary sewer force main shall be constructed of SDR-21 PVC pipe, AWWA C900 DR-18 PVC pipe or Class 51 ductile iron pipe and be joined with push-on joints as indicated on Drawings. High-density polyethylene (HDPE) DR-11 pipe is also acceptable for sewer force mains. HDPE pipe joints shall be connected using heat fusion, electrofusion, thermal welding and flanges in conformance with manufacturer's recommendations. Restraint joints shall be used for all bends and fittings. All valves, fittings, and other related appurtenances shall be rated for a minimum working pressure of 150 lbs. per square inch (PSI).

- C. Air Release Valve: Force main vacuum/air release valve shall be Crispin Model S20 or equal with a 1/2" orifice and 2-inch screened inlet furnished with backflushing attachment.

- D. Bedding: Bedding, haunching, and initial backfill construction shall be in accordance with the manufacturer's recommendation. All PVC pipe shall be bedded in compacted granular material. Haunching of pipe shall be accomplished with compacted granular bedding, which shall extend at minimum to the spring line of the pipe barrel. Granular material shall be well-graded, crushed stone meeting the requirements of VDOT gradation 57 or 68 stone.

- E. Service Connections: Polyvinyl chloride (PVC) sewer pipe conforming to ASTM Designation 3034-77 (SDR-35); or Schedule 40 PVC pipe conforming to ASTM Designation 1785-76 shall be used between the sewer main and the cleanout. SDR-21 PVC pipe shall be used where additional strength pipe is required.
 1. The PVC SDR 35 joints shall be made with bonded-in-bell elastomeric seal. Schedule 40 PVC joints shall be made with a solvent weld bell and spigot joint using PVC pipe cleaner and glue as supplied by the manufacturer.
 2. No-hub pipe shall not be permitted.
 3. There shall be no bends in service line from main to cleanout except as indicated on approved Utility Engineer Sewer Detail Drawings.

- F. Hydraulic Cement Mortar and Gravel: Cement mortar and grout shall consist of a mixture of hydraulic cement, fine aggregate, water and admixture.
 1. Cement shall be Portland Cement Type I or II.
 2. Fine Aggregate Grade C shall be used.
 3. Water used with cement or lime shall be clean, clear, and free of oil, acid, salt, alkali, organic matter or other deleterious substances.
 4. Admixtures shall conform to Section 217 of VDOT Specifications.
 5. Hydraulic cement mortar and grout shall contain from 3 to 7 percent entrained air. Air entrained cement may be used in lieu of plain cement and air entraining admixture. Mortar and grout shall be mixed with a minimum amount of water necessary to obtain required consistency. Mortar and grout shall be properly cured and protected for not less than three (3) days.

- a. **Cement Mortar** shall consist of one part hydraulic cement, 2 1/2 parts fine aggregate by weight and sufficient water to produce a stiff mix. Grade C Fine Aggregate shall be used.
- b. **Non-Shrink Mortar** shall consist of one part hydraulic cement, 2 1/2 parts fine aggregate by weight, a set retardant or other admixture which will reduce the amount of required mixing water and sufficient water to produce a stiff mix. Grade C Fine Aggregate shall be used.
- c. **Cement Grout** shall consist of one part hydraulic cement, 2 parts fine aggregate by weight and sufficient water to produce a free flowing mix. Grade A fine aggregate shall be used.
- d. **High Strength Grout and Mortar** shall consist of a prepackaged, non-shrink hydraulic cement mixture with a 7-day compressive strength of at least 4,000 psi when tested in accordance with ASTM C109 and with a 7-day bond strength of at least 1,000 psi when tested in accordance with VTM-41, except that epoxy will not be used to develop the bond.

PART THREE - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. All construction of sanitary sewer mains and appurtenances in the Authority shall be in strict accordance with plans and specifications prepared as part of the Contract Documents and as approved by the Authority. All materials shall be new and unused. Prior to construction of the approved sanitary sewer, Contractor shall provide field stakeout including adequate line and grade stakes in order that sanitary sewer and appurtenances may be constructed in accordance with Contract Drawings.
- B. Engineer or surveyor shall prepare legible cut sheets at all manholes and midpoints of pipe between manholes indicating all pertinent construction data to include sewer service connection locations, concrete encasement or cradle, manhole invert and top (frame and cover elevations). Three sets of all cut sheets shall be submitted to the Utilities Engineer Office for review.

3.2 EXCAVATION

- A. Dewatering equipment shall be sized to maintain the trench in a satisfactory dewatered condition suitable for pipe laying and backfilling. Pipe laying will be permitted only where the depth of water is maintained below the bedding material. Bedding material shall not be placed on unstable trench material.
- B. Excavation at manholes and similar structures shall provide a minimum clearance of eighteen inches (18") between the outer surface of the structure and the embankment or sheeting.

3.3 BACKFILL

- A. Manholes and cleanouts shall be backfilled in same manner as the sewer pipe.

3.4 PIPE INSTALLATION

- A. All gravity sewer mains, service laterals and force mains shall have a minimum cover of three feet (3') as measured from top of pipe to finish grade. The utility Engineer may require additional cover as needed for pipe protection. Sewers, which have a depth of cover less than three feet (3'), shall be approved and installed as per the Utility Engineer's written instructions.
- B. All pipe and fittings shall be carefully handled with non-metallic slings or other approved devices to prevent damage to protective coatings or joints. Lifting equipment shall be satisfactorily rated to handle the pipe sizes used. Pipe shall not be dumped or dropped into trench. Each section of pipe shall be thoroughly inspected for defects before being lowered into the trench.
- C. Pipe shall be laid true to line and grade with bells upstream and shall be jointed together such that the completed pipe will have a smooth invert. Pipe shall be pushed home by hand. The use of equipment (i.e. backhoe) shall not be permitted. Cutting of pipe shall be performed by sawing. Standard bedding shall be shaped to the curvature of both the bell and barrel of the pipe. The trench shall be kept free of water while the work is in progress. The ends of the pipe shall be cleaned so that proper joints can be made. As the work progresses, the interior of the pipe shall be cleared of dirt, cement, or other deleterious material.
- D. Except as required for use of a laser level, exposed end of all pipe and fittings shall be fully closed to prevent earth, water or other substances from entering pipe. Trench shall be completely backfilled at end of each workday. When new pipe is tied into an existing manhole, new pipe shall be plugged with a standard sewer plug and shall remain plugged until all new line(s) that will flow to existing manhole have been completed, tested, and accepted.
- E. Locator wire shall be installed with all force main PVC pipe. Refer to Detail Drawings. Minimum wire shall be U.S. standard gauge 12 solid copper, however Authority may require heavier gauge wire in depths of greater than 6'.

3.5 BY-PASS PUMPING DURING SEWER LINE INSTALLATION

- A. Contractor shall be responsible at all times for maintaining sewer flows during project to include any required by-pass pumping of wastewater between manholes during installation of sewer lines and/or manholes. By-pass pumping system shall provide continuous full conveyance and containment of wastewater present during the work and shall not surcharge the upstream (suction) manhole by more than two (2) feet above the manhole invert. Contractor shall be liable for any damage caused by backups or overflows.
- B. Contractor shall furnish all pumps, pipe, fittings, plugs, etc. required to perform by-pass pumping operation. Backup or replacement pumping equipment shall be available to the project site to ensure that continuous by-pass pumping can be provided. All pumping equipment shall be provided with sufficient mufflers to prevent excessive noise.
- C. Authorization from the ENGINEER shall be required to utilize by-pass pumping overnight or during the weekends. In the event it is not possible to temporarily reconnect sewer lines at the end of the work day or over week-ends, Contractor

shall be responsible for operating and maintaining by-pass pump operations around the clock to insure continued conveyance of existing wastewater flows.

- D. By-pass pumping shall not be diverted to another sanitary sewer system without the approval of the ENGINEER.
- E. A by-pass pumping plan shall be submitted for approval prior to beginning the work. This plan shall outline the by-pass pumping procedures and include the capacity and components of all by-pass pumping equipment.

3.6 TRENCH DEWATERING DURING SEWER LINE INSTALLATION

- A. All ground water which may be found in the trenches and any water which may get into them from any cause whatsoever shall be pumped or bailed out so that the trench shall be dry during the pipe laying period. No water shall be permitted to reach concrete until it has set sufficiently. All water pumped from the trenches shall be disposed of in a manner satisfactory to the OWNER. CONTRACTOR shall provide at least two (2) pumps for each trench opened in wet ground and at the same time, he shall have one (1) pump in reserve.
- B. If, during any time that CONTRACTOR is permitted to lay pipe in a trench containing unavoidable trench water and construction is interrupted for any reason, the open ends of pipe shall be closed by watertight plugs or caps, or other means approved by the OWNER. In any case, such protection shall be provided when work is suspended overnight or on weekends and holidays, regardless of the condition of the trench with respect to water at the time that the work is suspended.
- C. CONTRACTOR shall be responsible for the protection of all structures, including pipes and manholes, against any tendency to float under conditions of high water, whether due to high ground water or flood conditions on the project site. It shall be the responsibility of the CONTRACTOR to take whatever steps may be required, including the installation and operation of pumps and pumping systems, well points or relief devices, to prevent any structure from floating during construction.
- D. Cost of the necessary pumps, well points or other appurtenances required to prevent flotation shall be included in the unit prices bid in the Proposal for the various bid items, and no extra compensation shall be allowed for such work. Any damage which may occur to any part of the work as the result of the flotation effect of ground or flood waters shall be repaired in a manner fully satisfactory to the OWNER, at no additional cost to the OWNER.
- E. CONTRACTOR shall provide and place all necessary flumes or other channels of adequate size to carry temporarily all streams, brooks, stormwater or other water, which may flow along or across the lines of the pipe line. All flumes or channels thus utilized shall be tight so as to prevent leakage into the trenches. Water pumped from trenches shall be led to natural watercourses. Existing sewers shall not be employed as a drain for the removal of dewatering wastes.

3.7 SERVICE CONNECTIONS

- A. SDR 35 and schedule 40 PVC pipe lateral service connections to the sewer main shall be made by means of a commercially manufactured tee, wye, or wye branch. Service laterals may also be connected to the sewer system at a manhole using inside drop connection. A sewer cleanout the same size as the service line shall

be installed in accordance with the Detail Drawings. Pipe material shall be of the same type to and including the cleanout stack.

- B. All taps to an existing manhole or pipe will be performed by the Authority or may be performed by contractor if approved and inspected by the Authority. A minimum of 48 hours notification is required by the Authority when scheduling sewer taps.
- C. Sewer service line shall be four inches (4") minimum for residential service and six inches (6") minimum for non-residential service. Sewer cleanouts shall be same size as service line and shall be installed per the Utility Engineer Sewer Detail drawing. Additional sections of pipe shall be installed behind cleanout as indicated on detail drawings to prevent conflict with other utilities generally located in this area.
- D. Sewer service connections from manhole or sewer main to the cleanout shall be installed with the same care as the sewer main. Proper excavation, slope of pipe and standard granular bedding shall be provided throughout. All gravity sewer mains and service laterals shall be air tested. For air testing procedures see Section 3.11.
- E. No connection shall be made to the vertical portion of a cleanout except for private force main. Refer to Sewer Detail Drawings for specific requirements including the use of Schedule 40 material.
- F. All sewer service connections or portions of sewer service connections outside of the public right-of-way or sewer easement shall be privately owned and maintained.
- G. A sampling manhole, which conforms to Detail Drawings, shall be installed on sewer service lateral for all non-residential facilities. Manholes may be installed at property line in lieu of cleanout or between cleanout at the property line and the facility. Sampling manholes shall be tested by either vacuum method or exfiltration.

3.8 INTERCEPTORS/SEPARATORS

- A. Grease interceptors shall meet the requirements of the Authority's FOG Policy.

3.9 MANHOLES

- A. Only precast manhole sections shall be used. Manholes shall be constructed with manhole frames, covers and steps. Frames and covers shall be in conformance with S-05 and S-06. Bolt-down covers are to be used in areas subjected to flooding or as directed by Authority.
- B. Casting shall be best quality tough, gray iron, free from defects, blow holes, and other imperfections and shall meet the requirements of ASTM Designation A-48, Class 35 and current edition of AASHTO M 306. The castings shall be sound, free to form and thickness, cleaned by means of sand blast and neatly finished. The material bearing surfaces shall be machine ground and finished to insure satisfactory seating. Covers shall have the words "Sanitary Sewer" cast into the top. Castings shall receive one coat of black asphaltum paint at the factory. Locations and type of manhole vents will be as indicated on the Drawings.

- C. Covers shall be furnished with means of lifting. Covers that rock under normal load, will be rejected. Frames shall be bolt-down type, with butyl mastic sealer placed between frame and manhole. Mortar shall not be permitted. Frames shall have a nut and washer installed on top and bottom to facilitate minor elevation adjustments. The adjustment space between the bottom of the frame and the top of the manhole section shall be formed and filled with 3000 psi concrete.
- D. Steps for manholes shall be made of fiberglass construction, cast iron, or steel and shall have a plastic coating. Steps shall be spaced 16 inches (16") apart. The first step shall be within 12 inches (12") of the cover. The bottom step shall be within 24 inches (24") of the bottom of the manhole.
- E. Precast concrete manholes shall consist of precast reinforced concrete sections, an eccentric conical section and a standard base section with poured uniform bottom inverts. Flat top manholes can be used only with approval of the Authority. Where soil conditions dictate their use, expanded base section, extending a minimum of four inches (4") and a maximum of eight inches (8") beyond the outside vertical wall (riser section) of the manhole shall be used. Manhole shall be installed with steps vertically aligned over manhole bench. Access hole in flat top manhole section shall be centered over manhole steps.
- F. Precast base section shall be installed on a compacted stabilized foundation of bedding material foundation prepared similar to that required for the proper installation of the adjacent sewer pipe as described elsewhere in these Specifications.
- G. Precast manhole sections shall be manufactured in accordance with ASTM Designation C478, latest revision. Each section shall have not more than two (2) holes for the purpose of handling and setting. These holes shall be tapered and shall be plugged up with rubber stoppers and an approved non-shrink grout after installation.
- H. A cold applied butyl mastic joint sealer manufactured specifically for the purpose or other approved gasket material in accordance with ASTM C443 and meets ASTM C1244 testing standards shall be used to make a watertight joint between manhole sections and/or grade rings. Mortared joints are not permitted. All new manholes shall be pre-cast concrete inverts except straddle manhole.
- All straddle manhole and all field-constructed inverts shall be with ready mix (3000 psi) concrete and shall only be used with approval of Utility Engineer.
- I. Standard manhole drop connections shall be installed where indicated on the drawings. Drop connections shall conform to the Detail Drawings.
- J. The invert channels of the manhole shall be smooth and semi-circular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Invert benches shall be constructed of ready mix concrete (3,000 psi) over the entire existing bench.
- K. The invert channel shall be at least 0.75 times the diameter of the pipe in depth. The minimum difference in elevation of inverts of incoming and outgoing pipes shall be 0.10 feet.

- L. Where grade rings are required to meet specified grade, the maximum height/thickness and minimum number of rings shall be used. Cone sections and grade rings shall be predrilled with matching holes to accept threaded rod installation. Refer to Detail Drawings.

3.10 PIPE CONNECTION AT MANHOLES

- A. All new manholes shall be supplied with an approved flexible boot connection suitable for specified pipe and manhole. All rubber boots for 8 inch (8") pipe shall have a maximum flexibility of 24° in any direction from center. Boot flexibility for pipe sizes larger than 8 inch (8") shall be per the manufacturer's recommendations. Twenty inch (20") and larger pipe connections shall have the first joint located four feet (4') from the inside face of the manhole. Flexible joint manhole connection shall be as manufactured by Pres-Seal Gasket Corporation, Fort Wayne, IN; or approved equal.
- B. Manhole to pipe installation procedures shall be as follows:
 - 1. After manhole has been set to line and grade, inspect flexible connector boot for damage and clean out inside of boot. Clean surface of pipe barrel to be installed.
 - 2. Insert pipe into connector boot until end of pipe breaks plane of manhole wall and flush with manhole invert. Position pipe in center of connector.
 - 3. Install stainless steel band(s) in groove(s) at pipe receiving end of boot and tighten clamps to 60 in/lbs. of torque **PRIOR** to adjusting pipe to desired angle of deflection.
 - 4. After desired deflection angle of pipe has been achieved, install bedding and backfill material in accordance with these Specifications.
- C. Precast manhole sections shall be manufactured for the specified size, angle and number of pipe connections required. Field modification or abandonment of any part of a precast manhole will not be permitted without written approval of the Authority. Any approved field modification(s) or repairs shall be performed by a qualified person(s) approved by the manufacturer.
- D. Inside of manholes (walls, steps, invert, pipe connections, benches) and frame and cover shall be kept clean and free of dirt, stone, mastic, trash and construction materials. Manholes shall be cleaned prior to testing.
- E. Abandonment of manholes and sewer lines shall be performed in accordance with the Detailed Drawings.
- F. A rubber water stop shall be used around pipe at manhole connection of straddle manhole. Refer to Detail Drawings.

3.11 ACCEPTANCE TESTS

- A. General
 - 1. Sewers will be inspected to determine if any deviation from line and grade have occurred. Pipe alignment will be checked by illuminating interior of pipe. If pipe shows poor alignment, displaced pipe, or any defect, including

a visible leak, defect shall be corrected before leak testing of the pipe. All sewer lines are subject to internal inspection and testing by closed circuit TV at the Authority's discretion.

2. Air testing shall be used; test methods and acceptability criteria shall be in accordance with the Uni-Bell low pressure air test. Air testing of gravity lines shall be required for all types of pipe and materials.

B. Manhole Acceptance Tests

1. Manholes, including frame, shall be tested by vacuum testing (ASTM C1244-05) from the top of the frame. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested including any vent line. The stoppers shall be positioned in the lines far enough from the manhole to insure testing to those portions of the lines not air tested. Vacuum tests shall be made with a vacuum of 10" Hg. The time for the vacuum to drop from 10" to 9" of Hg must be greater than 60 seconds.
2. Contractor shall furnish weirs, stand pipes, pipe plugs, water, pressure gauges, stop watches, air compressor, vacuum pump, hose and such materials and assistance as required to perform these tests. All acceptance tests shall be conducted by Contractor in the presence of an Authority Inspector.
3. Acceptance tests shall not be made until sanitary sewer, manholes and proposed sewer service connections, as shown on the approved sewer plans, have been installed, the sewer trenches (including manholes and cleanout stacks) backfilled and compacted to finished sub-grade.
4. Contractor shall schedule all acceptance tests with the project inspector at least forty-eight (48) hours in advance. Each section of completed sewer shall be tested from manhole to manhole. No sewers or sewer service connections are to be excluded from this testing procedure.

C. Sewer Pipe Testing Procedures

1. Whenever it is necessary to construct underdrains or place gravel under pipe lines in order to dewater trench during construction of sewers, acceptance test will not be made until any pumps, which have been used in dewatering process, have been disconnected or drains have been taken out of service.
2. Contractor shall schedule all acceptance tests with the Authority at least forty-eight (48) hours in advance. Each section of completed sewer shall be tested. Generally, sewers will be tested from manhole to manhole. No sewer or sewer service connection is to be excluded from this testing procedure.
3. Low Pressure Air Testing Procedure - The test procedure shall be conducted in the following manner: (Vacuum test of manholes is generally inverse of low pressure air test of sewer lines)
 - a. PVC and PE – ASTM F1417-92(2005)
Ductile iron pipe – ASTM C924 and C828

- b. Contractor shall thoroughly clean and remove all debris, silt, earth or other materials from the sewer prior to acceptance testing.
- c. Proper test plugs shall be supplied and installed by Contractor. Test gauges used in air test procedure shall have a range of 0-10 psi and shall be calibrated in divisions of 0.10 psi with an accuracy of +/- one percent. Test gauges shall be calibrated at least once a year and the date and results displayed on the equipment including date of calibration. Calibrations shall be certified by an independent testing lab. Test gauges shall be located outside of manhole during testing.
- d. If pipe to be tested is expected to be below ground water table, Contractor shall either:
- Install a small diameter perforated vertical pipe from invert elevation of the sewer to the surface prior to backfilling; or
 - Insert a pipe probe by boring or driving into the backfilling material adjacent to the invert elevation of the pipe, and determine the depth of the ground water level above the pipe invert immediately prior to acceptance testing the sewer.
 - All gauge pressures for test shall be increased by the amount of this back pressure due to ground water over the invert of the pipe.
 - In lieu of the above water depth determination, Contractor may add three (3) psi to the gauge pressure in the test.
- e. Contractor shall add air slowly to the portion of the pipe under test until the internal air pressure is raised to 4.0 psi gauge plus the ground water pressure.
- f. As a safety precaution, no one shall be allowed in manhole after air pressure is increased in the sewer line.
- If the inspector suspects that the test plug may be leaking, pressure shall first be relieved before any adjustments are made to eliminate air leakage at the plug.
- g. Contractor shall allow air temperature to stabilize for at least two (2) minutes with the pipe subjected to an internal pressure of 4.0 psi by adding only the amount of air required to maintain the pressure between 3.5 and 4.0 psi.
- h. After temperature stabilization, the test will begin. If the internal air pressure decreases, the time required for the pressure to drop from 3.5 to 2.5 psi gauge will be observed and recorded. The time interval shall be compared with the established standards in accordance with S-28 or S-29 for time and length of test section for various diameters of the sewer. All pipes 15 inches or less shall be tested for a pressure drop of 1.0 psi gauge.
- i. Pipe which fails to maintain the stipulated pressure for a period equal to or greater than the holding time shown in the above

referenced tables shall be deemed to have failed the low pressure air test and is unsatisfactory for acceptance by the Authority. Any sewer that fails to pass this test **shall be replaced by the Contractor at his expense.** A single coupling or pair of repair clamps shall be allowed between manholes to facilitate replacement of defective materials or workmanship.

4. Sewer Force Main Testing Procedure – Sewer force mains shall be hydrostatically tested per AWWA 605-94 at 150% of the design operating pressure or a minimum pressure of 50 psi for 30 minutes. Allowable leakage shall be the same as established for water pipe lines in the Western Virginia Water Authority Regulations.

5. TELEVISION INSPECTION OF SEWER LINE:

A. General: Television inspection of sewer pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit color television. Television inspection shall include the following:

1. Video tapes (post installation) to be submitted to the Authority prior to processing of final invoice.
2. Videotapes to remain property of the Authority; CONTRACTOR to retain second copy for his use.
3. All flows tributary to reach of sewer being inspected are to be completely by-passed around the reach during video inspection, if necessary and/or required by the Authority.
4. Post construction videotape footage shall be taken upon completion of reconstruction of each reach of sewer with the voice description, as appropriate, and with stationing of service connections indicated. Data and stationing shall be indicated on video.
5. Should any portion of the inspection tapes be of inadequate quality or coverage, as determined by the Authority, CONTRACTOR shall have the portion re-inspected and video taped at no additional expense to the Authority.

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SECTION 2000

GENERAL WATER AND SEWER SPECIFICATIONS

PART ONE - GENERAL

1.1 QUALITY ASSURANCE

- A. Standards: Comply with all standards specified in this Section and as listed in General Conditions 6.03.
- B. Qualifications of manufacturers: Products used in this Work shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of quality production acceptable to the OWNER.
- C. Qualifications of installers: Use experienced workmen to ensure proper installation of the products specified herein. In the acceptance or rejection of installed Work, no allowance shall be made for the lack of experience on the part of the workmen.
- D. Main line construction can only be performed by contractors licensed by the state of Virginia.

1.2 LINES AND GRADES

- A. Pipes shall be laid true to the lines and grades as shown on the Drawings except as authorized by the OWNER/ENGINEER. The grade shown on the profile is the invert to which the work must conform. Work not conforming to the grade shall be corrected by the CONTRACTOR at his own expense in a manner acceptable to the ENGINEER.
- B. Locations of water and sewer lines:
 - 1. The locations of the proposed lines are shown on the Drawings.
 - 2. The OWNER/ENGINEER reserves the right to make changes in lines and grades of pipe lines, and in locations of pipes and/or appurtenances when such changes may be necessary or advantageous.

1.3 SUBMITTALS

- A. General: All submittals shall be made in accordance with Section 6.17 of the General Conditions. CONTRACTOR shall furnish engineering data covering design and installation. Submittal shall be made in a timely manner so that the project schedule can be met.
- B. Shop drawings: As a minimum, the following shop drawing information shall be submitted to the OWNER for review and approval:
 - 1. Complete bill of materials to be provided for the work described under this Section.
 - 2. Manufacturer's catalog cuts for all materials to be provided under this Section.

1.4 RESPONSIBILITY FOR MATERIALS

- A. Material furnished by CONTRACTOR: The CONTRACTOR shall be responsible for all material furnished by him and shall replace at his own expense all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered defective prior to the final acceptance of the work.
- B. Material furnished by OWNER: The CONTRACTOR'S responsibility for material furnished by the OWNER shall begin at the point of delivery to CONTRACTOR. Materials already on the site shall become the CONTRACTOR'S responsibility on the date of the award of the Contract. The CONTRACTOR shall examine all material furnished by the OWNER at the time and place of delivery to him and shall reject all defective material. Any material furnished by the OWNER and installed by the CONTRACTOR without discovery of such defects will, if found defective prior to final acceptance of the Work, be replaced with sound material by the OWNER. The CONTRACTOR, however, shall, at his own expense, furnish all supplies, labor and facilities necessary to remove said defective material and install the sound material in a manner satisfactory to the OWNER.

1.5 PRODUCT HANDLING

- A. Handling of materials:
1. All materials furnished by the CONTRACTOR shall be delivered and distributed by the CONTRACTOR. Materials furnished by the OWNER shall be picked up by the CONTRACTOR at points designated by the OWNER and hauled to and distributed at the site.
 2. Pipe, manholes, appurtenances, etc., shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
 3. In distributing the material at the site of work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.
 4. Pipe shall be so handled that any coating and lining shall not be damaged. If, however, any part of coating or lining is damaged, repair shall be made by CONTRACTOR at his expense in a manner satisfactory to the OWNER.
- B. Storage of Materials: CONTRACTOR shall be responsible for safe storage of material furnished by or to him, and accepted by him, and intended for the Work, until it has been incorporated in completed Project. Interiors of all pipes, fittings and other accessories shall be kept free from dirt and foreign matter at all times.
- C. Damaged Material: Any material furnished by OWNER that becomes damaged by CONTRACTOR after acceptance shall be replaced by CONTRACTOR at his expense.

1.6 COMPLIANCE WITH UNDERGROUND UTILITY DAMAGE PROTECTION ACT

CONTRACTOR shall be responsible for notifying "Miss Utility" a minimum of 48 hours prior to any excavating operations. CONTRACTOR shall be aware of and comply with all provisions of the Virginia Underground Utility Damage Protection Act as enforced by the State Corporation Commission.

1.7 COMPLIANCE WITH VA DEPARTMENT OF TRANSPORTATION STANDARDS

CONTRACTOR shall be aware of and comply with all provisions of the locality and Virginia Department of Transportation (VDOT) as contained in the latest editions of the VDOT Road and Bridge Specifications, VDOT Road and Bridge Standards, VA Work Area Protection Manual and VDOT Land Use Permit Manual.

1.8 ALTERNATIVES

Type of pipe material used in construction of the specified water or sewer pipeline shall be at CONTRACTOR'S option unless a specific type of pipe is required by note on the Drawings.

1.9 WARRANTY

All Work, including equipment and materials, shall be warranted to be free from defects in materials and workmanship for a minimum of one (1) year following acceptance by the OWNER.

PART TWO - EXECUTION

3.1 EXCAVATION CLASSIFICATIONS

- A. All excavated material shall be classified as either rock or earth excavation. The estimated quantity indicated for Rock Excavation in the Bid Form, if included, shall be the amount of rock expected to be encountered by the Contractor. The remainder of the excavation shall be assumed to be Earth Excavation, which shall be included in the unit price for installing the pipe complete-in-place.
- B. Rock excavation, if included in Bid Form, shall include boulders measuring one-third (1/3) cubic yards or more in volume and weighing more than eight hundred (800) pounds. Also included are solid ledges, bedded deposits, unstratified masses and conglomerations of materials so firmly cemented as to possess characteristics of solid rock, which cannot be removed without systematic drilling and blasting. Sidewalk, curb and gutter, paving and structures to be removed shall not be classified as rock.
- C. Rock excavation shall be defined and performed in accordance with Section 2230 – ROCK EXCAVATION.

3.2 GENERAL REQUIREMENTS

- A. Contractor shall provide all labor, equipment and material and perform all work required for installation of sewer and/or water lines, manholes and appurtenances

as outlined on Drawings and on Specifications, all of which become part of the Contract Documents.

- B. If any deviation is contemplated in location or line grade of any sewer, water line, structure or appurtenance as shown on the Contract Drawings, a revision of the Drawings showing the proposed deviation shall be submitted to the Utility Engineer for review and approval before any changes are constructed. Design Engineer of Record must concur in any revision of drawings. Minor field changes may be made with approval of an Authority field inspector.
- C. Contractor shall be responsible for determining exact location and depth of all underground utilities, which are shown on the Drawings or marked on the ground. Contractor shall exercise care in determining the location of any underground utility to avoid damaging or disrupting utility service. If Contractor inadvertently damages any utility line or cable, he shall be responsible for immediately contacting the affected utility company and repair, or have repaired, the damage at his expense.
- D. Should Contractor discover and/or damage any underground utility facilities, which are not shown on Drawings and/or marked on the ground, Contractor shall promptly notify utility owner and Owner's project representative. Relocation of any utilities shall be approved and coordinated with the appropriate utility owner. Repairs shall be at the expense of the contractor.

3.3 EXCAVATION

- A. Excavation shall conform to the lines and grades shown on the plans. Trench shall be dug so that pipe can be laid to the alignment and depth required. Excavation shall not be carried below the established grades and any excavation below the required level shall be backfilled with suitable, thoroughly compacted granular bedding material.
- B. Contractor shall install all sheeting, bracing, shoring, sloping or benching necessary to perform the work, to protect existing structures and all excavations as required for safety, in conformance with all local, state and federal safety regulations. Contractor shall comply with OSHA Subpart P, Excavations 29 CFR 1926.650, .651 and .652. Compliance with provisions of the Overhead High Voltage Line Safety Act is required.
- C. Trenches are not to be left open overnight unless adequate safety precautions are taken. The width of excavation for trenches shall be a minimum of 24" plus the outside diameter of the pipe. Where consistent with safety and space considerations, excavated material is to be placed on uphill side of trenches. Pipe shall not be strung along trench in excess of that which can be installed each day.
- D. Not more than one hundred fifty feet (150') of trench shall be opened in advance of the completed pipe laying.
- E. Wherever foundation material is unsuitable, it shall be excavated until a stable foundation is achieved. Granular material, VDOT stone type 21A, shall then be placed in six inch (6") layers and compacted until the trench bottom has been stabilized. Standard granular pipe bedding material shall be placed in accordance with Section 2731 Sanitary Sewer Collection Lines and manufacturer's specifications.
- F. Trench shall be excavated to depth required so as to provide a uniform and continuous bearing support for pipe on solid and undisturbed ground at every point between bell

holes, except that it will be permissible to disturb and otherwise damage finished surface over a maximum length of eighteen inches (18") near middle of each length of pipe by withdrawal of pipe slings or other lifting tackle. Damaged area shall be refinished as near as possible. Any part of bottom of trench excavated below specified grade, shall be backfilled with approved materials, and be thoroughly compacted. Finished subgrade shall be prepared accurately by means of hand tools.

- G. Bedding shall be placed as required by the pipe manufacturer's written installation instructions.
- H. Bell holes shall be provided at each joint to permit the jointing to be made properly and to permit maximum bedding length.
- I. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") below and on each side of pipe and appurtenances being laid and any part or projection of such rock, or stone. Subgrade shall be made by backfilling with compacted gravel or clean selected soil (if approved by governing locality).
- J. No pipe shall be laid in water or when, in the opinion of the Authority, trench conditions are unsuitable. If the Authority is of the opinion that trench bottom consists of wet, washable material or is otherwise incapable of properly supporting the pipe or structures, such material shall be removed and replaced with proper bedding material in addition to the standard bedding required.
- K. All bedding and backfill placed from bottom of trench to one foot above the pipe shall be placed in 6" lifts; backfill in this area shall not contain stones or earth clods greater than one inch in diameter. No stone, rock, or earth clod larger than five (5) inches in its greatest dimension shall be used in the backfilling one foot above the pipe to the finished grade on any water or sewer facility. All bedding and backfill outside traffic areas shall be compacted to at least 90% of maximum theoretical density as determined by ASTM D 698; beginning at one foot above the pipe to finished grade, the backfill shall be placed in 10" lifts. All bedding and backfill located within traffic areas shall be compacted to at least 95% of maximum theoretical density as determined by ASTM D 698; beginning at one foot above the pipe to finished grade, the backfill shall be placed in 6" lifts. All backfill material shall be free of perishable material, frozen clods, sticky masses of clay and other unsuitable matter.
- L. Backfill and replacement in existing or proposed roads shall be executed in full accordance with requirements of the Virginia Department of Transportation, or other applicable local government standards. All materials excavated, but not used in backfilling, shall be properly removed and disposed of by the Contractor in an approved location provided by the contractor.

3.4 SEPARATION OF WATER LINES AND SANITARY SEWERS

- A. General - The following factors shall be considered to provide adequate separation:
 - 1. Materials and types of joints for water and sewer pipe;
 - 2. Soil conditions;
 - 3. Service branch connections into the water line and sewer lines;
 - 4. Compensating variations in the horizontal and vertical separations;
 - 5. Offsetting of pipes around manholes.

B. Parallel Installation

1. Normal Conditions - Water lines shall be laid at least ten feet (10') horizontally from a sewer line whenever possible, distance shall be measured edge-to-edge unless determined by the Utility Engineer to be unusual conditions.
2. Unusual Conditions - When local conditions prevent a horizontal separation described above, the following construction shall be used:
 - a. Bottom (invert) of water main shall be at least eighteen inches (18") above top (crown) of sewer.
 - b. Where this vertical separation cannot be obtained, sewer shall be constructed of AWWA approved water pipe, hydrostatically pressure tested in place without leakage prior to backfilling. Pressure test shall be 30 psi.
 - c. Sewer manhole shall be made 100% water-tight construction and tested in place by vacuum testing to top of manhole cover frame without leakage for 30 minutes.
3. No drinking well shall have a sanitary sewer line within 50' unless adequate protection is provided in accordance with B.2.b above.

C. Crossing

1. Normal conditions - water lines crossing over sewers shall be laid to provide a separation of at least eighteen inches (18") between the bottom of the water line and the top of the sewer whenever possible.
2. Unusual conditions - when local conditions prevent a vertical separation as described above, the following construction shall be used:
 - a. Sewers passing over or under water lines shall be constructed of AWWA approved water pipe, hydrostatically pressure tested in place without leakage prior to backfill. Pressure test shall be 30 psi.
3. Water lines passing under sewers shall, in addition, be protected by providing:
 - a. Vertical separation of at least eighteen inches (18") between invert of sewer and crown of water line. Sewer shall be encased along its length where it is within 10' of water line.
 - b. Adequate structural support for sewers to prevent excessive deflection of joints and settling on and breaking of the water line.
 - c. Length of water line shall be centered at the point of the crossing so that joints shall be equidistant and as far as possible from sewer.

4. Sewers or Sewer Manholes. No water pipes shall pass through or come in contact with any part of a sewer manhole.
5. Other Utilities:
 - a. When other underground utilities (storm drains, gas, electrical, etc.) cross within six inches (6") above or below water lines, adequate structural support of the utilities shall be provided.
 - b. Water lines shall be placed over storm drains wherever practical.
 - c. Parallel installations shall have a minimum clearance of two (2) feet from edge of pipe to edge of other utility.

3.5 CARE AND RESTORATION OF PROPERTY

- A. All equipment shall be operated with care to prevent damage to existing structures and/or wires.
- B. On paved surfaces, the CONTRACTOR shall not use or operate tractors, bulldozers, or other power-operated equipment and treads or wheels which are so shaped as to cut or otherwise damage such surfaces.
- C. All surfaces, which have been damaged by CONTRACTOR'S operations shall be restored to a condition at least equal to that in which they were found immediately prior to beginning of operations. Suitable materials and methods shall be used for such restoration.
- D. CONTRACTOR shall replace and repair all lawns, terraces, shrubs, trees, plants, fences, sidewalks, curbs, cross walks, gutters, driveways, ditches, steps, mail boxes or pavements, and repair and make good all other damage, that may occur during construction work. CONTRACTOR will be held responsible for all damage that may occur after pipeline is constructed and which may be directly or indirectly attributed to operations as they are carried out. CONTRACTOR shall not operate equipment or store materials on private property without first having obtained written consent of property owner.
- E. CONTRACTOR'S attention is directed to importance of maintaining closed fences and/or gates on all property thus protected at present. In the event that fences are encountered in the line of the Project, or along rights-of-way, temporary fences shall be installed by CONTRACTOR before removal of existing fences. Temporary fences shall be installed totally on the Project easement near appropriate boundary of the right-of-way. Such temporary fence shall be of like quality and design as fence being replaced, and shall be maintained by CONTRACTOR in efficient condition until replaced by him with replacement fence. After construction has progressed beyond location of temporary fence, temporary fence shall be removed and permanent replacement fence, of quality and design at least equal to that existing, shall be erected on easement, in same location(s) as before construction.
- F. Wherever, with Property Owner's written permission, it is necessary that gates in fenced lands be opened, or used periodically, the CONTRACTOR shall use special caution to prevent the escape of, or damage to, livestock, horses, or other property thus now protected, including the installation of cattle-guard devices, if necessary.

- G. Damage to, or loss of, fenced property, real, live or other, shall be totally the responsibility of CONTRACTOR, and CONTRACTOR shall save harmless the OWNER and OWNER from any and all claims arising out of such damage or loss.
- H. NO ADDITIONAL COMPENSATION SHALL BE ALLOWED FOR TEMPORARY FENCES, THE COST OF WHICH SHALL BE INCLUDED IN RESPECTIVE UNIT PRICES BID IN PROPOSAL FOR VARIOUS DEPTHS AND SIZES OF PIPE INSTALLED. Upon completion of the construction, CONTRACTOR shall replace all the permanent fences on the rights-of-way or adjacent private property with fences of comparable type, size and construction as the original fences. NO ADDITIONAL COMPENSATION SHALL BE ALLOWED FOR REPLACEMENT OF PERMANENT FENCES, THE COST OF WHICH SHALL BE INCLUDED IN RESPECTIVE UNIT PRICES BID FOR THE VARIOUS DEPTHS AND SIZES OF PIPE INSTALLED.
- I. COMPENSATION FOR REPLACEMENT OF LAWNS, ORNAMENTAL SHRUBS, ETC., AND ANY ADDITIONAL WORK ARISING BY REASON OF CONSTRUCTION OF SEWER ON PRIVATE PROPERTY AND RIGHTS-OF-WAY SHALL BE INCLUDED IN RESPECTIVE UNIT PRICES BID FOR VARIOUS DEPTHS AND SIZES OF PIPE AND APPURTENANCES INSTALLED. UNLESS RESTORATION IS A SEPARATE BID ITEM, NO ADDITIONAL PAYMENT WILL BE MADE FOR REPAIRING PROPERTIES TO THEIR ORIGINAL STATE.
- J. Restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

3.6 PROTECTION OF EXISTING STRUCTURES, PRIVATE PROPERTY, AND RIGHTS-OF-WAY

- A. All existing pipes, poles, wires, fences, curbing, property-line markers, and other structures which, in the opinion of the OWNER must be preserved in place without being temporarily or permanently relocated, shall be carefully supported and protected from injury by CONTRACTOR, and in case of injury, CONTRACTOR shall notify the appropriate party so that proper steps may be taken to repair any and all damage done.

When owners do not wish to make the repairs themselves, all damage shall be repaired by CONTRACTOR, or, if not promptly done by him, OWNER may have repairs made at expense of CONTRACTOR.

- B. All utility services shall be supported by suitable means so that the services shall not fail when tamping and settling occurs. The CONTRACTOR must cover same in the unit price bid for sewer line construction.
- C. CONTRACTOR shall not be compensated for any additional work involved if utilities or underground structures cross trench line transversely above or below the sewer line.
- D. CONTRACTOR shall consult OWNER or his representatives prior to removing or disturbing any tree, shrub, bush, fence, sidewalk, building structure, or improvement that may be encountered in the line of the sewer line or in path of the easement, or right-of-way secured by the OWNER. Immediately upon completion of laying of necessary pipe, fittings, and appurtenances through each piece of private property,

CONTRACTOR shall backfill the trench, tamping same in a careful and workmanlike manner, replacing sod, lawns, bushes, shrubs, or whatever else may have been removed, disturbed or altered during progress of the work.

- E. Property corners, monuments, etc that are disturbed during construction shall be replaced by a surveyor licensed in the state of Virginia. UNLESS REPLACING PROPERTY CORNERS/MONUMENTS IS A SEPARATE BID ITEM, NO ADDITIONAL PAYMENT WILL BE MADE FOR REPLACING SURVEY REFERENCES.

3.7 AS-BUILTS

- A. Approved as-builts, completed by a licensed engineer or surveyor, are required prior to Substantial Completion.

- END OF SECTION -

SECTION 2110

CLEARING AND GRUBBING

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Perform all clearing and grubbing as specified herein. Such work includes but is not limited to the following:
1. Perform all clearing and grubbing necessary and required
 2. Site Clearing
 3. Tree and shrub removal and/or replacement
- B. Related work specified elsewhere:
1. Erosion and Sediment Control – Section 2270
 2. Water Distribution Lines - Section 2665
 3. Seeding and Mulching - Section 2900

1.2 PROTECTION

Streets, roads, adjacent property and other works to remain shall be protected throughout the work as defined in the General Conditions.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

State and local code requirements shall control the disposal of trees and shrubs.

PART TWO - PRODUCTS

2.1 MATERIALS

Materials shall be at the CONTRACTOR'S option.

PART THREE - EXECUTION

3.1 CLEARING

- A. CONTRACTOR is requested to limit his clearing to the area actually needed for construction and wherever possible to avoid clearing large trees.
- B. Limits of clearing shall be within the right-of-way, or easements obtained by the OWNER.
- C. Individual trees, groups of trees and other vegetation, which may be designated to be salvaged, shall be left standing and uninjured.

D. Remove trees, saplings, shrubs, bushes, vines and undergrowth within the limits of clearing to the heights above ground given in the following table:

1. Trees over 6-inches in diameter: 12 inches
2. Shrubs, bushes and trees under 6-inches in diameter: 3 inches
3. Vines and undergrowth: 2 inches

3.2 GRUBBING

- A. Limits of grubbing shall coincide with the limits of clearing.
- B. Remove all stumps, roots over 4-inches in diameter, and matted roots within the limits of grubbing to a depth of 24-inches below existing ground surface. Engineering requirements shall control removal of stumps smaller than 4-inches in diameter under fills, foundations, or any construction in contact with the stumps.

3.3 TRIMMING OF TREES/SHRUBS

- A. When required, with the ENGINEER'S approval, trees shall be trimmed to remove branches or roots, which interfere with construction or traffic.
- B. When trimming trees located in the right-of-way within the City of Roanoke, contractor shall coordinate work with the Urban Forester.
- C. When in VDOT right-of-way, written permission and a Tree Trimming Permit is required for the following: Trimming trees and/or shrubs, and for cutting tree roots larger than 3" in diameter.

3.4 SALVAGE

- A. It shall be understood and agreed upon by the CONTRACTOR that only those trees, which directly interfere with the construction of this Project shall be removed. Within the limits of clearing all trees 4-inches in diameter and smaller may be removed. No tree 5-inches or larger in diameter, which does not directly interfere with the construction of this Project shall be removed without the express written approval of the ENGINEER.
- B. Material which is to be salvaged, as a result of the CONTRACTOR'S clearing operations, shall include the following items which are to be turned over to the property Owner if the OWNER so desires:
1. Logs over 12-inches, butt diameter
 2. Branches over 6-inches, butt diameter
 3. Parts suitable for use as mulch
 4. Live plants suitable for replanting
- C. All ornamental trees and shrubs within temporary construction easements shall be carefully uprooted, stored, and replanted after construction is complete, unless otherwise directed. Ornamental trees and shrubs, which do not survive for a period of at least one (1) year, shall be replaced at the Contractor's expense. Unless clearly indicated on the plan, CONTRACTOR should only clear trees necessary to perform the work within the easement noted. Trees should not be

removed from the temporary easement area unless it is necessary for performance of the work or when the root structure of the tree would be damaged by the work.

- D. All salvageable material not desired by the property owner shall be removed at CONTRACTOR'S expense. Any desirable top-soil should be stock piled for possible use during Seeding and Mulching.

3.5 DISPOSAL

- A. Burning: Burning of materials on the site by the CONTRACTOR will not be permitted until all applicable permits have been obtained and copies of all permits are filed with the ENGINEER.
- B. Removal:
 - 1. Material to be removed shall be removed from the site daily as it accumulates.
 - 2. Should the CONTRACTOR elect to continue work beyond normal working hours, material to be removed shall not be allowed to accumulate for more than 48-hours.
 - 3. Prior to depositing surplus material at any off site location, the CONTRACTOR shall obtain a written agreement with the Owner of the property on which the disposal is proposed. The agreement shall state that the Owner of the property gives permission for the CONTRACTOR to enter and deposit the material at no expense to the OWNER. A copy of the agreement shall be furnished to the OWNER.

3.6 MEASUREMENT AND PAYMENT

No separate measurement and payment will be made for clearing and grubbing as they are considered incidental items to the work to which they are related and the costs, therefore, shall be included in the values bid for the appropriate items.

- END OF SECTION -

SECTION 2230

ROCK EXCAVATION

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Furnish all labor, material and equipment to excavate and dispose of rock as specified herein.
- B. Related work specified elsewhere:
 - 1. Erosion and Sediment Control - Section 2110
 - 2. Stream and/or Highway Crossings – Section 2310
 - 3. Water Distribution Lines – Section 2665

1.2 DEFINITION

- A. The word "rock," wherever used as the name of excavated material or material to be excavated, shall mean boulders and pieces of concrete or masonry exceeding 1/3 cubic yards in volume; or solid ledge rock which, in the opinion of the OWNER, requires, for its removal drilling and blasting, wedging, sledging, barring, or breaking up with power-operated tools.
- B. No soft or disintegrated rock which can be removed with a hand pick or power-operated excavator and/or loader; no loose, shaken, or broken stone in rock fillings or elsewhere; no frozen earth or existing paving; and no rock exterior to the maximum limits of measurement allowed, which may fall into the excavation, will be measured or allowed.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. Observe all municipal ordinances and State and Federal laws relating to the transportation, storage, handling and use of explosives.
- B. The licensed blaster(s) shall at all times have his license on the work site and shall permit examination thereof by officials having jurisdiction.

PART TWO - MATERIALS

2.1 EXPLOSIVES

- A. Where blasting is permitted, explosives shall be kept on the site only in such quantity as may be needed for the work under way and only during such times as they are being used.
- B. Explosives shall be stored in a secure manner, separate from all tools and flammable substances.

- C. Caps or detonators shall be safely stored at least a distance of 100-feet from explosives.
- D. When need for explosives has ended, all such materials remaining at site shall be promptly removed from the premises.

PART THREE - EXECUTION

3.1 GENERAL

- A. Excavate rock (as defined above), if encountered, to the lines and grades indicated on the Drawings or as required and dispose of the excavated material.
- B. Rock in pipe trenches shall be excavated so as to be not less than 6-inches from the invert of the pipe.
- C. Rock in structure excavations shall be excavated to the bottom of the foundation.

3.2 BLASTING

- A. All operations involving explosives shall be conducted by experienced personnel only, with all possible care to avoid injury to persons and damage to property. All licenses and blasting permits shall be kept on the job site at all times blasting is performed.
- B. Blasting shall be done only with such quantities and strengths of explosives and in such manner as will break the rock approximately to the intended line and grades and yet will leave the rock not to be excavated in an unshattered condition.
- C. Care shall be taken to avoid excessive cracking of the rock upon or against which any structure will be built, and to prevent damage to existing pipes or other structures and property above or below ground. The responsibility for accurately locating and for the complete protection of such items in the event of blasting for rock excavation and all repair to and/or replacement of same shall be the full obligation of the CONTRACTOR. In all cases of blasting, the prepared blast shall be carefully covered with an approved blasting mat so placed that the area affected by the explosion is positively confined.
- D. All blasting shots shall be covered with blasting mats or other approved material such that all structures, persons, and property are protected from injury. A pre-blast survey may be required if blasting is required in close proximity to structures.
- E. Sufficient warning shall be given to all persons in the vicinity of the work before a charge is exploded. Flagmen shall be employed to direct traffic as required.
- F. The Authority may prohibit blasting whenever it is felt that the protection provided is inadequate. Extreme care shall be used whenever blasting for the removal of hard materials is necessary.

- G. Blasting shall be prohibited on Sundays, Holidays, and between the hours of 7:00 p.m. and 7:00 a.m., unless previously approved in writing by the Authority and the applicable local government.
- H. Only the quantity and strength of explosives necessary for proper trench excavation shall be used. All explosives shall be detonated by an approved electric blasting device. Under no circumstances shall electric current from batteries, telephone or power lines be used for detonation.
- I. Contractor shall take into consideration location of existing utilities, or other structures when blasting. Contractor shall be responsible for taking all necessary precautions during blasting and general construction activities such that existing structures and facilities are protected from damage and will not be affected by construction activities.
- J. Contractor shall be responsible for notifying and coordinating with the proper authorities, utility companies, and potentially affected parties prior to and during all blasting activities.
- K. **When rock is encountered, Contractor shall notify the Construction Inspector in order that the quantities can be measured.**
- L. No blasting shall be performed within forty feet (40') of a tested or completed sewer /or water line. The ends of sewer /or water lines adjacent to blasting shall be covered to avoid receiving debris.

3.3 MEASUREMENT FOR PAYMENT

All rock excavation shall be paid for as an incidental part of the item on which the work is done except where a separate, unqualified item for rock excavation is indicated in the proposal or where rock excavation is ORDERED as an EXTRA by the OWNER, by WRITTEN ORDER. Where payment for rock excavation is established by the proposal or ORDERED as an EXTRA by the OWNER, CONTRACTOR shall be paid only for the quantity of rock removed, measured as follows:

- A. For all masonry structures such as buildings, tanks, vaults, catch basins, manholes and the like, the horizontal rock measurement shall be made to include 2-1/2 feet from the outside face of finished vertical sidewall of such structure and the vertical rock measurement shall be made from the top elevation of the rock, before disturbed or removed, to the elevation of the under or lower side of the bottom concrete slab of the structure. Any projection below the bottom slab of any structure required for sump, well, or other pertinent construction shall be measured separately.
- B. For installation of pipe lines and fittings the horizontal rock measurement shall be the nominal outside diameter of the pertinent pipe plus 16-inches, except, however, that no horizontal measurement shall be considered to be less than 27-inches; the vertical rock measurement shall be made from the top elevation of the rock, before disturbance or removal, to an elevation of 9-inches below the bottom outside surface of the pipe for pipe having a diameter of 8-inches through 24-inches, and to an elevation of 12-inches below the bottom outside surface of the pipe for all pipe having a diameter greater than 24-inches.

3.4 EXCESS ROCK EXCAVATION

If rock excavated beyond the limits of payment indicated on the Drawings, specified, or authorized in writing by the OWNER, the excess excavation whether resulting from over breakage or other causes, shall be backfilled, by and at the expense of the CONTRACTOR, as specified below:

- A. In pipe trenches, excess excavation above and below the elevation of the pipe bedding shall be filled as specified in Section 02731 - SANITARY SEWER COLLECTION LINES.
- B. In excavations for structures, excess excavation in rock beneath foundations shall be filled with concrete, which shall be Class A or B, at CONTRACTOR'S option.
- C. Quantity of rock for which payment will be made for installation of each fire hydrant will be limited to a rectangular area, top of which is upper surface of the rock, bottom of which is 2-feet below bottom-most point of the hydrant, in place, and of a square measurement of 3-feet on each of the four sides. Rock section excavation required for installation of fire hydrants shall not be less than stipulated above.

3.5 SHATTERED ROCK

If rock below normal depth is shattered due to drilling or blasting operations and such shattered rock is unfit for foundations, the shattered rock shall be removed and the excavation shall be backfilled as described above in EXCESS ROCK EXCAVATION. All such removal and backfilling shall be done at the expense of the CONTRACTOR.

3.6 BLASTING RECORDS

Keep and submit to the OWNER an accurate record of each blast. The record shall show the date, time of blast, general location of the blast, the depth and number of drill-holes, the kind and quantity of explosive used, and other data required for a complete record.

3.7 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

Attention of CONTRACTOR is specifically called to the fact that certain sections of the sewer line extension in this Project may be constructed in close proximity to existing buildings, storm sewers, gas lines, underground telephone cables, and private water mains. The responsibility for accurately locating and for the complete protection of such items in the event of blasting for rock excavation and all repair to and/or replacement of same shall be the full obligation of the CONTRACTOR. In all cases of blasting, the prepared blast shall be carefully covered with an approved blasting mat so placed that the area affected by the explosion is positively confined.

- END OF SECTION -

SECTION 2270

EROSION AND SEDIMENT CONTROL

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide all material, equipment and labor necessary to install erosion and sediment control elements as shown on Drawings and in accordance with this Specification. Prior to commencing work, CONTRACTOR's Certified Responsible Land Disturber shall obtain an erosion and sediment control permit for the project from the local controlling jurisdiction (if required). All costs for permit application shall be borne by the CONTRACTOR. Any permits required by the CONTRACTOR shall be available at the site at all times.
- B. Related work specified elsewhere:
1. Clearing and Grubbing - Section 2110
 2. Domestic Water Distribution Lines - Section 2665
 3. Seeding and Restoration - Section 2900
- C. All erosion control measures must be in accordance with State Minimum Criteria, as described in latest edition of the Virginia Erosion and Sediment Control Handbook.
- D. Measurement and Payment: No separate item is provided for erosion and sedimentation controls, therefore the CONTRACTOR must include the cost for such items in the unit prices to which the erosion controls pertain, or the cost must be included in the lump sum price of the Contract, wherever applicable.

PART TWO - PRODUCTS

2.1 STRAW BALES

All straw bales shall be securely tied. Moldy, musty or decayed bales are unacceptable.

2.2 SILT FENCING

- A. Burlap: Burlap shall be 10 oz. per yd.² fabric.
- B. Posts: Posts for silt fences shall be either 1" x 2" wooden stakes or equivalent metal stakes with a minimum length of 3 feet. Steel posts shall have projections for fastening wire to them.
- C. Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by manufacturer or supplier as conforming to the following requirements:

<u>PHYSICAL PROPERTY</u>	<u>TEST</u>	<u>REQUIREMENTS</u>
Grab tensile	ASTM-D-4632	175 lbs. (min. warp)
Grab elongation	ASTM-D-4632	25% (max.)
Mullen burst	ASTM-3786	300 psi. (min.)
Trapezoidal tear	ASTM-D-4533	50 lbs. (min.)
Puncture	ASTM-3787(mod.)	80 lbs. (min.)
U.V. resistance	ASTM-4355	70% (min.)
Equivalent opening size	U.S. sieve #	30/50
Filtering efficiency	VTM-51	75% (minimum)

Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0° F to 120° F. Silt fence shall be Amoco 1380 Silt Stop, Exxon GTF100S-105S silt fence, Mirafi Envirofence, or approved equal.

- D. Other materials: Select all other materials not specifically described but required for compliance with the erosion and sediment control plan, subject to approval by the ENGINEER.

PART THREE - EXECUTION

3.1 GENERAL

- A. CONTRACTOR shall familiarize himself with all the stipulations and requirements of the erosion and sediment control permit. CONTRACTOR shall be held responsible for strict adherence to these regulations and shall work closely with the administrating authority when under their jurisdiction. CONTRACTOR shall be deemed liable for any negligence or infringement, which results in non-compliance with this permit.
- B. The location of all sediment and erosion control measures shall be left to the CONTRACTOR'S discretion unless otherwise shown on the Drawings or required by the permit. Should there be no requirement of an erosion control plan, then CONTRACTOR shall be required to provide such measures necessary to prevent the formation of gullies or the spread of mud and debris across roads, into waterways or other areas where it may be considered a nuisance.

3.2 PLANNING OF CONSTRUCTION

- A. Planning and coordination of the construction is needed to minimize sediment pollution. Clearing shall be kept to shortest distance possible ahead of construction. Cleared areas shall be kept to minimum required to facilitate construction.
- B. Restoration work shall be performed as the Project progresses. and not be left until the end of the Project. No areas shall be left unprotected for longer than 10 days without some form of temporary seeding or, if during a non-growing season, some other form of stabilization, such as mulch.

3.3 EXCAVATION AND BACKFILL

Excavation shall be closely controlled. The material removed from the excavation shall be selectively stockpiled in areas where a minimum of sediment will be generated and where other damage will not result from piled earth. Drainageways shall be protected at all times and the piling of soil in drainageways shall not be allowed. Backfilling operations shall be performed in such a manner such that remaining trees are not damaged. Temporary repaving shall be placed promptly following completion of backfilling and compaction in improved areas.

3.4 STOCKPILES

- A. Stockpile areas shall be selected and maintained by on-site personnel. Site selection and stockpile design shall incorporate sediment and erosion control considerations to prevent the potential direct production and delivery of sediment to waterways, damage to vegetation, and the destruction of trees selected for preservation. Temporary stabilization of stockpiles shall be promptly instituted. The existence of critical slopes on stockpiles shall be avoided. Stockpiling in or immediately adjacent to diversion channels shall not be allowed. If a stockpile is to remain for over sixty (60) days, it shall be stabilized by soil stabilizing chemicals, temporary vegetation, interim structures or other approved practices.
- B. Temporary vegetative measures planned for implementation on stockpiles shall be established immediately after stockpile completion. Proper mulching and soil stabilization in conjunction with these seeding operations shall also be carried out.

3.5 STREAM PROTECTION

- A. Where construction is close to existing streams and other waterways, construction shall be performed in a manner which will not contribute to stream pollution. Construction practices shall include the following:
 - 1. Construction debris, excavated materials, brush, rocks, refuse and topsoil shall be kept as distant as possible from nearby waterways.
 - 2. Stream crossings and machinery operation in the stream shall occur only as required for construction of the project, and shall be kept to a minimum. Under no circumstances shall a stream bed be permitted to become a highway for machinery traffic.

3.6 PUMP WATER

Pump water management shall be practiced by CONTRACTOR to minimize production and transport of sediment. Pumped water shall be discharged onto stabilized surfaces and then allowed to be filtered by existing vegetation or other temporary measures as appropriate. Since ditches may be required to transport pumped water away from construction areas, they shall be given the same consideration as other waterways and shall be stabilized in a manner satisfactory to the ENGINEER/OWNER.

3.7 TEMPORARY STRAW BALE BARRIERS

- A. Place bales in a single row, lengthwise, on the contour and embedded 3" into the soil. In lieu of embedment, a 3" high shoulder of suitable soil may be compacted against the base of the straw bales.
- B. Securely anchor straw bales in place by means of wooden stake or steel rebar driven through the bales.

3.8 SILT FENCES

Place silt fences in a continuous row, parallel to the slope, waterway, roadway or other area being protected. Anchor the silt fence fabric to posts set at a minimum of 10 ft. apart. Embed the bottom of the fabric a minimum of 4" deep and backfill and compact soil over the embedded portion. Replace or repair any sections of fence, which collapse or are washed out during the construction period as soon as reasonably possible.

3.9 CLEAN UP

- A. Upon project completion, remove all temporary erosion and sediment control devices. Remove from job site all excess materials, debris, surplus tools and equipment. Leave site in a neat and orderly condition acceptable to the ENGINEER/OWNER.
- B. Upon removal of temporary erosion and sediment control devices, perform all required finish grading, seeding, and mulching as specified under Section 02900.

- END OF SECTION -

SECTION 2310

STREAM AND/OR HIGHWAY CROSSINGS

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Perform all labor, material and equipment to install steel casing pipe for stream and/or highway crossings in accordance with the Drawings and as specified herein.
- B. Related work specified elsewhere:
 - 1. Erosion and Sediment Control – Section 2270
 - 2. Water Distribution Lines - Section 2665
 - 3. Seeding and Mulching - Section 2900

1.2 PROTECTION

Streets, roads, adjacent property and other works to remain shall be protected throughout the work as defined in the General Conditions.

PART TWO - PRODUCTS

2.1 MATERIALS

- A. Steel casing pipe shall be smooth wall steel pipe as indicated with a minimum wall thickness of 0.25 inches conforming to the materials standards of ASTM A 252, grade 2. Joints of steel pipe shall be butt welded, watertight, in accordance with the American Welding Society's recommended procedures. The construction plan indicates the minimum thickness, casing pipe.
- B. Carrier pipe shall be ductile iron, cement lined, bituminous coated AWWA C 151, mechanical, push-on joint, or restrained push-on joint pipe as indicated on the plan or HDPE in accordance with our water and sewer standards.
- C. Pressure injected grout shall be a sand and cement grout mixture, consisting of 1.0 part cement, 2 parts sand (100 percent passing the No. 3/8 sieve and 94 to 100 percent passing a No. 4 sieve). Dry grout mix shall be combined with the minimum amount of water to achieve the necessary consistency and containing 3 to 7 percent entrained air. Maximum grouting pressure shall be 30 psi.

PART THREE - EXECUTION

3.1 STREAM CROSSING

Unless directed otherwise by permits issued by applicable Federal and/or State agencies, the following procedure shall be utilized:

- A. Contractor shall construct crossings of streams in the "dry" by providing a temporary cofferdam or bulkhead of non-erodible material. Cofferdam or bulkhead shall not obstruct more than one-half of water surface at any time and shall not extend more than three (3) feet above the normal water surface. Contractor shall not be allowed to operate construction equipment on the native stream bottom, except during removal of the cofferdam. Contractor shall be advised that the level in the stream(s) can increase rapidly due to rainfall in the upstream watershed.
- B. Non-erodible shall be defined as #1 coarse aggregate as defined in the Virginia Department of Transportation Road and Bridge Specifications" 2002 Edition. An earth core for the cofferdam may be constructed over the proposed excavation; however, the non-erodible material shall be in place prior to placement of the earth, so that the erodible earth does not come in contact with the flowing water.
- C. Contractor shall construct crossings as indicated in the details and shall then completely remove cofferdam, bulkhead, or whatever equipment or material that was used to construct the crossing. Bottom of the stream in the construction area shall be restored to its original cross section. All disturbed areas on the banks of streams shall be seeded and mulched as specified hereinafter in paragraph "Seeding."
- D. River/Stream crossing permits required from Virginia Marine Resource Commission and/or US Army Corps of Engineers have been obtained by the OWNER and are made part of the CONTRACT DOCUMENTS. Requirements of these permits are considered Special Conditions of the CONTRACT DOCUMENTS.
- E. Sewers located in streams will be tested in place and shall have zero leakage.

3.2 HIGHWAY CROSSING - BORE & JACK METHOD

- A. Pipeline crossing under highways shall be installed in a steel casing pipe installed by the "drive casing as you go" boring and jacking method unless otherwise indicated. Lengths of steel pipe shall be welded to preceding length installed. Voids between exterior of casing pipe and the ground shall be filled with pressure injected grout. Carrier pipe shall be protected on pipe protection saddles spaced at two (2) per length of pipe. Ends of casing pipe shall be plugged with sacking prior to backfilling. If trench is allowed to be open cut, casing pipe shall be provided unless otherwise indicated and trench shall be backfilled and pavement restored within one (1) day of placing casing pipe.
- B. The jacking operation shall be carried on in such a manner that settlement of the ground or the highway above the pipeline will not occur. The use of water or other fluids in connection with the boring and jacking operation shall not be allowed. Excavation shall not precede the jacking operation more than is necessary. The Contractor shall repair or replace, as directed by the Engineer, at the Contractor's expense, casing pipe which is damaged during the jacking operation.
- C. After installation of casing pipe and grout, if required, carrier pipe shall be installed. Carrier pipes shall be supported by steel saddles strapped to the pipe with steel straps, as specified.

- D. All operations of the Contractor shall be subordinate to the free and unobstructed use of the highway right-of-way for passage of traffic without delay or danger to life, equipment or property. Contractor shall provide all necessary flagging, warning devices, flagmen, bracing, bulkheads, and shields to ensure complete safety to all traffic at all times. Contractor shall notify the appropriate personnel in each locality, such as, Police, Fire and/or Rescue Departments, and Traffic Engineering Departments, etc. when restricting traffic to one lane.
- E. Any highway crossing permits required for an Authority project have been obtained by the OWNER. These permits and the requirements of the permit are made a part of the Special Conditions of the CONTRACT DOCUMENTS.

3.3 HIGHWAY CROSSING - OPEN CUT METHOD

- A. Any crossing that is made using the open cut method shall be performed in accordance with Virginia Department of Transportation standards and the governing locality's standards.
- B. Any highway crossing permits required for an Authority project are to be obtained by the OWNER and/or CONTRACTOR. These permits and the requirements of the permit are made a part of the Special Conditions of the CONTRACT DOCUMENTS.

3.4 MEASUREMENT AND PAYMENT

Measurement and payment for stream and/or highway crossings shall be made per lineal foot of casing pipe installed for each casing size as specified or indicated on the Drawings. Unit Price shall reflect complete installation of respective casing pipe.

- END OF SECTION -

SECTION 2670

HORIZONTAL DIRECTIONAL DRILLING (HDD) METHODOLOGY

PART ONE - GENERAL

1.1 DESCRIPTION

- A. Work included: Furnish all labor, materials, tools and equipment necessary to provide for installation of HDPE and/or restrained joint C900 PVC water pipe line and gravity sewer pipe line using current horizontal directional drilling technology in accordance with the Drawings and as specified herein.
- B. Related work specified elsewhere

General Water and Sewer Specifications – Section 2000
- C. General: This specification defines the approved method and material for the installation of water lines and gravity sewer lines utilizing horizontal directional drilling technology.
- D. Definition: Horizontal directional drilling (HDD) involves utilization of an electronically tracked bore-head to guide the borehole to a pre-designed configuration. The HDD process begins with boring a small, horizontal pilot hole with a continuous string of steel drill rod. When the bore-head and rod emerge on the opposite end of the crossing, a back reamer is attached to the drill rod string and pulled back through the pilot hole. The reamer serves to enlarge the pilot hole to allow the HDPE or restrained joint PVC pipe to be pulled through from the opposite end of the borehole. The size of the drilling equipment and required support equipment shall be determined by the CONTRACTOR based on the diameter and length of pipe to be installed.

1.2 QUALITY ASSURANCE

- A. Contractor Certification: CONTRACTOR shall be certified by the particular horizontal directional drilling manufacturer that CONTRACTOR is a fully trained user of the drilling equipment.
- B. Qualifications of Personnel: HDPE pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the HDPE pipe. Training shall be performed by a qualified representative.

1.3 SUBMITTALS

- A. Shop drawings: As a minimum, the following data and shop drawing information shall be submitted to the OWNER for review and approval:

1. Before beginning work, CONTRACTOR shall submit to the OWNER for approval, the Vendor's shop drawings, catalog data and specific manufacturer's technical data showing complete information on material composition, physical properties, and dimensions of new pipe and fittings. Include manufacturer's recommendations for handling, storage, and repair of pipe and fittings, which are damaged.
2. A certificate of "Compliance with Specification" shall be furnished for all materials supplied.
3. CONTRACTOR shall submit certification of workmen training for all personnel involved in installation of pipe.
4. CONTRACTOR shall submit a work plan to the OWNER for acceptance. Work plan shall address preparation steps required for pre-installation.
5. CONTRACTOR shall submit information to the OWNER for approval of the procedure and the steps to be followed for installation of the HDPE or restrained joint PVC pipe utilizing horizontal directional drilling technology, even if the process is named in the specification. Any proposed changes in installation procedures shall require submittal of revised procedures for acceptance by the OWNER.
6. CONTRACTOR shall submit to the OWNER for approval, full details about component materials and their properties, except those protected by trade secrets which may harm their claim to the product.

PART TWO - PRODUCTS

2.1 MATERIALS:

- A. HDPE Pipe: Polyethylene plastic pipe shall be high density polyethylene pipe which meets the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on Outside Diameter, ASTM D3350 and cell classification 345464E.

1. Sizes of the pipe to be used for installation of water and sewer lines shall be as directed by the OWNER.
2. All pipe shall be made of virgin material. No rework except that obtained from manufacturer's own production of the same formulation shall be used.
3. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
4. Dimension Ratios: The minimum wall thickness of the polyethylene pipe shall be as follows:

Gravity sanitary sewer line: SDR 17 and 345464E to assist video taping
 Sanitary sewer force main: DR-11
 Potable water line: DR-11.

5. For sewer installations pipe material color shall be white, black or whatever is specified with interior of pipe having a light reflective color to enhance viewing for television inspection.
6. Installation Method: HDPE pipe shall be continuously joined with a minimum length, which shall be that deemed necessary by the CONTRACTOR to effectively span the required distance from the inlet to the outlet of the respective pipe, unless otherwise specified. CONTRACTOR shall verify the lengths in the field before manufacturing.
7. Pipe Locator Wire: To facilitate future locating of HDPE water pipe and sanitary sewer force main, a 12 gauge copper wire shall be laid with pipe

B. PVC Restrained Joint Pipe:

1. PVC pipe meeting the AWWA Specification C900 for dimension ratio (DR) 14, pressure Class 200, shall be used for water lines. DR-25 pipe may be used for gravity sewer pipe installations. SDR-21 or DR-14 pipe may be used for sanitary sewer force mains. Pipe shall be Certa-Lok C900/RJ restrained joint PVC pipe or approved equal. PVC pipe materials shall be furnished by the OWNER and installed by the CONTRACTOR.
2. PVC pipe shall be installed according to the manufacturer's written instructions for installation by horizontal directional drilling. To facilitate future locating of PVC water pipe, a 12 gauge copper wire shall be laid with pipe.
3. Pipes shall be joined using non-metallic couplings, which have been designed with the pipe as an integral system for maximum reliability and interchangeability. High-strength, flexible thermoplastic splines shall be inserted into mating precision-machined grooves in the pipe and coupling to provide full, 360-degree restraint with evenly distributed loading at the joint. No external pipe-to-pipe restraining devices, which clamp onto or otherwise damage the pipe surface as a result of point loading shall be permitted. Solvent-weld cement joints shall not be allowed.

2.2 EQUIPMENT

A. Directional Drilling Machine:

1. Directional drilling equipment shall be self-powered and self-contained. Equipment shall be designed and manufactured with an electronically tracked bore-head so as to guide the borehole to a desired configuration, both horizontally and vertically.
2. Directional drilling equipment shall generate sufficient torque and thrust/pullback force to drill a pilot hole, enlarge the pilot hole by back reaming and pull the pipeline back through the enlarged hole.

3. CONTRACTOR shall comply with manufacturers specifications as to the machine size requirement for a given diameter and length of pipe, as well as parameters of the required size machine for percentage of upsize allowed.

B. Vacuum Excavation Unit:

1. Directional drilling operations shall be assisted by use of an adequately sized vacuum excavation system mounted on either a trailer or truck body.
2. Vacuum excavation system shall provide sufficient storage tank capacity and power pack to efficiently remove drilling fluid from the insertion pit during horizontal directional drilling operations.
3. Vacuum excavation system shall be equipped with a high-pressure water system designed to assist with "pothole" excavation operations.

C. Drilling Fluid Management System:

1. Directional drilling operations shall be assisted by use of a truck mounted drilling fluid mixing system.
2. Fluid management system shall include two mixing tanks to allow for flexibility in mixing, transferring and delivering drilling fluid.
3. Fluid management system shall have the capability to transfer between tanks while providing drilling fluid to the directional drilling machine.

2.3 SHIPPING & HANDLING

HDPE and/or PVC pipe materials and fittings shall be protected from kinking and gouging during shipping, handling, and storage.

2.4 MATERIAL TESTING

Tests for compliance with this specification shall be made as specific herein and in accordance with the applicable ASTM Specification. A certificate with this specification shall be furnished, upon request, by the manufacturer for all material furnished under this specification. Polyethylene plastic pipe and fittings may be rejected to meet any requirements of this specification.

PART THREE - EXECUTION

3.1 HORIZONTAL DIRECTIONAL DRILLING OPERATION AND PIPE INSTALLATION

A. Access to the project site:

1. Access to the site of the project under construction shall be primarily by respective pipeline easement and/or existing road rights-of-way.

Access through private property will not be permitted without the explicit

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written permission of the property owner. Two (2) copies of such written permission shall be given to the OWNER for his review and records. At all locations where the CONTRACTOR desires to enter the easement from a road, an access approach will be constructed. All construction within the road right-of-way shall conform to the standards and requirements of the Virginia Department of Transportation and the governing localities.

2. Whenever such access approaches are in use, a flagman shall be posted at the State road. Whenever such access approaches are not in use, a barricade, a chain, fence or gate will be installed to prevent unauthorized and accidental entry to the project site.
3. CONTRACTOR shall not employ those portions of the pipeline easement, which have had pipe line construction completed by others, as an access route, without express permission from the OWNER in writing.

B. Pre-Installation Preparations: CONTRACTOR's work plan shall address the following minimum preparations/steps, unless approved otherwise by the OWNER.

1. **SAFETY:** The CONTRACTOR shall carry out operations under this section in strict accordance with all applicable OSHA Standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space. It shall be the CONTRACTOR's responsibility to comply with OSHA Standards and Regulations pertaining to all aspects of the work.
2. **DIVERSION PUMPING:** When required for acceptable completion of the directional drilling and pipe installation process, CONTRACTOR shall provide for continuous sewage flow around section(s) of pipe designated for pipe installation.
 - a. By-passing of sewage flow shall be accomplished by use of a diversion pump and piping system. Diversion pump and bypass lines shall be of adequate capacity and size to handle the flow. All costs for by-pass pumping required during installation of the pipe shall be paid in conformance with the respective bid item.
 - b. CONTRACTOR shall be responsible for continuity of sanitary sewer service to each facility connected to the section of sewer during execution of the work.
 - c. If sewage backup occurs and enters buildings, CONTRACTOR shall be responsible for clean-up, repair, property damage cost and claims.

C. Installation Procedures - General: All approved installation instructions and procedures submitted shall be carefully followed during installation. OWNER shall provide all grade profiles and field stakeout required for pipe centerline grade and offsets. Any proposed changes in installation procedures shall require submittal of revised procedures and acceptance by the OWNER.

1. Equipment used to perform the work shall be located as far away from buildings as possible. Provide enclosed, insulated power packs for all mechanical equipment to reduce machine noise, as required to meet local requirements.
2. CONTRACTOR shall install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing structures, and to protect the pipe from damage during installation. Lubrication shall be used as recommended by the manufacturer. Under no circumstances will the pipe be stressed beyond its elastic limit.

D. Pipe Joining of HDPE Pipe:

1. HDPE pipe shall be assembled and joined at the site using either the butt-fusion or electro-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections shall not be permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified, as fusion technicians, by a manufacturer of polyethylene pipe and/or fusing equipment.
2. Butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. Joint shall be allowed adequate cooling time before removal of pressure. Fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the OWNER and/or his representative prior to insertion.
3. All defective joints shall be cut out and replaced at no cost to the Authority. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the OWNER and/or his representative shall be discarded and not used.
4. Terminal sections of pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp or equal. Butt gap between pipe ends shall not exceed one-half (½) inch. Also Unicore Plastic Fusion System, unicore can be used to butt fuse the sewer pipe material.

- E. Connection of HDPE Pipe to Fittings: HDPE Pipe shall be joined to ductile iron fittings, valves and fire hydrants in strict compliance with manufacturer's recommendations.
1. HDPE Mechanical Joint adapters shall be either butt-fused or electro-fused to the HDPE pipe to provide a leak proof joint in compliance with Specification Section 02670-3.1-D. Ductile iron fitting, gate valve or fire hydrant shall be bolted to the M.J. adapter in compliance with the manufacturer's recommendations.
 2. H.D.P.E. pipe may be joined directly to ductile iron fittings, valves and fire hydrants by the use of Mega-Lug joint restraints, or approved equal, in strict compliance with the manufacturer's recommendations. Stainless steel insert pipe stiffeners shall be used with all such connections.
 3. Ductile iron fittings, valves and hydrants with integral H.D.P.E. stub-outs shall be either butt-fused or electro-fused directly to the H.D.P.E. pipe in compliance with Specification Section 02670-3.1-D. All gate valves with integral H.D.P.E. stub-outs of 4" or smaller size shall incorporate an H.D.P.E. valve foundation to prevent operating torque being transferred from the valve to the pipe connections.
- F. Pipe Joining of Restrained Joint PVC Pipe:
1. Restrained joint PVC shall be assembled and joined at the site using non-metallic couplings designed with the pipe as an integral system. Pipe and coupling shall be restrained using high-strength, flexible thermoplastic splines inserted into mating precision-machined grooves in the pipe and coupling. Threaded or solvent-cement joints and connections shall not be permitted.
- G. Field Testing of Sewer Pipe:
1. For sewer pipe installation pipe shall be internally inspected with a television camera and videotape as required. Finished tape shall be continuous over the entire length of the sewer between two manholes to be free from visual defects.
 2. Defects, which may affect the integrity or strength of the pipe in the opinion of the OWNER, shall be repaired or the pipe replaced at CONTRACTOR's expense.
 3. Service Reconnection:
 - a. Once installation of sewer pipe has been completed, CONTRACTOR shall reconnect existing live service connections. These services shall be reconnected by one of the approved methods listed in Paragraph D-3e below.

- b. All sewer service connections shall be identified and located prior to pipe insertion operations to expedite reconnection. Upon commencement of pipe installation, pipe insertion shall be continuous and without interruption from one manhole to another, except as approved by the OWNER and/or his representative. Upon completion of installation of new sewer pipe, CONTRACTOR shall expedite reconnection of services so as to minimize any inconvenience to customers.
- c. Installed pipe shall be allowed manufacturer's recommended amount of time, but not less than four (4) hours, for cooling and relaxation due to tensile stressing prior to any reconnection of service lines, sealing of the annulus or backfilling of the insertion pit. Sufficient excess length of new pipe, but not less than four (4) inches, shall be allowed to protrude into the manhole to provide for occurrence of pipe relaxation.
- d. Following relaxation period, the annular space may be sealed. Sealing shall be made with material approved by the OWNER and/or his representative and shall extend a minimum of eight (8) inches into the manhole wall in such a manner as to form a smooth, uniform, watertight joint.
- e. Sewer service connections shall be connected to new pipe by various methods that are compatible with the new HDPE sewer pipe. If a saddle is used, that saddle once secured in place, drill a hole full inside diameter of saddle outlet in pipe liner.
 - e1.) Mechanical saddles shall be made of polyethylene pipe compound that meets the requirements of ASTM D1248, Class C, have stainless steel straps and fasteners, neoprene gasket and backup plate. Mechanical saddles shall be Strap-On-Saddle Type as manufactured by Driscopipe or approved equal. (800-527-0662).
 - e2.) Inserta-Tee Connection by Fowler Manufacturing (503) 357-2110 shall also be allowed to be used. Also approved is the Unicore Plastic Fusion System (705) 876-6400 that uses butt-fusion to connect a tee or prefabricated polyethylene saddle or equivalent to sewer pipe material.

4. Finished Pipe

- a. Installed sewer pipe shall be continuous along entire length of each pipe segment from manhole to manhole and shall be free from visual defects such as foreign inclusions, concentrated ridges, discoloration, pitting, and other deformities.
- b. Pipe with gashes, nicks, abrasions, or any such physical damage, which may have occurred during storage and/or handling and which

are larger/deeper than 10 percent (10%) of the wall thickness shall not be used and shall be removed from the construction site.

- c. Sewer pipe passing through or terminating in a manhole shall be carefully cut out in a shape and manner approved by the OWNER. Installed sewer pipe shall meet the leakage requirements of the pressure test as specified.

HDPE or PVC pipe within the manhole shall be neatly cut off at least a minimum of 4" away from manhole wall. The invert in the manhole shall be a smooth continuation of the pipe(s) and shall be merged with other lines, if any. Channel cross-section shall be U-shaped with a minimum height of half pipe diameter to three-fourths of pipe diameter for fifteen inch and larger. The side channels shall be built up with mortar/concrete to provide benches at a maximum of 1 in 12 pitch towards the channel.

- d. All manholes shall be individually inspected for water migration, cutoffs, benches, and invert works.

5. Process Limitations:

Though installation process may be licensed or proprietary in nature, CONTRACTOR **SHALL NOT** change any material, thickness, design values or procedural matters stated or approved in SUBMITTALS, without OWNER's prior knowledge and pre-approval.

3.2 TESTING OF SEWER PIPE

- A. General: Testing will be required after the pipeline has been installed between manholes. Test shall consist of a low-pressure air test of the sewer pipe before any service connections to the new installed pipe have been made. The purpose of this test is to check the integrity of the pipe and to verify that the pipe has not been damaged during operations when pulling it through the borehole space created by directional drilling.
- B. Plugging of Test Section: After a manhole-to-manhole section of sewer pipe has been lined, it shall be plugged at each manhole with pneumatic plugs. Design of the plugs shall be such that they will hold against the test pressure without requiring external blocking or bracing. One of the plugs shall have three air hose connections, one for inflation of the plug, one for reading of the pressure into the sealed line and one for introducing air into the sealed line.
- C. Low Pressure Test:
 - 1. See Section 2731 3.11 Acceptance Test C. 3. Low Pressure Air Testing Procedure. Test shall be in accordance with ASTM F1417-92.
 - 2. When prevailing groundwater is above the sewer liner pipe being tested, test pressure shall be increased 0.43 PSI for each foot that the water table is above the invert.

SEWER SIZE (Inches)	MINIMUM TEST TIME (Minutes)
8	4
10	5
12	6
15	7.5
18	7.5

3. If the time for the pressure to drop 0.5 PSI is 125% or less of the time given in the table, the line shall immediately be re-pressurized to 3.5 PSI and the test repeated.
4. Pressure gauges used shall be supplied by the CONTRACTOR and have minimum divisions of .010 PSI.

D. Post Televising of Completed Sections: CONTRACTOR shall provide to OWNER a color video tape showing the completed work, including condition of the restored service connection. Video shall be taken by a pan and tilt radial viewing pipe inspection camera, which pans +/-275 degrees and rotates 360 degrees. Camera shall have an accurate footage counter, which shall display on the monitor the exact distance of the camera from the centerline of the starting manhole.

E. Restoration of Project Area: Upon completion of the installation work, testing, and televising, CONTRACTOR shall restore/clear the project area affected by his operations. No trash, rubbish, etc., shall be stored at any site whether the work is in progress or not.

3.3 TELEVISION INSPECTION OF SEWER LINE:

A. General: Prior to Substantial Completion, Contractor shall provide a televised inspection of sewer pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit color television. Television inspection shall include the following:

1. Video tapes (post installation) to be submitted to the Authority prior to processing of final invoice.
2. Videotapes to remain property of the Authority; CONTRACTOR to retain second copy for his use.
3. All flows tributary to reach of sewer being inspected are to be completely bypassed around the reach during video inspection, if necessary and/or required by the Authority.
4. Post construction videotape footage shall be taken upon completion of reconstruction of each reach of sewer with the voice description, as appropriate, and with stationing of service connections indicated. Data and stationing shall be indicated on video.
5. Should any portion of the inspection tapes be of inadequate quality or coverage, as determined by the Authority, CONTRACTOR shall have the

portion re-inspected and video taped at no additional expense to the Authority.

3.4 HYDROSTATIC TESTS FOR LEAKAGE

A. General:

1. All new water mains shall be tested, after backfilling to a hydrostatic pressure of not less than 100 psi above design water pressure for the system or 150 psi, whichever is greater. Allowable leakage shall be calculated by the following formula and is shown in columnar form in Table 6:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where: L = allowable leakage in gallons per hour
 S = length of pipe tested in feet
 D = nominal diameter of pipe in inches
 P = average test pressure during leakage test in psi

TABLE 6

Allowable Leakage per 1,000 ft. (305 m) of Pipeline*--gph[^]

Average Test Pressure PSI (Bars)	NOMINAL PIPE DIAMETER - Inches							
	3"	4"	6"	8"	10"	12"	14"	16"
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20

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

[^]To obtain leakage in liters/hour, multiply the values in the table by 3.785.

- B. No water line shall be placed in service until the leakage is less than the allowable leakage as indicated above. Testing of water mains shall only be done after installation of all valves, taps and service laterals are complete. All portions of the water system, including hydrants and service lines, shall be subject to hydrostatic pressure during the leakage test. Testing of water mains shall be observed and documented by an Authority Inspector/Engineer.
- C. All high points and service lines in portion of system under test shall be vented and all air expelled from system prior to beginning test. All fittings and hydrants shall be properly braced or blocked before applying pressure. Where concrete thrust blocks are used, they shall have attained their final set prior to testing.
- D. After section of system under test has reached required pressure as stated above, said pressure shall be maintained for two (2) hours. At conclusion of pressure test,

volume of makeup water required to refill pipeline shall be determined by measurement with displacement meter or by pumping from a vessel of known volume.

- E. All joints or fittings at which leakage occurs shall be reworked to insure tightness. All visible leaks shall be repaired regardless of amount of leakage. If measured amount of leakage exceeds values for the appropriate size as found in AWWA Specification C600, Hydrostatic Testing (Table 6), pipeline shall be repaired and retested until leakage is within limit set by the referenced specification. Methods of repair prior to retesting will be done with the Authority's approval and inspection. Repairs of new construction will be by adjustment or replacement of material only. The use of repair clamps or bell clamps will not be acceptable.

3.4 DISINFECTION OF WATER MAINS

- A. General - After testing and before final inspection of the completed systems, water mains and service laterals shall be flushed and disinfected in accordance with AWWA Specification C651 latest revision. Flushing shall be accomplished at a flow velocity of not less than 2.5 feet per second.
- B. Disinfection Procedures:
 - 2. Disinfection as described in AWWA C651 - "Placing of calcium hypochlorite tablets" shall be used. Five gram (5g) calcium hypochlorite tablets with 3.25 gram available chlorine per tablet shall be attached at the inside top of the pipe by an adhesive such as Permatex No. 2 or equal. The following number of tablets for the given pipe size shall be used for an initial dose of twenty-five (25 mg/1 (ppm) chlorine:

<u>Pipe Diameter</u>	<u>Number Tablets Per 18-20 Ft. Pipe Section</u>
6"	1
8"	2
10"	3
12"	4

or the number of tablets equal to $0.0012d^2L$ rounded to the next higher integer, where d is the inside diameter, in inches, and L is the length of the pipe section, in feet. Use of the continuous feed or slug method of disinfecting may only be used to re-chlorinate a water pipe after the initial disinfection or in other specific cases approved by the Authority.

- 2. Disinfection solution shall remain in pipe line for not less than twenty-four (24) hours, after which time a chlorine residual of 10 ppm at all parts of line shall be required.
- 3. Following chlorination, piping shall be thoroughly flushed. Water in the new main shall be proven comparable in quality, by testing, to the existing public water supply. The Virginia Waterworks Regulations require at least two consecutive satisfactory bacteriological samples from distribution system before system can be placed in service. The Authority will pay the cost of

lab testing for first set of bacteriological samples. Contractor shall pay all costs associated with disinfection and testing of installed facilities and any additional bacteriological samples required after first set.

3.5 PAYMENT

- A. The installed pipe shall be paid for per linear foot of the size pipe specified and shall include all pipe bedding, backfill material, annulus sealing material and launching pits. Locating and reconstruction of services and all reconnections of services shall be paid for per each connection made, including fittings and pipe.
 - 1. The work performed as prescribed by this item will be paid at the hourly rates for labor and equipment required to install water or sanitary sewer pipe installed by horizontal directional drilling for the specified pipe diameter and location, which price shall be full compensation for installation of the new pipe, placing of all materials, labor, tools, equipment, cleaning, and any other operations necessary to complete the project.
- B. The cost of any necessary by-pass pumping shall be paid based on the hourly rate submitted as part of the bid.
- C. All costs for testing the pipe after installation shall be considered incidental to the cost of the project.
- D. All other payments shall be made as per bid items. No payment shall be made for work considered incidental or complimentary to a pay item already in bid. The contractor shall clarify, for his own benefit, all work required for any item, incidental or otherwise, prior to bidding.

- END OF SECTION -

SECTION 2900
SEEDING AND MULCHING

PART ONE - GENERAL

1.1 DESCRIPTION

A. Work included:

1. Preparation of ground, seeding, protection and cleanup of Work areas designated for grading and seeding operations.
2. Disking and harrowing of ground for seeding purposes where grade is undisturbed by construction unless otherwise specified.
3. Proper protection of seeded, disturbed, or a combination of both, areas from erosion.

B. Areas responsible for:

1. All areas within the construction easement.
2. All areas disturbed by the Contractor and his personnel during construction of project under contract.

C. Related work described elsewhere:

1. Erosion and Sedimentation Control - Section 2270

1.2 QUALITY ASSURANCE

A. Selection of materials:

1. The selection of all materials required from Drawings and Specifications shall be subject to the Engineer's approval.
2. The Engineer shall have the right to reject any and all materials, which do not meet the Specification requirements or are not otherwise satisfactory at any stage of operations.
3. The Contractor shall remove all rejected materials immediately from the site at no additional cost to the Owner.

B. Execution of the Work:

1. The execution of all grading, seeding and other operations required under Drawings and Specifications shall be subject to Engineer's approval.

2. The Engineer shall have the right to reject any and all methods of operations found unacceptable for the Work required.

PART TWO - PRODUCTS

2.1 FERTILIZER

Grade 10-10-10 fertilizer, uniform in composition, free-flowing, and suitable for application with approved equipment, shall be provided. Deliver fertilizer to the site in bags or other convenient containers, each fully labeled, conforming to applicable commonwealth or state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer.

2.2 LIMESTONE

Furnish agricultural-grade limestone ground to pass an 8-mesh sieve with 25% passing a 100-mesh sieve. In addition, calcareous limestone shall contain not less than 50% calcium oxide, and dolomitic limestone shall contain not less than 40% magnesium oxide. Coarser materials may be acceptable provided the specified rates of application are increased proportionately, on the basis of quantities passing the 8- and 100-mesh sieves, but no additional payment shall be made for increased quantity.

2.3 MULCH

Furnish threshed straw of cereal grain such as oats, wheat, barley, rye, rice, etc. or grass hay. Materials that contain objectionable weed seeds or other species that might be detrimental to planting being established or to adjacent farmland shall not be acceptable.

2.4 SEED

- A. Furnish seed labeled Virginia CERTIFIED or APPROVED, unless written exception is granted. Furnish seed in sealed, standard containers unless written exception is granted. Seed that is wet or moldy or that has been otherwise damaged in transit or stage shall not be acceptable.
- B. Mixtures: Furnish seed of Southern Lawn turf type tall fescue blend, Blue Tag Certified or equivalent. Application rate shall be 8 lbs. per 1,000 sq. ft.
- C. All permanent seeding (Section IV) shall be applied between September 1 and October 20, or between February 15 and April 15. All seeding done outside these periods shall be temporary, for erosion control only.

2.5 TEMPORARY SEEDING

Between April 16 and August 31, temporary seeding shall consist of German Foxtail Millet, applied at a rate of 30 lbs/acre. Between October 21, and February 14, temporary seeding shall consist of winter rye (cereal rye), applied at rate of 120 lbs/acre. Temporary seed may be broadcast, and shall be fertilized with an organic based fertilizer (14-3-6) at a rate of 1½ lbs of nitrogen per 1.000 square feet, and mulched with continuous straw bale coverage at a rate of 80 bales/acre.

2.6 SOIL FOR REPAIRS

For fills and topsoiling areas to be repaired, soil shall be of at least equal quality to existing in areas adjacent to the area to be repaired. Soil used shall be free from roots, stones, and other materials that hinder grading, planting, and maintenance operations and free from objectionable weed seeds and toxic substances.

2.7 TOPSOIL

Topsoil stockpiled under other sections of these Specifications shall be utilized and shall contain no rocks or lumps 2" in greatest dimension. If stockpiled topsoil is unavailable, the Contractor shall import the soil, subject to Engineer's approval.

2.8 WATER

Water shall be free from oil, acid, alkali, salt, and other substances harmful to growth of grass, and shall be from a source approved prior to use by Engineer.

PART THREE - EXECUTION

3.1 GENERAL

- A. Area and requirements of Work: All disturbed ground areas within limits of construction shall be graded, topsoiled, tilled, fertilized, limed, seeded, and mulched. For cut and fill areas which consist of primarily rock or rough rock/soil, topsoiling, and tilling shall be waived.
- B. Equipment: Provide equipment in good condition for the proper ground preparation and for hauling and placing of materials. Equipment shall be approved before work is started.

3.2 PREPARATION OF GROUND SURFACE

- A. Clearing: Prior to grading and tilling, vegetation that may interfere with operations shall be moved and grubbed; remove collected material from site, or when suitable, used material for mulch as approved by Engineer. Clear surface of stumps, roots, cable, wire, rocks or lumps greater than 2", and other materials that might hinder Work or subsequent maintenance.
- B. Grading: Maintain previously established grades on the areas to be treated in a true and even condition; make necessary repairs to previously graded areas. Where grades have not been established, grade areas as shown on Drawings, and leave all surfaces in an even and properly compacted condition to prevent formation of depressions. Finished grade shall be such that after subsequent treatments, i.e. tillage, topsoiling, and planting, planted grade shall join 1 inch below adjoining surfaced grade of walks and drives.
- C. Tillage: After areas required to be treated have been brought to grades shown, till soil to a depth of at least 3 inches by plowing, disking, harrowing, or other approved operations until condition of soil is acceptable. Perform Work only during periods when, in Contractor's or Engineer's opinion, beneficial results are likely to be

obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, Work shall be stopped when directed. Level undulations or irregularities in surface before next specified operation.

D. Topsoiling:

1. Distribute topsoil uniformly and spread evenly to a settled thickness of 4 inches. Spread topsoil so that planting can proceed with little additional soil preparation or tillage.
2. Level surface irregularities resulting from topsoiling or other operations to prevent depressions. Adjust grade to assure that planted grade will be 1 inch below adjoining grade of any surfaced area in accordance with requirements of Paragraph 3.2, B.
3. Topsoil shall not be placed when subgrade is frozen, excessively wet, extremely dry, excessively compacted, or in a condition detrimental to proposed planting or grading.
4. Pulverize soil compacted by construction equipment or soil on compacted cut slopes or grades to a minimum depth of 2 inches by disking or plowing before applying topsoil.

E. Fertilizing:

1. Distribute fertilizer uniformly at a rate of 25 pounds per 1,000 square feet over areas to be seeded, and incorporate it into soil to a depth of at least 3 inches by disking, harrowing, or other acceptable methods. Incorporation of fertilizer may be part of operation specified in Paragraph 3.2, C.
2. If liquid fertilizer is used, apply it in amounts sufficient to provide the same value of nutrients per unit of surface area specified for dry fertilizer. If a liquid fertilizer is used in a hydroseeder, apply material on a poundage basis mixed with same volume of water used with dry fertilizer.
3. Use of approved hydraulic equipment or seed drill equipped to sow seed and distribute fertilizer at the same time shall be acceptable.

F. Liming: Immediately following or simultaneously with incorporation of fertilizer, distribute limestone uniformly at a rate of 80 pounds per 1,000 square feet, and incorporate it into soil to a depth at least 3 inches by disking, harrowing, or other acceptable methods. Incorporation of limestone along with fertilizer may be part of the operation specified in paragraph 3.2. C.

G. Leveling: Level surface irregularities resulting from tillage, fertilizing, liming, or other operations before seeding.

3.3 PLANTING SEED

A. General: Sow seed between dates of April 15 and May 30 or August 15 and October 1, unless otherwise directed in writing.

1. Employ a satisfactory method of sowing, using approved mechanical power-drawn drills or seeders, mechanical hand-seeders, hydraulic seeders, or other approved methods. When drills are used, provide markers or other means to ensure that successive seeded strips will overlap or be separated by a space no greater than equipment row spacings.
 2. When delays in operations extend work beyond the most favorable planting season for species designated or when conditions are such by reason of drought, high winds, excessive moisture, or other factors that satisfactory results are not likely to be obtained, halt work as directed and resume only when conditions are favorable or when approved alternate or corrective measures and procedures have been effected.
 3. If inspection during seeding operations or after there is show of green indicates that strips wider than space between rows planted have been left unplanted, or other areas skipped, sow additional seed at no additional cost to Owner.
- B. Broadcast seeding: Broadcast seed either by hand or with approved hydraulic seeding equipment, as specified hereinbefore, in combination with fertilizer, or with other approved sowing equipment at the rate shown under Paragraph 2.4, B.
1. Distribute seed uniformly over designated areas.
 2. Sow half of seed with sower moving on one direction.
 3. Seed shall be covered to an average depth of 1/4" by brush harrow, spike-tooth harrow, chain harrow, cultipacker, hand rake, or other approved device.
 4. Seed shall not be broadcast during windy weather.

3.4 COMPACTING

- A. Equipment: Immediately after the seeding operation has been completed, the surface shall be compacted by a cultipacker, roller, or other approved equipment weighing 100 to 160 pounds per linear foot of roller.
1. When planting by machine, the roller shall be operated immediately behind the planter unless otherwise directed. Under certain soil conditions, the Engineer may direct that rolling be delayed for 15 to 30 minutes following planting to avoid balling the soil on the roller or squeezing water out of furrows.
 2. If the soil is of such type that a smooth or corrugated roller cannot be operated satisfactorily, a pneumatic-tired roller, not wobble-wheel, shall be used. A roller having tires of sufficient size shall be used, or sufficient passes of the roller shall be made, to cover the soil surface completely.

3.5 MULCHING

- A. Conditions: Straw or hay mulch shall be spread uniformly in a continuous blanket, using 100 pounds per 1,000 square feet.
- B. Equipment: Mulch shall be spread by hand or by a manure spreader, a blower-type mulch spreader, or other suitable equipment.
- C. Method:
 - 1. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered. The mulch shall not be bunched.
 - 2. Immediately following spreading, the mulch shall be anchored to the soil by a V-type wheel land packer, a scalloped-disk land packer designed to force mulch into the soil surface, or other suitable equipment.
 - 3. The number of passes needed, not to exceed three, shall be determined by the Engineer.

3.6 WATERING

- A. Water shall be delivered in a manner that will ensure that the upper 6" of the soil surface is moistened. Distribution shall be at an even rate and in a manner to prevent erosion.
- B. Watering equipment of a type that prevents damage to finished surface shall be used.

3.7 ESTABLISHMENT AND MAINTENANCE

- A. General: Protection shall be provided against traffic or other use by erecting barricades immediately after treatment is completed, and by placing warning signs, as directed, on various areas. Contractor shall assume responsibility for proper care of seeded areas while grass is becoming established for three months after completion of treatment on the entire project, unless desired cover is established in a shorter period of time and the Engineer shortens the responsibility period. When any portion of the surface becomes gullied or otherwise damaged or treatment is destroyed, the affected portion shall be repaired to re-establish condition and grade of soil and treatment prior to injury, as directed. Repair work required because of faulty operations or negligence on the part of the Contractor shall be performed without additional cost.
- B. Postplanting fertilization: From 40 to 60 days after seeding or planting, Grade 10-10-10 fertilizer shall be applied uniformly at a rate of 15 pounds per 1,000 square feet over areas seeded or planted. Fertilizer conforming to physical condition, packaging, and marking as specified shall be provided. Fertilizer shall be applied when grass blades are dry to minimize burning. When water is available, the planted area shall be irrigated to thoroughly moisten the upper 6" of the soil surface after the fertilizer is applied. Engineer shall designate areas needing further refertilization at least 15 days before application is required.

- C. Reseeding: The Engineer shall designate areas requiring reseeding at least 15 days before the period specified for reseeding. Seed specified shall be drilled at 4 pounds per 1,000 square feet, in a manner that will cause minimum disturbance to existing stand of grass, and at an angle of not less than 15 degrees from direction of previously seeded rows.
- D. Mulching: Mulched areas shall be maintained until all work or designated portions thereof have been completed and accepted. Any damage shall be repaired, and mulch material that has been removed by wind or other causes shall be replaced and secured.

- END OF SECTION -

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