CITY OF CHARLOTTESVILLE, VA
SANITARY SEWER SYSTEM
STANDARD SPECIFICATIONS AND DETAILS

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GENERAL PROVISIONS
1.01  ABBREVIATIONS

AIA – American Institute of Architects
AASHTO – American Association of State Highway and Transportation Officials
ACI – American Concrete Institute
ACSA – Albemarle County Service Authority
AMR – Automatic Meter Reading
ANSI – American National Standards Institute
AREA – American Railway Engineering Association
ARV – Air Relief Valve or Combination Air-Vacuum Relief Valve
ASA – American Standards Association
ASME – American Society of Mechanical Engineers
ASTM – The American Society for Testing Materials
AWG – American Wire Gauge
AWS – American Welding Society
AWWA – American Water Works Association
BOCA – Building Officials and Code Administrators
CAD – Computer-Aided Drafting
C.I. – Cast Iron
CMU – Concrete Masonry Unit
CSI – Construction Specifications Institute
DEQ – Virginia Department of Environmental Quality
D.I. – Ductile Iron
ERT – Electronic Radio Transmitter
F – Fahrenheit
fps – Feet per second
Galv. – Galvanized
gpd – Gallons per day
gpm – Gallons per minute
H:V – Horizontal to Vertical
I.D. – Inside Diameter
IBC – International Building Code
IPC – International Plumbing Code
ksi – Thousand pounds per square inch
M.H. – Manhole
No. – Number
NSF – National Sanitation Foundation
O.D. – Outside Diameter
OSHA – Occupational Safety and Health Administration
pcf – Pounds per Cubic Foot
PE – Polyethylene
PI – Plasticity Index
psi – Pounds per Square Inch
psig – Pounds per Square Inch Gage
PVC – Polyvinyl Chloride
R.C. – Reinforced Concrete
1.02 DEFINITIONS

Agreement – The written contract between Owner and Contractor covering the Work to be performed; other contract Documents are attached to the Agreement and made a part thereof as provided therein.

As-built – Construction plans and details that have been edited after construction to reflect accurate locations and features of all appurtenant utilities.

Bedding – A layer of granular material, gravel, or crushed rock immediately below and supporting a conduit or fully or partially encasing a conduit. Material existing in a trench, ditch, or tunnel, upon which conduit is placed directly, is considered to be bedding.

Bid – The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

Building Sewer – In plumbing, the extensions from the building drain to the public sewer or other place of disposal. Also called a building connection.

Change Order – A written order issued by the City to the Contractor directing certain changes, additions, or reductions in the Work or in the materials used.

City – The City of Charlottesville, Virginia, referred to as Owner.

Construction approval – A letter issued by the City of Charlottesville to a developer that authorizes him to construct facilities for which the design plans and specifications have been approved by the City of Charlottesville.

Contractor – The person, firm, or corporation with whom Owner has entered into the Agreement.

Department of Public Works – The Department of Public Works of the City of Charlottesville, Virginia, its designated employ in charge of the project, or contracted representative.

Developer – Any person, firm, corporation or association having an interest in constructing improvements to alter the use of land. Of particular interest to the City are developers constructing facilities to be dedicated to public use within the jurisdictional area of the City.

Drainage Ditch – A natural or artificially constructed open depression for the purpose of carrying off surface water.

Drawings – The drawings which show the character and scope of the Work to be performed by the Contractor and which have been prepared or approved by the City and are referred to in the Contract Documents.

Easement – A grant of a right of use of the property of an owner for a certain purpose at the will of the grantee.

Engineer – An individual, firm, association, properly qualified person, or the legally authorized representative(s), designated by the Owner, experienced in and legally qualified to practice the profession involved. The term shall apply to the Owner when the Owner is acting as its own Architect or Engineer.

Guarantee Period – One year following the date of final acceptance of the work by the Owner unless otherwise specified.

Infiltration – groundwater entering sewers through defective joints and cracks in pipes and manholes.

Inflow – water discharged into sewers from foundation and roof drains, outdoor paved areas, cooling water from air conditioners, and unpolluted discharges from businesses and industries.

Inspector – The person appointed by the City, whose duty it is to inspect the materials used, and see that the work is performed in accordance with the Contract documents; and carry out such instructions as given him by the Engineer.

Interceptor – a sewer that receives sewage flow from a number of gravity mains, trunk sewers, sewage force mains, etc. On June 23, 2006 the City of Charlottesville defines interceptors as continuous sections of 24” diameter and greater sanitary sewer lines that continue to increase in diameter as they approach the RWSA interceptor.
Invert – The lowest point in the internal cross-section of a pipe.

Lateral – a sewer that has no other common sewers discharging into it.

Laws and (or) Regulations – Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

Main or trunk – a sewer that receives sewage flow from one or more sub main sewers. *Sewer mains are generally 8” and 10” diameter. Sewer trunks are hereby defined as 12”, 15”, 16”, 18”, 21” diameter.*

Plans – The drawings which show the character and scope of the Work to be performed by the Contractor and which have been prepared or approved by the City and are referred to in the Contract Documents.

Potable Water – Water suitable for human consumption and domestic use.

Right-of-Way – A general term denoting land, property, or interest therein, usually in a strip, that is acquired or devoted to transportation or other public facilities, but is not meant to denote the legal nature of ownership.

Roadway – That portion of the street intended for use of vehicular traffic.

Sanitary Sewer – A pipe or conduit that carries wastewater.

Service Lateral – a sewer that has no other common sewers discharging into it. *These lines are generally 4” diameter.*

Sewer Service – See “Service Lateral”

Shop Drawings – All drawings, diagrams, illustrations, brochures, schedules, and other data that are prepared by the Contractor, a Subcontractor, manufacturer, supplier, or distributor that illustrate the equipment, material, or some portion of the Work.

Specifications – Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the Work and certain administrative details applicable thereto.

Storm Sewer – A sewer that carries storm water and surface water, street wash and other wash waters, or drainage, but excludes domestic wastewater and industrial wastes. Also called a storm drain.

Street – The whole right-of-way included between property lines, reserved for the accommodation of the traveling public, and its appertaining structures and slopes, and all ditches, channels, waterways, etc., necessary to its correct drainage.

Subcontractor – An individual, firm, or corporation having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the site.

*Sub main – a sewer that receives flow from one or more lateral sewers. These sewers are generally 6” and 8” diameter.*
Superintendent – The executive representative of the Contractor authorized to receive and fulfill instructions from the City and supervise and direct the construction.

Wastewater – The spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.

Water Service – Water supply pipeline to a customer's building service line.

Work – The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.
SECTION 2. GENERAL CONDITIONS

2.01 ENGINEERING AND ARCHITECTURAL GENERAL CONDITIONS

A. General.

1. The design of all potable water systems and sanitary sewer systems shall be performed under the direction of a registered professional engineer with a current registration in the Commonwealth of Virginia in accordance with Title 54.1, Chapter 3 of the Code of Virginia, 1950, as amended. Where applicable and in accordance with DPOR Regulations, design may be performed under the direction of a certified land surveyor in accordance with Section 54.1-408 of the above-cited Code.

2. The design of all potable water systems shall conform to the Virginia Department of Health Waterworks Regulations and to the requirements of other state and federal agencies having jurisdiction. The design of all sanitary sewer systems shall conform to the Virginia Department of Environmental Quality Sewage Collection and Treatment Regulations and to the requirements of other state and federal agencies having jurisdiction.

3. All designs shall conform to the requirements of the City of Charlottesville. Where the requirements of the state and city are in conflict, the more restrictive requirements shall govern.

4. The designer shall be responsible for obtaining the review and necessary approvals of all drawings and specifications by applicable agencies having jurisdiction. Copies of such approvals shall be submitted to the City prior to final review.

5. Water lines for developments or subdivisions are to be designed for maximum build-out of the area of which the subdivision or development is a part. Sanitary sewer lines for development or subdivisions are to be designed to serve the entire watershed of which the subdivision or development is a part. This necessitates consideration of property beyond the development or subdivision in question. The designer is required to design and construct the system, properly sized and at an appropriate location, to permit future extensions to be made at the limits of the subdivision or development in question. Elevation of the proposed sewer system lines and structures must be designed such that future extensions can serve the entire area that naturally drains towards the existing system.

B. Engineering report.

1. An engineering report shall be submitted to and approved by the City before approval of drawings and specifications, with the exception of lateral connections. The engineering report shall include a preliminary system design and an overall system layout plan. The report shall demonstrate that the water lines are designed to serve the entire subdivision or development. Where
phased development is contemplated, the extent of each phase shall be clearly delineated.

b. Capacity studies for water lines will be required on an as-need basis as deemed necessary by the City Engineer for developments exceeding 40,000 gallons per day average flow based on VDH Water Works Regulations.

c. **Capacity Study Requirements for Sanitary Sewer**

*Estimate of flow rate of sewage from a development*

The estimated flow rate shall be based on Table 3 in VDH Sewage Collection and Treatment Regulations (SCAT) 9VAC25-790-460. These figures may need to be adjusted to include infiltration and inflow.

Additional provisions for inflow, infiltration and appropriate peaking factors shall be provided by the City of Charlottesville in consultation with the designer.

The basis of design shall, in general, be that the sewer systems be designed for the estimated ultimate tributary population with an upper limit consisting of the 50-year population growth projection, except when considering parts of the systems that can be readily increased in capacity. Consideration shall be given too land use plans and to other planning documents and to the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc. as required by SCAT Regulations 9VAC 25-790-310.B.

The minimum peak design capacity for lateral and submain sewers should be 400% of the average design flow SCAT Regulations 9VAC 25-790-310.D. This includes the effect of infiltration.

The minimum peak design capacity of main and trunk sewers should be 250% of the average design flow and minimum peak design for interceptor sewers shall be 200% of the average design flow SCAT Regulations 9VAC 25-790-310.D. This includes the effect of infiltration.

**Guidance for determining sewer system adequacy**

Sewage collection system downstream of the development shall be evaluated on an as-needed basis determined by the City of Charlottesville. In general, developments generating 4000 gallons per day (average daily flow) or more sewage shall comply with the following. The designer shall:

- provide sewage quantity estimates from the development
- provide capacity of receiving line at tie-in point and downstream at any critical points (as determined in consultation with the City) to where the line connects with a trunk line (as defined above)
- provide a plan indicating the sanitary sewershed that the proposed development will impact. Label manholes with the city manhole ID numbers. Indicate MH top elevations, invert elevations, slope of line, and diameter of pipes. Include this information in a table as well, and
• provide a table indicating the proposed additional load on the sewage collection system, the current capacity of the downstream lines analyzed, and a determination if there is available capacity to handle the proposed additional load.
• evaluation of capacity of the existing system shall include flow monitoring at a minimum of one location and may include additional locations as determined by the City of Charlottesville after consultation with the designer. Flow monitoring device(s) shall be in place so as to obtain 30 days flow data. The City requires analysis to a point where the sanitary sewer becomes a trunk line (i.e. is a continuous 12-inch diameter or greater).

Sharing of data

All data submitted to the City shall be made available to any and all interested parties.

2. Preliminary system design.

   a. An analysis shall be prepared that tabulates the number of people being served or proposed to be served. The tabulation shall be by incremental areas for evaluation purposes.

   b. Average and maximum flows shall be developed for areas and sub-areas and tabulated in the report as deemed necessary or appropriate.

   c. The design documentation shall address total current and projected future flows and system capacities of existing and proposed utilities and shall provide the proposed line sizes.

   d. Facility sizing shall be based on ultimate development (complete build-out of the area) and shall present all information necessary for a sound evaluation of the factors used in development of the report.

   e. If proposed, an alternate design incorporating interim or stated construction shall be included.

3. The system layout plan shall delineate service area boundaries and clearly define the areas pertinent to interim and ultimate development of the service area. The system layout plan shall show present and future development, proposed interim and future utilities, and existing utilities that will be affected by or have an effect on the proposed utilities. Existing and proposed ground elevations shall be shown at contour intervals not exceeding two (2) feet unless otherwise approved by the City. Proposed utilities necessary to serve adjacent properties and associated easements shall be shown.

C. Contacting property owners: Prior to performing any survey and design work on private property, the engineer/surveyor shall notify the affected landowner of the proposed project. Notification shall be made in the form of a letter to be sent to the property owner 7 to 10 days before commencing work. Copies of such letter shall be provided to the City along with the initial plan submittal.

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D. City review of construction drawings.

1. Prior to construction of potable water facilities and/or new sanitary sewer facilities, construction drawings for the proposed facilities must be submitted for review to the City. The construction drawings must be in a form acceptable to the City. Five (5) copies shall be submitted for review.

2. Easements.

   a. Off-site easements shall be recorded and the deed book and page numbers of the recordation included on the utilities plans before receiving approval of the plans for construction.

   b. Easements shall be required except where installed within a public right-of-way of the City of Charlottesville or the Virginia Department of Transportation. If the utility is placed within the outer 10 feet of the VDOT right-of-way, additional private easements shall be provided to allow 10 feet from the center of the pipeline. Easements shall not be less than 20 feet in width centered on the main. Combined sewer and water easements shall not be less than 30 feet in width with both mains 10 feet from the edges of the easement. The City reserves the right to require additional easement width if construction and maintenance activities require it.

All easements shall have the right of ingress and egress fully provided for in the recorded deed. Where deemed necessary, easements shall extend to adjacent property for orderly extensions of service. No trees, shrubs, structures, fences, or obstacles shall be placed within an easement that would render the easement inaccessible by equipment. Any person who constructs a structure within the utility easement shall be liable for the cost of removal and any damage to the pipeline.

2.02 CONSTRUCTION DRAWING ORGANIZATION AND FORMAT

A. Drawing organization.

   1. Drawings shall consist of the following types of sheets arranged in the order listed.

      a. Cover sheet.

      b. Index sheet (if necessary).

      c. Plan and profile sheets.

      d. Standard sheets and special details.

      e. Erosion and sediment control details.

B. Sheet format.

   1. All construction drawings shall be on sheets 24 inches by 36 inches.

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2. The cover sheet shall contain the City’s name and project description in large, distinctive letters, a vicinity map drawn on a scale of 1 inch = 2000 feet to indicate the general vicinity of the contemplated construction, an index to the plan sheets, and a seal of the design engineer or person responsible for the design (i.e. consistent with DPOR regulations). The vicinity map shall include a North arrow and a scale.

3. A plan index map shall be prepared for all pipeline projects. The index map shall be to a scale of not less than 1 inch = 600 feet, and shall show all proposed utilities with tie-ins to existing utilities. The lines of the proposed construction, together with proposed utility structures, shall be indexed to the drawings to indicate the extent of coverage on each drawing.

4. Plan sheets, as well as plan and profile sheets, shall show horizontal, vertical, and topographical data.

5. All plans shall bear a suitable title showing the City’s name and project title. The plans shall also show the scale in feet, the North arrow, the date, and the name of licensed professional responsible for preparation of the plans. Each plan sheet shall bear the same general title identifying the overall project, and shall be numbered.

C. Drafting conventions.

1. Industry standard symbols should be used for drawings where applicable. When standard symbols are not used, a symbol key shall be included in the drawing set. Existing facilities shall be differentiated from new facilities.

2. Standard symbols — proposed facilities: Symbols shall be as noted above except that solid lines shall be used for pipes, line weight shall be no lighter than 0.024 inches and no heavier than 0.031 inches.

3. Text, dimensions and notes: Lettering shall be consistent and clear with a minimum height of 0.125 inches (1/8 inch). The larger size lettering type shall have proportionately wider line widths. When drawings are prepared using computer-aided drafting (CAD), the minimum text height shall be 0.10 inches.

D. Drawing standards.

1. All plans shall comply with the format and quality control requirements of the City. Plans that do not meet these criteria will not be acceptable for review.

2. Plans submitted for review shall be direct blue line or black line prints. Photocopies or facsimile reproductions will only be accepted for information or preliminary review purposes.

3. Drawings shall be clear and legible. Text shall be readable when drawings are reduced to half size.

4. The contrast of the printed material shall be high, with blank areas being as white as possible, and all information being as dark as practicable, while remaining clear and distinct.
5. Shading, such as on plan views for paving, shall not be used on the drawings where it will hide any information when the drawing is photocopied or scanned. For areas that need to be identified or highlighted, stippling or cross-hatching may be used, provided no other information is hidden.

E. Additional information.

1. Horizontal scale in plan and profile sheets shall be no smaller than 1 inch = 50 feet.

2. Vertical profile scale shall be no smaller than 1 inch = 10 feet.

3. A bar scale shall be included on each sheet.

4. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, sewer mains, gas mains, storm drains, utility service lines, etc., shall be shown in plan and profile. Approximate locations shall be noted as such.

5. Benchmarks shall be set no more than 500 feet apart along the lines of construction but outside the limits of construction. Datum for elevations shown shall be North American Vertical Datum 1988 (NAVD88).

6. Drawings shall show off-site easements required and identify deed book and page number.

7. Drawings shall show all property lines bordering the proposed work area. Property owners and tax map parcels shall be identified.

8. Project specifications shall be in the Construction Specifications Institute (CSI) 16-Division format. Specification sections contained herein shall be incorporated into the project specifications.

9. All sub-surface investigations, including test bores, reports, etc., utilized in the design shall be incorporated into the project specifications.

10. “As built” drawings shall be prepared and delivered to the City of Charlottesville by the designer, based on information provided by the Contractor, if so required in the contractual agreement between City and designer or developer.

2.03 CONTRACTOR GENERAL CONDITIONS

General Conditions of the Contract entitled, General Provisions, published by City of Charlottesville and as amended by Supplemental Conditions shall be made a part of the Contract documents and shall apply to all Contractors and Subcontractors.

All Contractors and Subcontractors will be held to have examined and made themselves familiar with the articles of the General Conditions and the modifications and Supplemental Conditions thereof.

Unless otherwise indicated, in cases where a water service lateral or sewer service lateral is permanently taken out of service or abandoned (aka demolished) such as in the case of
the demolition of a building, the contractor is responsible for removing the service line to the main. In the case of a water service abandonment, the contractor shall remove all service lines to the corporation stop and shut off the corporation stop. In the case of a sanitary sewer service abandonment, the contractor shall remove all service line to the main and plug the tap and/or repair the main to the satisfaction of the City of Charlottesville. The contractor is responsible for any and all permits required to perform the work and repairing the paved surfaces as per these standards.

END OF SECTION
DESIGN REQUIREMENTS
DESIGN REQUIREMENTS

1.01 GENERAL REQUIREMENTS - WATER

A. Introduction.

1. The potable water distribution system currently in place consists of a network of interconnecting pipe with minimal dead-end lines. The designer shall make every effort possible to minimize the use of dead-end lines in the replacement of existing water lines and in the design of new extensions of the distribution system.

B. Basis.

1. All distribution system extensions and modifications shall be designed to adequately serve the ultimate needs of the area in which located. The design flow shall be based on acreage density with proper allowances for fire flows and future expected maximum growth per the Comprehensive Plan, latest edition, future land use map.

2. In the absence of information on population densities or unit flows, the designer shall supply sufficient information, substantiated by sound engineering judgment, to verify the design flow rates. The information shall be subject to approval by the City.

C. Design.

1. All water lines shall be located in:

   a. Legally established road rights-of-way; or
   
   b. Legally established permanent easements for such purpose, either existing or as proposed by the designer.

2. Alignment shall be along the centerline of rights-of-way or easements except when this location has been previously used by any other utility. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.

3. Dead-ends should be minimized by looping of all mains. Where dead-end lines occur, they shall be provided with a fire hydrant, flushing hydrant, or blowoff for flushing purposes. No flushing device shall be directly connected to any sewer. However, where dead-end lines are unavoidable, they shall be designed subject to the approval of the City Engineer. The use of fittings shall be minimized where possible by the use of pipe-joint deflections.

4. Provide thrust restraint at all fittings and as shown and called out on the Plans as necessary to conduct final pressure test of the completed line.

   a. Fire Hydrants shall be installed in accordance with the detail provided in the specifications. The Contractor may elect to use restrained joint pipe from the Tee to the fire hydrant. If restrained joint pipe is used, the thrust block at the main, the thrust block under the valve, and the threaded rods may be eliminated.

   b. Restrained Joint Pipe, Mechanical Joint Pipe with Mega Lug Retaining Glands, or traditional Push-on Pipe with Thrust Blocks may be used along the pipe alignment.
c. Ductile Iron Pipe with Restrained Joints shall meet the applicable provisions of AWWA C-110 and AWWA C-111. The accepted manufactures are as follows:

i. United States Pipe & Foundry Company, “TR FLEX” restrained joint or “Fast-Grip” restrained joint.


iv. Or Approved Equal

d. Retainer Glands may be used in lieu of restrained joint pipe and shall be manufactured by EBAA Iron, Inc., Series 100 “Megalug.” “Or Equals” will be considered but must be approved in advance by the City Engineer. Retainer glands may be used on proposed mains to restrain pipe with mechanical joints in accordance with the manufacturer’s recommendation. All pipe where retainer glands are used shall have a hardness of 180-200 BHN (Brinell Hardness Number) to allow proper activation of the glands.

e. Thrust restraints shall be used at all fittings. The designer shall confirm the adequacy of the thrust blocks shown on Detail Drawings W 2.0, W 2.1, W 2.2, and W 2.3 for each application.

5. The designer may submit for approval proprietary pipe restraints in lieu of concrete thrust blocks.

a. Provide the City with manufacturer’s calculations showing adequacy of restraints for maximum pressure including surge allowance.

6. Maximum velocity within water line at peak demand shall be less than 5.0 fps.

7. Water lines shall be located a minimum of 10 feet horizontally from any part of a building, structure, or its foundation.

8. The designer shall consider the following factors in preparing layout:

a. Topography of the area.

b. Location of other utilities.

c. Groundwater elevations.

d. Sub-surface conditions.

e. Possible future structure locations.

1.02 TECHNICAL DESIGN - WATER

A. Design capacity.
1. The water distribution system and any extensions thereof shall have adequate capacity to supply the peak hour demands of all customers - domestic, public, commercial and industrial - while maintaining a pressure of not less than 30 pounds per square inch at all points of delivery. In addition, the system shall be capable of delivering maximum hour customer demand plus flows required for fire protection as determined by the City’s Fire Marshal while maintaining a residual pressure of not less than 20 pounds per square inch at each service connection.

B. Customer demand.

1. The following criteria will be used in estimating customer water demands for hydraulic design computations.

a. Residential demand (including single-family homes, townhouses, apartments).

   1) Maximum hour demand: 2 gpm per connection.
   2) Peak hour demand: 3 gpm per connection.
   3) Where the number of residential units is less than 1,000, the greater of the following equation or 2 gpm per connection shall be used to estimate maximum hour demand:

   \[ Q = 11.4 \times N^{0.544} \]

   where
   
   \[ Q = \text{total demand (gpm)} \]
   \[ N = \text{total number of residential units} \]

b. Commercial, industrial, and institutional water demand.

   1) Maximum hour demand: Use Tables A and B for estimation of water demand. Maximum hour demand shall be at least 300% of average hour demand computed from average daily flows. Note: In cases where VUSBC (Virginia Uniform Statewide Building Code) requirements are more stringent, the VUSBC requirements govern.
   2) Peak hour demand: Calculate peak hour demand by applying a 1.5 factor to maximum hour demand.
   3) Industrial flows shall be estimated from flow records or s for large water users.
   4) Maximum hour demand and peak hour demand per connection shall not be less than 2 gpm and 3 gpm, respectively.

c. Applicable design flows shall be selected through coordination with the City Engineer, Department of Public Works, City Fire Marshal, and other local offices, as required.

2. When water distribution system extensions are to be made, the designer shall first determine the quantity of water required and then obtain from the City the hydraulic gradient for the point of connection to the City's system while providing said demands. Distribution piping design will be based upon providing capacities and service pressures in accordance with these standards from the supply design gradient furnished by the City.

3. Hydraulic design of distribution piping will be based on pipe carrying capacities consistent with head losses determined in accordance with the following Hazen-Williams Coefficients.
<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Coefficient “C”</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>100</td>
</tr>
<tr>
<td>8”</td>
<td>110</td>
</tr>
<tr>
<td>10”</td>
<td>115</td>
</tr>
<tr>
<td>12” and greater</td>
<td>120</td>
</tr>
</tbody>
</table>

C. Distribution system layout criteria.

1. Secondary loops and cross mains with diameters less than 12” shall be spaced not more than 1,000 feet apart with no dead-end length exceeding 500 feet for any 8-inch main.
   a. Dead ends should be minimized by looping all mains where possible.
   b. The minimum size pipe for water distribution systems shall be 6 inches in diameter for residential areas, and 8 inches in diameter for commercial and industrial areas.
   c. Any departure in minimum sizing shall be justified by hydraulic analysis and future water use and shall be considered only in special circumstances.
   d. Water mains not sized for fire flows shall not be connected to fire hydrants.

2. All mains, branches, and dead-ends shall be equipped with blow-offs and/or hydrants of adequate size and number to develop a velocity in the main of at least 2.5 feet per second. Blow-offs will be required at low points of lines 8-inches I.D. and larger where practical.

3. Separation of water lines and sanitary sewers.
   a. General. The following factors shall be considered in providing adequate separation.
      1) Materials and types of joints for water and sewer pipes.
      2) Soil conditions.
      3) Service branch connections into the water line and sewer lines.
      4) Compensating variations on the horizontal and vertical separations.
      5) Space for repairs and alterations of water and sewer pipes.
      6) Offsetting of pipes around manholes.
      7) Standards and recommendations by Virginia Department of Health and DEQ.
   b. Parallel installation.
      1) Potable water lines and sanitary sewers shall be separated horizontally by a clear distance of not less than 10 feet edge-to-edge wherever possible.
      2) If local conditions preclude a clear horizontal separation of 10 feet, the installation will be permitted provided the potable water line is in a separate trench and at such elevation that bottom of the potable water main is at least 18 inches above the top of the sewer.
3) Where this separation cannot be obtained, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling. Sewer manholes shall be of watertight construction and tested in place.

c. Crossings.

1) Provide a minimum vertical separation of 18 inches between the outside of the potable water line and the outside of the sewer when a potable water line must cross over a sewer line.

2) Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling.

3) Sewers passing over potable water lines shall be constructed of AWWA specified water pipe. Minimum vertical separation of potable water line and sewer shall be 18 inches.

   a) Center 1 full-length section of pipe so that the sewer joints will be equidistant from the potable water main joints.

   b) Provide adequate structural support for the sewer so as to maintain line and grade.

4. Separation of water lines and other utilities.

   a. Potable water lines shall have a minimum parallel separation of 5 feet from gas lines where practical. All other utilities shall have a minimum edge-to-edge separation of 12 inches.

   b. At all crossings, provide a minimum vertical separation of 12 inches between potable water lines and gas mains or "wire-type" utilities.

   c. No water lines shall pass through or come in contact with any part of a storm sewer or manhole.

5. Depth of cover.

   a. Water pipe shall be laid with a minimum cover of three (3) feet measured from established finished grade to the top of the pipe. Depth of cover shall increase at high points within the piping where doing so will result in the elimination of air relief valves. Where air relief valves are to be installed, the designer shall ensure adequate cover exists to satisfactorily install the air relief valve assembly and vault.

6. Automatic combination air-vacuum release valves shall be installed at the high points of water mains 10-inches I.D. and larger, where accumulation of air may interfere with flow. Automatic air release valves shall be installed in all other main sizes as required.

7. Valves shall be installed at the intersections of all water lines. Generally, three (3) valves will be used at crosses and two (2) valves at tees. A valve shall also be installed every 1000 feet on distribution mains. Additional valves may be required at the discretion of the City.

8. Fire hydrants shall be located on the distribution system as follows:
a. In water systems and extensions serving 1- or 2-family residential areas, fire hydrants shall be located and installed so that there will be at least one hydrant within 300 feet of any building (existing or proposed in ultimate development) serviced by said system or extension.

b. Hydrants along streets or roads on which 1- or 2-family residences front shall be spaced not more than 600 feet apart.

c. In commercial, industrial, apartment, and townhouse areas, fire hydrants shall be provided as required to meet the fire protection standards of the American Insurance Association. In no case shall more than 300 feet of fire hose be required to reach any point at the base of any exterior building wall from the nearest fire hydrant or from each of the hydrants required to supply the stipulated fire flow.

d. Not more than one fire hydrant shall be located on any 6-inch I.D. dead-end main and said fire hydrant shall be located not more than 300 feet from a looped main.

e. Any deviation from the above requirements shall be approved by the City Fire Marshal.


a. Water lines intended to cross streams, rivers, or other surface waters, with either continuous or intermittent flows, present special problems and should be discussed with the City, VDH and VMRC before final plans are prepared. Only under extraordinary conditions will the City approve aboveground crossings.

b. The water line is to be installed a minimum of three (3) feet under the stream or river bed and be of special construction having flexible watertight joints.

c. Valves shall be provided at both ends of the water crossing so that the section can be isolated for tests or repairs; the valves shall be easily accessible and not subject to flooding.

d. Permanent 1-inch taps shall be made at each end of the crossing for testing and locating leaks. Taps shall be located within manhole-type vaults with watertight frames and covers.

e. The designer is reminded that specific requirements of the Army Corp of Engineers, DEQ, and/or VMRC may apply to any stream crossing. A joint permit application may be filed with VMRC for review by these agencies.


a. All roadway crossings are subject to the approval and requirements of the governing authority having jurisdiction. Where approved, roadway crossings are to be by “open cut.” Encasement in a steel casing pipe shall be done only at the direction of the governing authority. Where encasement is required, it shall be in compliance with the requirements of the governing authority and Detail Drawing W 9.0.

b. Where crossings are required to be tunneled, bored, or jacked, said crossings are to be in compliance with the requirements of the governing authority and Detail Drawing W 9.0.

c. Valves shall be provided at both ends of the crossing so that the pipe section can be isolated for testing or repairs. Valves are to be located a minimum of 40 feet from the
ends of the crossing, easily accessible and not subject to flooding. No service connections shall be located between valves unless approved otherwise by the City.

11. Railroad crossings.

Railroad crossings are subject to the approval and requirements of the operating railway company. Crossings are to be by tunneling, boring, or jacking, and are to comply with the requirements of the railway and Detail Drawing W 9.1.

a. Valves shall be provided at both ends of the crossing so that the pipe section can be isolated for testing or repairs. Valves are to be located a minimum of 40 feet from the ends of the encasement, easily accessible, and not subject to flooding. No service connections shall be located between valves unless approved otherwise by the City.

D. Water service laterals.

1. Service laterals shall be sized for maximum anticipated peak flow demand for the building being serviced in accordance with the requirements of the Virginia Uniform Statewide Building Code. Service lateral shall not be less than 3/4-inch diameter.

Table C is provided to assist in selecting appropriate service lateral pipe size. Maximum allowable water velocity for cold water service is 8 feet per second. Note: In cases where VUSBC requirements are more stringent, VUSBC governs.

2. All service laterals are to be installed with 36 inches minimum cover on the City side of the meter. Service lateral shall run perpendicular to the main straight to the meter box or vault. Minimum cover may be reduced to 24 inches with written permission of the City Engineer.

3. Where a service lateral must cross a sanitary sewer, the bottom of the service lateral within 10 feet of the point of crossing shall be at least 12 inches above the top of the sewer.

4. Service laterals shall be provided complete with the exception of the meter and associated automatic meter reading components. Meter and associated automatic meter reading components will be provided and installed by the City. Table D is provided to assist in meter selection. Note: In cases where VUSBC requirements are more stringent, VUSBC governs.

5. Meter boxes or vaults are to be located a minimum of 12 inches and a maximum of 36 inches directly behind the curb where possible or as directed by the Public Utilities Manager. Where no curb exists, meter boxes and vaults shall be installed in readily accessible locations beyond the limits of the street surfacing and driveways as directed by the City.

6. Warning tape and 14-gauge tracer wire shall be installed with each service lateral. Terminate tracer wire in a loop within the meter box or vault.

E. Piping materials.

1. All pipe for water main construction shall be cement-lined ductile iron pressure pipe of the push-on joint or mechanical joint or restrained joint variety, conforming to ANSI 21-51 (AWWA C151, latest revision). Thickness class shall be a minimum Class 52 for all pipe diameters.
Fittings for ductile iron pipe shall be mechanical joint ductile iron in accordance with AWWA Specifications C111, latest revision, with a minimum pressure rating of 250 pounds per square inch.

2. Service lines 2 inches and smaller shall be soft copper tubing, Type K, conforming to ASTM B88 and ANSI/AWWA C800. Service lines four (4) inches and larger shall be ductile iron pipe as noted in paragraph E.1 above. Three (3) inch service line is not allowed without written approval of the Public Utilities Manager.

The City may approve alternate piping material at its discretion.

Table A.

AVERAGE FLOW QUANTITIES

<table>
<thead>
<tr>
<th></th>
<th>Gallons/Day/Acre</th>
<th>Equivalent Persons/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (R-25, R-40)</td>
<td>500</td>
<td>5</td>
</tr>
<tr>
<td>Medium (R-9, R-12, R-15)</td>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>High (RTH, RMF)</td>
<td>2500</td>
<td>25</td>
</tr>
<tr>
<td>Other (Agriculture/ Undeveloped Land)</td>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>2000</td>
<td>20</td>
</tr>
<tr>
<td>Office</td>
<td>1500</td>
<td>15</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light (M-1)</td>
<td>2000</td>
<td>20</td>
</tr>
<tr>
<td>Medium (M-2, M-3), Heavy</td>
<td>3500</td>
<td>35</td>
</tr>
</tbody>
</table>

Note: R-9, R-12, R-15, R-25, R-40, RTH, RMF, M-1, M-2 and M-3 are defined in BOCA National Building Code, latest edition.
Table B.

AVERAGE FACILITY FLOW RATES

<table>
<thead>
<tr>
<th>Discharge Facility</th>
<th>Design Units</th>
<th>Flow (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family units (includes townhouses, individual house trailers, etc.)</td>
<td>3.5 people/dwelling</td>
<td>400</td>
</tr>
<tr>
<td>Apartments and condominiums</td>
<td>4 people/3 bedroom apt.</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>3 people/2 bedroom apt.</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>2 people/1 bedroom apt.</td>
<td>200</td>
</tr>
<tr>
<td>Schools with showers and cafeteria</td>
<td>Per person – elementary</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Per person – high school</td>
<td>25</td>
</tr>
<tr>
<td>Motels and hotels at 65 gals./person (rooms only)</td>
<td>Per room</td>
<td>130</td>
</tr>
<tr>
<td>Trailer courts at 4 persons/trailer</td>
<td>Per trailer</td>
<td>400</td>
</tr>
<tr>
<td>Restaurants</td>
<td>Per seat</td>
<td>50</td>
</tr>
<tr>
<td>Service stations</td>
<td>Per vehicle services</td>
<td>10</td>
</tr>
<tr>
<td>Factories</td>
<td>Per person per 8 hr. shift</td>
<td>25</td>
</tr>
<tr>
<td>Shopping centers</td>
<td>Per 1000 sq. ft.</td>
<td>250</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Per bed</td>
<td>300</td>
</tr>
<tr>
<td>Nursing homes</td>
<td>Per bed</td>
<td>200</td>
</tr>
<tr>
<td>Homes for the aged</td>
<td>Per bed</td>
<td>100</td>
</tr>
<tr>
<td>Doctor’s office in medical center</td>
<td>Per 1000 sq. ft.</td>
<td>500</td>
</tr>
<tr>
<td>Laundromats, 9 to 12 machines</td>
<td>Per machine</td>
<td>500</td>
</tr>
<tr>
<td>Theaters (auditorium type)</td>
<td>Per seat</td>
<td>5</td>
</tr>
<tr>
<td>Bowling alleys</td>
<td>Per lane</td>
<td>75</td>
</tr>
<tr>
<td>Office buildings</td>
<td>Per 1000 sq. ft. of ultimate floor space</td>
<td>200</td>
</tr>
</tbody>
</table>

Note: Other classifications may be found in the BOCA National Plumbing Code, latest edition; the Virginia Department of Health Waterworks Regulations, latest edition, and the Virginia Department of Environmental Quality Sewage Collection and Treatment Regulations (SCAT Regs), latest edition.
### Table C.

**SIZING BASED ON VELOCITY LIMITATIONS**  
COPPER WATER TUBE - TYPE K (ASTM B88)

<table>
<thead>
<tr>
<th>Nominal Size (in.)</th>
<th>Actual I.D. (in.)</th>
<th>Velocity - 4 feet per second</th>
<th>Velocity - 6 feet per second</th>
<th>Velocity - 8 feet per second</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum Probable Flow (gpm)</td>
<td>Friction (psi/100 ft.)</td>
<td>Maximum Probable Flow (gpm)</td>
</tr>
<tr>
<td>1/2</td>
<td>.527</td>
<td>2.72</td>
<td>8.55</td>
<td>4.08</td>
</tr>
<tr>
<td>3/4</td>
<td>.745</td>
<td>5.43</td>
<td>5.70</td>
<td>8.15</td>
</tr>
<tr>
<td>1</td>
<td>.995</td>
<td>9.69</td>
<td>4.06</td>
<td>14.5</td>
</tr>
<tr>
<td>1-1/4</td>
<td>1.245</td>
<td>15.2</td>
<td>3.12</td>
<td>22.8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>1.481</td>
<td>21.5</td>
<td>2.55</td>
<td>32.2</td>
</tr>
<tr>
<td>2</td>
<td>1.959</td>
<td>37.6</td>
<td>1.84</td>
<td>56.4</td>
</tr>
<tr>
<td>2-1/2</td>
<td>2.435</td>
<td>58.0</td>
<td>1.42</td>
<td>87.1</td>
</tr>
<tr>
<td>3</td>
<td>2.907</td>
<td>82.7</td>
<td>1.16</td>
<td>124</td>
</tr>
<tr>
<td>4</td>
<td>3.857</td>
<td>146</td>
<td>0.83</td>
<td>218</td>
</tr>
</tbody>
</table>

Excerpt from The BOCA National Plumbing Code
### Displacement type (AWWA Standard C700-77, cold water meters - displacement type)

<table>
<thead>
<tr>
<th>Meter size (in.)</th>
<th>Safe maximum operating capacity (gpm)</th>
<th>Maximum pressure loss at safe maximum operating capacity (psi)</th>
<th>Recommended maximum rate for continuous operations (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>20</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>5/8 x 3/4</td>
<td>20</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>3/4</td>
<td>30</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>1-1/2</td>
<td>100</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>160</td>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>15</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>15</td>
<td>250</td>
</tr>
</tbody>
</table>

### Compound type (AWWA Standard C-702-78, cold water meters - compound type)

<table>
<thead>
<tr>
<th>Meter size (in.)</th>
<th>Safe maximum operating capacity (gpm)</th>
<th>Maximum rate for continuous duty (gpm)</th>
<th>Maximum allowable loss of head at safe maximum operating capacity (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>160</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>320</td>
<td>160</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>250</td>
<td>20</td>
</tr>
</tbody>
</table>

### Turbine type (AWWA Standard C-701-78, cold water meters - turbine type for customer service)

**Class I -- Vertical shaft and low velocity horizontal type**

<table>
<thead>
<tr>
<th>Meter size (in.)</th>
<th>Safe maximum operating capacity (gpm)</th>
<th>Maximum rate for continuous duty (gpm)</th>
<th>Maximum loss of head at safe maximum operating capacity (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2</td>
<td>100</td>
<td>50</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>160</td>
<td>80</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>350</td>
<td>175</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>600</td>
<td>300</td>
<td>15</td>
</tr>
</tbody>
</table>

**Class II -- In line (high velocity type)**

<table>
<thead>
<tr>
<th>Meter size (in.)</th>
<th>Safe maximum operating capacity (gpm)</th>
<th>Maximum rate for continuous duty (gpm)</th>
<th>Maximum loss of head at safe maximum operating capacity (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>160</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>350</td>
<td>240</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>630</td>
<td>420</td>
<td>7</td>
</tr>
</tbody>
</table>

From The BOCA National Plumbing Code

Design Requirements -11
A. Introduction.

1. Sewage collection systems shall be designed and constructed to achieve total containment of the predicted sewage flows contributed from the established service area and population. Sewers shall be designed and constructed to prevent the discharge of inadequately treated wastes not only within the new systems but in the receiving systems as well. Any projected overflows within receiving systems shall be addressed.

B. Basis.

1. Sewer systems should be designed for the estimated ultimate tributary population with an upper limit consisting of the 50-year population growth projection. Proper allowance for peak flow shall be included as per the State Sewage Collection and Treatment Regulations. Consideration shall be given to land use plans, to the Comprehensive Plan of the City of Charlottesville, and to other relevant planning documents and to the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc.

C. Factors.

1. In determining the required capacities of sanitary sewers, the following factors shall be considered.
   a. Maximum hourly sewage flow.
   b. Additional maximum sewage or wastewater flows from industrial sources.
   c. Groundwater infiltration.
   d. Topography of area.
   e. Location of existing sewers.
   f. Depth of excavation.
   g. Pumping requirements.
   i. Occupancy rates.

D. Sanitary sewer service laterals.

1. Service laterals shall be minimum 4-inch inside diameter. Slope shall be minimum of 2% (1/4”/ft.) unless otherwise approved in writing by City Engineer.

2. Ownership of service laterals. All newly installed sanitary sewer laterals will be owned and maintained by the City of Charlottesville from the property line to the main. Any replacements or upgrades made to existing service laterals will also be owned and maintained by the City of Charlottesville from the property line to the main. New service laterals and replacements/upgrades shall have a clean out at the property line to be installed in accordance with detail WW 5.0. Each individual dwelling shall have its own separate service lateral service line and connection in cases where each dwelling has its own tax map and parcel number.
2.02 TECHNICAL DESIGN – SANITARY SEWER

A. Capacity.

1. New sewer system capacity shall be designed on the basis of an average daily per capita flow of sewage of not less than that set forth in Table B herein. These figures are assumed to include infiltration but do not address inflow from surface water. When deviations from the foregoing per capita rates and established peak flow factors are proposed, a description of the procedure used to establish those design flows shall be provided to the City for approval.

2. The minimum peak design capacity for lateral and sub-main sewers shall be 400 percent of the average design flow.

3. Minimum peak design capacity of main and trunk sewers shall be 250 percent of the average design flow.

4. Minimum peak design for interceptor sewers shall be 200% of the average design flow.

B. Pipe sizing.

1. Gravity sewers shall be sized to serve the estimated ultimate tributary population and maximum anticipated flows for commercial, industrial, and institutional users consistent with the 50-year growth and land use projections for the City of Charlottesville. Hydraulic computations and other design data should clearly establish the capacity of proposed sewers.

2. Sewer size shall not be less than 8 inches in diameter, except under the following conditions.
   a. Calculations and justifications indicating that reduced line size of six (6) inch diameter is adequate shall be provided for review and approval prior to inclusion within the system design.
   b. This exception will only be allowed for laterals serving six or fewer connections.

3. Generally, the size of pipes shall be continually increasing in direction of flow with addition of tributary areas. However, when steep grades are available and length is such that significant cost savings will result without jeopardizing the system, the size of pipe may be reduced to no more than one nominal diameter, but not below 10 inches. Proper hydraulic allowances must be made for resulting head losses.

4. The following table represents the minimum slopes to be provided for gravity sewers; however, slopes greater than those listed are desirable:

<table>
<thead>
<tr>
<th>Sewer Size</th>
<th>Minimum Slope in Feet Per 100 Feet Non-Settled Sewage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>0.49</td>
</tr>
<tr>
<td>8”</td>
<td>0.40</td>
</tr>
<tr>
<td>10”</td>
<td>0.28</td>
</tr>
<tr>
<td>12”</td>
<td>0.22</td>
</tr>
<tr>
<td>14”</td>
<td>0.17</td>
</tr>
<tr>
<td>15”</td>
<td>0.15</td>
</tr>
<tr>
<td>16”</td>
<td>0.14</td>
</tr>
<tr>
<td>18”</td>
<td>0.12</td>
</tr>
<tr>
<td>21”</td>
<td>0.10</td>
</tr>
<tr>
<td>24”</td>
<td>0.08</td>
</tr>
<tr>
<td>27”</td>
<td>0.067</td>
</tr>
<tr>
<td>30”</td>
<td>0.058</td>
</tr>
</tbody>
</table>
a. Sewers shall be installed with uniform slope between manholes.

b. Sewers constructed on 20 percent slope or greater shall be anchored securely with concrete anchors or equal. Minimum anchorage is as follows:

1) Slopes 20% to 35%: Not over 36 feet center-to-center.
2) Slopes 35% to 50%: Not over 24 feet center-to-center.
3) Slopes over 50%: Not over 16 feet center-to-center.

5. All sewer lines shall be designed for a minimum mean velocity of 2.0 fps when flowing full. Computations for velocity of flows shall be based upon the following values of “n” as used in the Manning formula for velocity of flow in pipes flowing full.

a. Sizes 8 inches through 21 inches: “n” equals 0.014

b. Sizes 24 inches and above: “n” equals 0.014 unless justification is provided for an alternate value.

c. Manning Formula: \[ v = \left( \frac{1.49}{n} \right) R^{2/3} S^{1/2} \]

Where: 
- \( R \) = Hydraulic radius
- \( S \) = Slope
- \( n \) = Manning’s roughness coefficient

The maximum permissible velocity shall not exceed 15 feet per second. Suitable provisions shall be provided to break steep slopes to limit the velocities in the connecting sewer pipes between manholes. Where velocities greater than 15 feet per second are unavoidable, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards or specifications, which provide protection against internal erosion.

C. Layout criteria.

1. All sanitary sewers shall be located in:
   a. Legally established road rights-of-way; or
   b. Legally established permanent easements for such purpose, either existing or as proposed by the designer.

2. Construction shall be along the centerline of rights-of-way or easements except when this location has been previously used by another utility. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.

3. Sewers shall be installed at a sufficient depth of 24-inches of cover (minimum) to prevent ice formation due to cooling of the wastewater flows that results in blockage of the flow channel.
   a. Exceptions to the above requirements will be considered only if it is impractical to provide required depths, in which case special approval must be secured, in writing, from the City. In the special case of less than minimal cover, ductile iron pipe of adequate thickness shall be provided.
4. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance shall be made for loads on the sewer as a result of the width and depth of the trench.

5. Where sewer depth is 10 feet or less, sewer lines and manholes shall be located a minimum of 10 feet horizontally from any part of a building, structure, or its foundation. Where the depth of sewer is greater than 10 feet, the sewer lines and manholes shall be located a minimum of 15 feet from any part of a building, structure, or its foundation.

6. All sewers shall be installed with a straight alignment between manholes. No curved sewers are allowed.

7. Sewer size shall remain constant between manholes.

8. Sewers should intersect in manholes at deflection angles no greater than 90 degrees. In the event that this is impractical, the designer must provide head loss calculations as part of the hydraulic analysis. This request for this exception must be submitted in writing to the City Engineer.

9. Only ductile iron or PVC will be considered acceptable material for sewers. The material selected shall be adapted to local conditions such as character of industrial waste, possibility of septicity, soil characteristics, exceptionally heavy internal-external loadings, abrasions, and similar problems. The pipe material shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards.

10. The design engineer shall certify that all existing and proposed sites will be served by gravity with sewer service connections installed at a slope of 1/4 inch per 1 foot (2%) except where shown otherwise and noted on the Plans.

11. Separation of sewers and potable water lines.
   a. Parallel installations.
      1) Sewers shall be laid at least ten (10) feet horizontally from a water main. The distance shall be measured edge-to-edge.
      2) When the minimum 10-foot separation between manholes and water lines cannot be attained, manholes must be both of watertight construction and tested in place.
      3) When local conditions prohibit horizontal separation, the sewer may be laid closer provided that the water main is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water main is at least 18 inches above the top of the sewer.
      4) Where this vertical separation cannot be obtained, the sewer shall be constructed of water pipe material in accordance with AWWA specifications and pressure tested in place without leakage prior to backfilling. The hydrostatic test shall be conducted in accordance with the most recent edition of the AWWA standard (ANSI/WWA C600-82) for the pipe material with the minimum test pressure of 30 psi. Sewer manholes shall be of watertight construction.
   b. Crossings.
1) Provide a minimum vertical separation of 18 inches between the bottom of the potable water main and the top of the sewer when a sewer line passes under the water line.

2) Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling in accordance with State SCAT regulations.

3) Sewers passing over potable water lines shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling in accordance with State SCAT regulations. Minimum vertical separation of potable water line and sewer shall be 18 inches.

4) For all crossings:
   a) Center one (1) full-length section of pipe so that the sewer joints will be equidistant from the potable water line joints.
   b) Provide adequate structural support for the sewer so as to maintain line and grade. Provide adequate structural support for water mains to prevent settlement.

12. Water and Sewer Service line separation.
   a. All sewer service lines shall be laid a minimum of five (5) feet from any water line. All water service lines shall be laid a minimum distance of five (5) feet from any sewer line.

13. Separation of sewers and other utilities.
   a. A minimum horizontal separation of five (5) feet shall be maintained between parallel sewers and gas lines. Should this horizontal separation not be obtainable, This maybe be reduced to three (3) feet with approval of the City Gas Engineer.
   b. Sewers shall have a minimum edge-to-edge separation of 12 inches from all other utilities.
   c. At all crossings, provide a minimum vertical separation of 12 inches between sewers and other utilities.
   d. Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, the sanitary sewer shall be constructed of AWWA specified ductile iron pipe. Concrete supports may be required for the storm sewer.

14. No sewer line shall pass within 50 feet of a drinking water supply well, source, or structure unless special construction and pipe materials are used to obtain adequate protection. The proposed design shall identify and adequately address the protection of all drinking water supply wells, sources, and structures up to a distance of 100 feet of the sewer line installation.

E. Surface water crossings.
   1. Sewer lines intended to cross streams, rivers, or other surface waters, with either continuous or intermittent flows, present special problems and should be discussed with the City before final plans are prepared. Only under extraordinary conditions will above ground crossings be approved by the City.
2. The tops of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, one (1)-foot minimum of suitable cover shall be provided. All proposed sewer stream crossings shall be encased in concrete. Stream crossings should also take future streambed improvements into consideration.

3. Sewers shall remain fully operational during the 25-year flood. Sewers and their appurtenances located along streams shall be protected against the normal range of high and low water conditions, including the 100-year flood. Sewers located along streams shall be located outside of the streambed and should be sufficiently removed therewith to provide for future possible channel widening.

4. Sewers entering or crossing streams shall be constructed of watertight pipe. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Such sewers on piers shall be constructed of ductile iron pipe and in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade due to anticipated hydraulic and physical loads, erosion, and impact.

5. Depressed sewers or siphons where approved by the City shall have not less than 2 barrels, with a minimum pipe size of 6 inches and shall be provided with necessary appurtenances for convenient flushing and maintenance. The inlet and outlet chambers shall be designed to facilitate cleaning. Sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3 feet per second for average flows. The inlet and outlet details shall be arranged so that normal flow is diverted to 1 barrel so that either barrel may be removed for service or cleaning.

6. The designer is reminded that specific requirements of the Army Corp of Engineers, DEQ, and/or VMRC may apply to any stream crossing. A joint permit application may be filed with VMRC for review by these agencies.

E. Roadway crossings.

1. All roadway crossings are subject to the approval and requirements of the governing authority having jurisdiction. Where approved, roadway crossings are to be by “open cut.” Encasement in a steel casing pipe shall be done only at the direction of the governing authority. Where encasement is required, it shall be in compliance with the requirements of the governing authority and Detail Drawing WW 3.0.

2. Where crossings are required to be tunneled, bored, or jacked, said crossings are to be in compliance with the requirements of the governing authority and Detail Drawing WW 3.0.

3. Manholes shall be provided at both ends of the crossing when casing is required to be installed. Manholes shall be located a maximum of 60 feet from the end of the casing and shall be easily accessible and not subject to flooding.

F. Railroad crossings.

1. Railroad crossings are subject to the approval and requirements of the operational railway company. Crossings are to be by tunneling, boring, or jacking, and are to comply with the requirements of the railway and Detail Drawing WW 3.1.

2. Manholes shall be provided at both ends of the crossing a maximum of 60 feet from the end of the casing. Manholes shall be easily accessible and not subject to flooding.
G. Manholes.

1. Manholes shall be installed at the end of each line, at all grade, size, or alignment changes, and at all sewer line intersections.
2. When manholes are located in areas accessible to vehicular traffic, they shall be spaced at distances no greater than 400 feet. When located in inaccessible areas, spacing of manholes on sewer lines shall not exceed 300 feet.
3. Sewer lines shall be protected from a 100-year flood by either raising manhole tops one (1) foot above base flood elevation of 100-year flood plain or by the use of watertight frames and covers. Where watertight frames and covers are used, unventilated length of sewer shall not exceed 1,000 feet. In addition, watertight frames and covers or watertight manhole inserts shall be used whenever manhole tops may be flooded for several hours.
4. Manholes shall be constructed of pre-cast concrete sections sized in accordance with Appendix E.
5. The use of drop manholes shall be avoided if possible. Where the use of a drop manhole is necessary the following requirements shall apply.
   a. A drop pipe should be provided for an upstream sewer entering a manhole at an elevation of 24 inches or more above the manhole invert.
      1) Internal pipe drops shall only be used at existing manholes and only with the approval of the City. Where approved, the number of internal pipe drops at a manhole shall be limited to one.
   b. Sewer lines entering a manhole less than twenty-four (24) inches above the manhole invert shall not enter the manhole greater than twelve (12) inches above the manhole invert and shall be incorporated into a smooth transition by filleting the invert.
6. Miscellaneous head losses at manholes shall be computed as follows. Junctions of more than 2 pipes will require special consideration.
   a. Manholes where radius of turn is less than 2 pipe diameters:
      \[
      H = (0.50) \left( \frac{\text{angle}}{90} \right) \left( \frac{V^2}{2g} \right)
      \]
      Where:  “angle” = horizontal deflection angle  
                 \( V^2/2g \) = velocity head of effluent pipe  
                 \( V \) = velocity in ft./sec.  
                 \( g \) = earth gravity acceleration
   b. Manholes where radius of turn is greater than 2 pipe diameters:
      \[
      H = (0.25) \left( \frac{\text{angle}}{90} \right) \left( \frac{V^2}{2g} \right)
      \]
      Where:  “angle” = horizontal deflection angle  
                 \( V^2/2g \) = velocity head of effluent pipe  
                 \( V \) = velocity in ft./sec.  
                 \( g \) = earth gravity acceleration
c. Head loss for straight run manhole shall be 0.05 feet. In no case shall loss less than 0.05 feet be allowed.

d. Where pipe diameters increase at manholes, in direction of flow, effluent invert shall be lowered below influent invert as follows:

\[
\text{Change} = 0.8 \ (D_1 - D_2)
\]

Where:  
\(D_1\) = downstream pipe diameter  
\(D_2\) = upstream pipe diameter

This adjustment shall be in addition to computed miscellaneous head loss.

e. Special consideration shall be given to cases where pipe diameters decrease in direction of flow.

7. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity.

8. A monitoring manhole shall be required on all new construction or renovations or modifications to existing facilities, where the discharge originating in the new, renovated, or modified facility is, or will have the potential to be, non-domestic in nature. All wastewater from the facility shall flow through the monitoring manhole.

   a. These facilities include but are not limited to industrial facilities, food preparation establishments, grocery stores, bakeries, automobile service stations, gasoline stations, hospitals, animal hospitals, cleaners, machine shops, photographic finishers, printing shops, laboratories, funeral homes, etc.

   b. For multi-use buildings such as shopping centers, the sewer should be an adequate distance from the building to allow installation of a monitoring manhole and grease trap on each sewer lateral when the tenant spaces are upgraded.

   c. A sewer lateral is required for each individually metered facility. Adequate space to accommodate installation of monitoring manhole and/or grease trap should be provided.

   d. If the facility is master metered, a monitoring plan is required for the entire facility. A grease trap and monitoring manhole is required for each individual unit meeting the above definition.

H. Oil and grease interceptors and separators (traps). Oil and grease traps shall be provided for all commercial and industrial facilities connected to the public sewer in accordance with the Virginia Uniform Statewide Building Code (reference International Plumbing Code Section 1003). Traps shall be maintained in an operation condition by periodic removal of accumulated deposits.
# Appendix E. Manhole Sizing and Minimum Angle Table

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MIN. ANGLE

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Design Requirements -20
SITE WORK
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Contractor shall provide all labor, equipment, materials, and incidentals necessary to perform all clearing and grubbing within the limits of work as shown on the Drawings and specified herein.

1.02 RELATED WORK

A. Section 02200, Excavation and Backfill.

B. Section 02270, Erosion and Sediment Control.

C. Section 02280, Seeding, Topsoiling, Fertilizing, and Mulching.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 CLEARING

A. The area to be cleared and grubbed shall be completely cleared of all timber, brush, stumps, roots, grass, weeds, rubbish, and all other objectionable obstructions resting on or protruding through the surface of the ground. Clearing operations shall be conducted so as to 1) prevent damage to existing structures and installations, and to those under construction, and 2) provide for the safety of employees and others.

B. Minimize damage to trees outside construction limits and preserve as specified hereinafter.

3.02 GRUBBING

A. Grubbing shall consist of the complete removal of all stumps, roots larger than 1-1/2 inches in diameter, matted roots, brush, timber, logs, concrete rubble, and all other debris encountered. All depressions excavated below the original ground surface for or by the removal of such objects shall be refilled with suitable materials and compacted to a density conforming to the surrounding ground surface.
3.03 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

A. The Contractor shall dispose of all material and debris from the clearing and grubbing operation by hauling such material and debris away to an approved dump. Disposal by burning or burial will not be permitted. Chipped material may be spread evenly across the easement or right-of-way with prior approval of the City.

3.04 PRESERVATION OF TREES

A. Trees beyond construction limits shall be carefully protected from damage. The Contractor shall erect such barricades, guards, and enclosures he may consider necessary for the protection of the trees during all construction operations. Materials and equipment shall be maintained beyond the drip lines of such trees to the extent practicable. Where required, cut back limbs and branches to preserve trees and paint with an approved tree wound paint.

3.05 PRESERVATION OF DEVELOPED PRIVATE PROPERTY

A. The Contractor shall exercise extreme care to avoid unnecessary disturbance of adjacent private property. Trees, shrubbery, gardens, lawn, and other landscaping damaged by the Contractor beyond the construction limits shall be restored to pre-construction conditions.

B. All soil preparation procedures and replanting operations shall be performed under the supervision of a licensed nurseryman approved by the City or its representative.

END OF SECTION
SECTION 02140
DEWATERING AND DRAINAGE

PART 1 GENERAL

1.00 STATUTORY REQUIREMENTS

A. Obtain and pay for all permits required for temporary dewatering and drainage systems.

B. Original permits shall be prominently displayed on the site prior to constructing dewatering and drainage systems.

1.01 SCOPE OF WORK

A. Furnish, install, operate, monitor, maintain, and remove temporary dewatering and drainage systems as required to lower and maintain groundwater levels below sub-grades of excavations and trenches. Prevent surface water runoff from entering or accumulating in excavations and trenches.

B. Furnish the services of a licensed professional engineer, registered in the Commonwealth of Virginia, to prepare dewatering and drainage system designs and submittals.

C. Collect and properly dispose of all discharge water from dewatering and drainage systems in accordance with state and local requirements and permits.

D. Repair damage caused by dewatering and drainage system operations.

E. Remove temporary dewatering and drainage systems when no longer needed. Restore all disturbed areas.

1.02 RELATED WORK

A. Section 02200, Excavation and Backfill.

B. Section 02270, Erosion and Sediment Control.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 GENERAL

A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, and bearing soils are maintained undisturbed. Prevent softening, or instability of, or disturbance to, the sub-grade due to water seepage.

B. Provide adequate protection against flotation for all work.
C. The anticipated subsurface soil/water conditions shall be considered when selecting methods of excavation and temporary dewatering and drainage systems. Where groundwater levels are above the proposed bottoms of excavations, a pumped dewatering system shall be evaluated for pre-drainage of the soils prior to excavation to final grade and for maintenance of the lowered groundwater level until construction has been completed to such an extent that the foundation, structure, pipe, or fill will not be floated or otherwise damaged. Type of dewatering system, spacing of dewatering units, and other details of the work are expected to vary with soil/water conditions at a particular location. Excavation support system designs shall be prepared by a licensed professional engineer registered in the Commonwealth of Virginia.

3.02 SURFACE WATER CONTROL

A. Control surface water runoff to prevent flow into excavations. Provide temporary measures such as dikes, ditches, and sumps.

3.03 EXCAVATION DEWATERING

A. Provide and maintain adequate equipment and facilities to promptly remove and properly dispose of all water entering excavations. Excavations shall be kept in-the-dry, so as to maintain an undisturbed sub-grade condition throughout construction below grade, including backfill and fill placement.

B. Pipe shall not be installed in water or be allowed to be submerged prior to backfilling. Pipe that becomes submerged shall be removed and the excavation dewatered and restored to proper conditions prior to reinstalling the pipe.

C. Excavations for foundations and structures shall be maintained in-the-dry for a minimum of 4 days after concrete placement. In no event shall water be allowed to enter an excavation and rise to cause unbalanced pressure on foundations and structures until the concrete or mortar has set at least 24 hours.

D. Dewatering and drainage operations shall at all times be conducted in such a manner as to preserve the natural, undisturbed bearing capacity of the sub-grade at the bottom of the excavation. If the sub-grade becomes disturbed for any reason, the unsuitable sub-grade material shall be removed and replaced with compacted granular fill to restore the bearing capacity of the sub-grade to its original undisturbed condition. Costs of such removal and restoration shall be the responsibility of the Contractor.

E. Dewatering and drainage operations shall be conducted in a manner that does not cause loss of ground or disturbance to the pipe bedding or soil that supports overlying or adjacent structures.

F. Provide diesel or gasoline powered standby pumping units ready for immediate use to serve the system in case of failure of normal pumping units.

G. The Contractor shall prevent flotation by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages that may result in failure of this system.
H. The Contractor shall take all necessary precautions to preclude the accidental discharge of fuel, oil, etc., in order to prevent adverse effects on groundwater or surface water quality.

I. If for any reason the dewatering system is found to be inadequate to meet the requirements set forth herein, the Contractor shall at his own expense make such additions, changes and/or replacements as necessary to provide a satisfactory dewatering system.

J. Removal of dewatering equipment shall be accomplished after the system is no longer required. The Contractor shall remove the material and equipment constituting the system.

3.04 DISPOSAL OF DRAINAGE

A. All water discharged from temporary dewatering and drainage systems shall be disposed of in accordance with the sediment and erosion control plan as specified in Section 02270.

END OF SECTION
SECTION 02200
EXCAVATION AND BACKFILL

PART 1   GENERAL

1.00   STATUTORY REQUIREMENTS

A. All excavation, trenching, sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and any state and local requirements. Where conflict between OSHA, state, and local regulations exists, the most stringent requirements shall apply.

1.01   SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidental required and perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable waste and surplus materials as shown on the Drawings and as specified herein.

B. Provide the services of a licensed professional engineer, registered in the Commonwealth of Virginia, to prepare temporary excavation support system designs and to inspect the installed temporary support systems.

C. Furnish and install temporary excavation support systems, including sheeting, shoring, and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc., in accordance with federal, state and local laws, regulations, and requirements.

D. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

1.02   RELATED WORK

A. Section 02100, Clearing and Grubbing.

B. Section 02140, Dewatering and Drainage.

C. Section 02230, Fill and Granular Fill Materials.

D. Section 02270, Erosion and Sediment Control.

E. Section 02280, Seeding, Topsoiling, Fertilizing, and Mulching.

F. Section 02575, Asphaltic Concrete Pavement and Appurtenances.
1.03 SUBMITTALS

A. Test reports of compaction testing on embankment, fill, and backfill materials shall be submitted directly to the City with copies to Contractor.

1.04 REFERENCE STANDARDS

   1. ASTM A36 - Specification for Carbon Structural Steel.
   2. ASTM A328 - Specification for Steel Sheet Piling.

B. Virginia Department of Transportation (VDOT).
   1. Road and Bridge Specifications.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Excavation support system designs shall be prepared by a licensed professional engineer registered in the Commonwealth of Virginia.

B. Materials will be tested and observed as described in the following paragraphs. Free access to the work for selection of test materials and observations shall be granted to the testing agency.

   1. Materials to be used in the work shall be tested by a certified independent testing laboratory engaged by the Contractor and acceptable to the City to demonstrate conformance with the requirements of these Specifications.

   2. Testing methods shall comply with the latest applicable ASTM or VDOT Standards specified.

   3. During the placement of bedding, backfill, and fill, the soils testing laboratory shall perform in-place soil density testing to confirm that fill material has been compacted in accordance with the requirements of this Section. The City may designate areas where soil density testing will not be required.

      a. At least 1 density and moisture content test for each 1,000 square feet of surface area for each compacted lift of fill at construction areas.

      b. At least 1 density and moisture content test for each 400 linear feet of installed pipe.
4. Materials that have been previously tested may be subjected to further testing from time to time and may be rejected if it is determined that they do not conform to the requirements of these Specifications. Rejected materials shall be removed from the Work immediately when so directed by the City, notwithstanding the results of previous testing.

1.06 PROJECT/SITE CONDITIONS

A. Boring locations and logs, if available, are included in the Contract documents. The data and recommendations presented are based on observations at specific boring locations as designated therein. Conditions between or away from the borings may vary from the conditions reported. No warranty of subsurface conditions, expressed or implied, is intended or made to any reviewer of the report.

B. Existing structures. The Drawings may show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the Contractor. Contractor shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from damage by Contractor. If they are broken or damaged by Contractor, Contractor shall restore them immediately at his expense.

C. Existing utilities.

1. It shall be the responsibility of the Contractor to conduct the Work in such a manner as to avoid damage to, or interference with, any utility services. The Contractor is responsible for providing temporary supports for any utility that may be affected by its work. If any damage, interference, or interruption of service occurs as a result of its work, it shall be the Contractor’s responsibility to promptly notify the City and utility owner of the occurrence and to repair, or cause to be repaired, the damage immediately, at Contractor’s expense, and to the satisfaction of the City and the owner of the utility.

2. It shall be the Contractor’s responsibility to uncover and expose the location of all service connections to avoid damage or interruption of service. If damage occurs, the Contractor shall make the necessary repairs in accordance with the above requirements.

3. It is the responsibility of the Contractor to determine in advance of beginning the construction effort the exact location of all utilities, and the affect they will have on the Work. Contractor shall contact “Miss Utility” 48 hours prior to starting work. All costs related to identification of utility location shall be the responsibility of the Contractor.

4. Do not interrupt existing utilities serving facilities occupied and used by the City or others, except when permitted in writing by the City and then only after acceptable temporary utility services have been provided.

5. Demolish and completely remove from site the existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. If conditions at variance with those described in the Contract Documents or Supplemental Project Information are encountered during construction, immediately notify the City in accordance with the requirements of the General Conditions.
1.07 DEFINITIONS

A. Where the phrase "in-the-dry" is used in this Section, it shall be defined to mean a soil sub-grade that is stable with no ponded water, mud, or muck, and is able to support construction equipment without rutting or disturbance.

B. Where used in this Section, "structures" refers to all buildings, wet wells, manholes, and below-grade vaults.

PART 2 PRODUCTS

2.01 GENERAL

A. Fill materials designated for use in this Section are specified in Section 02230.

B. Filter fabric.

1. Filter fabric shall conform to the following requirements.
   a. Minimum grab strength of 120 lbs. per ASTM D1682.
   b. Apparent opening size to be equal to or greater than the U.S. Standard Sieve No. 100 (0.210 mm) per ASTM D4751.
   c. Percent open area not to exceed 30 percent. The “percent open area” is defined as the ratio of the sum of 20 or more individual open areas (times 100) to the sum of the corresponding 20 or more individual total areas.
   d. Coefficient of permeability shall not be less than 0.2 cm/sec.
   e. Filter fabric shall be Mirafi Type 140N; Dupont Type PAR, Style 3401; or approved equal.

C. High strength geotextile fabric.

1. Geotextile fabric shall conform to the following requirements.
   a. Minimum tensile strength of 360 lbs. per ASTM D4632.
   b. Minimum puncture strength of 150 lbs. per ASTM D4833.
   c. Apparent opening size to be equal to or greater than the U.S. Standard Sieve No. 40 per ASTM D4751.
   d. Fabric material shall be woven polypropylene or polyester.
   e. High strength geotextile fabric shall be LINQ Industrial Fabrics, Inc., GTF 375N, or approved equal.
PART 3 EXECUTION

3.01 PREPARATION

A. Contact “Miss Utility” before beginning excavations and allow required time for marking. Before excavating within 20 feet of utility poles and after pipeline stake out, coordinate construction with the appropriate utility company. Immediately notify the City of any conflict of new Work with existing utilities that may require relocation of new Work or of existing utilities. All necessary support of utility poles shall be the sole responsibility of the Contractor at no additional expense to the owner or City.

B. Prior to excavation, other utilities and underground facilities shall be located to confirm location, proper depth, and clearances. Care shall be taken in excavating to prevent damage to underground structures, utilities, and adjacent properties. When approaching and crossing such installations, a combination of installation methods may be used. Trenching equipment shall not be used within 2 feet of existing utilities.

C. Test holes.

1. Perform exploratory excavation work (test holes) for the purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work. Contractor shall immediately notify the City if such exploratory work yields information that may alter the design or installation of the pipeline.

2. Test holes shall be backfilled as soon as the desired information has been obtained. Backfilled surfaces shall be stabilized in accordance with approved erosion and sediment control plans. Test holes in asphalt pavement shall be patched with a thickness equal to existing adjacent areas.

D. Dewatering and drainage systems.

1. Temporary dewatering and drainage systems shall be in place and operational prior to beginning excavation work.
3.02 EXCAVATION SUPPORT

A. Furnish, install, monitor, and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc.) as required by federal, state, or local laws, ordinances, regulations, and safety requirements. Support the sides of excavation to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement, or other damage. Take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with common fill material. Voids in locations that cannot be properly compacted upon backfilling shall be filled with 2000 psi concrete or flowable fill.

B. Install excavation supports outside the neat lines of foundations. Supports shall be plumb and securely braced and tied in position. Excavation support shall be adequate to withstand all pressures to which the supports will be subjected. Any movement or bulging of supports shall be corrected to provide the necessary clearances, dimensions, and structural integrity.

C. Excavation supports left in place.

1. Excavation supports are required to remain in place if installed below the foundation and within a zone extending from the edge of the foundation and then outward and downward at 1H:1V below the pipe springline, or as specified on the Drawings.

2. The City may direct that certain excavation supports remain in place, or be cut off at any specific elevation. If the Contractor believes that such a directive increases Contractor's cost and would thereby entitle Contractor to a change in contract cost, Contractor shall notify the City in accordance with the applicable article(s) in the Contract General Conditions pertaining to changes in the Work.

3. The right of the City to direct that certain excavation supports remain in place shall not be construed as creating any obligation to give such direction, nor shall failure to give such direction relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence, or otherwise growing out of a failure on the part of the Contractor to leave in place sufficient excavation supports to prevent any movement of the ground or damage to adjacent structures.

D. Excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with sand and compacted.

E. Excavation support systems shall be inspected during and after installation and monthly thereafter by the support system design engineer. The support system design engineer shall submit a written report to the Contractor for each inspection describing recommendations, if any.
3.03 EXCAVATION BELOW GRADE

A. If the bottom of any excavation is taken out below the limits shown on the Drawings, specified, or directed by the City, it shall be refilled at the Contractor's expense with 4-inch layers of compacted granular fill or other material approved by the City.

B. If the sub-grade is damaged by water, remove the unsuitable material and replace it with compacted granular fill or other approved material at Contractor's own expense so that the condition of the sub-grade meets with the approval of the City before any work is placed thereon.

C. If, in the opinion of the City, the material, in its undisturbed natural condition at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for the work being performed, it shall be removed to such depth and width as directed and be replaced with suitable material for which compensation will be made at the unit prices established in the Contract.

3.04 STRUCTURE EXCAVATION

A. Excavation shall be made to the grades shown on the Drawings and to such widths as will give suitable room for construction of the structures for bracing, shoring, and dewatering. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the City.

B. Excavation and dewatering shall be accomplished by methods that preserve the undisturbed state of sub-grade soils. Exposed soil and rock sub-grades shall be proof rolled with at least two coverages of the compaction equipment. Sub-grade soils that become soft, loose, "quick," or otherwise unsatisfactory for support of structures as a result of inadequate excavation dewatering, proof rolling, or other construction methods shall be removed and replaced by granular fill at the Contractor's expense.

C. Dewatering shall be such as to prevent boiling or detrimental under-seepage at the base of the excavation as specified herein.

D. Excavation equipment shall be satisfactory for carrying out the Work in accordance with the requirements specified. In no case shall the earth be plowed, scraped, or dug with machinery so near to the finished sub-grade as to result in excavation of or disturbance of material below grade. Equipment used for excavation to final sub-grade shall furnish an undisturbed sub-grade surface.

E. During final excavation to sub-grade level, take whatever precautions are required to prevent disturbance and remolding. Material that has become softened and mixed with water shall be removed. Hand excavation of the final 3 to 6 inches may be required to obtain a satisfactory undisturbed bottom. The City will be the sole judge as to whether the work has been accomplished satisfactorily.
3.05 EXCAVATION AND BACKFILLING FOR UNDERSLAB TRENCHES

A. Excavation for all pipelines beneath structures shall be carried out with the excavating equipment operating from above the sub-grade for the structure. The excavation shall be carried out in-the-dry and in a manner that will preserve the undisturbed state of the sub-grade soils. The excavations may be completed with shoring and bracing at the Contractor's option with no additional cost to the City.

3.06 TRENCH EXCAVATION AND BACKFILLING

A. Excavation for all trenches required for the installation of pipes shall be made to the depths indicated on the Drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trench, for bracing and shoring, and dewatering. Render the bottom of the excavations firm and dry and in all respects acceptable to the City.

Pavement, when encountered, shall be cut along straight lines before excavating. All excavations in concrete shall be precut in neat straight lines with a pavement breaker or saw. In sidewalks the excavation shall be a minimum of one “block” in size. If the sidewalk is combined with the curb, the curbing shall also be removed.

B. Rock shall be removed to a minimum 6-inch clearance around the bottom and 12-inch minimum clearance on the sides of all pipe being laid.

C. Excavation of earth material below the bottom of a trench shield shall not exceed the limits established by ordinances, codes, laws, and regulations.

1. When using a trench shield for installing rigid pipe, any portion of the shield extending below mid-diameter shall be raised above this point prior to moving the shield ahead to install the next pipe.

2. When using a trench shield for installing flexible pipe (PVC, PE, etc.), the bottom of the shield shall not extend below mid-diameter at any time.

3. When a shield is removed or moved ahead, extreme care shall be taken to prevent the movement of pipe or the disturbance of the pipe bedding. Pipe that has been disturbed shall be removed and reinstalled at Contractor’s own expense.

D. Where pipelines are to be constructed in fill areas, all fill material to a level 2 feet above the “top of pipe” elevation shall be placed and compacted to 95 percent dry density as determined by ASTM D698 prior to excavating pipe trench.

E. Backfill excavations as promptly as work permits, removing bracing and shoring as backfilling progresses.

F. In rock excavations, granular fill as noted on the Detail Drawings shall be placed and compacted in 6-inch lifts to a minimum depth of 12 inches above top of pipe. Compaction shall be to 95 percent of maximum dry density as determined by ASTM D698.

G. In earth excavations, backfill as noted on the Detail Drawings shall be placed and compacted in 6-inch lifts to a minimum depth of 12 inches above top of pipe. Compaction shall be to 95...
percent of maximum dry density as determined by ASTM D698. Pipe bedding shall be as shown on the Detail Drawings.

H. Where the pipes are laid in unpaved areas, the remainder of the trench shall be filled with common fill in lifts not to exceed 1 foot and thoroughly compacted by rolling or tamping to prevent subsequent settling. The top 1-foot lift shall be select common fill. The backfill shall be mounded 3 inches above the existing grade or as directed. Wherever a loam or gravel surface exists prior to excavation, it shall be removed, conserved, and replaced to the full original depth as part of the Work. In some areas it may be necessary to remove excess material during the clean-up process so that the ground may be restored to its original level and condition. If storage of loam, gravel, or topsoil is not preferred, replace it with material of equal quality and in equal quantity at Contractor’s own expense.

I. Where the pipes are laid in streets or other paved areas, the remainder of the trench shall be backfilled with VDOT #21A crushed stone in 1-foot layers thoroughly compacted by rolling or tamping. The top 1-foot lift below the bottom of the specified paving shall be compacted in 6-inch layers.

J. Along the length of all pipeline, construct impervious dams or bulkheads of clay or concrete in the trench bottom at 300-foot intervals or at manholes and structures, whichever is less, to obstruct the free flow of groundwater after construction is completed. Install impervious dams at all points where a pipe trench enters an excavated area where a permanent under-drain system is installed.

3.07 MISCELLANEOUS EXCAVATION

A. Perform all miscellaneous excavations as required to complete the Work. Make all excavations necessary to permit the placing of loam and plants, for constructing roadways, and any other miscellaneous earth excavation required under the Contract.

3.08 ROCK AND BOULDER EXCAVATION AND DISPOSAL

A. Rock excavation may be performed by jack hammering, expansive chemical splitting, or other similar processes. Blasting will not be permitted without written authorization by the City. The City must approve all rock excavation processes prior to any rock excavation.

1. All blasting operations required for the purpose of rock excavation, including but not limited to permit acquisition, employee training/certification, explosives handling/storage and charge detonation, shall be performed in accordance with 29 CFR 1926, Subpart U – Blasting and the Use of Explosives.

The Contractor shall be responsible for securing any and all required permits and for providing trained and certified blasting personnel. Prior to blasting, the Contractor shall submit to the City for approval a written blasting procedure that includes addressing the protection of existing subsurface utilities and structures.

Blasting mats shall be required for all blasting operations. Blasting operations shall not be performed within 15 feet, or a distance otherwise determined by the City, of any existing water, gas, fuel, and/or sanitary sewer lines or drainage structures. The Contractor shall
provide the City with charge specifications and soil type in the area adjacent to these utilities for review and approval prior to initiating any blasting operations.

Any and all damage resulting from blasting operations shall be the responsibility of the Contractor, and shall be promptly repaired to the satisfaction of the City and at no cost to the City, utility, or property owner.

2. **EXCAVATION IS UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION.**

B. Fragmented rock with dimensions not exceeding 4 inches in any direction may be mixed with common fill and used as common fill in accordance with Section 02230.

C. Unused rock and boulders shall be removed and disposed off site.

3.09 **BACKFILLING - COMMON FILL**

A. Common fill may be used as trench backfill, as embankment fill, or in other areas as designated by the City. Material conforming to the requirements of common fill shall be placed in lifts having a maximum thickness of 1 foot measured before compaction.

B. Common fill shall be compacted to at least 95 percent of maximum density as determined by ASTM D698.

C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making due allowance for settlement of the material and for the placing of loam thereon.

D. The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the Plans. No soft spots or uncompacted areas will be allowed in the Work.

E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.10 **BACKFILLING - STRUCTURAL FILL**

A. Structural fill shall be placed in lifts having a maximum thickness of 6 inches in open areas and 4 inches in confined areas including points where piping joins structures, measured before compaction. Each lift of fill shall be compacted to at least 95 percent of maximum dry density determined by ASTM D698 using methods approved by the City. The limits of structural fill adjacent to structures shall extend as shown on the Drawings.

B. Structural fill shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice, or frozen earth be incorporated in the compacted fill.

C. Structural fill shall be compacted by at least 4 coverages of all portions of the surface of each lift by compaction equipment. “One coverage” is defined as the condition obtained when all portions of the surface of the fill material have been subjected to the direct contact of the compactor.
3.11 BACKFILLING - GRANULAR FILL

A. Place granular fill within pipe trenches and under structures as shown on the Drawings.

B. Granular fill shall be placed in lifts having a maximum thickness of 1 foot measured before compaction. Each lift shall be compacted to at least 95 percent of maximum dry density determined by ASTM D698.

C. Granular fill shall be compacted by at least 4 coverages of each lift with vibratory compaction equipment acceptable to the City.

3.12 EARTH EMBANKMENTS

A. Prior to placing embankment fill materials, all organic materials (including peat and loam) and loose inorganic silt material (loess) shall be removed from areas beneath the embankments. If the sub-grade slopes are excessive, the sub-grade shall be stepped to produce a stable, horizontal surface for the placement of embankment materials. The existing sub-grade shall then be scarified to a depth of at least 6 inches. Adjust the moisture content of the scarified zone to slightly above optimum, and compact the sub-grade.

B. Embankment fill shall consist of common fill material and shall be placed and compacted in even lifts of 12 inches (compacted thickness) and compacted to at least 90 percent of maximum dry density as determined by ASTM D698.

C. Rock may not be used in embankment fill.

3.13 IMPERVIOUS FILL

A. Impervious fill shall be placed in controlled, even lifts having a maximum thickness (measured before compaction) of 6 inches. Compaction shall be sufficient to attain a permeability of less than 1 x 10^{-7} cm/sec.

B. Moisture content of impervious fill to be compacted shall be maintained at or near its optimum moisture content (-2 to +3 percent).

3.14 DISPOSAL OF SURPLUS MATERIAL

A. Excess excavated materials shall be removed from the site and disposed of in accordance with local, state, and federal regulations. Materials shall be neatly piled so as to inconvenience as little as possible the public and adjoining property owners until used or otherwise disposed of as specified below.

Erosion and sediment control measures shall be installed in accordance with Section 02270 as appropriate.

B. Suitable excavated material meeting the requirements of Section 02230 may be used for fill embankments or backfill on the different parts of the Work as required.
Surplus materials shall become the property of the Contractor and shall be removed and disposed off site.

3.15 GRADING

A. Grading in preparation for placing of loam, planting areas, paved walks and drives, and appurtenances shall be performed in all places that are indicated on the Drawings, to the lines, grades, and elevations shown, and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature within the limits indicated, shall be removed and disposed of in accordance with these specifications. During the process of grading, the sub-grade shall be maintained in such condition that it will be well drained at all times.

B. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. The City reserves the right to make minor adjustments or revisions in lines or grades if found necessary as the Work progresses.

D. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 12 inches of the finished sub-grade of all fills or embankments.

E. In cuts, all loose or protruding rocks on the bank slopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the Drawings.

3.16 RIPRAP FOR SLOPE STABILIZATION

A. Prepare sub-grade for riprap. Remove vegetation, brush, tree stumps, or other objectionable material. Cut or fill to the required lines and grades. Any fills required shall be of the same type as and compacted to a density approximating that of the surrounding undisturbed material.

B. Before installing riprap, install geotextile filter fabric as shown on the Drawings and in accordance with the geotextile manufacturer's instructions.

C. Place riprap as soon as practicable after embankment construction. Limit lag between placement of embankment and riprap protection to the least time possible, and prevent mixture of soil with riprap material.

D. Place riprap as shown on the Drawings and in conformance to the requirements of VDOT Road and Bridge Specifications Section 418 – Riprap. Place stones so that the weight of the stones is carried by the underlying material and not by the adjacent stones. Place large stones at the bottom of the slope. Fill spaces between stones with spalls of suitable size to construct a solid, stable slope, free from large voids and defects.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. Granular fill materials are specified in this Section, but their use for bedding pipe, replacement of unsuitable materials, cushion in ledge excavation, pavement base, foundation support, fill and backfill, and similar uses are specified in detail elsewhere.

1.02 RELATED WORK

A. Section 02200, Excavation and Backfill.

1.03 SUBMITTALS

A. At least five (5) working days prior to the date of anticipated use of any backfill or fill material, submit a representative sample of the proposed material weighing at least 50 pounds to the soils testing laboratory (retained by the Contractor and acceptable to the City) for analyses.

B. Test reports.

1. For each fill material proposed for incorporation into the Work or reuse, submit the following test results. Indicate the testing standard and method used for each material.

   a. Gradation test in accordance with ASTM D422, AASHTO T27, or VTM-25 as noted.

   b. Moisture-density test in accordance with ASTM D698 or ASTM D1557.

   c. Atterberg limits (liquid limit, plastic limit, and plasticity index) in accordance with ASTM D4318 or VTM-7 as noted.

   d. Unified Soil Classification System identity in accordance with ASTM D2487.

2. At the discretion of the City, the Contractor may furnish a certification of conformity to VDOT Road and Bridge Specifications requirements from the material manufacturer in lieu of testing. Confirm acceptability of such a certification for each material before submitting.

1.04 REFERENCE STANDARDS

A. American Association of State Highway & Transportation Officials (AASHTO).


1. Standard Specifications as referenced.

C. Virginia Department of Transportation (VDOT).

1. Road and Bridge Specifications.


PART 2 PRODUCTS

2.01 MATERIALS

A. Riprap shall conform to VDOT Road and Bridge Specifications Section 204.02b and shall be sound, durable stone of igneous or metamorphic origin, and shall be free from seals, cracks, or structural defects.

B. Gravel or crushed stone shall be open-graded coarse aggregate with clean, hard, tough, and durable pieces free from adherent coatings and deleterious amounts of friable, thin, elongated, or laminated pieces, soluble salts, or organic materials. Coarse aggregate shall conform to VDOT Road and Bridge Specifications Section 203 and the following requirements.

1. VDOT No. 57: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.

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<thead>
<tr>
<th>Sieve</th>
<th>% Passing by Weight</th>
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<tr>
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<td>Min. 100</td>
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<tr>
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<td>95 ± 5</td>
</tr>
<tr>
<td>1/2”</td>
<td>43 ± 17</td>
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<tr>
<td>No. 8</td>
<td>Max. 3</td>
</tr>
</tbody>
</table>

2. VDOT No. 68: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>Min. 100</td>
</tr>
<tr>
<td>3/4”</td>
<td>95 ± 5</td>
</tr>
<tr>
<td>3/8”</td>
<td>48 ± 17</td>
</tr>
<tr>
<td>No. 4</td>
<td>Max. 20</td>
</tr>
<tr>
<td>No. 8</td>
<td>Max. 8</td>
</tr>
<tr>
<td>No. 16</td>
<td>Max. 5</td>
</tr>
</tbody>
</table>

3. VDOT No. 1: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.
C. VDOT No. 25: Crusher run aggregate shall be crushed from stone, slag or gravel, and shall contain all of the sizes produced when the original aggregate is reduced through a series of crushers to the maximum size specified. The material shall conform to the following gradation when tested in accordance with AASHTO T27.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”</td>
<td>Min. 100</td>
</tr>
<tr>
<td>3-1/2”</td>
<td>95 ± 5</td>
</tr>
<tr>
<td>2-1/2”</td>
<td>43 ± 17</td>
</tr>
<tr>
<td>1-1/2”</td>
<td>Max. 15</td>
</tr>
<tr>
<td>3/4”</td>
<td>Max. 5</td>
</tr>
</tbody>
</table>

D. Fine aggregate shall be crushed from Grade A stone or gravel and shall conform to the requirements of VDOT Road and Bridge Specifications Section 202, Grading F or G. The material shall conform to the following gradations when tested in accordance with AASHTO T27.

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Grading F % Passing by Weight</th>
<th>Grading G % Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8”</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>92 ± 8</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td>80 ± 20</td>
<td></td>
</tr>
<tr>
<td>No. 16</td>
<td>62 ± 22</td>
<td>70 ± 30</td>
</tr>
<tr>
<td>No. 30</td>
<td>39 ± 19</td>
<td>50 ± 35</td>
</tr>
<tr>
<td>No. 50</td>
<td>Max. 26</td>
<td>Max. 26</td>
</tr>
<tr>
<td>No. 100</td>
<td>Max. 10</td>
<td>Max. 10</td>
</tr>
<tr>
<td>No. 200</td>
<td>Max. 7</td>
<td>Max. 5</td>
</tr>
</tbody>
</table>
E. VDOT 21A: Structural fill shall consist of gravel stone or slag screenings; fine aggregate and crushed coarse aggregate; sand-clay-gravel mixtures; or combinations of these materials. It shall be free of organic material, loam, wood, trash, snow, ice, frozen soil, and other objectionable material and shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>100</td>
</tr>
<tr>
<td>1”</td>
<td>94-100</td>
</tr>
<tr>
<td>3/8”</td>
<td>63-72</td>
</tr>
<tr>
<td>No. 10</td>
<td>32-41</td>
</tr>
<tr>
<td>No. 40</td>
<td>14-24</td>
</tr>
<tr>
<td>No. 200</td>
<td>6 to 12</td>
</tr>
</tbody>
</table>

F. Screened gravel shall be hard, durable, rounded, or sub-angular particles of proper size and gradation and shall be free from sand, loam, clay, excess fines, and other deleterious materials. Screened gravel shall be graded within the following limits:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Finer by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8”</td>
<td>100</td>
</tr>
<tr>
<td>1/2”</td>
<td>40 to 100</td>
</tr>
<tr>
<td>3/8”</td>
<td>15 to 45</td>
</tr>
<tr>
<td>No. 10</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>

G. Common fill shall consist of uniformly graded mineral soil, substantially free of clay, organic material, loam, wood, trash, snow, ice, frozen soil, and other objectionable material which may be compressible, or which cannot be compacted properly. Common fill shall not contain rocks larger than 4 inches in any dimension, broken concrete, masonry, rubble, asphalt pavement, or other similar materials.

1. Common fill shall have a maximum 75 percent passing the No. 40 sieve and a maximum of 20 percent passing the 200 sieve.

2. Soft, wet, plastic soils that may be expansive, and clay soils having natural in-place water content in excess of 30 percent, shall not be used.

3. Soils containing more than 5 percent (by weight) fibrous organic materials or having a plasticity index (PI) greater than 30 shall not be used.

4. Rocks larger than 2 inches in any dimension shall not be permitted within 12 inches of finished grade.

H. Select fill shall be as specified for common fill, except that the material shall contain no stones and shall have a plasticity index less than 20. Select fill used immediately above/around the pipe may contain no stones greater than 1 inch.

I. Sand shall conform to VDOT Road and Bridge Specifications Section 202, Grade A for fine aggregate.

02230-4
J. Impervious fill shall consist of on-site clayey sandy silt or imported material with a permeability coefficient (K-value) less than $1 \times 10^{-7}$ that can be readily spread and compacted. Low permeability fill shall not be placed under sidewalks or paved areas.
SECTION 02270
EROSION AND SEDIMENT CONTROL

PART 1   GENERAL

1.01   SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals necessary to perform all installation, maintenance, removal, and area cleanup related to sedimentation control work as specified, shown, and required by the City, local sediment control inspectors, and any other regulatory agency that has control or jurisdiction in the area in which the project is located. The Work shall include, but not necessarily be limited to, installation of temporary access ways and staging areas, silt fences, block and gravel filters, sediment traps, diversion dikes, splash aprons, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, erosion control matting installation, and final cleanup.

1.02   RELATED WORK

A. Section 02100, Clearing and Grubbing.
B. Section 02140, Dewatering and Drainage.
C. Section 02200, Excavation and Backfill.
D. Section 02280, Seeding, Topsoiling, Fertilizing, and Mulching.

1.03   SUBMITTALS

A. Contractor shall submit to the City an Erosion and Sediment Control Plan showing details of erosion and sediment control devices and locations, and technical product literature for all commercial products to be used for sedimentation and erosion control.

B. Contractor shall submit copies of approved Erosion and Sediment Control Permits from appropriate governing agencies.

1.04   REFERENCE SPECIFICATIONS

A. The materials and method of construction shall be in accordance with the latest edition of the Virginia Erosion and Sediment Control Handbook.

1.05   PERFORMANCE REQUIREMENTS

A. Contractor shall be responsible for obtaining all erosion and sediment control permits required prior to any land-disturbing operations.

B. Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off-site areas or into the stream system via surface runoff or underground drainage systems.
Measures in addition to those shown on the Erosion and Sediment Plan necessary to prevent the movement of sediment off-site shall be installed, maintained, removed, and cleaned up at no additional cost to the City. Should the Contractor fail to control the movement of sediment from the construction area into the storm sewer system, the City may at its discretion require the Contractor to clean the sediment from the affected reaches of the storm sewer system at the Contractor's expense.

C. Sedimentation and erosion control measures shall conform to the requirements of the Virginia Sediment and Erosion Control Regulations, 4 VAC 50-30-10 et seq.

D. Where Contractors’ efforts to control erosion have been demonstrated to be ineffective or potentially ineffective in the opinion of the City, the City may order that the Erosion Control Plan be amended and that additional erosion control measures be constructed at no additional cost to the City.

PART 2 PRODUCTS

2.01 MATERIALS

A. Coarse aggregate shall conform to Section 02230.

B. Silt fence.

1. Steel posts shall be a minimum of 5 feet in length, 2-1/2-inch by 2-1/2-inch by 1/4-inch angle post with self-fastening tabs and a 5-inch by 4-inch (nominal) steel anchor plate at bottom.

2. Welded wire fabric shall be 6-inch by 6-inch mesh of 14.5 gauge by 14.5 gauge steel wire.


4. Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings), or 1/32-inch diameter soft aluminum wire.

5. Commercially available silt fence assemblies (2-inch by 2-inch wooden posts with attached filter fabric) may be substituted in lieu of separate steel posts and filter fabric.

C. One quarter (1/4) inch woven wire mesh shall be galvanized steel or hardware cloth.

D. Straw mulch shall be utilized on all newly graded areas to protect against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold, or other objectionable material. The straw mulch shall contain at least 50 percent by weight of material to be 10 inches or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.

E. Latex acrylic copolymer, such as Soil Sealant with coalescing agent as manufactured by Soil Stabilization Co., Merced, CA, or approved equivalent shall be used as straw mulch tackifier.
F. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer, and only with prior written approval from the City.

G. Erosion control matting shall be installed in all seeded drainage swales and ditches as directed by the City. Erosion control matting shall be from the Virginia Department of Transportation's approved products list for the use specified, or equal.

H. CMU units for block and gravel curb inlet sediment filter shall conform to ASTM DC90, lightweight Grade N, Type 1, hollow units of 8 inch by 16-inch nominal face size.

I. Pipe for slope drains shall be flexible, corrugated polyethylene pipe, non-perforated, as manufactured by Advanced Drainage Systems, Inc., Columbus, OH, or equal.

J. Other materials shall be as specified by the Virginia Erosion and Sediment Control Handbook (VESCH) latest edition.

PART 3 EXECUTION

3.01 INSTALLATION

A. Silt fence installation.
   1. Silt fences shall be positioned as necessary to prevent off-site movement of sediment produced by construction activities.
   2. Dig trench approximately 6 inches wide and 4 inches deep along proposed fence lines.
   3. Drive steel posts 10 feet on center (maximum) at back edge of trenches. Posts shall be driven 2 feet (minimum) into ground.
   4. Hang 6-inch by 6-inch woven wire mesh on posts, setting bottom of wire in bottom of trench. Secure wire to posts with self-fastening tabs.
   6. Backfill trench with excavated material and tamp.

B. Construct block and gravel curb inlet sediment filters from 1/4-inch woven wire mesh, CMU, and crushed gravel. Lower course of CMU shall be laid with openings facing to the side. Top course shall be placed with openings facing up. Cover lower course of CMU openings with woven wire mesh and crushed stone.

C. Staging areas and access ways shall be surfaced with a minimum depth of 4 inches of crusher run aggregate.

D. Installation of other items shall be as per the VESCH latest edition.
3.02 INSPECTIONS AND MAINTENANCE

A. Inspections.

1. Contractor shall make a visual inspection of all sedimentation control devices once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to off-site areas, Contractor shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device maintenance.

1. Silt fences.
   a. Remove accumulated sediment once it builds up to 1/2 of the height of the fabric.
   b. Replace damaged fabric, or patch with a 2-foot minimum overlap.
   c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

2. Block and gravel curb inlet sediment filters: Replace crushed stone when it becomes saturated with silt.

3. Rock check dams.
   a. Sediment must be removed when the level of deposition reaches approximately 1/2 the height of the barrier.
   b. Erosion caused by high flows around the edges of the dam should be corrected immediately.

4. Add crushed stone to access ways and staging areas as necessary to maintain a firm surface free of ruts and mud holes.

3.03 TEMPORARY MULCHING

A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.

B. Straw mulch shall be applied at rate of 100 lbs./1000 ft.² and tackified with latex acrylic copolymer at a rate of 1 gal./1000 ft.² diluted in a ratio of 30 parts water to 1 part latex acrylic copolymer mix.

3.04 EROSION CONTROL MATTING

A. Erosion control matting shall be installed in all seeded drainage swales, ditches, and slopes greater than 2 to 1 as directed by the City in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, fertilized, and seeded with permanent vegetation before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the
fibers in contact with the soil over the entire area. The blankets shall be applied in the direction of water flow, and stapled. Blankets shall be placed a minimum of 3 rows (of 4 foot) wide (total approximately 12 foot width) within the drainage swale/ditch and stapled together in accordance with manufacturer's instructions. Side overlaps shall be a minimum of 4 inches. The staples shall be made of wire, .091 inch in diameter or greater, U-shaped with legs 10 inches in length and a 1-1/2-inch crown.

Upper and lower ends of the matting shall be buried to a depth of 4 inches in a trench. Erosion stops shall be created every 25 feet by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be 4 inches below the ground surface. Staple on both sides of fold. Where the matting must be cut or more than 1 roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of 4 inches. Overlap lower end of upstream roll 4 inches past edge of downstream roll, and staple.

To ensure full contact with soil surface, roll matting with a roller weighing 100 pounds per foot of width perpendicular to flow direction after seeding, placing matting, and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

3.05 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as specified herein.

END OF SECTION
SECTION 02280
SEEDING, TOPSOILING, FERTILIZING AND MULCHING

PART 1   GENERAL

1.01   SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to place topsoil, finish grade, and apply lime, fertilizer, seed, and mulch. Maintain all seeded areas as specified herein, including all areas disturbed by the Contractor.

1.02   RELATED WORK

A. Section 02100, Clearing and Grubbing.
B. Section 02200, Excavation and Backfill.
C. Section 02270, Erosion and Sediment Control.

1.03   SAMPLES AND APPROVAL OF MATERIAL

A. Samples of all materials shall be submitted for inspection and acceptance upon request.

PART 2   PRODUCTS

2.01   MATERIALS

A. Topsoil shall be fertile, friable, natural topsoil typical of topsoil of the locality, and shall be obtained from a well-drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants or their roots, sticks, clay, peat, and other extraneous matter. Topsoil shall not be placed while in a frozen or muddy condition. Topsoil delivered to the site shall have pH between 6.0 and 7.0 and shall contain not less than 3 percent organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees Celsius.

B. Fertilizer shall be commercially mixed free flowing granules or pelleted fertilizer, 10-10-10 (N-P2O5-K2O) grade for lawn and naturalized areas. Fertilizer shall be delivered to the site in original unopened containers each showing the manufacturer's guaranteed analysis conforming to applicable state fertilizer laws. At least 40 percent of the nitrogen in the fertilizer used shall be in slowly available (organic) form.

C. Seed shall be labeled in accordance with Federal Seed Act Regulations (7 C.F.A. Section 201) and shall comply with the requirements of the Virginia Erosion and Sediment Control Handbook standard. Seed shall be furnished in sealed bags or containers bearing the date of the last germination, which date shall be within a period of 6 months prior to commencement of planting operations. Seed shall be from same or previous year's crop; each variety of seed shall have a purity of not less than 85 percent, a percentage of germination not less than 90 percent,
shall have a weed content of not more than 1 percent and contain no noxious weeds. The seed mixtures shall consist of seed proportioned by weight as follows.

Acceptable permanent seeding mix for use in all areas:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky 31</td>
<td>70%</td>
</tr>
<tr>
<td>Perennial Rye</td>
<td>30%</td>
</tr>
</tbody>
</table>

Seed mix for permanent seeding shall be as above or in strict accordance with the VESCH. All temporary seeding shall be as per VESCH. Seed shall be accompanied by an affidavit for seed conforming to Section 244.02 (c) of Virginia Department of Transportation Road and Bridge Specifications, latest edition.

D. The seed shall be furnished and delivered pre-mixed in the proportions specified above. The manufacturers for each seed type shall submit a manufacturer’s certificate of compliance to the specified mixes. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.

E. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.

F. Straw mulch shall be as specified in Section 02270.

G. Mulch for hydroseeding operations shall be a specially processed cellulose fiber containing no growth or germination inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form an homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall not contain in excess of 10 percent moisture and shall be marked by the manufacturer to show the air-dry weight content.

H. Mulch tacking agent shall be as specified in Section 02270.

PART 3 EXECUTION

3.01 APPLICATION

A. Acceptable topsoil shall be placed to a minimum compacted depth of 6 inches on all disturbed areas.

B. For all areas to be seeded:

1. Fertilizer (10-10-10) shall be applied at the rate of 40 pounds per 1,000 square feet and lightly worked in by approved methods.

2. Seed mix shall be applied at a rate of 20 pounds per 1,000 square feet.

3. Mulch shall be applied at the rate of 40 pounds per 1,000 square feet.
C. The application of fertilizer may be performed hydraulically in one operation with hydro-seeding and fiber mulching. The Contractor is responsible for cleaning all structures and paved areas of unwanted deposits of the hydroseeded mixture.

3.02 INSTALLATION

A. Previously established grades as shown on Drawings shall be maintained in a true and even condition.

B. The topsoil shall be carefully prepared by scarifying or harrowing and hand raking after it has been spread. All stiff clods, lumps, roots, litter, and other foreign material shall be removed from the loamed area and disposed of by the Contractor. The areas shall also be free of smaller stones in excessive quantities as determined by the City. The whole surface shall then be rolled with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be re-graded and rolled until a smooth and even finished grade is created.

C. Seeding, mulching, and conditioning shall only be performed during those periods within the seasons that are normal for such work as determined by the weather and locally accepted practice.

D. Schedules for seeding and fertilizing must be submitted to the City for approval prior to the work. Seeding as specified herein shall be accomplished between the period of April 1 to May 31 or August 16 to October 15. Seeding during the periods from October 16 to March 31 and from June 1 to August 15 shall only be undertaken upon approval of the City.

E. Seeding shall be done within 5 days following soil preparation. Seed shall be applied at the rates and percentages indicated.

F. Slopes whose vertical height is less than 20 feet but more than 5 feet shall be seeded in 2 equal increments. Slopes whose vertical height is 5 feet or less may be seeded in one operation. Slopes greater than 2H:1V shall be protected by erosion control matting acceptable to the City.

G. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainage ways, the Contractor shall carry out seeding and mulching as soon as he has satisfactorily completed a unit or portion of the project or when 1,000 square feet of ground surface has been disturbed. When protection of newly topsoiled and graded areas is necessary at a time which is outside of the normal seeding season, the Contractor shall protect those areas by whatever means necessary as approved by the City and shall be responsible for prevention of siltation in the areas beyond the limit of Work.

H. When newly graded sub-grade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, the Contractor shall protect those areas against erosion and washouts by whatever means necessary such as straw applied with a tar tack, wood chips, or by other approved measures. Prior to application of topsoil, any such materials applied for erosion control shall be thoroughly incorporated into the sub-grade by disking. Fertilizer shall be applied prior to spreading of topsoil.
I. On slopes, the Contractor shall provide against washouts by an approved method. Any washout that occurs shall be re-graded and re-seeded at the Contractor's expense until a good sod is established.

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. The Contractor shall maintain seeded areas, re-seeding if and when necessary, until a good, healthy, uniform growth is established over the entire area seeded.

B. The City will inspect all work for provisional acceptance at the end of a 10-week maintenance period upon receiving written request from the Contractor at least 10 days prior to the anticipated date of inspection.

C. A satisfactory stand will be defined as a section of turf of 1,000 square feet or larger that has:
   1. No bare spots larger than three square feet.
   2. No more than 10 percent of total area with bare spots larger than 1 square foot.
   3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

D. After all necessary corrective work and clean up has been completed, certification of provisional acceptance will be issued. The Contractor's responsibility for maintenance of lawns, or parts of lawns, shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. The Contractor shall guarantee all seeded areas for not less than 1 full year from the time of provisional acceptance.

B. At the end of the guarantee period, the City will make an inspection upon written request submitted by the Contractor at least 10 days before the anticipated inspection date. Seeded areas not demonstrating satisfactory stands as outlined above shall be scarified, re-seeded, fertilized, and mulched, meeting all requirements as specified herein.

C. After all necessary corrective work has been completed, the City shall certify in writing the final acceptance of the seeded areas.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. Scope.

1. Contractor shall provide all labor, materials, equipment, supervision, and incidentals required to furnish and install casing pipe and carrier pipe as shown on the Details and as required to complete the Work.

2. The Details indicate the smallest diameter casing that is acceptable for the installations. The Contractor may elect to use a larger diameter casing. If the Contractor elects to utilize the casing diameter called for on the Details, and the installation must be abandoned due to the inability of the Contractor to hand mine the casing, the installation will be abandoned at the Contractor’s expense.

B. Related sections.

1. Section 02100, Clearing and Grubbing.

2. Section 02200, Excavation and Backfill.

3. Section 03300, Concrete.

4. Division 15, Mechanical.

1.02 QUALITY ASSURANCE

A. Installer's qualifications and experience.

1. Installer shall be a specialist in the construction of casing pipes by jacking, boring, or by installation of tunnel liner plates, and shall have at least 5 years of experience in this specialty. Installer shall have satisfactorily constructed, during the past 5 years, not less than 10 similar installations that are comparable in diameter and length to that shown and specified herein.

2. Use only personnel thoroughly trained and experienced in the skills required. The field supervisor of boring operations and the boring machine operator shall have not less than 12 months’ experience in the operations of the equipment being used.

3. Welds shall be made only by welders, tackers, and welding operators who have been previously qualified by tests to perform the type of work required, as prescribed in American Welding Society, AWS D.1.1.
B. Permits. The Contractor shall be responsible to obtain and pay for all permits, insurance, and bonds required to complete the Work.

C. Requirements of regulatory agencies.

1. The Contractor shall comply with all provisions of all permits required by the governing authorities at his own expense. The Contractor’s responsibility under this paragraph may include, but is not limited to the following:
   a. Constructing and removing temporary facilities or structures.
   b. Providing details of construction methods.
   c. Providing detailed construction schedules.
   d. Reimbursing the applicable authority for all expenses incurred by them in connection with the Work.
   e. Traffic maintenance.
   f. Coordination of scheduling with the authority.
   g. Necessary clean up and restoration.

2. Materials and methods of construction used on railroad company property shall be subject to the approval of the railroad company. Contractor shall at all times conduct his work and operations fully within the railroad company's rules, regulations, and requirements. The Contractor must ascertain from the railroad company its rules, regulations, and requirements, and what, if any, delays may be encountered. If required by the railroad company, the Contractor must submit for approval specific details of the methods of construction he intends to utilize together with any sketches or drawings.

D. Tolerances. The casing pipes shall be installed as shown on the Details and within tolerances required to allow the carrier pipe to be properly installed to the lines and grades shown on the Plans.

E. Reference standards.

1. ASTM A139, Electric-Fusion (ARC Welded) Steel Pipe.
2. ASTM A153, Zinc-Coating (Hot Dip) on Iron and Steel Hardware.
4. ASTM A569, Hot-Rolled Carbon Steel Sheets and Strip, Commercial Quality.
5. ASTM S252, Welded and Seamless Steel Pipe Piles.
1.03 SUBMITTALS

A. Installation methods. The Contractor shall submit drawings and descriptions showing methods and equipment for the installation of the casing and carrier pipe for approval by the City. The description shall include subsurface information, dewatering methods, jacking pit elevations, and profile of proposed bore.

B. Welder’s certification to perform required work.

C. Casing pipe certificates from manufacturer.
   1. Certificate of conformance in accordance with paragraph 20.2 of ASTM A139-90.
   2. Hydrostatic test report in accordance with paragraph 12 of ASTM A139-90.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery.
   1. Exercise special care during delivery not to damage the casing pipe and carrier pipe.
   2. Damaged materials will be replaced by the Contractor at his expense.
   3. The City will not accept shipments of any kind for the Contractor.

B. Storage.
   1. Store casing pipe and carrier pipe on approved blocking for protection from corrosion until incorporation into the Work in accordance with manufacturer's recommendation.
   2. The City shall be permitted access to inspect the materials in storage areas.

C. Handling.
   1. Handle materials in a manner so as to avoid damage.
   2. Materials damaged during handling shall be repaired or replaced as ordered by the City.
1.05 JOB CONDITIONS

A. Protection. Guardrail, fences, signs, lights, barricades, barrels, and all other protective items necessary shall be provided in accordance with the requirements of all applicable permits, laws, regulations, and ordinances, including the Virginia Work Area Protection Manual, and as necessary to prevent damage or injury to private or public property or to workmen or the general public.

B. Adequately support and protect utilities and facilities that are encountered in, or may be affected by, the Work.

C. If the railroad company requires the installation of track supports, the Contractor shall install such supports. If the railroad company does not furnish the supports, the Contractor shall be responsible for fabricating the track supports in accordance with the requirements of the railroad company's chief engineer. It should be noted, however, that railroad companies usually require that any work involving rails, ties, or other track material be performed by their own forces. The cost of such work, even though carried out by the railroad company, is at the expense of the Contractor.

D. The Contractor must observe all necessary and appropriate safety precautions when working on railroad rights-of-way or property. At the discretion of the railroad, the Contractor shall provide a qualified watchman or pay for a watchman supplied by the railroad to warn workmen of the approach of any train or other moving equipment upon the tracks of the railroad, and to keep all workmen or other persons, equipment, and materials from the tracks including any power, communication, and signal wires, so that there will be no contacts with trains, rolling equipment, or wires. Contractor shall comply with all railroad requirements.

E. All excavations shall be sheeted, shored, and braced as required to prevent subsurface subsidence.

F. Boring pits shall be kept dewatered, and pumps shall be attended on a 24-hour basis, if conditions so require. Close observation shall be maintained to detect any settlement or displacement of facilities during dewatering operations. Dewater into a sediment trap and comply with applicable environmental protection criteria specified in Section 02270.

G. Maintain the air quality in the pipe or tunnel, when hand excavating, in a condition suitable for the health of workmen at all times in accordance with OSHA requirements.
PART 2  PRODUCTS

2.01  MATERIALS

A. Steel casing pipe.

1. Casing pipe shall be new steel casing pipe meeting the requirements of ASTM A139, Grade B, leakproof construction. Minimum impact factor shall be 1.0. Pipe shall be seamless or have not more than one (1) longitudinal weld.

2. Minimum wall thickness shall be as shown on the Details.

3. Casing pipe shall be designed for earth cover shown on the Plans and live load including impact equal to Cooper E-80 railroad loading for railroad crossings and HS-20 wheel loading for roadway crossings.

4. If the casing pipe is furnished in sections to be field welded, then casing pipe shall be supplied with plain ends, mill beveled for field butt welding. Field welded joints shall be performed by AWS D.1.1 certified welders and be full penetration single-vee groove, butt type welds around the entire circumference of the pipe. All welding shall receive non-destructive testing. Copies of test reports shall be submitted to the City.

5. Coatings. The exterior and interior surfaces of the casing pipe shall receive surface preparation conforming to SSPC-SP6. Provide Tnemec, TnemeTar, 2 coats, 8.3 dry mils per coat, or approved equal.

6. For casing pipe 30-inches in diameter and larger, provide an adequate number of 1-1/2-inch or 2-inch holes drilled 3 feet on center alternating 30 degrees with a vertical plane through the casing pipe. The holes shall be tapped for plugs. Plugs shall be furnished and installed by the Contractor. Cost for installation of holes and plugs shall have been included in the Contract price bid.

B. Tunnel liner plate.

1. Tunnel liner plates, bolts, and nuts shall conform to the requirements of the Specification for Steel Tunnel Liner Plates as developed by the American Association of State Highway and Transportation Officials, Committee on Bridges and Structures, latest revision.

2. Liner plate tunnel shall be designed for earth cover shown on the Drawings and live load, including impact, equal to Cooper E80 railroad loading for railroad crossings or HS-20 wheel loading for roadway crossings.

3. Minimum liner plate thickness shall be 0.1345 inch.

4. Minimum moment of inertia shall be 0.0549 inch$^4$/inch.

5. Liner plates shall be galvanized in accordance with ASTM A123 and coated with a bituminous coating.
6. Liner plates may be “2-flanged” or “4-flanged,” but must not be mixed on any specific tunnel.

7. Nuts and bolts shall be hot dipped galvanized in accordance with ASTM A153, latest revision.

8. Shape plates such that erection can be completely and readily effected from within the tunnel.

9. Provide plate dimensions of such size and with such tolerances that plates of similar curvature are interchangeable.

10. Punch all plates for bolting on both longitudinal and circumferential joints.

11. Fabricate each plate from one piece of metal, including circumferential and longitudinal flanges.

12. Provide all plates with circumferential flanged joints.

13. Provide either flanged or offset lap seam type longitudinal joints.

   a. Space in accordance with manufacturer’s recommended standard spacing.
   b. Space as a multiple of plate length so that plates having the same curvature are interchangeable and permit staggering of the longitudinal joints.

15. Longitudinal bolt-hole spacing. Space in accordance with manufacturer’s recommended standard spacing.

16. Provide tapped grout holes consisting of welded half-couplings with pipe plugs 2 inches minimum in diameter. Number, size, type, and location of grout holes shall be shown on the (shop drawing) details of the liner plates; but shall not occur in less than 10 percent of plates. Additional holes shall be inserted in the field if necessary to make sure all voids are filled.

C. Cement grout. Uniform mixture of cement and sand, in accordance with Section 03600.

D. Casing spacers.
   1. Provide bolt-on style casing spacers for positioning carrier pipe within tunnel or casing pipe and for electrically isolating the carrier pipe from the tunnel or casing pipe.

   2. The casing spacers shall support the carrier pipe in the center of the tunnel or casing pipe.

      a. Shell. Type 304 stainless steel with PVC liner.
b. Runners. Ultra high molecular weight polymer supported by Type 304 stainless steel risers welded to the shell or high density polyethylene. All welds shall be passivated.

c. Bolts and nuts. Type 304 stainless steel.


5. Extent. Refer to Drawings.


D. End seals.

1. End seals shall be 1/8 inch thick neoprene rubber secured with ½ inch wide T-304 stainless steel banding straps with a 100% non-magnetic worm gear mechanism. Edge seals shall be pressure sensitive butyl mastic strips.


PART 3 EXECUTION

3.01 GENERAL

A. Installation of the crossings shall be by jacking, boring, microtunneling, or tunnel with liner plate and shall conform in all respects to the requirements contained herein and other applicable standards.

B. Lines and grades. The Contractor is responsible for establishing and maintaining proper line and grade at each crossing.

1. The Contractor shall periodically check his line and grade to assure conformance with line and grade within the tolerances indicated in this Section.

2. Extra work required because of the Contractor’s failure to maintain the proper line and grade as shown on the Plans shall be performed by the Contractor at no additional cost to the City.

3.02 INSPECTION

A. As required by the City, VDOT, railroad, or other regulatory authority.

B. Contractor shall check for voids around casing pipes 30 inches or larger in diameter.

3.03 PREPARATION

A. Work pits at each end of the crossings shall be sufficiently large to permit satisfactory installation of the casing pipe or tunnel liner plates. All excavation, backfill, sheeting, shoring,
bracing, and dewatering shall comply with the applicable requirements of these Specifications and the requirements of the applicable authorities.

B. The Contractor shall dispose of excess excavated material or drilling mud/cuttings in an approved disposal site at the expense of the Contractor.

3.04 INSTALLATION

A. Installation of steel casing pipe by jacking.

1. Install in accordance with current American Railroad Engineering Association Specifications for railroad crossings and VDOT Road and Bridge Standards for roadway crossings.

2. Design bracing and backstops and use jacks of sufficient rating such that jacking can be accomplished in a continuous manner until the leading edge of the pipe reaches the final positions shown on the Plans.

3. If voids develop around the casing pipe as it is jacked, pump cement grout to fill all such voids, or fill by other means acceptable to the City, the railroad or VDOT, where applicable.

4. Fill all voids as specified hereafter as soon as possible after completion of jacking operation.

B. Installation of steel casing pipe by boring.

1. The boring method shall consist of pushing the pipe into the fill with a boring auger rotating inside the pipe to remove the soil.

2. Provide the front of the casing pipe with suitable mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe.

3. The equipment and mechanical arrangements or devices used to bore and remove the earth shall be removable from within the casing pipe in the event an obstruction is encountered.

4. The face of the cutting edge shall be arranged to provide reasonable obstruction to the free flow of soft or poor soil.

5. Do not use water or other liquids to facilitate casing emplacement or spoil removal.

6. If voids develop around the casing pipe as it is bored, pump cement grout to fill all such voids, or fill by other means acceptable to the City, VDOT, or railroad, where applicable.

7. Fill all voids as specified hereafter as soon as possible after completion of boring operation.

C. Installation of tunnel liner plating.

1. Assemble plates in accordance with the manufacturer's recommendations.
2. Make all circumferential and longitudinal joint connections with specified nuts and bolts.

3. Mine tunnel by approved methods that will prevent loss of material outside the plate section and as follows:
   a. Excavate for 1 course at a time.
   b. Place and securely bolt liner plates in sequence immediately following excavation for them, and prior to excavation for the next course.
   c. Where material is lost outside the plate sections, grout to completely fill all voids in a manner acceptable to the City, the railroad or VDOT, where applicable.
   d. Grout all voids full as close to the header as possible, using grout stops behind plates, if necessary.
   e. Provide and maintain a solid, approved bulkhead at the end of work at the end of each day's operations.

D. Grouting.

1. Start at the lowest hole of each section to be grouted, grout holes above to remain open, and proceed upward progressively and, if possible, simultaneously on both sides of the casing or tunnel until all voids are completely filled with 1:4 cement grout as specified in Section 03600, Grout.

2. Provide grout holes in addition to those specified where directed by the City to insure filling of all voids.

3. At any given location, grouting pressures shall not exceed 1/2 psi for each foot of earth overburden.

E. Obstructions. If an obstruction is encountered during installation to stop the forward action of the casing pipe, and it becomes evident that it is impossible to advance the pipe, the Contractor may choose either of the follow procedures.

1. Operations will cease and the casing pipe shall be abandoned in place and filled completely with grout. The pipe location shall be changed to an approved location and the crossing re-bored or re-jacked at the Contractor’s expense and at no additional cost to the City.

2. The Contractor may continue the casing pipe by tunneling and installation of tunnel liner plates as described herein. The continuation by the tunneling method shall be at the Contractor’s expense and at no additional cost to the City.

F. Installation of the pipe.
1. After completion of the tunnel or steel casing pipe, the carrier pipe shall be installed and pressure tested in accordance with these Specifications.

2. Care shall be taken to prevent undue disturbances of the joints.

3. Carrier pipe shall be blocked in place, using stainless steel casing spacers to secure it against movement at maximum spacing of 9 feet.

4. The Contractor shall repair, replace, or take whatever action is deemed necessary by the City to correct all disturbed joints at no additional cost to the City.

G. Installation of end seals.

1. Install end seals consistent with manufacturers’ recommendations. Installed end seal shall prevent foreign material from entering the space between the carrier pipe and the casing and allow for some movement of the carrier pipe.

H. Bulkheads.

1. After the carrier pipe is installed in the tunnel or steel casing and successfully pressure tested, construct bulkheads as shown in the Details and as specified herein.

2. Prior to the installation of bulkheads, the line shall be properly and sufficiently secured against flotation and against all movement that would disturb joints.

3. On railroad crossings, a vent shall be installed in accordance with AREA recommendations.

4. Masonry bulkheads shall be eight (8) inches wide unless otherwise indicated.

END OF SECTION
PART 1   GENERAL

1.01   SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install asphaltic paved roadways, parking areas, temporary paving, markings, tie-ins to existing paving, and appurtenances as shown on the Drawings and as specified herein.

B. Maintain new pavements for one year after Final Completion. Promptly refill and repave areas that have settled or are otherwise unsatisfactory for traffic.

1.02   RELATED WORK

A. Section 02100, Clearing and Grubbing.

B. Section 02200, Excavation and Backfill.

C. Section 02230, Fill and Granular Fill Materials.

1.03   REFERENCE STANDARDS

A. Where reference is made to the standards listed below, the revision in effect at the time of bid opening shall apply.

B. Except as otherwise specified herein, materials and construction shall be in accordance with the Virginia Department of Transportation Road and Bridge Specifications, latest edition.

PART 2   PRODUCTS

2.01   MATERIALS

A. Asphaltic concrete paving wearing course shall be Type SM-9.5 as specified in Section 211.04 of the above-referenced specifications.

B. Asphaltic concrete binder course shall be Type BM-25 as specified in Section 211.04 of the above-referenced specifications.

C. Aggregate base material shall be as specified in the Drawings and Section 02230.

D. Tack coat shall consist of either emulsified asphalt or cutback asphalt conforming to the requirements of Section 311 of the above-referenced specifications.
E. Gravel sub-base shall be as specified in the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Pavements shall be placed at the locations shown on the Drawings and as directed.

B. The work for new or for repair of existing pavement shall include the placing and compacting of the base course, the priming of the base, the placing and maintaining of the binder and surface treatments, and any special requirements, all as specified herein.

C. Pavement, at a minimum, shall consist of a 4-inch layer of asphaltic concrete binder course, Type BM-25, placed on a 6-inch compacted stone base course, with a 2-inch asphaltic concrete surface course, Type SM-9.5, placed so that the top layer matches the grade of existing pavement.

D. The binder course shall be placed as soon as possible after the 6-inch stone base has been prepared, shaped, and compacted.

E. The binder course shall be placed and compacted by steel-wheeled rollers with a minimum weight of 3 tons. New pavement shall be rolled smooth and even with the existing pavement.

F. All pavement thicknesses referred to herein are compacted thicknesses. Place sufficient mix to ensure that the specified thickness of pavement is achieved.

G. Hose clean all road surfaces after backfilling and before any surfacing, but in no case shall pavement be placed until the stone base is dry and compacted to at least 95 percent maximum dry density at optimum moisture content as determined by ASTM D698.

H. All manhole frames and utility boxes are to be set to the grade of the wearing course. At no time shall the frames or boxes be allowed to protrude above the surface of the wearing course.

I. The contact surfaces of castings and other structures shall be painted with a tack coat.

J. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers weighing not less than 240 pounds per inch width of tread.

K. Final compaction of the surface shall be accomplished by rollers weighing not less than 285 pounds per inch width of tread. Along curbs, structures, and all places not accessible with a roller, the mixture shall be thoroughly compacted with tampers. Such tampers shall weigh not less than 25 pounds and shall have a tamping face of not more than 50 square inches. The surface of the mixture after compaction shall be smooth and true to the established line and grade.

L. When the air temperature falls below 50 degrees F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and placing and compacting the mixtures.
M. No mixtures shall be placed when the air temperature is below 40 degrees F, nor when the material on which the mixtures are to be placed contains frost or has a surface temperature less than 35 degrees F.

N. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the City.

3.02 CUTTING PAVEMENT

A. Cut and remove existing pavement as necessary for installing the new pipe lines and appurtenances, for making connections to existing pipe lines, and for making tie-ins between existing and new pavements.

B. Pavements to be cut shall be marked neatly, paralleling pipe lines and street lines. Asphaltic concrete pavement shall be cut along the markings with a jackhammer, rotary saw, or other suitable tool. Concrete pavement and asphaltic pavement on concrete base shall be scored to a depth approximately 2 inches below the surface of the concrete along the marked cuts. Scoring shall be done by use of a rotary saw, after which the pavement may be broken below the scoring with a jackhammer or other suitable equipment.

C. No pavement shall be machine pulled until completely broken and separated along the marked cuts.

3.03 PAVEMENT REPAIR AND REPLACEMENT

A. All existing pavement cut or damaged by construction shall be repaired to match the original surface material and original grade unless otherwise specified or shown on the Drawings. Materials and construction procedures for sub-base, base course, and pavement repair shall conform to VDOT standards.

B. The width of all repairs shall extend at least 6 inches beyond the excavation or limits of any damaged section. The edge of the pavement to be left in place shall be saw cut to a true edge so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

C. After all repair and restoration or paving has been completed, all excess asphalt, dirt, rock, and other debris shall be removed from the roadways. All storm sewers and inlets shall be checked and cleaned of any construction debris.

D. The pavement adjacent to pipeline trenches shall neither be disturbed nor damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, the damaged pavement shall be removed and replaced at no expense to the City.

3.04 TRENCH PAVEMENT RESTORATION

A. Place 6-inch compacted stone base course and 4-inch minimum binder course over trenches cut in existing paved areas no later than 1 week after the trench has been backfilled. The paving shall be maintained until overlaid with a 2-inch wearing course. Contractor may elect to install
temporary pavement repair in accordance with the Detail Drawings until such time as permanent repair can be made.

B. If points of settlement or holes appear in the pavement, repair the same within 3 days of notification by the City. If after due notice Contractor fails to make the repairs, the work will be done by the City and the total cost of such repairs will be charged to the Contractor.

3.05 CUTTING CONCRETE STRUCTURES

A. Cut and remove concrete sidewalks, curbs, gutters, etc., as necessary for the installation of new piping. Cutting and removal of concrete sidewalk sections shall correspond to existing jointing of the sidewalk. Removal of partial sidewalk sections shall not be permitted.

B. Cutting of sidewalks, curbs, gutters, etc., shall be performed using appropriate concrete saws and shall be in a neat and workmanlike manner. The Contractor shall only remove sections necessary for the proper installation of the piping or sections damaged as a result of the construction activity.

C. All concrete sections removed as part of the Work shall be removed from the job site and disposed of in accordance with the requirements of federal, state, and local regulations.

3.06 CONCRETE STRUCTURE REPAIR AND REPLACEMENT

A. Concrete structures, including but not limited to curbing, gutters, driveways, and sidewalks, damaged during construction shall be promptly and satisfactorily restored to pre-construction condition, or as directed by the City, in accordance with all applicable sections of the Virginia Department of Transportation Road and Bridge Specifications, latest edition.

B. Sidewalks and driveways shall be repaired or replaced to the thickness of the adjacent undisturbed sections or 4 inches, whichever is greater. The finish shall be floated or broomed to match the existing concrete. Joints shall be tooled to match the spacing of the existing sections. WWF 6 x 6, W 1.4 x 1.4 steel mesh reinforcement shall be required for all installations.

C. Curbing and gutters shall be rebuilt to original lines, grade, cross-section, and finish. Any curbing or gutters that have settled or shifted as a result of the Work shall be replaced at the Contractor’s expense.

3.07 MAINTENANCE AND GUARANTEE

A. All wearing surfaces shall be maintained in good order and be suitable for traffic at all times for a period of 1 year after Final Completion and acceptance of the Work.

B. At the end of the maintenance period, a final inspection will be made of the repaired and new surfaces and any settlement or depression shall be repaired as specified above.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION

A. Scope. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all precast manholes.

B. General.

1. Manholes shall conform in shape, size, dimensions, material, and other respects to the Details shown.

2. The Contractor will provide the cast-iron frames and covers.

3. Cast-in-place manholes will not be permitted unless specifically approved by the City.

4. Masonry manholes will not be permitted.

C. Related sections.

1. Design Requirements.

2. Division 2, Site Work.

3. Division 15, Mechanical.

1.02 QUALITY ASSURANCE

A. Reference standards.

1. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.

2. AWWA C302 - Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids.


4. ASTM A48 – Class 30 gray iron for manhole frame and covers.

5. AWWA C302 – AWWA Standard C302 for Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.03 SUBMITTALS
A. Shop drawings. Submit for approval drawings showing design and construction details of precast concrete manholes, standard frames and covers, water-tight frames and covers, and any specialized appurtenances.

PART 2  PRODUCTS

2.01 PRECAST CONCRETE MANHOLES

A. Precast manholes shall conform to the Details shown and as specified herein.

B. Except where otherwise specified, precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C478, except as modified herein.

C. Precast, reinforced concrete manhole bases, riser sections, flat slabs, and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing, or other imperfections. Concrete used in the construction of the manholes shall have a minimum 28 day strength of 4000 psi and be air entrained with four (4) to six (6) percent air. The base inside diameter of manholes shall be a minimum of 42 inches. Larger base diameters are preferred.

D. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket and shall conform to AWWA C302. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections, and top cones or slabs of manholes 72 inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72 inches in diameter shall be provided with steel bell and spigot rings.

E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have 2 cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than five (5) inches. Base thickness shall not be less than six (6) inches.

F. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured to provide the correct height with the fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than 1 foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

G. A precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

H. Manhole sections shall contain manhole steps accurately positioned and embedded in the concrete.

I. Gasketed flexible watertight connections shall be supplied for any inlet and outlet pipes joined to the manhole. Provide flexible pipe-to-manhole connectors as manufactured by KOR-N-SEAL, NPC or equal.
J. Manhole interior coating. Manhole interior to receive one (1) coat protective, solvent-free, colored epoxy resin coating. Color shall be light gray or other approved color. Use Sikagard 62 manufactured by Sika Corporation of Lyndhurst, NJ or approved equal.

K. Manhole exterior coating. Manhole exterior to receive one (1) coat coal tar epoxy coating. Coal tar epoxy to be amine cured with a mix ration of 1:1.

2.02 MISCELLANEOUS METALS

A. Metal frames and covers.

1. Frames and covers shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings. Depending on the application, covers shall have letters “SANITARY SEWER” or “WATER” embossed on top.

2. Frames and covers shall be Model MH-3000 24” as manufactured by Capitol Foundry of Virginia, Inc., or equal by East Jordan Iron Works, Inc.

3. Watertight frame and cover shall have bolt-holes for anchoring the frame to the precast manhole cone. The joint between the frame and the manhole section shall be sealed with a polysulfide base sealant. Proposed model shall be submitted to the City for approval. Watertight frame and cover shall be Model MH-3000 WT 24” as manufactured by Capitol Foundry of Virginia, Inc. or equal by East Jordan Iron Works, Inc.

4. The clear opening in the manhole frame shall be a minimum of 24 inches.

B. Manhole steps.

1. Manhole steps shall be "Wedge-Lok" type as manufactured by Delta Pipe Products, or approved equal. Step shall be steel bar encapsulated in polyurethane plastic conforming to requirements of ASTM C478 and OSHA standards.

2. Space steps uniformly at a maximum of 16 inches on centers and project evenly from manhole or chamber walls. Encasement depth shall be as required by manufacturer (4 inches minimum).

3. The first step shall be no greater than 28 inches and no less than 24 inches from the top of the frame.

2.03 DROP CONNECTIONS

A. Exterior drop connections for manholes shall be constructed where shown on the Drawings or as approved by the City. Exterior drops shall conform to the design and details shown in the Detail Drawings. Pipe and fittings shall be ductile iron (thickness class 52) or SDR-35 PVC. Drop connections shall be ductile iron pipe or PVC pipe backfilled in six (6) inch lifts and compacted by hand tampers.
B. Interior drop manholes will only be allowed where specifically approved by the City. If allowed, provide a drop manhole cross piping management as manufactured by GPK Products, Inc., or equal.

1. Drop stacks may be placed inside the manhole only if the inside diameter is 48 inches or greater. For manholes less than 48 inches in diameter, drop stacks must be installed outside the manhole.

2. Drop stacks must discharge onto a prepared channel at no greater than 18 inches from the manhole invert.

PART 3 EXECUTION

3.01 MANHOLE BASES

A. Precast bases shall be set on No. 57 stone foundation as shown. Precast bases shall be set at the proper grade and carefully leveled and aligned. Manholes shall be installed plumb. The flow channel through the manhole shall be of such shape and slope to provide smooth transition between inlet and outlet sewers and to reduce turbulence. Benches shall be sloped to the channel to prevent accumulation of solids.
3.02 PRECAST MANHOLE SECTIONS

A. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.

B. Install sections, joints, and gaskets in accordance with manufacturer’s recommendations.

C. All manholes shall receive 1 exterior and 2 interior coats of coal tar epoxy. Cement mortar joint seals specified above shall receive one coat of coal tar epoxy, inside and out, prior to backfilling.

3.03 MANHOLE CHANNELS

A. All invert channels through manholes shall be constructed of concrete or grout. Channels shall be properly formed to the sizes, cross sections, grades, and shapes shown or as directed. Benches shall be built up to the heights shown or as directed and given a smooth, steel trowel finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.04 GRADING RINGS

A. Grading rings shall be used for all precast manholes where required. Grade rings shall be stacked in 2- or 3-inch increments to a maximum of 9 inches in height constructed on the cone section on which the manhole frame and cover shall be placed. The height of the grade rings shall be such as is necessary to bring the manhole frame to the proper grade. If more than 3 adjustment grade rings are required, a separate riser section must be used. Grade rings, when used, shall receive an interior sealing coat of Flex-Seal Utility Sealant by Sealing Systems, Inc., in accordance with manufacturer's instructions.

3.05 FLEXIBLE MANHOLE CONNECTION AT MANHOLE BASE

A. Provide a flexible manhole connection between each pipe entering and exiting the manhole. The joint shall be completely watertight. Provide flexible pipe-to-manhole connectors as manufactured by KOR-N-SEAL, NPC, or equal.

3.06 GRADING AT MANHOLES

A. All manholes in unpaved areas shall be built as shown or directed to an elevation higher than the original ground. If no elevation for top of manhole is shown, install top of manhole 12 inches above finished grade. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1:5 slope to the existing surrounding ground unless otherwise shown. In maintained, seeded areas such as yards, parks, etc., top of manhole must be flush with finished grade.

B. Manholes in paved areas shall be constructed to meet the final surface grade. Manholes shall not project above finished roadway pavements.
C. Contractor shall be solely responsible for the proper height of all manholes necessary to reach the final grade at all locations. Contractor is cautioned that the City's review of Shop drawings for manhole components will be general in nature and Contractor shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.07 MANHOLE WATERTIGHTNESS

A. Each manhole shall be tested for leaks, and all leaks found shall be repaired in a manner subject to the City's approval. Manhole testing shall be accomplished by one of the following two methods:

1. Exfiltration test. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The manhole shall be filled with water to the top of the rim. Manholes shall be filled with water and allowed to sit up to a maximum of 12 hours prior to beginning test to allow for absorption. After testing, water shall be disposed of in a suitable manner as approved by the City.
   a. Test duration: 2 hours
   b. Allowable leakage: 0.25 gallon per hour per foot of depth.

2. Vacuum test.
   a. Testing shall be accomplished in accordance with ASTM C1244, latest edition, for watertightness. Testing shall include the entire manhole, including the joint between the cone section and the frame.
      1. The test method is only to be applied to precast concrete manholes.
      2. Stub outs, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn.
   b. A measured vacuum of 10 inches of mercury shall be established in the manhole. The time for the vacuum to drop to 9 inches of mercury shall be recorded. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. The maximum allowable leakage rate shall be in accordance with the following:
<table>
<thead>
<tr>
<th>Manhole Size (Diameter in Feet)</th>
<th>Depth*</th>
<th>Minimum Time for a 1&quot; Hg Pressure Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Less than 10’</td>
<td>60 sec.</td>
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<tr>
<td>4</td>
<td>Greater than 10’ but less than 15’</td>
<td>75 sec.</td>
</tr>
<tr>
<td>4</td>
<td>Greater than 15’ but less than 25’</td>
<td>90 sec.</td>
</tr>
<tr>
<td>5</td>
<td>Less than 10’</td>
<td>75 sec.</td>
</tr>
<tr>
<td>5</td>
<td>Greater than 10’ but less than 15’</td>
<td>90 sec.</td>
</tr>
<tr>
<td>5</td>
<td>Greater than 15’ but less than 25’</td>
<td>105 sec.</td>
</tr>
<tr>
<td>6</td>
<td>Less than 10’</td>
<td>90 sec.</td>
</tr>
<tr>
<td>6</td>
<td>Greater than 10’ but less than 15’</td>
<td>105 sec.</td>
</tr>
<tr>
<td>6</td>
<td>Greater than 15’ but less than 25’</td>
<td>120 sec.</td>
</tr>
</tbody>
</table>

*Manholes greater than 25 feet in depth shall be reviewed and testing requirements established on a case-by-case basis.

c. If the manhole fails the test, necessary repairs shall be made and the vacuum test repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.

END OF SECTION
DIVISION 3 – CONCRETE
PART 1   GENERAL

1.01   SCOPE OF WORK

A. Furnish all labor and materials required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.

1.02   RELATED WORK

A. Section 03600, Grout.

1.03   SUBMITTALS

A. Submit to the City shop drawings and product data including the following:

1. Sources of cement, pozzolan, and aggregates.


4. High-range water-reducing admixture (plasticizer). Product data including catalog cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range, and conformity to ASTM standards.

5. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, concrete slump, type, and manufacturer of cement.

B. Certifications.

1. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify mix design meets requirements of the City's standard "City Mix" concrete mix design if applicable.

1.04   REFERENCE STANDARDS
   1. ASTM C31 - Standard Practice for Making and Curing, Concrete Test Specimens in the Field.
   7. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

B. American Concrete Institute (ACI).
   1. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
   2. ACI 305R - Hot Weather Concreting.
   4. ACI 318 - Building Code Requirements for Structural Concrete.
   5. ACI 350R - Environmental Engineering Concrete Structures.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
1.05 QUALITY ASSURANCE

A. Reinforced concrete shall comply with ACI 318, the recommendations of ACI 350R and other stated requirements, codes, and standards. The most stringent requirement of the codes, standards, and this Section shall apply when conflicts exist.

B. Only one (1) source of cement and aggregates shall be used on any single structure. Concrete shall be uniform in color and appearance.

PART 2 PRODUCTS

2.01 GENERAL

A. The City's standard "City Mix" Portland cement concrete mix design shall be used for all curbs, gutters, sidewalks, and driveways. The color shall be “Omaha Tan.”

B. All other uses of cast-in-place concrete shall meet the design requirements specified herein.

2.02 MATERIALS

A. Cement: Domestic Portland cement complying with ASTM C150 – Type II. Cement brand shall be subject to approval and one brand shall be used throughout the Work.

B. Supplemental cementitious material: Ground granulated blast-furnace slag.
   1. Meet ASTM C989 (Grade 120).
   2. Blend with Portland cement meeting requirements of ASTM C595 Type IS or IS(MS).

C. Fine aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.

D. Coarse aggregate: Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 3 for the specified coarse aggregate size number. Limits of deleterious substances and physical property requirements shall be as listed in ASTM C33 Table 3 for severe weathering regions. Size numbers for the concrete mixes shall be as shown in Table 1 herein.

E. Water: Potable water, free from injurious amounts of oils, acids, alkalis, salts, organic matter, or other deleterious substances.

F. Admixtures: Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.
   1. Air-entraining admixture: The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
2. Water-reducing agent: The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer’s recommendations.

3. High-range water-reducer (plasticizer): The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

4. Admixtures causing retarded or accelerated set of concrete shall not be used without written approval from the City. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.

G. Sheet curing materials: Waterproof paper, polyethylene film, or white burlap-polyethylene sheeting all complying with ASTM C171.

2.03 MIX

A. Development of mix design and testing shall be by an independent testing laboratory acceptable to the City engaged by and at the expense of the Contractor.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance, and other required properties. Proportion ingredients to produce a homogenous mixture that will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory engaged by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7- and 28-day compressive strengths of concrete made using the proposed materials. Four (4) or more points shall determine the curves, each representing an average value of at least 3 test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mix to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strength. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1 below.

D. Compression tests: Provide testing of the proposed concrete mix to demonstrate compliance with the specified design strength requirement in conformity with the above paragraph.

E. Entrained air, as measured by ASTM C231, shall be as shown in Table 1 below.
1. If the air-entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.

F. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1 below. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10 inches.

G. Proportion admixtures according to the manufacturer's recommendations. Two (2) or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

### TABLE 1

CONCRETE MIX REQUIREMENTS

<table>
<thead>
<tr>
<th>Class</th>
<th>Design Strength (1)</th>
<th>Cement (2)</th>
<th>Fine Aggregate (3) (4)</th>
<th>Coarse Aggregate (3) (4)</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>3000 psi</td>
<td>588 lb/cu yd</td>
<td>1362 lb/cu yd</td>
<td>1811 lb/cu yd</td>
<td>33.5 gal/cu yd</td>
</tr>
<tr>
<td>City Mix (9)</td>
<td>3500 psi</td>
<td>588 lb/cu yd</td>
<td>1260 lb/cu yd</td>
<td>1811 lb/cu yd</td>
<td>33.5 gal/cu yd</td>
</tr>
<tr>
<td>A4</td>
<td>4000 psi</td>
<td>635 lb/cu yd</td>
<td>1219 lb/cu yd</td>
<td>1811 lb/cu yd</td>
<td>33.5 gal/cu yd</td>
</tr>
<tr>
<td>Flowable Fill</td>
<td>30 psi</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>W/C Ratio (5)</th>
<th>Fly Ash</th>
<th>AE Range (6)</th>
<th>WR (7)</th>
<th>HRWR (8)</th>
<th>Slump Range Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>0.56</td>
<td>--</td>
<td>6 +/- 2%</td>
<td>--</td>
<td>--</td>
<td>1-5”</td>
</tr>
<tr>
<td>City Mix</td>
<td>0.49</td>
<td>Not allowed</td>
<td>6 +/- 2%</td>
<td>--</td>
<td>--</td>
<td>1-5”</td>
</tr>
<tr>
<td>A4</td>
<td>0.45</td>
<td>--</td>
<td>6 +/- 1%</td>
<td>--</td>
<td>--</td>
<td>2-4”</td>
</tr>
<tr>
<td>Flowable Fill</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

NOTES:
(1) Minimum compressive strength in psi at 28 days.
(2) Min. amount of Type I or Type II Portland Cement per ASTM C 150
(3) Saturated surface dry weight
(4) #57 size manufactured and tested for acceptance by ASTM C33 and The Virginia Department of Transportation Road and Bridge Specifications.
(5) Max. water-cementitious ratio by weight.
(6) AE is percent air-entrainment. AE admixtures to meet or exceed requirements of ASTM C-260 and AASHTO M-154.
(7) WR is water-reducer admixture. WR admixtures to meet or exceed requirements of ASTM C-494 and AASHTO M-194.
(8) HRWR is high-range water-reducer admixture. HRWR admixtures to meet or exceed requirements of ASTM C-494 Types A & F and AASHTO M-194 Types A & F.
(9) “City Mix” to be colored “Omaha Tan” using Rockwood Pigments/Davis Colors #5084. “City Mix” shall meet requirements of VDOT A3.5 concrete unless otherwise indicated.
PART 3  EXECUTION

3.01  MEASURING MATERIALS

A. Concrete shall be composed of Portland cement, blast-furnace slag, fine aggregate, coarse aggregate, water, and admixtures as specified and shall be produced by a plant acceptable to the City. All constituents, including admixtures, shall be batched at the plant except a high-range water reducer may also be added in the field.

B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified.

C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batching tickets.

D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
   1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
   2. Inject multiple admixtures separately during the batching sequence.

3.02  MIXING AND TRANSPORTING

A. Concrete shall be ready-mixed concrete produced by equipment acceptable to the City. Hand mixing will not be permitted. Equip each transit-mix truck with a continuous, non-reversible, revolution counter showing the number of revolutions at mixing speeds.

B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the nameplate.

C. The City must direct any addition of water. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.

D. Re-tempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar that has reached initial set will not be permitted.

E. Furnish a delivery ticket for ready-mixed concrete batch. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, and the time any water is added. Show the time of day batched and time of discharge from the truck.
F. Temperature control.

1. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees F.

2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.

3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.

3.03 PLACING AND COMPACTING

A. Placing.

1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, excess water, dirt, and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman at the location of the placement who can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous sub-grades or forms to eliminate suction of water from the mix. Seal extremely porous sub-grades in an approved manner.

2. Deposit concrete as near its final position as possible to avoid segregation due to re-handling or flowing. Place concrete continuously at a rate that ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete that has partially hardened or has been contaminated by foreign materials or on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.

3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping.

4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.

5. Slabs.

a. After suitable bulkheads, screeds, and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.

b. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously
placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.

B. Compacting.

1. Consolidate concrete by vibration, puddling, spading, rodling, or forking so that concrete is thoroughly worked around reinforcement, embedded items, and openings, and into corners of forms. Puddling, spading, etc., shall be continuously performed along with vibration to eliminate air or stone pockets that may cause honeycombing, pitting, or planes of weakness.

3.04 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing methods.

1. Curing methods for concrete surfaces: Cure concrete to retain moisture and maintain minimum temperature at the surface for a minimum of 2 days after placement. Curing methods to be used are as follows:

   a. Sheet material curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

   b. Liquid membrane curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, or where concrete sealers or surface coatings are to be used. Application shall be in compliance with the manufacturer's recommendations.

C. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

D. Cold weather concreting.

1. "Cold weather" is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40 degrees F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Discuss a cold weather work plan with the City. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing, and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the City.
E. Hot weather concreting.

1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity, and wind velocity that produces a rate of evaporation estimated in accordance with ACI 305R, approaching or exceeding 0.2 lbs./sq.ft./hr.

2. Concrete placed during hot weather, shall be batched, delivered, placed, cured, and protected in compliance with the recommendations of ACI 305R and the additional requirement specified herein.
   a. Temperature of concrete being placed shall not exceed 90 degrees F. Every effort shall be made to maintain a uniform concrete mix temperature below this level.

3. Discuss with the City a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the City.

3.05 INSPECTION AND FIELD TESTING

A. The batching, mixing, transporting, placing, and curing of concrete may be subject to the inspection of the City at any time.

B. The City may have cores taken from any questionable area in the concrete work for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, or rejection of the concrete work.

C. The Contractor shall cooperate in obtaining cores by allowing free access to the work and permitting the use of incidental equipment as may be required. The Contractor shall also repair all core holes. Cores for testing shall not be taken until concrete has aged a minimum of 60 days. The work of cutting and testing the cores will be at the expense of the City.

3.06 FAILURE TO MEET REQUIREMENTS

A. When the tests on specimens of concrete fall below the specified strength, the City will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39 at the Contractor's expense. In the case of cores not indicating adequate strength, the City, in addition to other recourses, may require, at the Contractor’s expense, the replacement of those portions of the concrete work that fail to develop the required strength.

END OF SECTION
PART 1   GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and install grout complete as shown on the Drawings and as specified herein.

B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the City but engaged by and at the expense of the Contractor.

1.02 RELATED WORK

A. Section 02300, Crossings by Jacking, Boring, and Tunneling.

B. Section 03300, Concrete.

1.03 SUBMITTALS

A. Submit to the City product data showing materials of construction and details of installation for:

1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.

2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards, and Material Safety Data Sheet.

3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.

1.04 REFERENCE STANDARDS


3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.


B. U.S. Army Corps of Engineers Standard (CRD).

1. CRD C-621 - Corps of Engineers Specification for Nonshrink Grout.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Qualifications.

1. Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.

B. Services of manufacturer's representative.

1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall be available, as required, to assist with correct installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer’s recommended storage time, whichever is less.

C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the City.

D. Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.

E. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, 3-component systems requiring only blending as directed by the manufacturer.

1.07 DEFINITIONS
A. Nonshrink grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state, and bonds to a clean base plate.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

A. Nonshrink cementitious grout.

1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents, and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.

   a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp., or equal.

   b. Flowable (precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp., or equal.

B. Nonshrink epoxy grout.

1. Nonshrink epoxy-based grout shall be a pre-proportioned, 3-component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of $30 \times 10^{-6}$ when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Inc.; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co., or equal.

C. Cement grout – General.
1. Cement grouts shall be a mixture of 1 part Portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Cement grout – Steel casing installations.

1. Cement grout shall be a mixture of 1 part Portland cement conforming to ASTM C150, Type I and 4 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to allow the grout to flow into voids surrounding the steel casing.

E. Water.

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the City.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance, and paints; and free of all loose material or foreign matter which may affect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance, and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil, or other deleterious substances from metal embedments or bottom of base plates prior to the installation of the grout.

E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the City. Upon completion of the 24-hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved for each specific location of grout installation.

F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
G. Construct grout forms or other leak-proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.

1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.

I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks, or other approved means. The shims, wedges, and blocking devices shall be prevented from bonding to the grout by appropriate bond-breaking coatings and removed after grouting unless otherwise approved by the City.

3.02 INSTALLATION - GENERAL

A. Mix, apply, and cure products in strict compliance with the manufacturer's recommendations and this Section.

B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 60 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of base plates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.

E. Install grout in a manner that will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying, expansion, control, and construction joints through the grout.

3.03 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

A. Mix in accordance with manufacturer’s recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval.

B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
C. Placements greater than 3 inches in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise approved by the City. Finish this surface with a wood float (brush) finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding, or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect windbreaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

E. Finish grout by puddling, to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

F. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

END OF SECTION
DIVISION 15 -- MECHANICAL
SECTION 15051
SEWER PIPING INSTALLATION

PART 1   GENERAL

1.01   DESCRIPTION

A. Scope. Contractor shall provide all labor, materials, equipment, and incidentals as shown,
specified, and required to install and test all piping, fittings, and specials. The Work includes,
but is not limited to, the following:

1. All types and sizes of piping except those specified under other Sections.
2. Supports, restraints, and thrust blocks.
3. Pipe encasements.
4. Work on or affecting existing piping.
5. Testing.
6. Cleaning.
7. Installation of all jointing and gasketing materials, specialties, flexible couplings,
   mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work
   required to complete the piping installation.

B. Related sections.

1. Section 02200, Excavation and Backfill.
2. Section 02611, Manholes.
3. Section 03300, Concrete.
4. Section 15065, PVC Pipe.
5. Section 15072, Ductile Iron Pipe and Fittings.

1.02   QUALITY ASSURANCE

A. All pipe to be installed under this Contract may be inspected at the place of manufacture for
compliance with the Specifications by an independent testing laboratory provided by the City.
The Contractor shall require the manufacturer’s cooperation in these inspections. The cost of
inspection of all pipe approved for this Contract will be borne by the City.

B. The City will inspect the pipe after delivery. The pipe shall be subject to rejection at any time
due to failure to meet any of the specified requirements herein, even though pipes may have
been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.

C. Reference standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ASTM D2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.


3. AWWA C105 - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.

4. AWWA NU3 - PVC - Design and Installation.


1.03 SUBMITTALS

A. Shop drawings. Submit for approval the following:

1. Laying schedules for all pipe.

2. Full details of piping, specials, manholes, joints, and connections to existing piping, structures, equipment, and appurtenances.

B. Certificates. Submit certificates of compliance with referenced standards.

C. Record drawings. Submit record drawings prior to the time of final completion.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle all pipe, fittings, specials, and accessories carefully with approved handling devices as per manufacturer’s requirements. Do not drop or roll material off trucks. Do not otherwise drop, roll, or skid piping.

B. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground. Pipe shall not be stacked higher than the limits recommended by the manufacturer and storage shall conform to the manufacturer’s recommendations. Pipe and fittings strung out for installation within 5 working days may be placed in contact with the ground.

C. Unload pipe, fittings, and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter.

D. Inspect delivered pipe for cracks, gouges, chips, dents, or other damages and immediately remove damaged pipe from site.
PART 2  PRODUCTS

2.01  MATERIALS

A. Refer to applicable Pipe Sections for material specifications.

B. Pipe marking.

   1. Cast or paint material, type, and pressure designation on each piece of pipe or fitting four (4) inches in diameter and larger.

C. Tracer wire. Tracer wire shall be AWG No. 14, single-conductor solid copper with 600-volt insulation designed to meet U.S.E. requirements for buried service.

D. Warning tape. Warning tape shall have a minimum 5.0 mil overall thickness. The warning tape, including labeling, shall not contain any dilutants, pigments, or other contaminants, and shall resist degradation by elements encountered in the soil. The warning tape for sewer service installations shall be color-coded green and imprinted with the words, "Caution -- Sewer Line Buried Below."

PART 3  EXECUTION

3.01  INSTALLATION

A. General.

   1. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe, linings, or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed. Handling and laying of pipe and fittings shall be in accordance with the manufacturer’s instructions and as specified herein.

   2. If there is a conflict between manufacturer's recommendations and the Drawings or Specifications, request instructions from the City before proceeding.

   3. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plugs or other approved means.

   4. All piping and fittings shall be installed true to alignment and rigidly supported. Anchorage shall be provided where required. Any damage to linings shall be repaired to the satisfaction of the City before the pipe is installed. Each length of pipe shall be cleaned before installation.
5. A firm, even bearing throughout the length of the pipe barrel shall be constructed by tamping crushed stone at the sides of the pipe up to mid-diameter (i.e. spring line) then selected fill up to one (1) foot over the top of the pipe. Blocking will not be permitted. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at Contractor's own expense.

6. Where pipe cutting is required, the cutting shall be done by abrasive saw, leaving a smooth cut at right angles to the axis of the pipe. Any damage to the lining shall be repaired to the satisfaction of the City. Field cuts ends shall be in accordance with the manufacturer’s instructions.

   a. The Contractor shall confine construction operations to the immediate vicinity of the project location as shown on the Plans, and in no case shall the Contractor encroach beyond the limits of the City’s property, easements, or rights-of-way. He shall further use due care in placing construction tools, equipment, excavated materials, and pipeline facility materials and supplies so as to cause the least possible damage to property and the least interference with traffic. The placing of such tools, equipment, and materials shall be subject to the approval of the City. Any damage resulting from the placement of equipment and materials or construction operation occurring outside of designated work areas shall be the sole responsibility of the Contractor. The Contractor shall make satisfactory settlement for any damage directly with the property owner involved.

   b. The Contractor shall conduct the construction in such a manner to cause the least inconvenience to the citizens of the area, thereby maintaining good public relations. The Contractor shall not unnecessarily interfere with the use of any public or private improvements, including landscaping; nor shall he unnecessarily damage such improvements. The Contractor shall repair any damage to such improvements to pre-construction condition, or as otherwise directed by the City.

   c. The Contractor shall use care in protecting existing property irons and monuments adjacent to his working area. If a property iron or monument must be removed to install new facilities, the Contractor shall retain the services of a properly registered surveyor to immediately replace it after construction of the new facilities.

8. Work within city rights-of-way, VDOT rights-of-way, and City easements. Work within railroad property and right or way only with the permission of the railroad and in compliance with all applicable law, rules and regulations.
   a. Permits. The Contractor shall be responsible for obtaining and paying for all permits, insurance, and bonds required to complete the Work.

   b. The Contractor shall comply with all provisions of all permits required by the governing authorities at his own expense. The Contractor’s responsibility under this paragraph may include, but is not limited to, the following:
      1) Constructing and removing temporary facilities or structures.
      2) Providing details of construction methods.
3) Providing detailed construction schedules.

4) Reimbursing the applicable authority for all expenses incurred by them in connection with the Work.

5) Traffic maintenance.

6) Coordination of scheduling with the City.

7) Necessary clean up and restoration.

c. Maintenance of traffic.

1) The Contractor shall provide maintenance of traffic within the construction area for the duration of the construction period, including during any temporary suspension of Work. Maintenance of traffic shall conform to the current editions of the Manual on Virginia Traffic Control Devices, Virginia Work Area Protection Manual, Virginia Department of Transportation Road and Bridge Specifications, and the Virginia Department of Transportation Guidelines for Temporary Traffic Control and shall be subject to the approval of the City Traffic Engineer.

2) The City may provide a general Traffic Maintenance Plan for portions of the Work to be performed under this contract. If a general Traffic Maintenance Plan is provided, the Contractor is required to conform to this plan. The City may require that the Contractor submit a detailed Traffic Maintenance Plan prior to commencing work on a particular portion of the project. If the Contractor is asked to submit such a plan, work must not commence on the portion of the project covered by the plan until approval of the detailed Traffic Maintenance Plan by the City.

3) The amount of roadway closure shall be limited to the immediate work area and shall be in accordance with the above-mentioned manuals and specifications.

d. Maintenance of ingress and egress. The Contractor shall strive to maintain, at all times during the execution of the Work, continuous ingress and egress to all affected parcels and traveled ways. When ingress and egress to affected parcels must be blocked due to the direct execution of the Work, 24-hours advance notice must be given to the affected property owner. In no case shall the blocking of ingress and egress be allowed for more than 24 consecutive hours.

e. Construction activities within City rights-of-way are subject to the requirements of the City. Contractor shall ascertain from the City its rules, regulations, and requirements.

1) The Contractor shall maintain traffic control in a safe and professional manner. All traffic control measures, including signage, shall be in conformance with VDOT Guidelines for Temporary Traffic Control subject to the approval of the City Traffic Engineer.
2) Contractor shall erect and maintain barriers, lights, and other necessary protective devices as required by the City. Road, sidewalk, or other access-way closure will only be allowed with prior approval of the City.

3) Required notice for work within City roadways is seven (7) calendar days.

f. Construction within VDOT rights-of-way shall be subject to the approval and issuance of a construction permit by VDOT. Contractor shall at all times conduct his work and operations in accordance with the issued permit and the Virginia Department of Transportation Road and Bridge Specifications. If required by VDOT, the Contractor shall submit for approval specific details of construction methods proposed for Work within VDOT rights-of-way.

g. Materials and methods of construction used on railroad company property or rights-of-way shall be subject to the approval of the railroad company. Contractor shall at all times conduct his work and operations fully within the railroad company’s rules, regulations, and requirements. The Contractor must ascertain from the railroad company its rules, regulations, and requirements, and what, if any, delays may be encountered. If required by the railroad company, the Contractor must submit for approval specific details of the methods of construction he intends to utilize together with any sketches or drawings.

The Contractor must observe all necessary and appropriate safety precautions when working on railroad rights-of-way or property. At the discretion of the railroad, the Contractor shall provide a qualified watchman or pay for a watchman supplied by the railroad to warn workmen of the approach of any train or other moving equipment upon the tracks of the railroad, and to keep all workmen or other persons, equipment, and materials from the tracks including any power, communication, and signal wires, so that there will be no contacts with trains, rolling equipment, or wires. Contractor shall comply with all railroad requirements.

9. Warning tape shall be installed with each reach of sanitary sewer line and each service lateral. Warning tape shall be installed 12 inches above the sewer line or lateral and shall be continuous over the length of the sewer line or lateral. Tracer wire shall be installed with all PVC piping (sewer lines and laterals). Terminate tracer wire in a loop within a 1/2-inch diameter PVC pipe located at manholes or clean-outs as applicable.

B. Above-grade pipe installation.

1. All above-grade pipe shall be flanged unless otherwise shown or specified.

2. Flanged joints shall be made using gaskets, bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI standard as the flanges.

3. Bolts in flanged joints shall be tightened alternately and evenly as per manufacturer’s recommendations.

C. Buried piping installation.
1. Separation of sewers and potable water lines.

a. Parallel installations.

1) Potable water lines and sanitary sewers shall be separated horizontally by a clear distance of not less than ten (10) feet edge-to-edge wherever possible.

2) When local conditions prohibit this horizontal separation of ten (10) feet, the installation will be permitted provided the sewer line is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water line is at least 18 inches above the top of the sewer.

3) Where this vertical separation cannot be obtained, the sewer shall be constructed of water pipe material in accordance with AWWA specifications and pressure tested in place without leakage prior to backfilling. The hydrostatic test shall be conducted in accordance with the most recent edition of the AWWA standard (ANSI/AWWA C600-82) for the pipe material, with a minimum test pressure of 30 psi. Sewer manholes shall be of watertight construction and tested in place.

b. Crossings.

1) Provide a minimum vertical separation of 18 inches between the top of the sewer line and the bottom of the potable water line where the sewer passes under the water line.

2) When local conditions prohibit this vertical separation, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without any leakage prior to backfilling, in accordance with these standards.

3) Sewers crossing over potable water lines shall be constructed of AWWA approved water pipe, and pressure tested in place without leakage prior to backfilling, in accordance with these standards. Minimum vertical separation of potable water line and sewer shall be 18 inches measured edge to edge.

a) Center one (1) full-length section of pipe so that the sewer joints will be equidistant from the potable water line joints.

b) Provide adequate structural support for the sewer so as to maintain line and grade.

c. Separation of sewers and other utilities.

1) A minimum horizontal separation of five (5) feet shall be maintained between parallel sewers and gas lines. Should this horizontal separation not be obtainable, the separation may be reduced to three (3) feet with the written approval of the Chief Gas Engineer.

2) Sewers shall have a minimum edge-to-edge separation of 12 inches from all other utilities.
3) At all crossings, provide a minimum vertical separation of 12 inches between sewers and other utilities.

4) Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, the sanitary sewer shall be constructed of AWWA specified ductile iron pipe. Concrete support piers shall be required for the storm sewer and these piers shall be built on undisturbed earth with ready mix Class A3 concrete. Details of the design are subject to the approval of the City Engineer.

2. Pipe bedding.
   a. Bed pipe as specified below and in accordance with the Drawings.
   b. Trench excavation, backfill, and bedding materials shall conform to the requirements of Section 02200, Excavation and Backfill, and Section 02230, Fill and Granular Fill Materials.
   c. Excavate trenches below the pipe bottom by the amount specified. Remove all loose and unsuitable material from the trench bottom.
   d. Carefully and thoroughly compact all pipe bedding with hand-held compactors.
   e. If a conflict exists, obtain clarification from the City before proceeding.
   f. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.

3. Laying pipe.
   a. Conform to manufacturer's instructions and requirements of the reference standards where applicable.
   b. Install all pipe accurately to line and grade shown on the Drawings unless otherwise approved by the City. Remove and When local conditions prohibit horizontal separation, the sewer may be laid closer provided that the water main is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water main is at least 18 inches above the top of the sewer. Re-lay pipes that are not laid correctly.
   c. Slope piping uniformly between elevations shown.
   d. Ensure that ground water level in trench is at least 6 inches below bottom of pipe before laying piping. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete.
   e. Start laying pipe at lowest point and proceed towards the higher elevations, unless otherwise approved by the City.
f. Place bell and spigot pipe so that bells face the direction of laying, unless otherwise directed or approved by the City.

g. Field cut pipe, where required, with a machine specially designed for cutting piping. Make cuts carefully, without damage to pipe or lining, and with a smooth end at right angles to the axis of pipe. Cut ends on push-on joint shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed unless otherwise approved in writing by the City Engineer.

h. Inspect interior of all pipe and fittings and completely clean all dirt, gravel, debris, or other foreign material from pipe interior and joint recesses before it is moved into the trench. Bell and spigot mating surfaces shall be thoroughly wire brushed and wiped clean, and dry immediately before the pipe is laid.

i. Carefully examine all pipe for cracks, damage, or other defects while suspended above the trench before installation. Immediately remove defective materials from site.

j. Excavate around joints in bedding and lay pipe so that the barrel bears uniformly on the trench bottom.

k. Blocking under piping will not be permitted unless specifically approved by the City for special conditions.

l. Touch up protective coatings in a satisfactory manner prior to backfilling.

m. On steep slopes, take measures to prevent movement of the pipe during installation.

n. Exercise care to avoid flotation of pipe when placing concrete around pipe during concrete encasement.

4. Polyethylene encasement.

   a. Provide polyethylene encasement for ductile iron piping where shown on the Drawings to prevent contact between the pipe and surrounding bedding material and backfill.

   b. Polyethylene may be supplied in tubes or in sheet material.

   c. Polyethylene encasement materials and installation shall be in accordance with the requirements of AWWA C105.

5. Jointing pipe.

   a. Ductile iron mechanical joint pipe.

      1) Wipe the socket, plain end, and adjacent areas clean immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.

      2) Place the gland on the plain end with the lip extension toward the plain end.
3) Lubricate the plain end and gasket with soapy water or an approved pipe lubricant in accordance with AWWA C111, and slip the gasket onto the plain end of the joint assembly with the narrow edge of the gasket toward the plain end.

4) Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.

5) Push gland toward socket and center it around pipe with the gland lip against the gasket.

6) Insert bolts and hand-tighten nuts.

7) Make deflection after joint assembly, if required, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. The bolt torque shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Size (Inches)</th>
<th>Bolt Size (Inches)</th>
<th>Range of Torque (Ft.-lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5/8</td>
<td>45-60</td>
</tr>
<tr>
<td>4-24</td>
<td>3/4</td>
<td>75-90</td>
</tr>
<tr>
<td>30-36</td>
<td>1</td>
<td>100-120</td>
</tr>
<tr>
<td>42-48</td>
<td>1-1/4</td>
<td>120-150</td>
</tr>
</tbody>
</table>

b. Ductile iron push-on joint pipe.

1) Prior to assembling the joints, the last 8 inches of the exterior surface of the spigot and the interior surface of the bell shall be thoroughly cleaned with a wire brush, except where joints are lined or coated with a special protective lining or coating.

2) Rubber gaskets shall be wiped clean and flexed until resilient. Refer to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.

3) Insert gasket into joint recess and smooth out the entire circumference of the gasket to remove bulges and to prevent interference with the proper entry of the spigot of the entering pipe.

4) Immediately prior to joint assembly, apply a thin film of approved lubricant to the surface of the gasket that will come in contact with the entering spigot end of pipe. Contractor may, at his option, apply a thin film of lubricant to the outside of the spigot of the entering pipe.

5) For assembly, center spigot in the pipe bell and push pipe forward until it just makes contact with the rubber gasket. After gasket is compressed and before pipe is pushed or pulled all the way home, carefully check the gasket for proper position around the full circumference of the joint. Final assembly shall be made by forcing the spigot end of the entering pipe past the rubber gasket until it makes contact with the base of the bell. When more than a reasonable amount of force is required to assemble the joint, the spigot end of the pipe shall be removed to verify the proper...
positioning of the rubber gasket. Gaskets that have been damaged shall not be reused.

6) Maintain an adequate supply of gaskets and joint lubricant at the site at all times when pipe-jointing operations are in progress.

c. Proprietary joints. Pipes which use proprietary joints shall be installed in strict accordance with the manufacturer’s instructions.

d. Thermoplastic pipe joints (PVC).

1) Solvent cement joints.

a) Bevel pipe ends and remove all burrs before making joints. Clean both pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F, or in wet conditions.

b) Use solvent cement supplied or recommended by the pipe manufacturer.

c) Apply joint primer and solvent cement and assemble joints in strict accordance with the recommendations and instructions of the manufacturer of the joint materials and the pipe manufacturer.

d) Observe safety precautions with the use of joint primers and solvent cements. Allow air to circulate freely through pipelines to permit solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.

2) Push-on joints.

a) Bevel all field-cut pipe, remove all burrs, and provide a reference mark the correct distance from the pipe end.

b) Clean the pipe end and the bell thoroughly before making the joint. Insert the O-ring gasket making certain it is properly oriented. Lubricate the spigot with an approved lubricant; do not lubricate the bell or O-ring. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell.


a. Conform to the applicable requirements of Section 02200.

b. Place backfill as construction progresses. Backfill by hand and use power tampers until pipe is covered by at least 1 foot of fill.

D. Installation of sewer service laterals.

1. Connection to new sanitary sewer lines.
a. All lateral connections to a new sanitary sewer main shall be made at appropriate fittings installed during construction of the new sewer; or shall be installed as described below for connections to an existing sanitary sewer line.

b. Fittings for lateral connections shall be oriented such that connected laterals will enter the sewer main on a slope less than or equal to 45 degrees from horizontal.

c. Lateral connections into new manholes shall be as described below for connections to existing sanitary sewer line manholes.

2. Connection to existing sanitary sewer lines.

a. All Work necessary to install a sewer lateral to an existing sanitary sewer line shall be performed by workers experienced in the installation of sewer lines and laterals.

b. Contractor shall notify the City 48 hours prior to beginning construction.

c. When tapping the sewer line, a mechanical hole-cutter designed specifically for the piping material and an approved pipe saddle must be used. The tap shall be located such that the lateral connections will enter the existing main sewer line on a slope less than 45 degrees from horizontal.

d. When tapping into a manhole, insure the lateral connection enters above the manhole shelf but no higher than one (1) foot above the outlet pipe invert. A channel to carry flow from the connection must be built inside the manhole. Contractor may elect to install a “drop” at deep manholes in accordance with the detail Drawings and these standards.

1) All holes cut into existing manhole walls shall be made with a mechanical hole-cutter unless otherwise approved in writing by the City Engineer. Seal annular space between manhole wall and installed sewer lateral with non-shrink grout.

2) Maximum number of lateral connections at any one manhole shall be three (3) unless otherwise approved in writing by the City Engineer.

3) Maximum number of internal “drops” at any one manhole 48-inches diameter or less shall be one (1). Internal “drops” shall be installed only upon prior written approval by the City Engineer.

3. Minimum lateral inside diameter shall be four (4) inches.

3.02 TESTING

A. Test piping in accordance with Section 15053.

B. Test manholes in accordance with Section 02611.

END OF SECTION
SECTION 15053
SEWER PIPE TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK
A. This Section specifies the general requirements for testing the piping systems shown on the Drawings and specified elsewhere in these Specifications.

1.02 RELATED WORK
A. Piping materials and systems are included in other Sections of Division 15.
B. Section 15051, Piping Installation.

1.03 SUBMITTALS
A. Test records.
   1. Maintain records of all tests performed.
   2. Test records shall include:
      a. Date of testing.
      b. Identification of piping tested.
      c. Test fluid.
      d. Test pressure.
      e. Signature of contractor.
   3. If leaks are found, they shall be noted on the record, and then repaired. After repair, retest as specified for original test.
   4. Submit test records to City within 24 hours of testing.

1.04 GENERAL REQUIREMENTS
A. General.
   1. Test all piping except as otherwise authorized by the City.
   2. The Contractor shall notify the City 48 hours in advance of testing.
   3. Provide all testing apparatus, including pumps, compressor, hoses, gauges, and fittings.
4. Repair and retest pipelines which exceed the allowable leakage rate.

5. Conduct all tests in the presence of the City’s representative.

6. Manholes should be tested prior to pipeline testing.

PART 2 PRODUCTS

2.01 TEST FLUIDS

A. Hydrostatic test. Potable water shall be used as the test fluid whenever possible. In piping systems where access to potable water is not possible, non-potable water may be used upon written authorization from the City Engineer.

B. Pneumatic test. Compressed air shall be used for all pneumatic tests.

2.02 TEST EQUIPMENT

A. Pneumatic test.

1. Provide a compressor capable of the required test pressure.

2. Valves shall be provided on the discharge side of the compressor.

3. Relief valve to relieve at 10 to 15 percent over the test pressure.

4. Pressure gauge(s) capable of reaching 50 percent over the test pressure.

PART 3 EXECUTION

3.01 SAFETY

A. All tests shall be performed under the direct supervision of the Contractor and in the presence of a representative of the City.

B. Restrict personnel in the test area to those involved in the test.

C. Safety glasses must be worn throughout testing.

3.02 TESTING OF GRAVITY SEWER PIPING

A. All gravity sewer lines shall be tested in accordance with the procedures outlined below. Leakage test may be either hydrostatic ex-filtration or air test.

B. Visual alignment test.
1. A light will be flashed between manholes by means of a flashlight or reflection of sunlight with a mirror, or by other methods as may be adopted by the City. If the illuminated interior to the pipe shows poor alignment, displaced pipe, blockage, or other defects, the defects shall be corrected so as to meet all standards governing the construction of sewer mains. All costs involved shall be borne by the Contractor.

C. Thermoplastic pipe distortion test.

1. All thermoplastic pipe shall be subject to a distortion test as deemed necessary by the City. Such test shall be conducted following completion of backfill.

2. Maximum allowable distortion shall not exceed 5 percent of the pipe’s internal diameter. Distortion test shall be conducted using a properly sized "go-no-go" mandrel or by other methods acceptable to the City.

3. Sewer sections failing to meet the distortion requirements shall be corrected at Contractor’s expense.

D. Hydrostatic ex-filtration test.

1. Test shall be conducted between successive manholes under observation of a representative of the City.

2. The reach under test shall be subjected to a minimum of four (4) feet of head (water column) or up to the head to the top of the previously tested manhole, whichever is the lesser, above the crown of the pipe at the upstream manhole of the section being tested.

3. Contractor shall maintain the water column (head) for the two(2) hour test duration, recording the volume of water added. The added water shall be the leakage experienced by the pipe reach during the test.

Allowable leakage shall not exceed 100 gallons per inch of nominal pipe diameter per mile per day (2400 gpd/mile maximum) for any section of the system.

E. Air test.

1. Test methods and acceptability criteria shall be in accordance with the procedures outlined below and the appropriate ASTM specification for the pipe material being tested.

2. Air test equipment shall consist of two (2) inflatable plugs, air compressor, air shut-off valve, pressure regulating valve, pressure reduction valve, and a monitoring pressure gauge having a range from 0.0 to 5.0 psi graduated in 0.1 psi with an accuracy of ±0.04 psi. The test equipment shall be set up outside the manhole.

3. Pressurize pipe reach under test to four (4) psig. Allow the pressure inside the pipe to stabilize at or above the initial test pressure of 3.5 psig.

4. Adjust the pressure inside the pipe to 3.5 psig and commence test.

5. Record the drop in pressure for the test period as calculated by the following equation:
\[ T = (0.0007) D^2 L \]

\( T = \text{Required test period (min.)} \)
\( D = \text{Nominal pipe diameter (in.)} \)
\( L = \text{Length of reach under test (ft.)} \)

6. No pipe reach will be accepted if the pressure drop during the test period calculated exceeds 1.0 psig.

F. Any leaks or deficiencies noted during either ex-filtration or air testing are to be remedied at Contractor’s expense, even to the extent of disassembling and remaking the joint. All defective pipe and fittings shall be removed and replaced in a manner acceptable to the City.

G. Chemical sealants, tape, or cement shall not be used to repair leaks unless approved by the City. Leaks in PVC piping shall be repaired as specified and conforming to the manufacturer’s current printed recommendations. Cemented PVC socket weld fittings and screwed nipples with improperly cut threads shall not be reused, nor shall threaded PVC pipe and fittings be over-tightened or sealed with chemical sealants. Leaks shall not be repaired by back welding.

H. Wherever possible, each piping system shall be tested as it is completed in order to uncover faulty materials or workmanship.

I. If air testing is employed, the manholes shall be tested by ex-filtration.

3.03 CLEANING

A. Thoroughly clean all piping and flush prior to placing in service in a manner approved by the City.

3.04 VIDEO INSPECTION

A. Video inspection is required by the City. The Contractor shall perform a video inspection of the new pipe. In some cases, depending on the availability of equipment and manpower, the City may conduct the inspection with its own equipment and crew. This decision will be at the City’s sole discretion.

B. Video inspection shall be in accordance with City specifications, which will be provided to the Contractor when video inspection is requested.

C. City-required video inspections will not be considered extra work.

END OF SECTION
PART 1  GENERAL

1.01  DESCRIPTION

A.  Scope.

1.  Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required for demolition, removal, and disposal Work.

2.  Included, but not limited to, are demolition and removal of existing materials, equipment, or work necessary to install the new Work as shown, specified, and required. Demolition may include structural concrete, foundations, attachments, appurtenances, piping, paving, curbs, walks, fencing, and similar existing facilities. The owner/contractor performing demolition is obligated to remove water and sewer service lines back to the main and is also obligated to obtain permits and repair pavement.

B.  Related sections.

1.  Section 02100, Clearing and Grubbing.

2.  Section 02200, Excavation and Backfill.

3.  Section 02270, Erosion and Sediment Control.

1.02  SUBMITTALS

A.  Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of the City's or other's operations.

1.03  JOB CONDITIONS

A.  Protection.

1.  Perform all demolition and removal Work to prevent damage or injury to persons, structures, and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use and free and safe passage to and from adjacent structures.

2.  Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted. All operations shall be conducted with a minimum interference to vehicular and pedestrian traffic on these ways.
3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices in accordance with the approval of authorities having jurisdiction. Road, sidewalk, or other access way closure will only be allowed with approval of authorities having jurisdiction.

B. Notification: At least 48 hours prior to commencement of a demolition or removal, notify the City in writing of the proposed schedule. The City will inspect the existing equipment and mark for identification those items that are to remain the property of the City.

C. Explosives.

1. Do not bring explosives on site or use explosives without written consent of the City and authorities having jurisdiction. Such written consent will not relieve Contractor of total responsibility for injury or damage caused by blasting operations.

2. Perform all blasting, if permitted, in compliance with applicable governing regulations.

PART 2 PRODUCTS

2.01 Mechanical Plugs

A. Mechanical plugs furnished for water main and sanitary sewer service abandonment shall consist of an adjustable plug with an extra large wing nut and a natural rubber o-ring.

B. Mechanical plug shall be "Gripper Plug" by Cherne Industries, Inc. of Minneapolis, MN or approved equal.

2.02 Low Pressure Repair Clamp (gravity sanitary sewer)

A. Low pressure repair clamp band shall be stainless steel Type 304. Lugs shall be high strength ductile rion ASTM A536. Gasket shall be nitrile (Buna N). The bridge plate shall be stainless steel recessed flush and bonded into gasket. Bolts shall be high strength low alloy ASTM A325 or A242 with heavy semi-finished hexagon nuts ASTM A563.

B. Low pressure repair clamps shall be Smith-Blair 226 Full Circle Single Band style manufactured by Smith-Blair, Inc. of Texarkana, AR or approved equal.

2.03 High Pressure Repair Clamp (water main)

A. High pressure repair clamp band shall be stainless steel Type 304. Gasket shall be tapered with a gridded design.

B. High pressure repair clamps shall be Dresser 360 repair clamp manufactured by Dresser Piping Specialties DMD-ROOTS Division of Bradford, PA or approved equal.

PART 3 EXECUTION
3.01 GENERAL

A. All materials and equipment removed from existing work shall become the property of Contractor, except for those that the City has identified and marked for their use. All cobblestones, paving bricks, and other materials and equipment marked by the City to remain theirs shall be carefully removed by the Contractor, so as not to be damaged, and shall be cleaned and stored on or adjacent to the site in a protected place specified by the City or loaded onto trucks provided by the City.

B. Contractor shall dispose of all demolition materials, equipment, debris, and all other items not marked by the City to remain as property of the City, off the site and in conformance with all existing applicable laws and regulations.

C. Pollution controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.
D. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new Work or is shown or specified to be removed. For water lines, saw cut ends and fill ends with foam to provide watertight seal or as directed by City representative.

E. Any changes to potable water piping shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with local codes and Section 15052.

3.02 SANITARY SEWER AND MANHOLE ABANDONMENT

A. Sanitary sewers.

1. Sanitary sewers designated to be abandoned, but not removed, shall be excavated at the main, cut and properly capped or plugged at all open ends.

2. Grout plugs shall use ordinary cement-sand grout.

3. When required by the City, Contractor shall fill the abandoned sanitary sewer with a cement-sand grout slurry or flowable fill. Lines to be filled shall be capped or plugged at the downstream end, filled with the approved mixture, and capped or plugged at the upstream end.

B. Manhole and/or clean-out abandonment.

1. Contractor shall remove the top 2 feet of the structure including frame and cover. Frames and covers shall be returned to the City.

2. Contractor shall fill the manhole or clean-out with No. 57 stone or other suitable approved material.

3. Sewer lines entering or exiting the manhole or clean-out shall be capped or plugged in accordance with Paragraph 3.02.A above.

4. Contractor shall restore the area above the manhole or clean-out to match the surrounding area. Where manholes or clean-outs are located in a roadway, roadway shall be restored in accordance with all VDOT requirements.

C. Sanitary Sewer Services.

1. Sanitary sewer services designated to be abandoned shall be removed in their entirety in the public right-of-way including removal to the tap fitting at the sanitary sewer main.

2. In cases where the tap is in a terra cotta main using a tapping tee and the tapping tee bell is in good condition, install a twist type plug manufactured by Cherne Industries, Inc. or approved equal.

3. In cases where the the tap is in a terra cotta main using a tapping tee and the tapping tee bell is not in good condition, install a replacement section of sanitary sewer main with two Ferco adapters.

4. In cases where the tap is in a terra cotta main using a cemented-on wye, remove the wye and install a repair clamp consisting of a rubber gasket and steel band at least ten (10) inches wide. Use Smith-Blair 226 Full Circle Low Pressure Repair Clamp Single Band or approved equal.
5. In cases where the tap is in PVC pipe, plug the main using a glue on cap or plug.
6. In all other cases, contact the City of Charlottesville for instructions on how to seal the main.

3.03 WATER MAIN ABANDONMENT

A. Water mains.

1. Water mains designated to be abandoned, but not removed, shall be excavated at the main, cut and properly capped or plugged at all open ends. Cap or plug shall result in a permanent and watertight seal. Install a mechanical cap or plug, foam plug, a combination of a mechanical plug and foam plug or other method to the satisfaction of the City of Charlottesville.

3.04 CLEAN-UP

A. Contractor shall remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment waste, and debris of every sort shall be removed and premises shall be left clean, neat, and orderly.

END OF SECTION
SECTION 15065
PVC SEWER PIPE

PART 1   GENERAL

1.01   SCOPE OF WORK

   A. Furnish all labor, materials, equipment, and incidentals required to install poly(vinyl chloride) (PVC) pipe, complete as shown on the Drawings and as specified herein.

1.02   RELATED WORK

   A. Section 02200, Excavation and Backfill.
   B. Section 02230, Fill and Granular Fill Materials.
   C. Section 15051, Piping Installation.
   D. Section 15053, Pipe Testing.
   E. Section 15121, Piping Specialties.

1.03   SUBMITTALS

   A. Submit shop drawings and schedules of all PVC pipe and fittings as required to the City.
   B. Submit tabulated layout drawings showing actual pipe lengths, diameters, fittings, and appurtenances.
   C. Prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM standards specified herein.

1.04   REFERENCE STANDARDS

   E. ASTM F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
1.05 QUALITY ASSURANCE

A. All PVC pipe shall be from a single manufacturer. The supplier shall be responsible for the provisions of all test requirements specified.

B. The City may make inspections of the pipe after delivery. The pipe shall be subject to rejection at any time due to failure to meet any of the Specification requirements. Pipe rejected shall be marked for identification and shall be removed from the job at once.

C. Certificates of compliance with applicable ASTM designations and strength classifications covering the pipe, joints, gaskets, and fittings will be required directly from the pipe manufacturer as deemed necessary by the City.

PART 2 PRODUCTS

2.01 NON-PRESSURE SEWER PIPE

A. PVC gravity sewer pipe shall be manufactured of compounds conforming to ASTM D1784-81, current revision. Pipe and fittings shall meet and/or exceed all of the requirements of ASTM Specification D3034-89 PSM SDR 35, or current revision, for heavy wall PVC as manufactured by National Pipe & Plastics, Johns-Manville Corporation, Certainteed, or approved equal.

B. PVC sewer pipe shall be SDR 35 unless shown otherwise on the Drawings.

C. The maximum allowable joint length for PVC pipe is 13 feet.

2.02 JOINTS

A. Poly(vinyl chloride) pipe.

1. PVC pipe shall be joined by bell and spigot type connections. The pipe joint shall be tightly sealed against infiltration and ex-filtration by means of a locked-in rubber sealing ring conforming to ASTM D3212, latest revision. The connection shall also permit the thermal expansion or contraction of the pipe.

B. Gaskets.

1. Gaskets for sewer pipe and fittings shall be vulcanized natural or vulcanized synthetic rubber free of porous areas, foreign material, or visible defects. Rubber gaskets shall conform to all applicable provisions of ASTM F477.

2. Gaskets shall be protected from exposure to excessive heat, cold, direct sunlight, ozone (from electric motors and equipment), oil, grease, or other contaminants.

PART 3 EXECUTION

3.01 INSTALLATION OF PVC PIPE AND FITTINGS
A. PVC pipe shall be shipped and stored so that warping of pipe does not occur. PVC pipe to be stored outside should be covered to protect it against the sun’s rays, per manufacturer’s published recommendations.

B. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

C. PVC pipe installations shall be in strict accordance with manufacturer’s instructions and Section 15051.

END OF SECTION
PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install ductile iron pipe and fittings complete as shown on the Drawings and as specified herein.

B. Installation of piping in accordance with Section 15051, Sewer Piping Installation.

C. Where the word "pipe" is used, it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02  RELATED WORK

A. Section 02200, Erosion and Backfill.

B. Section 02230, Fill and Granular Fill Materials.

C. Section 15053, Sewer Pipe Testing.

D. Section 15121, Sewer Piping Specialties.

1.03  SUBMITTALS

A. Submit to the City shop drawings and product data required to establish compliance with this Section.

B. Submit tabulated layout drawings showing actual pipe lengths, diameters, fittings, and appurtenances.

C. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings, and exterior coatings for this project have been manufactured and tested in accordance AWWA and ASTM standards and requirements specified herein.

1.04  REFERENCE STANDARDS


1. ASTM A377 - Standard Index for Specification for Ductile-Iron Pressure Pipe


B. American National Standards Institute (ANSI).

1. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.

C. American Water Works Association (AWWA).

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings 3-In. through 48-In. (75MM through 1200 mm) for Water and Other Liquids.
2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All ductile iron pipe and fittings shall be from a single manufacturer, unless otherwise approved by the City.

B. All ductile-iron pipe and fittings to be installed under this Contract shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the City sworn certificates of such tests and their results prior to the shipment of the pipe.

C. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the City, at the City's expense.
D. Inspection of the pipe and fittings will also be made by the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.

E. All pipe and fittings shall be permanently marked with the following information:

1. Manufacturer, date.
2. Size, type, class, or wall thickness.
3. Standard produced to (AWWA, ASTM, etc.).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal lining of the pipe.

B. Materials, if stored, shall be kept safe from damage. The interior of all pipes, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. Joints shall be as shown on the Drawings and as specified. If not shown or specified, provide push-on or mechanical joints for buried pipe and flanged joints for above-grade pipe.

B. Conform to AWWA C151 for material, pressure class, dimensions, tolerances, tests, markings, and other requirements.

C. Use Special Thickness Class 52 for all pipe unless otherwise shown or specified.

D. Ductile iron pipe and fittings shall have a shop-applied Hi-Alumina or Protecto 401 interior lining.
E. Unless otherwise specified, ductile iron pipe and fittings shall receive a shop-applied exterior asphaltic coating. Field repair of damaged pipe coating shall be allowed. However, if, in the opinion of the City, the coating damage is beyond repair, the pipe shall be replaced at the expense of the Contractor. Unless otherwise noted, field applied coating material shall be compatible with or equal to the shop applied material.

2.02 FLANGED DUCTILE IRON PIPE AND FITTINGS

A. Flanged joint pipe.

1. Ductile iron pipe shall conform to AWWA C115. Pipe wall thickness shall be Special Thickness Class 53 minimum.

2. Flange shall be flat face type, unless otherwise noted, conforming to ANSI B16.1, Class 125.

3. Flange gasket shall be full-face rubber per AWWA C111. Thickness shall be 1/8 inch unless otherwise indicated.

4. Assembly bolts shall be square headed carbon steel machine bolts with hexagon nuts per ANSI B18.2. Thread shall conform to ANSI B1.1. Bolt length shall be such that after joints are assembled, the bolts shall protrude through the nuts, but not more than 1/2 inch.

B. Flanged joint fittings.

1. Flanged joint fittings shall conform to AWWA C110.

2. Pipe fittings shall be ductile iron with a pressure rating of 250 psi.

3. Flanges shall be flat face meeting the requirements of ANSI B16.1, Class 125.

4. Flange gaskets shall be full-face rubber per AWWA C111, 1/8 inch thick unless otherwise indicated.

5. Assembly bolts and nuts shall be as specified for flange joint pipe above.

2.03 MECHANICAL JOINT PIPE AND FITTINGS

A. Mechanical joint pipe.

1. Mechanical joint pipe shall conform to AWWA C151 with joint accessories conforming to AWWA C111.

2. Glands shall be ductile iron.

3. Gaskets shall be plain-tipped rubber.

4. Assembly bolts and nuts shall be high-strength, low alloy steel.

B. Mechanical joint fittings.
1. Mechanical joint fittings shall conform to AWWA C110 with accessories conforming to AWWA C111.

2. Pipe fittings shall be cast iron or ductile iron with a pressure rating of 250 psi.

3. Fitting glands shall be cast iron for cast iron fittings and ductile iron for ductile iron fittings.

4. Gaskets shall be plain-tipped rubber.

5. Assembly bolts and nuts shall be as specified for mechanical joint pipe above.

2.04 PUSH-ON JOINT PIPE AND FITTINGS

A. Push-on joint pipe.

1. Push-on joints shall conform to AWWA C151 and AWWA C111.

2. Gaskets shall be molded rubber.

3. Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.

B. Push-on joint fittings.

1. Push-on joint fittings are not acceptable.

2.05 PROPRIETARY RESTRAINED JOINT PIPE AND FITTINGS

A. Restrained joint pipe and fittings shall be ductile iron restrained push-on joint.

B. Restrained pipe shall conform to applicable requirements of AWWA C151. Restrained fittings shall conform to applicable requirements of AWWA C110 or AWWA C153.

C. Joints shall be suitable for 250 psi working pressure and be fabricated of heavy ductile iron casting.

D. Bolts and nuts shall conform to ASTM A307, Grade B.

E. Restrained joint pipe and fittings shall be “TR Flex” restrained joint pipe by U.S. Pipe and Foundry; “Flex-Ring” and “Fast-Grip” restrained joint pipe by American Cast Iron Pipe Company; “SNAP LOK” restrained joint pipe by Griffin Pipe Products Co., or approved equal.

F. Retainer Glands may be used in lieu of restrained joint pipe and shall be manufactured by EBAA Iron, Inc., Series 1100 “Megalug.” “Or Equals” will be considered but must be approved in advance by the City Engineer. Retainer glands may be used on proposed mains to restrain pipe with mechanical joints in accordance with the manufacturer’s recommendation. All pipe where retainer glands are used shall have a hardness of 180-200 BHN (Brinell Hardness Number) to allow proper activation of the glands.

PART 3 EXECUTION

3.01 PIPE INSTALLATION
See Section 15051, Sewer Piping Installation.

END OF SECTION
PART 1   GENERAL

1.01   SCOPE OF WORK
A. Furnish all labor, materials, equipment, and incidentals required to install, complete, and ready for operation. Test all piping specialties concurrent with the pipe section within which installed.

1.02   RELATED WORK
A. Piping materials and systems are included in other Sections of Division 15.
B. Section 15051, Piping Installation.
C. Section 15053, Pipe Testing.

1.03   SUBMITTALS
A. Submit shop drawings and product data for all piping specialties specified in this Section.
B. Submit operating and maintenance data as required.

1.04   REFERENCE STANDARDS
   2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
B. American National Standards Institute (ANSI).
   1. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
   2. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
C. American Society of Mechanical Engineers (ASME).

2. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.

3. ASME B16.5 - Pipe Flanges and Flange Fittings.

D. American Welding Society (AWS).

1. AWS B3.0 - Welding Procedure and Performance Qualifications.

E. American Water Works Association (AWWA).

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in. Through 48-in. (75mm through 1200mm), for Water and Other Liquids.

2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

1.05 QUALITY ASSURANCE

A. All materials shall be new and unused.

B. Install piping to meet requirements of local codes.

C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps, and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The use of a manufacturer's name and/or model number is for the purpose of establishing the standard of quality and general configuration desired.

B. Materials and products shall be of the sizes and types shown on the Drawings or as noted herein. As far as possible, materials and products of the same type shall be identical and shall be from one manufacturer.

C. Materials and products shall have the name of the manufacturer, nominal size, flow directional arrows (if applicable), working pressure for which they are designed, and standard referenced specifications cast in raised letters or indelibly marked upon some appropriate part of the body.

D. Unless otherwise noted, piping specialties shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.
2.02 MISCELLANEOUS ADAPTERS

A. Special adapters may be required between different types of pipe and/or fittings to provide proper connection. Some of these may be indicated on the Drawings or specified with individual types of pipe or equipment. Provide all adapters as required, whether specifically noted or not, to ensure proper connection between various types of pipe.

B. Adapters shall be suitable for direct burial when installed below grade, with proper dielectric insulation. If metallic (not stainless steel or galvanized), adapters shall be painted with 2 coats of Coal Tar Epoxy. Non-metallic adapters shall be flexible mechanical compression type couplings with No. 305 stainless steel bands as manufactured by Joints, Inc. (Calder) of Gardena, CA; Fernco Joint Sealer Co. of Ferndale, MI; or equal.

2.03 FLEXIBLE CONNECTORS

A. Sleeve couplings.

1. Flexible couplings shall be of a gasketed, sleeve type. Each coupling shall consist of a middle ring, two followers, two wedge section gaskets and sufficient track head steel bolts to properly compress the gaskets. Couplings shall be of the type to match piping in which installed. Couplings shall be Style 38 as manufactured by Dresser Manufacturing Division of Dresser Industries or Smith-Blair Type 441.

2. Nuts and bolts.

a. Provide bolts and bolt-studs in accordance with ASTM A307 and ANSI B1.1 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered.

b. Project ends 1/4 inch beyond surface of nuts.

c. Hexagonal nuts with dimensions in accordance with ANSI B18.2 and coarse threads in accordance with ANSI B1.1.

3. Middle ring of each mechanical coupling shall have a thickness at least equal to that specified for size of pipe on which coupling is to be used and shall not be less than 10 inches long for pipe 30 inches and larger and not less than seven (7) inches long for pipe under 30 inches in diameter.

4. Clean and shop prime with manufacturer's standard rust inhibitive primer.

5. Furnish gaskets of a composition suitable for exposure to the fluid service.


a. Joint harness bolts shall be of sufficient length, with harness lugs placed so that coupling can be slipped at least in 1 direction to clear joint. Provide harnesses of sufficient number and strength to withstand test pressure.

b. Each harness shall have a minimum of two 3/4-inch diameter bolts.
7. Similar insulation type couplings shall be provided at the face of buildings, between different type metals, or where otherwise noted.

2.04 SERVICE SADDLES

A. Service saddles for four (4) inch through 12-inch outlet sizes shall have iron bodies and a neoprene circular cross section O-ring gasket confined within the body. Outlet shall be as required for the application. Straps shall be alloy steel, minimum 1/4-inch by 1-1/2-inch in cross section and fabricated with 3/4-inch threaded ends.

2.05 HARNESSING AND RESTRAINT

A. Where harnessed couplings or adapters are noted, they shall conform to AWWA Manual M11 except as modified by the Drawings or this Section.

B. Unless otherwise noted, size and material for tie rods, clamps, plates, and hex nuts shall be as shown on the Drawings, or, if not shown on the Drawings, shall be as required in AWWA Manual M11. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation, Columbus, OH, or equal.

C. Ductile iron pipe mechanical joint restraints. Restraint for standardized mechanical joints shall be incorporated in the design of the follower gland and shall impart multiple wedging action against the pipe, increasing its resistance as the pressure increases. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action. Restraining glands shall be manufactured of ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12. Wedging mechanisms shall be manufactured of ductile iron heat treated to a hardness of 370 BHN minimum and shall be contoured to fit each pipe size exactly. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53, latest revision. Twist off nuts shall be incorporated in the design of the wedge activation screws to insure proper torque during installation. The mechanical joint restraining device shall have a working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in the dead-end situation. The mechanical joint restraint shall be Megalug Series 1100 by EBAA Iron Works, Uni-Flange Series 1400 by Ford Meter Box Co., or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. All dirt, scale, weld splatter, water, and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
B. All work shall be accomplished using recognized methods and procedures of pipe fabrication and in accordance with the latest revision of applicable ANSI/AWWA Standards.

1. Use full length of pipe except where cut lengths are necessary. Do not spring or deform piping to make up joints.

2. Pipe shall be cut square, not upset, underside, or out-of-round. Ends shall be carefully beveled and cleaned before being installed. Bending of pipe is not permitted. Use fittings for all changes in direction.

C. Installation of sleeve couplings.

1. Prior to installation of sleeve couplings, the pipe ends shall be cleaned thoroughly for a distance of at least 12 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about six (6) inches from the end, the middle ring shall be placed on the already installed pipe and shall be inserted into the middle ring flair and brought to proper position in relation to the pipe already installed. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.

2. After the bolts have been inserted and all nuts have been made up finger tight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.

3. The correct torque as indicated by a torque wrench shall not exceed 75 ft.lbs. for 5/8-inch bolts and 90 ft.lbs. for 3/4-inch bolts.

4. If a wrench other than a torque wrench is used, it should be no longer than 12 inches so that when used by the average person the above torque values shall not be exceeded.

3.02 TESTING

A. Testing of pipelines, including piping specialties, is specified in Section 15053. Furnish all labor, testing plugs or caps, pipe connections, gauges, and all other equipment required to complete the tests as specified.