

DESIGN AND CONSTRUCTION STANDARDS

SECTION 3 – DRINKING WATER SYSTEMS

3.1 General Requirements

Drinking water facilities are to be provided for the purpose of supplying drinking water, fire protection and irrigation. All designs must comply with all applicable federal, state, and local regulations and standards. These regulations and standards include, but may not be limited to:

Virginia Department of Health (VDH), Office of Drinking Water, *Waterworks Regulations*
http://www.vdh.virginia.gov/content/uploads/sites/14/2016/04/12VAC5-590_10-10-14.pdf

American Water Works Association (AWWA)
<http://www.awwa.org/>

Insurance Services Office, Inc. (ISO), *Guide for Determination of Needed Fire Flow*
<https://www.isomitigation.com/ppc/technical/needed-fire-flow/>

Hampton Roads Planning District Commission (HRPDC), *Regional Construction Standards*, 6th edition, Section 801
<https://www.hrrcs.com/ras/category/6/current-standards>

American Society of Civil Engineers (ASCE) Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data CI/ASCE 38-02
<http://www.dot.ga.gov/PartnerSmart/utilities/Documents/ASCE%2038-02.pdf>

Similarly, all applicable approvals and permits must be obtained prior to construction.

For Capital Improvement Projects: A detailed Preliminary Engineering Report or Technical Memorandum may be required by the Department prior to design. For Developer Projects: An overall utility layout plan, applicable design checklist(s), and design calculations shall be submitted for approval. Design calculations shall use the current edition of American Water Works Association (AWWA) Manuals M22 and M31, and the Insurance Services Office, Inc. (ISO) standards.

The design project shall be approved through the Department of Planning's Site Plan Review process prior to the collection of any utility tap fees and/or the commencing of construction.

In accordance with the Virginia Department of Health General Permit for Distribution Mains, the following requirements apply to all water main extension projects (installation where no water main previously existed):

- A. “This General Permit is limited to the review and approval of distribution main extension projects only. The maximum pipe diameter to be reviewed under this program shall be 16-inches.”

- B. “All individual projects serving more than 15 service connections or consisting of pipe greater than 8 inches in diameter, shall have specific engineering plans and specifications prepared and approved under the General Permit prior to construction.” These plans and specifications must be prepared by a Virginia Licensed P.E., independent and separate from the Department of Utilities. Note: A new apartment building is considered one service connection.

If a water main is 18-inches or greater in diameter, plans and specifications must be submitted to the Virginia Department of Health for review and approval.

All road improvements and large construction project that necessitate the relocation of utilities, shall adhere to the standards outlined in this document.

3.2 Specifications and Layout

The drinking water system consists of two water main classifications: Transmission and Distribution. A transmission main conveys finished water to and from a storage facility to a large volume customer, or to a distribution main. Distribution mains convey finished water to the customer via individual service connections. Unless approved by the Department, service connections on transmission mains are not permitted.

A. Minimize Pipe Size and Material

1. The minimum pipe size for distribution mains shall be 8 inches in diameter.
2. Water mains equal to and larger than 12-inch diameter shall be considered transmission mains.
3. The preferred material type for water mains is ductile iron with a single-layer cement-mortar interior lining and zinc exterior coating. The minimum thickness class for ductile iron water mains shall be Class 52. Exceptions to the preferred material type are identified in the following Item No. 4
4. Corrosivity and resistivity testing and analysis of the soils, groundwater and electrical currents shall be performed and reported with recommendations for the pipe material, corrosion control measure or both, best suited for the existing environment. If the existing environment is found to be corrosive, then PVC, HDPE and other pipe materials are to be considered. Refer to AWWA Standard C105/A21.5-10. C.
5. Non-ferrous mains shall have a detectable 10 gage insulated copper tracer wire attached to the top of the pipe with plastic wire ties, and a non-detectable warning tape 12 inches above tracer wire. The tracer wire shall be looped at each appropriate appurtenance.
6. All proposed water mains shall be of new material without splices of dissimilar materials.

B. Separation and Clearances

1. A minimum depth of cover of 36 inches is required for all water mains less than 24 inches in diameter. Additional depth shall be provided where required for thrust restraint or to clear underground obstructions.
2. A minimum depth of cover of 42 inches is required for all water mains 24 inches in diameter or greater.
3. Water mains shall be installed a minimum of 20 feet from any part of any structure, building, or its foundation, measured from edge-to-edge.
4. All water mains shall be located, where practical, in legally established road rights-of-ways. Where possible, water mains shall be installed a minimum of 5 feet from curbs, gutter pans, sidewalks, and similar structures.
5. Separation of water and sewer lines shall be in accordance with 12VAC5-590-1150, Separation of water mains and sewers:
6. “The following factors shall be considered in providing adequate separation of water mains and sewers:
 - a. Materials and types of joints for water and sewer mains;
 - b. Soil conditions;
 - c. Service branch connections into the water main and sewer mains;
 - d. Compensating variations in the horizontal and vertical separations;
 - e. Space for repairs and alterations of water and sewer mains;
 - f. Offsetting of pipes around manholes; and
 - g. Identification of the physical restraints preventing normal separation.
7. Parallel Installation
 - a. Under normal conditions water mains shall be laid at least 10 feet horizontally from a sewer or sewer manhole. The distance shall be measured edge-to-edge.
 - b. Under unusual conditions when local conditions prevent a horizontal separation of 10 feet, the water main may be laid closer to a sewer or sewer manhole provided that:
 - i. The bottom (invert) of the water main shall be at least 18 inches above the top (crown) of the sewer;
 - ii. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure-tested in place without leakage prior to backfilling; and the sewer manhole shall be of watertight construction and tested in place.

8. Crossing

- a. Under normal conditions water lines crossing sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water line and the top of the sewer whenever possible.
- b. Under unusual conditions when local conditions prevent a vertical separation described in subdivision 8.a of this section, the following construction shall be used:
 - i. Sewers passing over or under water mains shall be constructed of the materials described in subdivision 7.b.ii of this section; and
 - ii. Water lines passing under sewers shall, in addition, be protected by providing:
 1. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line;
 2. Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the waterline; and
 3. That the length of the water line is centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer.
 - iii. No water pipes shall pass through or come in contact with any part of a sewer manhole.

C. Appurtenances

1. Connections to Water Mains
 - a. A connection to an existing main shall be made with a full-body, stainless steel tapping sleeve, valve, and hardware unless otherwise approved during plan review.
 - b. The use of size on size tapping sleeves will be evaluated on a case-by-case basis.
 - c. Where a new main system is installed, connections at intersections may be made with a mechanical joint tee or cross.
 - d. Taps 4" and greater shall be installed at least 5 feet apart and shall be at least 5 feet from any pipe joint.
2. Valves
 - a. All valves 12-inch and smaller shall be gate valves; valves larger than a 12-inch shall be butterfly.
 - b. Water main valves shall open clockwise and close counterclockwise.
 - c. Water shutoff valve to be located as close to intersections as practical.
 - d. Mainline valves are shown at intervals not greater than 1000 feet and at tees and crosses. One less valve than the number of connecting mains at a tee or cross may be allowed.
 - e. Fire hydrant valve shall be located within 3 feet of the service tee.
 - f. A valve shall be installed before and after each new hydrant connection on new main installations. Minimizing service interruptions during flushing and pressure testing procedures, and maintenance or repair should be considered when determining these valve locations.

- g. Air release valves shall be provided at high points as necessary. The Design Engineer shall specify the size, but in no case, smaller than 1-inch.
 - h. Air relief pipes shall be below grade and be equipped with an extension fitting that extends above grade.
 - i. Air relief valves shall be 1/4-turn, lever-operated ball valves.
 - j. Air and sediment accumulations may be removed through a standard fire hydrant; compressed air and pumping may be used for dewatering mains through hydrants.
 - k. Chambers or pits containing valves, blow-offs, meters, or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer.
 - l. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water or to absorption pits located above the seasonal groundwater table elevation. Sump pumps may be used where other means are not practicable.
3. Water Service Taps and Meters
- a. The public service line connects the water main to the City water meter. If a proposed public service line exceeds 40 feet in length, a water main extension is required to limit the length to 40 feet.
 - b. If an easement on private property is needed to convey City water service, proof of recordation of a deed of easement is required.
 - c. Domestic water services shall be installed in accordance with Sec. 46.1-8, Application for service generally; water taps for new connections, Chapter 46.1 of the *Code of the City of Norfolk*: “Except as otherwise provided in this chapter, in the introduction of water from the city water system into any house or lot, there shall be a separate tap or connection with the water main of the city and a separate tap for each premise(s), and no tap shall be used for supplying more than one premise(s).”
 - d. Master meters may be installed in accordance with Sec. 46.1-10, Service and meters for multi-occupant or multiple unit premises, Chapter 46.1 of the *Code of the City of Norfolk*: “All owners of multiple-family houses or business establishments occupied by more than one tenant shall provide a separate water supply with a separate meter, for each such occupant, or in lieu thereof, shall themselves make application for water service for the entire premise(s) and become responsible for all public service bills incurred on such premise(s).”
 - e. Fire services shall be installed in accordance with Sec. 46.1-13, Service for fire protection, Chapter 46.1 of the *Code of the City of Norfolk*: “Where residential (except single-family detached dwellings and single-family townhouse dwellings up to a maximum of three (3) stories), institutional or commercial fire service is provided, a separate tap and fire service meter must be installed in the addition to the water distribution system of the City. The water service line for all sprinkler systems and fire service lines shall be protected from backflow/back-siphonage in accordance with the provisions of Chapter 11.1, article VII of this Code and as provided by the USBC.”
 - f. Domestic taps 2" and smaller shall be installed a minimum of 18 inches apart and shall be staggered along the water main.

- g. Tapping saddles and sleeves shall be installed in accordance with Norfolk Water Detail CW 01.
- h. Connection of new water mains or new service lines of the same size as the existing water mains using tapping saddles or sleeves is prohibited.
- i. Commercial properties require a separate tap on the water main for an irrigation service line. Residential properties may tap the existing domestic service line prior to the domestic meter. The irrigation service will be metered and billed separately. Both commercial and residential irrigation connection types shall have a backflow prevention device.
- j. Water Meter Sizing: The design engineer shall be responsible for designing the service line and meter size for actual conditions. Calculations for the size of services and meter sizes shall be performed in accordance with AWWA Manual M22, *Sizing Water Service Lines and Meters*.
 - i. Design demands shall be calculated using the most recent edition of AWWA Manual M-22 fixture counts. The design engineer shall refer to the chapter regarding estimating demands and using fixture values.
 - ii. When selecting a meter, the designer shall refer to the chapter regarding sizing meters and use the “AWWA meter standards” table. The meter shall be sized such that the customer peak demand does not exceed the maximum flow rate allowable by the meter. Oversizing meters is not permitted.
 - iii. Meter sizes 5/8-inch, 3/4-inch, and 1-inch shall be positive displacement type. Meter sizes 1 1/2-inch up to and including 6-inch shall be ultrasonic type. Meter sizes larger than 6-inch shall be electromagnetic type.
 - iv. All meters shall be compatible with Advanced Metering Infrastructure (AMI) technology.
 - v. The minimum size domestic tap is a 1," with either a 5/8", 3/4" or 1" meter (based on demand calculations). For all other domestic and fire services, the meter and/or detector check size shall be the same size as the tap.
 - vi. Water meters shall be located in the public right of way or a utility easement. Backflow prevention devices shall be located on private property downstream of the meter.
 - vii. A reduced pressure zone (RPZ) device for backflow prevention shall be installed on all service lines for commercial properties, including multi-family dwelling units served by a single meter.
- k. Type K copper tubing shall be used for service lines 2 inches or smaller.
- l. Use of lead water services is prohibited. A new service, corporation stop to water meter, must be installed.
- m. Water meters shall be placed within the right-of-way and at a minimum distance of 5' off the property line. Avoid placement in sidewalks, driveways, other high traffic areas and drainage swales.
- n. Where exposed to traffic, meter boxes and vaults shall be designed for the appropriate traffic rating and loading.
- o. Detector checks shall be direct-bury, unless otherwise directed by the Department.
- p. When a meter box relocation is requested, a new tap is required for distances greater than 10 feet. The relocation and/or tap will be performed by City forces at

- the property owner's expense. Water service splicing is prohibited.
- q. Meter sizes 1-1/2 inches and above will require a vault instead of a box. Refer to Norfolk Standard Details CW05, CW06, CW07.
- r. In accordance with City Code Chapter 46, Article III, Sec. 46.1-28(d), "...The department of utilities may deny or discontinue the water service to a customer if it is found upon proper inspection that any violation of the city's building code may endanger the city's water supply system and/or be a public health hazard." All service line connections shall adhere to the provisions outlined in City Code Chapter 11.1, Article II: Cross Connections.

3.3 Design Standards

Drinking water systems shall be designed to provide adequate flow and pressure for both domestic supply and fire flow, based on sound hydraulic system analysis.

A. System

- 1. The system shall be designed to maintain a minimum pressure of 40 psi. Where the pressure at the service tap exceeds 80 psi, the provisions of the Uniform Statewide Building Code (International Plumbing Code) shall apply.
- 2. Dead-ends should be minimized by the looping of all mains. Where dead-end lines are unavoidable, they shall be provided with a fire hydrant, or flushing hydrant for flushing purposes. The flushing device shall not be directly connected to any sewer. De-chlorination is required on any flushing device.
- 3. The design documentation shall address total current and projected future flows and system capacities of existing and proposed utilities and shall provide the proposed water main sizes. Design assumptions shall be clearly documented, and the average and peak domestic and fire flows tabulated in a report.

B. Hydraulic

- 1. Hydraulic design shall be accomplished by use of established equations acceptable to the Department. A Hazen-Williams coefficient of friction equal to 120 shall be used for purposes of design for new pipes. Friction coefficients for existing pipes shall be determined based on the best available information and shall be subject to the approval of the Department.
- 2. If current data is not available, the Department may conduct a fire hydrant flow test at the Design Engineer's request. Results shall be documented and included with the calculations.
- 3. For existing mains, the coefficient of friction (c-factor) shall be determined using the best available information. If no information is available, a c-factor equal to 100 shall be used.
- 4. The maximum allowable velocity is five feet per second for domestic design and nine feet per second for domestic plus fire flow.

C. Structural

1. Bedding may be required. Bedding shall be a minimum of 6 inches of crushed stone or gravel aggregate conforming to VDOT No. 57 stone, or as required for the existing conditions.
2. Where required, the proper restraint of proposed and/or existing mains must be provided and shown on the drawings. Thrust blocks will not be permitted. Design calculations and summary table shall be submitted for proposed restraint lengths.
3. Proper support and accessibility shall be provided for aerial or suspended lines. Any potable water line crossing over surface water must be:
 - a. Adequately supported.
 - b. Protected from freeze damage.
 - c. Accessible for repair or replacement.
 - d. A minimum of one foot above the 100-year flood plain elevation.
4. Any potable water line crossing under a surface water must meet the following minimum requirements:
 - a. The pipe shall be of special construction having flexible watertight joints.
 - b. 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.
 - c. Permanent sample taps shall be located at each end of the crossing and at a reasonable distance from each side of the crossing for testing and locating leaks.

3.4 Fire Protection

A. Flow Requirements

Requirements for fire protection shall be estimated based on the latest edition of the Insurance Services Office (ISO) *Guide for Determination of Needed Fire Flow* and AWWA Manual 31. A maximum allowance of 50% reduction in needed fire flow may be allowed for buildings with automatic sprinkler systems that provide full protection.

1. The minimum fire flow from any individual fire hydrant shall be 500 gpm.
2. The maximum fire flow from any individual fire hydrant shall be 1500 gpm at 20 psi. An additional hydrant shall be provided if the flow required exceeds 1500 gpm.
3. During maximum rated fire flow conditions, the minimum calculated residual City system pressure at any point shall not be less than 20 psi.
4. The minimum size water main for new service connections shall be 8 inches.
5. The minimum size service line used for fire protection systems shall be 4 inches. The minimum size service line for any connection serving a fire hydrant shall be 6 inches.

6. The sizing of fire service lines shall be determined by hydraulic analysis. Not more than one fire hydrant shall be installed on a 6-inch dead-end line.
7. Dead-end lines shall not contain more than 600 feet of minimum sized pipe. Additional lengths required shall be provided by increasing the line size.
8. The minimum pressure during fires shall be 20 psi.

B. Fire Hydrants

1. Hydrants shall be installed in accordance with the Department's standard details and shall be located at intersections wherever possible. The location should be:
 - a. On the same side of the street as the main.
 - b. As safe from traffic as possible.
 - c. A minimum disruption to parking.

The location of fire hydrants shall be subject to the approval of the Department and the Norfolk Fire Department.
2. Mid-block hydrants should be installed at property lines wherever possible. On curbed and guttered streets, hydrants shall be 18" to 24" back of the curb. Where curbs and gutters do not exist, hydrants shall be 8' to 15' from solid roadway, where possible.
3. The break flange shall be located from 0" to 4" above ground elevation and the outlet centers shall be a minimum of 18" above ground elevation.
4. Fire hydrant spacing for properties zoned single family residential shall not exceed 500 feet.
5. Fire hydrant spacing for properties zoned multi-family residential, commercial, or industrial shall not exceed 350 feet.
6. No fire hydrant shall be placed closer than 50 feet from the face or overhang of any building to be protected.
7. The above criteria for spacing fire hydrants may be modified by the Fire Department to improve fire hydrant accessibility for fire-fighting purposes.
8. Structures fully protected by an automatic sprinkler system and directly connected to the City's water system require installation of a detector check and an appropriate backflow prevention device. 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 prevention device. The dedicated hydrant is not credited toward external protection requirements.

Siamese connections must be located within 50 feet of a dedicated hydrant.

3.5 Special Considerations

A. Road and Rail Crossings

The Design Engineer shall coordinate any rail crossing with the appropriate rail company and obtain all required permits and approvals. Any water lines crossing VDOT right-of-way will also require the Design Engineer to coordinate with VDOT and obtain all required permits and approvals. The Design Engineer is cautioned that the jurisdictional agency may require design provisions greater than what is listed herein, and it is the Design Engineer's responsibility to comply with the more stringent requirements. All water line crossings of railroads, major roadways, and other major structures shall be encased in a casing pipe. Design of railroad crossings shall comply with the requirements of American Railway Engineering Association Specifications, Part 5 – Pipelines (latest revisions). Additionally, the following parameters also apply:

- a. Steel casing pipes have minimum yield strength of 35,000 psi.
- b. The casing pipe shall be electrically isolated from carrier pipe.
- c. Casing pipe shall be sloped at a minimum grade of 1/16-inch per foot.
- d. A 2-inch weep hole or 2" casing vent shall be provided at each end for leak detection.
- e. Seals are required, unless written approval to waive this requirement is received from the Department.

B. Stormwater, Sanitary Sewer, and Electrical Ductbank Crossings

The Department of Utilities at its sole discretion may require that water mains crossing stormwater pipes, sanitary sewer pipes, and electrical ductbanks be protected by a steel casing pipe at least ten feet longer than the diameter of the crossing pipe or width of the ductbank and equally spaced from the center of the crossing.

C. Existing Drinking Water Transmission Mains

If a property owner, developer, or contractor proposes a temporary or permanent crossing of an existing drinking water transmission main and co-location, encroachment, or occupation of an existing easement, right-of-way, or real estate property owned by the City of Norfolk, then an application and site plan documents must be submitted to the Department of Planning for review and approval. In addition to the standard application and site plan documents, the submittal must include:

- Quality Level A Subsurface Utility Engineering (SUE) survey providing horizontal and vertical location information for the existing drinking water transmission main
- Horizontal and vertical information for the separation of the existing drinking water transmission main and the proposed improvements
- A metes and bounds description of the proposed crossing area if outside an established right-of-way
- Calculations and narrative of the proposed method of protecting the drinking water transmission main

No construction work shall commence without advanced approval.

The following notes are required as communication from the property owner or developer to the contractor and shall be included on the site plan drawings.

1. The amount of construction activity and construction traffic over the top of the existing water transmission main shall be limited.
2. Extreme care shall be taken while demolishing existing street pavement around the existing drinking water transmission main.
3. Construction equipment shall cross the existing drinking water transmission main at only one location.
4. The existing drinking water transmission main at the crossing location shall be protected by the approved method.
5. Hand digging is required at the crossing location with the existing drinking water transmission main.
6. No materials or equipment shall be stored within 15 feet of the existing drinking water transmission main.
7. At least three business days prior to excavation over the existing drinking water transmission main, contact the Department of Utilities' Chief of Construction Operations at (757) 823-1012 to schedule inspection.
8. Wire and cable shall not be installed within 5 feet of the existing drinking water transmission main.
9. There shall be at least 24 inches of vertical separation maintained between the top of the existing drinking water transmission main and the pavement sub grade or undercut excavation during construction.

Table 3.2 indicates the minimum wall thickness allowable for casing pipe.

TABLE 3.2

MINIMUM WALL THICKNESS FOR CASING PIPE

PIPE CASING						
CARRIER PIPE DIAMETER (IN.)	MINIMUM CASING PIPE DIAMETER (IN.)	MINIMUM WALL THICKNESS, inches				
		CRITERIA WITHIN RAILROAD RIGHT-OF- WAY		CRITERIA WITHIN CITY OR VDOT RIGHT-OF-WAY		MINIMUM NUMBER OF CASING SPACER RUNNERS
			STEEL WITH PROTECTIVE COATING		STEEL	
4	12		0.375		0.250	4
6	18		0.375		0.250	4
8	18		0.375		0.250	4
10	20		0.375		0.250	4
12	24		0.375		0.250	4
16	30		0.500		0.375	6
18	30		0.500		0.375	6
20	36		0.563		0.375	6
24	42		0.625		0.500	6

B. Cathodic Protection

The design engineer shall test and analyze the soils, groundwater and electrical currents and report the results with recommendations for suitable corrosion protection where necessary. For pipe sizes greater than 18 inches, the design engineer shall consult a corrosion specialist.

1. All hardware shall be stainless steel.
2. The designer engineer may evaluate and recommend other applicable methods of protection for review and approval by a certified corrosion specialist and the Department.

C. Other Considerations

1. The profile of water services at ditch lines shall be shown on the drawings. The water service shall be Type K copper and have a minimum cover of 24 inches at the ditch invert.
2. Where water lines are subject to extreme variations in temperature (i.e., attached to bridges or box culverts) consideration shall be given to expansion and contraction of pipe materials and the freezing of the line contents.
3. Abandoned water mains larger than 8-inch shall be filled with flowable fill.
4. To abandon a water service line, the corporation stop shall be closed and checked for leakage, the service line shall be disconnected from corporation stop and from the yoke at the meter box, and the service line shall be crimped shut at both ends.

C. Testing & Inspection

In accordance with the latest edition of the *Regional Technical Standards*, Section 801-2.8, A.1, “All flushing, pressure testing and disinfection procedures shall conform to this Section and the applicable sections of the Virginia Department of Health Waterworks Regulations.” Section 801 also references specific AWWA standards that must be adhered to prior to a main, new or existing, being put into service.

Water for pressure testing shall be obtained through a fully valved manifold, with an approved backflow preventer. Any other source or procedure must be pre-approved by the Department of Utilities. Water mains shall be filled with water and subjected to a hydrostatic pressure of 150 psig, measured at the highest point along the test section. The pressure test duration shall be at least two hours.

Water mains shall be flushed with potable water prior to disinfection. After disinfection, potable water from a City connection shall be used for a final flush. Potable water from a tank truck is not acceptable. Dechlorination shall be performed at the point of flushing discharge in accordance with the Hampton Roads Planning District Commission’s *Regional Construction Standards*. Service lines shall not be connected until negative bacteriological test results have been received