

SECTION 4 - DESIGN STANDARDS FOR WATER DISTRIBUTION FACILITIES

4.1. General Requirements

4.1.01 Water distribution and fire protection facilities are to be provided solely for the purpose of supplying potable water and fire protection. Under no circumstances shall cross-connections be allowed to unapproved water facilities. All plans must comply with the Department's Cross Connection Control Program. The following design parameters should be used in the design of water distribution facilities. Water transmission facility design parameters are not included herein and such criteria will be established on a case by case basis.

4.1.02 The Department has received a General Permit for Distribution Mains from the Virginia Department of Health. This allows the Department to approve water distribution mains with diameters less than or equal to 24 inches.

4.1.03 Water lines are to be designed to serve the entire service area of which the subdivision or development is a part. This necessitates consideration of property beyond the development or subdivision in question. The developer is required to design and construct his 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.

4.2. Technical Design

4.2.01 System Layout

- A. The overall layout and general design shall conform to the parameters set forth in the approved Engineering Report (Form F-1). The System Layout Plan shall delineate pressure zone boundaries. The map shall clearly define the areas pertinent to interim and ultimate development of the area proposed to be served. The System Layout Plan shall show present and future development and proposed interim and future utilities, as well as those 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 5 feet unless otherwise approved. Proposed utilities necessary to serve adjacent properties and associated easements shall be shown.

- B. Valves are required at the following locations. A sufficient number of valves shall be provided to minimize service disruptions and sanitary hazards during repairs.
 - (1.) Main line valves are required at intervals of 1000 feet.
 - (2.) Valves shall be provided on 2 sides of each tee and 3 sides of each cross.
 - (3.) Valves shall be provided on all fire hydrant tees.
 - (4.) Valves shall be provided at both ends of any surface water crossing.

- (5.) Valves shall be provided at the dead end of any main that will be extended in the future. Adequate valve restraint will be achieved through the use of restrained joints or extending pipe beyond the valve location.
 - (6.) Valves shall be provided on water service tees and fire service tees that connect service lines that are 4" or larger to the main line.
 - (7.) The Engineer shall locate proposed watermains within roadways such that valve operators which are offset from the main line are not located in ditch lines or conflict with proposed or existing curb and gutter or other utilities.
- C. All water mains shall be located, where practical, in:
- (1.) Legally established road rights-of-way.
 - (2.) Legally established permanent easements for such purpose which are immediately adjacent to legally established road rights-of-way or paved areas either existing or as proposed by the designer in accordance with Section 1.3 - "Easement Requirements" of these Standards.
 - (3.) Paved areas.
 - (4.) Water lines installed in accordance with 4.2.01 C.(1.), (2.), and (3.) will be within or adjacent to vehicle lanes or travel lanes.
 - (5.) Water Lines installed where normal vehicle access for inspection, testing, and maintenance is limited will be considered only when required to satisfy requirements for looping of water mains when compliance with 4.2.01 C(1.), (2.) or (3.) is not possible.
- D. Construction shall generally be parallel to the center line of roads or easements. The same offset shall be used throughout except when existing utilities dictate a change in offset along the proposed line.
- E. Water mains shall be installed a minimum of 10 feet from any part of any structure, building, or its foundation.
- F. Water services and water meter boxes for residential projects shall not be located within driveways, sidewalks or other paved areas unless approved by the Director. No fire hydrant, valve or valve box shall be installed within concrete curbs, gutters, or sidewalk ramps.
- G. Backflow preventers (BFP) in residential facilities shall be at the meter or, if an inside installation, in a room accessible directly from the exterior of the building. If proposed in a mechanical room or closet, this must be accessible from a common hallway exterior to any apartment. If proposed in a mechanical room, then the Department of Public Utilities Operations Division must approve to the location. In no case will access through the living unit of any apartment be acceptable.
- (1.) Plans must completely document where an inside BFP will be installed so that

Owner, County and contractors are completely clear on where installation will occur. Plans must clearly note that Owner and contractor are responsible for coordinating requirements of DPU approval with building/plumbing permit.

- H. Separation between water mains and sanitary or combined sewers shall be in accordance with Section 2.2.09.

4.2.02 System Design

- A. The proposed facilities together with the pertinent existing facilities shall be evaluated based on the hydraulic design, demand design, and fire protection design requirements contained herein.
- B. The Design Engineer shall submit to the Department a neat and orderly set of design calculations that include domestic and fire flows, pipe size selection, and fire protection requirements. The Department will provide pressure and flow at the proposed connection point to the existing water system to be used for hydraulic design. Where system flow information is needed, the Engineer shall submit a "Water System Flow Request" (Form F-7).
- C. The system shall be designed to maintain a minimum pressure of 20 psi at ground level elevation at all points in the distribution system with peak flow conditions. Peak flow is the total of domestic flow plus fire flow. The minimum working pressure in the system will be 45 psi for any proposed extensions or modifications. Where the pressure at the service tap exceeds 80 psi, the provisions of the Uniform Statewide Building Code shall apply.
- D. Non-ferrous water mains shall have a warning tape in the trench 18 inches above the main but no less than 24 inches below grade. The tape shall be marked for water lines.
- E. Electronic markers (ball type) shall be installed on all water mains, sewer gravity mains and sewer force mains in accordance with the following:
 - (1.) Ball type electronic markers shall be passive type as manufactured by 3M or Omni.
 - a. Water main markers shall be rated and color coded for water.
 - (2.) Locations for electronic markers shall be as shown on Standard Drawings titled Electronic Marker Placement Detail for Water lines and for Sewer Force Mains (D-740).
 - a. Minimum distance between markers shall be 6 feet.
 - b. Markers shall be a minimum of 4 inches above the pipe.

- c. Markers shall have a maximum of 3 feet of cover.
- d. When pipe joints are deflected, place markers at the pipe joint beginning and ending the deflection and at intermediate joints for every one foot (maximum) of deflection.
- e. Locations for Markers shall be in accordance with the following:
 - 1. Valves
 - 2. Tees
 - 3. Cross
 - 4. Bends
 - 5. Deflections (begin, end, max of each one foot of deflection)
 - 6. Casing ends
 - 7. Pipe vertical adjustments (beginning and end)
 - 8. Corporation stop
 - 9. Maximum spacing of 100 feet for metallic pipe and 50 feet for non-metallic pipe
 - 10. All points where the line crosses over or under other utilities
 - 11. Dead end

F. Dead end lines shall be minimized by looping mains for commercial, residential and multi-family development. Looping of mains increases service reliability and minimizes impacts of service outages for customers.

- (1.) Where looping is required, the minimum size pipe shall be 6 inches.
- (2.) Dead end mains up to six hundred (600) feet will be allowed in permanent cul-de-sacs.
- (3.) Dead end mains greater than six hundred (600) feet and less than twelve hundred (1200) feet in permanent cul-de-sacs will be considered on a case by case basis.
- (4.) Dead end mains longer than twelve hundred (1200) feet are expressly prohibited.
- (5.) Dead end mains to promote phased construction will be considered on a case by case basis. Where phased construction or future extensions of water mains will occur, the main shall be terminated in a valve and plug immediately beyond a fire hydrant or flushing hydrant, as appropriate. This will permit future extension of the main without a shut down of the main or loss of service to existing customers.
- (6.) It may be necessary to install water lines in areas of limited accessibility to comply with requirements for looping mains. In these cases all pipe shall be ductile iron. Valves shall be installed to allow piping in these areas to be isolated from the system. No service connections are permitted on lines in areas of limited accessibility.
- (7.) Dead ends of all mains shall be provided with either a fire hydrant or a flushing hydrant, as appropriate, to provide adequate flushing of the main.

- G. Determine corrosiveness of soils along route of proposed water main.
- (1.) Take a soil sample at 500 feet intervals along the proposed water main. A minimum of 2 samples are required for any proposed extension. Samples shall be tested at a certified lab for the following parameters.
 - a. Moisture content (ASTM D-2216)
 - b. Resistivity (ASTM G-57)
 - c. Redox Potential (AWWA C-105)
 - d. Sulfides (AWWA Qualitative Test)
 - e. pH (ASTM G-51)
 - (2.) If soils are found to be aggressive in accordance with DIPRA recommendations using sample results from Paragraph G (1) above, take necessary action to protect the water main and appurtenances in accordance with the ductile iron pipe manufacturer's recommendations.
 - a. Encase water main in polyethylene.
 - b. Severe cases may require cathodic protection.
 - (3.) If groundwater is contaminated by organic compounds, pipe and joint materials which do not allow permeation of the organic compounds shall be used for all pipe, joint materials, hydrant leads and service connections.
- H. Engineer shall refer to the Virginia Department of Health Waterworks Regulations and the Department's Cross Connection Control Manual for backflow requirements. Standard installation schematics are included in the Cross Connection Control Manual. Hydrants, flushing devices, and chambers or pits containing valves, blow-offs, meters, air relief valves or other such appurtenances shall not be directly connected to any sewer or storm drain.
- I. Fire protection flow requirements shall be shown on the plans.
- J. Detailed design for all system appurtenances shall be in accordance with the latest revisions of the Henrico County Department of Public Utilities Standard Details, unless other applications are approved as being necessary by the Department.

4.2.03 Hydraulic Design

- A. Hydraulic design shall be accomplished by use of the Hardy-Cross Network Analysis Method or similar method acceptable to the Department. A Hazen-Williams coefficient of friction equal to 120 shall be used for purposes of design unless the Department has data to indicate a lesser coefficient should be used for existing lines. Pressure and flow at the proposed connection point to the existing water system as provided by the Department shall be used as the basis for hydraulic design.

4.2.04 Demand Design

- A. Maximum rates of water consumption shall be calculated and used as a basis of hydraulic design. Average daily water consumption rate values for the number and type of consumers anticipated to be served shall be based on those contained in the Virginia Department of Health Waterworks Regulations. Any such rates not given or any deviations from tabulated rates shall be estimated and justified by the Design Engineer and approved by the Department. The average annual daily water consumption rates shall be adjusted by a multiplier to arrive at the maximum daily water consumption rate expressed as follows:

$$Q_m = Q_a \times C$$

Q_m is maximum daily water consumption rate.

Q_a is average annual daily water consumption rate.

C is constant. The value of C shall be 1.75.

Q_m shall be used as the basis for hydraulic design.

4.2.05 Fire Protection

- A. Rates of flow for fire protection shall be estimated based on the Insurance Services Office (ISO) calculation method as documented in its Fire Suppression Rating Schedule. This required rate of flow is called the Needed Fire Flow (NFF).
- B. AWWA Manual of Practice M31, "Distribution System Requirements for Fire Protection," Fourth Edition, demonstrates the methods for estimating NFF and provides the tables and graphs referenced in these Standards.
- (1.) Use Table 1-6 for one- and two-family dwellings not more than 2 stories.
 - (2.) For other non-sprinklered or partially-sprinklered buildings use Form F-9 with 3500 gpm as the maximum NFF.
 - (3.) For a fully-sprinklered building use Form F-9. The NFF is the required sprinkler system demand plus hose stream allowance, with a minimum of 500 gpm.
- C. The minimum fire flow from any individual fire hydrant shall be 500 gpm. The minimum flowing pressure at maximum flow shall be 20 psi.
- D. During maximum rated fire flow conditions, the pressure drop in any fire protection system shall not exceed 15 psi beginning at the point of connection to the existing

County system to the fire hydrant (or any combination of required hydrants) used to satisfy the fire protection requirements.

- E. The minimum size water line used for fire protection to properties zoned agricultural or single family residential shall be 6 inches. The minimum size water line used for fire protection to properties zoned multi-family residential, commercial, or industrial shall be 8 inches.
- F. The minimum sized fire service lines above shall be looped to provide feed from at least two directions. The sizing of minimum-sized and larger than minimum-sized fire service lines shall be determined in accordance with Sections 4.2.03 and 4.2.05 - "Hydraulic Design" and "Fire Protection." Not more than one fire hydrant shall be installed on a 6-inch dead end line.
- G. Dead end lines shall not contain more than 600 feet of the minimum sized line. Additional lengths required shall be provided by increasing the line size.
- H. Fire hydrants shall be located no further from edge of roadway shoulder than 10 feet.
- I. Fire hydrants shall be placed on legal rights-of-way and shall generally be placed in line with street intersections. This shall be deemed to be the P.T. of the returns at intersections on the rights-of-way. Where long block lengths require the use of intermediate fire hydrants, they shall be placed in line with the property boundary between adjacent lots or parcels of land. Where fire hydrants cannot be placed in a legal right-of-way, an easement shall be provided.
- J. Fire hydrant spacing for properties zoned agricultural or single family residential shall not exceed 1000 feet or require a hose lay of over 650 feet from the hydrant to any part of any structure to be protected.
- K. Fire hydrant spacing for properties zoned multi-family residential, commercial, or industrial shall not exceed 500 feet or require a hose lay of over 350 feet from the hydrant to any part of any structure to be protected. Where multiple fire hydrants are needed to supply the required fire flow, all necessary hydrants must be located within the specified hose lay.
- L. No fire hydrant shall be placed closer than 50 feet from the face or overhang of any building to be protected. For commercial, industrial, and multi-family construction, fire hydrants not more than 300 feet from the protected building may be rated for not more than 1000 gpm. Fire hydrants further than 300 feet from the building to be protected shall be rated in accordance with the ISO standards.
- M. The above criteria for spacing fire hydrants may be modified by the Department to

improve fire hydrant accessibility for fire fighting purposes.

- N. The fire hydrant shall be located so that there are no obstacles, barriers or topographical constraints to limit the Fire Department's ability to use the hydrant. Maintain 8 feet clear area around the fire hydrant.
- O. Structures fully protected by an automatic sprinkler system and directly connected to the County's water system require installation of a detector check. Structures protected by automatic sprinkler systems and with a fire department connection (Siamese connection) require installation of a detector check, dedicated fire hydrant, and the appropriate backflow device. The dedicated hydrant is not credited toward external protection requirements. Siamese connections must be located within 50 feet of a dedicated hydrant.

4.2.06 Structural Design

- A. Structural requirements must be considered in the design of all water mains and appurtenances.
- B. The proper strengths shall be specified for the pipe material being specified. Strength shall be based on operating pressures, depth of bury, trench width, and foundation conditions. This is an engineering matter and not subject to generalization.
- C. Proper blocking and/or restrained joints must be provided and shown on the drawings for dead ends, valves, bends, tees, fire hydrants, at reducers, and for fittings otherwise unrestrained. Where blocking is not detailed on the drawings, restrained joints shall be used. The restrained length shall be shown on the profile.
 - (1.) For concrete blocking, specify the size and shape of concrete thrust blocks. See Standard Drawings.
 - (2.) For restrained joint piping, provide the length of restrained joint piping on the profile. Specify joint restraint glands, clamps, friction slab or other approved anchors to be provided.
 - (3.) The designer shall be responsible for evaluating the soil type, bearing capabilities and corrosion potential for the installation.
- D. Proper support shall be provided for aerial or suspended lines.
- E. Any potable water line crossing above surface water must be:
 - (1.) Adequately supported.
 - (2.) Protected from freeze damage.
 - (3.) Accessible for repair or replacement.

- (4.) Above the 100-year flood plain elevation.
- F. Any potable water line crossing under surface water must meet the following requirements:
 - (1.) The pipe shall be of special construction having flexible watertight joints.
 - (2.) Valves shall be provided at both ends of the water crossing so that the section can be isolated for test or repair; the valves shall be easily accessible and not subject to flooding.
 - (3.) For the purpose of testing the section of line crossing the surface water and for locating leaks in that section, permanent sample taps shall be available at each end of the crossing and at a reasonable distance from each side of the crossing.
- G. All water line horizontal and vertical realignments to avoid roadway drainage structures shall conform, in structural configuration and materials, to Henrico County Standard Drawing D-485.
- H. Steel casing pipe shall have minimum yield strength of 35,000 psi and a minimum internal diameter of 4 inches greater than the largest external diameter of the carrier pipe. The wall thickness of casing pipe shall be sufficient to resist loads to which it will be subjected, but in no case less than 0.250 inches. Standard installation detail shall be as shown in VDOT Road and Bridge Standards except that the leak detector pipe shall be eliminated. The permitted thickness of the casing shall be as required by VDOT for State Roads and the DPW for County Roads. Requirements for railroads shall be as specified in a permit issued by the railroad.
- I. The size casing pipe needed for each size of ductile iron pipe is shown in Section 2.2.05M.
- J. Where exposed to traffic, meter boxes and vaults shall be designed for the appropriate traffic loading.

4.2.07 Meters and Services

- A. Domestic meter calculations shall be shown on the plans
- B. The profile of water services at ditch lines shall be shown on the plans. The water service shall have a minimum cover of 36 inches at the ditch invert.
- C. The minimum size service line from the County main to the meter shall be 1 inch diameter

- D. Water service lines shall be installed approximately perpendicular to the main and shall connect directly into main without crossing side or rear lots of adjacent parcels and without running parallel to the center line of the Right of Way.
- E.. Service lines larger than 1 inch, with meters larger than 5/8 inch, shall be sized in accordance with AWWA Manual M-22, Sizing Water Service Lines and Meters, except as follows:

- (1.) Use constant pressure factor of 1.
- (2.) Include all outside hose bibs in combined fixture value total.
- (3.) Irrigation System shall be excluded from domestic meter sizing criteria except as follows:
 - a. Exclusion meters shall be at least one (1) size smaller than the domestic meter.
 - b. If metered separately, the irrigation meter shall be sized based on demand criteria furnished by the Engineer.
- (4.) For non-residential facilities or facilities with flush valve fixtures, the meter will be sized as follows:

METER SIZE (INCHES)	COMBINED FIXTURE VALUE TOTAL
1	41 - 100
1 ½	101 – 400
2	401 - 1200

- (5.) For residential facilities and office buildings with tank type water closets the meter will be sized as follows:

METER SIZE (INCHES)	COMBINED FIXTURE VALUE TOTAL
5/8	0 - 40
1	41 – 400
1 ½	401 - 5500

- (6.) Plumbing Fixture Values shall be as shown in AWWA M-22, Second Edition, for 35 psi.
- (7.) Meter installations requiring a flow of greater than 160 gpm or greater than the combined fixture value totals indicated above shall be reviewed and/or approved on a case by case basis in accordance with AWWA Manual M-22.
- (8.) A 5/8" meter may be used for non-residential facilities with tank type water closets and a combined fixture value total of 0 - 40. A 1" meter will be the minimum size used for any facility with flush valve fixtures.

4.2.08 Miscellaneous Considerations

- A. The minimum size pipe to be used for domestic water mains shall be 4 inches. Consideration should be given to the use of 4-inch diameter mains in cul-de-sacs.
- B. Where provisions for air relief are needed, provide hydrants, air or air/vacuum valves, blow-off tees and any related fittings. The type, size, etc., shall be specified by the Design Engineer, subject to approval by the Department.
- C. Provide pressure reducing valves if extensions of water mains cross a pressure zone boundary.
- D. The minimum depth of cover for water mains shall be 3½ feet. Additional depth shall be provided where required for thrust restraint or to clear underground obstructions. A minimum cover of 4½ feet shall be provided at the location of all proposed 16" Resilient Seat Gate Valves to facilitate the installation of a standard height valve box.
- E. Where water lines are subject to extreme variations in temperature (i.e., attached to bridges or box culverts) design shall consider expansion and contraction of pipe materials and the freezing of the line contents.
- F. Irrigation systems shall use the appropriate backflow prevention devices as indicated in the Department's Cross Connection Control Manual.
- G. Cathodic Protection
 - (1.) The Design Engineer shall consider ground conditions in the case of metallic conduits and provide suitable cathodic protection where necessary.
 - (2.) Provide soil samples to confirm if soil is corrosive.
 - (3.) Protection for ductile iron pipe shall be as recommended by the manufacturer.