PART 7 - WATER DISTRIBUTION SYSTEM

November 2016

7.01 APPROVALS, PERMITS, AS-BUILTS AND MAINTENANCE BONDS

A. Plans and specifications for public water distribution facilities must be certified by a professional engineer registered in the State of Iowa and utilize the NGVD of 1988.

B. Plans and specifications for public water distribution facilities must be reviewed and approved by the City Engineer prior to construction.

C. Plans and specifications for public water distribution facilities must be reviewed and approved by the Iowa Department of Natural Resources prior to construction. Private water service installations which result in two or more public water mains being looped together also must be reviewed and approved by the Iowa Department of Natural Resources prior to construction. Other local, state and federal permits may be required, depending on the circumstances. It shall be the responsibility of the Engineer of Record to acquire all applicable permits. A copy of all permits shall be provided to the City Engineer before construction.

D. All infrastructure connected to the City of Iowa City water distribution system shall follow the approved standards, specifications, and policies of the City of Iowa City Water Division and City of Iowa City Code. All plans shall meet the same minimum standards and specifications as those set out for public improvements.

E. The Engineer of Record is responsible to submit "Record of Construction" drawings to the City Engineer.

F. A five-year maintenance bond covering defective materials and workmanship is required for all water main improvements.

G. All plans submitted for water work shall include water use design assumptions and design flow calculations for all water mains and/or water services. Design flows shall be listed by specific water use type: domestic use, fire flows, irrigation, etc.

7.02 DESIGN RESOURCES

The design for water distribution facilities and service lines shall conform with the following; in case of a conflict between design standards, the most restrictive requirement shall apply:

A. Requirements and Standards of the Iowa Department of Natural Resources.

B. City of Iowa City Construction Specifications.

C. City of Iowa City Water Division Procedures and Policies.

D. City of Iowa City Code.

E. American Water Works Association Standards.

F. Great Lakes-Upper Mississippi River Board. *10 State Standards*. 2012.

G. Insurance Service Office (ISO). *Fire Suppression Rating Schedule*.

H. Iowa Administrative Rules.

I. American Society of Civil Engineer Books and Manuals.

J. Iowa Statewide Urban Design and Specifications (SUDAS).

7.03 DEFINITIONS

A. **Jurisdiction**: The City of Iowa City, Iowa.

B. **Jurisdictional Engineer**: City Engineer of Iowa City, Iowa City Water Superintendent, or designee.

C. **Private Fire Hydrant:** A fire hydrant located on privately owned property, or on streets not dedicated to public use unless the water main is within a public easement. Private fire hydrants shall meet all requirements of a public fire hydrant, and be served by a minimum 6-inch pipe. A private fire hydrant is the responsibility of the property owner and shall be used for fire protection only. Where it is the owner's intention that these hydrants be used by the City Fire Department, these hydrants shall conform to the Department of Public Works specifications for fire hydrants. The City has the right to utilize the hydrants for flushing purposes.

D. Reference City of Iowa City Code for definitions not included within this standard.

7.04 CONSTRUCTION SPECIFICATIONS

A. Construction must comply with the City's standard construction specifications for water distribution facilities.

B. Only materials on the “Accepted Products for Water Distribution Materials” list or products given special exemption by the Jurisdictional Engineer shall be used in the water distribution system and all connected services.

7.05 SYSTEM DESIGN

A. **General:** Domestic usage requirements for a service area can be determined either from past records or from general usage information shown in Table 4B-1.01. This data should then be adjusted for commercial, industrial, and projected growth factors to ensure the system's design capacity should meet future demand. A factor in sizing main facilities is the need for fire protection. Fire flow requirements are set by the Insurance Services Office (ISO). This group determines the minimum flow the system must be able to maintain for a specified period of time in order to achieve a certain fire protection rating. Fire insurance rates are then based, in part, on this classification.

B. **Network Analysis:** Pipe carrying capacity depends on pipe size, pressure, flow velocity, and head loss resulting from friction. Friction factors include roughness of pipe, flow velocity, and pipe diameter. The required pipe size can be calculated when the other requirements and characteristics are known. When the distribution system or system expansion is extensive, it may be necessary to analyze the system and balance the flow among all areas in relation to demand. This analysis requires a plot of pressures and flows at points throughout the system.

C. **Velocity Requirements:** Velocity of flow is also a factor in determining the capacity of pipes and, therefore, the required pipe size. Velocities should normally be 5 fps or less, due to high friction losses that occur at greater velocities. Any pipe with a calculated velocity over 5 fps shall be clearly noted on the water plan sheet and shall require the approval of the Jurisdictional Engineer. This may be difficult to obtain under normal operating conditions, and velocities can significantly exceed this guideline under fire-flow conditions.

D. **Minimum Criteria**

1. Minimum Design Period Requirements: Water mains should have a minimum size based on a hydraulic analysis utilizing 20 year design for a specified water demand. Consideration should be given to projected land uses and demand based on full development of the service area. The specified water demand depends on the area to be serviced and the type of water main (feeder, arterial, or distribution).

2. Minimum Size Requirements:
   a. Water Service Line: The water service line must meet the Jurisdiction’s standards and provide adequate design flows. Individual water services shall be no smaller than 1” in diameter from the water main up through the stopbox.

b. Distribution Mains: All water mains should be sized large enough to provide existing and future residential, commercial, and industrial water demands and fire protection flows to the area to be served. The minimum water main size is 8 inches in diameter, unless otherwise approved by the Jurisdictional Engineer. The Jurisdiction reserves the right to increase the size of the mains to meet future water demands.
c. Arterial or Feeder Mains: Arterial or feeder mains, typically 12 inches and larger, should conform to an existing grid pattern or as directed by the Jurisdiction to meet long range plans of the Jurisdiction.

3. Pressure Requirements: The recommended minimum operating pressure of the distribution system should be no less than 35 psi. The residual pressure required under fire flow conditions should not drop below 20 psi at any hydrant or any point in the system. When operating pressure exceeds 100 psi, individual or system pressure reducing devices may be required.

E. Flow Considerations

1. Design Flows: The water main system must be able to meet the following flow requirements:
   a. Peak day demands plus fire flow demands.
   b. Instantaneous peak demands for water mains from source, treatment, and/or storage facilities.
2. Peak Day Demands:
   a. General: The peak day demand is the average rate of consumption on the maximum day. The maximum day is the 24 hour period during which the highest consumption total is recorded in the latest 3 year period. High consumption that will not occur again due to changes in the system, or that was caused by unusual operations, should not be considered. When no actual figure for maximum daily consumption is available, it should be estimated on the basis of consumption in other cities of similar character. Such estimates should be at least 2.0 times greater than the average daily water demand for cities having more than 500 people and 2.5 times greater than the average daily water demand for cities having 500 people or less.
   b. Average Day Demand (minimum):

Area x Area Density x Rate = Average Daily Demand (Equation 4B-1.01)

Number of Units x Unit Density x Rate = Average Daily Demand (Equation 4B-1.02)

3. Instantaneous Peak Demands: Where existing data is not available to accurately predict the instantaneous peak demand for the design year, the following criteria may be used as a minimum for estimating the instantaneous peak demand:

a. 220 people or less = Average day demand (gpm) x 9.0.

b. More than 220 people = Average day demand (gpm) x $7/P^{0.167}$
P = design year population in thousands.

If major water users exist in the system, the peak may be greater than those listed above.

Table 4B-1.01: Density

Land Use	Area Density	Unit Density	Rate
Low Density (Single Family) Residential	10 people/AC	3.0 people/unit	100 gpcd
Medium Density (Multi-Family) Residential	15 people/AC	3.0 people/unit 6.0 people/duplex	100 gpcd
High Density (Multi-Family) Residential	30 people/AC	2.5 people/unit	100 gpcd
Office and Institutional	Special Design Density[1]		
Commercial	Special Design Density[1]		
Industrial	Special Design Density[1]		

[1] Special design densities should be subject to approval by the Jurisdictional Engineer based on methodology provided by the Project Engineer.

Note: If the Project Engineer uses values different than the above table, approval by the Jurisdictional Engineer and Iowa DNR is required.

4. Fire Flows: The following general information is taken from the *Fire Suppression Rating Schedule* (Edition 05-2008) of the Insurance Services Office (ISO). The latest ISO requirements must be checked to verify fire flow criteria. Insurance requirements for fire protection may vary with each Jurisdiction and must be confirmed by the Project Engineer.

a. For one- and two- family dwellings not exceeding two stories in height, the following needed fire flows should be used.

Distance Between Buildings	Needed Fire Flow
Over 100’	500 gpm
31’ to 100’	750 gpm
11’ to 30’	1,000 gpm
10’ or less	1,500 gpm

For wood shingle roof coverings on the building or on exposed buildings add 500 gpm to the needed fire flows.
b. Multi-family, commercial, and industrial areas are considered high risk areas. The fire flows available in these areas require special consideration. The distribution and arterial mains in the high risk areas are to accommodate required fire flows in those areas.

7.06 FACILITY DESIGN

A. **General:** Water mains and appurtenances, including hydrants and valves, should be provided along all streets including connections to and extensions from existing water systems. The location and spacing of water mains and their appurtenances is not only important for service and fire protection, but also maintenance requirements.

1. All public water mains should be located within the public right-of-way. In rare exceptions, dedicated easements may be used for location of water main outside of public right-of-way.

2. All water mains outside public right-of-way shall be placed in an easement for operation and maintenance. Easement width shall generally be 1.5 times the pipe depth rounded up to the nearest 5 feet. The minimum easement width is 15 feet. Easements should be centered on the water main, with a 5-foot minimum horizontal separation from the edge of easement to nearest edge of the pipe.

B. **Water Mains:** Water main pipe will typically be either polyvinyl chloride (PVC) pipe or ductile iron pipe (DIP); and meet AWWA Standards.

1. Refer to Water Division LUST Policy for additional documentation criteria for projects within area of a leaking underground storage tank site.

2. PVC pipe shall not be used around cul-de-sacs, small radius curves of 45 feet or smaller, or for pipe 12-inch diameter and larger. PVC water main materials shall not be bent.

3. Pipe installed by directional boring shall not use slip-joint pipe. Ductile iron pipe that is directionally bored, requires restrained joints, or is suspended from structures, shall be special thickness Class 53.

4. Where there is evidence there will be considerable underground construction or several large diameter service taps or connections, ductile iron pipe materials shall be used.

5. Where there is considerable deflection of the water main materials required for either horizontal or vertical changes in alignment, ductile iron materials shall be used. PVC water main joint deflections shall be limited to manufacturer's recommendations.

6. All mains shall be looped, except for short runs to serve cul-de-sacs where the distance is less than 500 feet.

7. Water mains shall be constructed such that no services shall be extended beneath the paving of the circular turnaround on cul-de-sacs.

8. Water distribution mains will be extended to and through or across the frontage of all subdivisions and land development projects. Provisions will be made to connect water mains to serve future adjacent undeveloped land.

9. Water mains will be located so the front of each property has access for a service connection.

10. New main installation should be located in the parking area (between the curb and the property line) of the right-of-way and minimum of 4 feet behind the curb. Where possible, water mains should be located along the south and east sides of the street. Water mains shall be placed a minimum of 1.5 times the depth from building setback lines; greater separation distances are desirable.

11. Dead-ends should be minimized by looping mains whenever possible. Dead-ends should terminate with either a dead-end hydrant assembly (fig CIC-4C.1) or future extension assembly (fig. CIC-4C.2). These pipes will provide sufficient support for the valve and allow a future extension to be made without impacting current water customers.

12. Water main shall be installed with a minimum depth of cover of 5½ feet. Generally, the maximum depth shall not exceed 7 feet. Greater depths of cover, surface loading conditions, or unusual trench conditions may require a stronger class of pipe according to the AWWA Standard regarding the type of pipe being installed.

13. Where a dip must be placed in a main in order to pass under another utility, the length of the deeper main should be kept to a minimum, and bends shall be used to affect the desired offset.

14. Water mains should be adequately protected from corrosive soil environments. Comply with AWWA C105. Include polyethylene encasement for ductile iron pipe, valves, and fittings or use of other

nonmetallic pipe materials. If nonmetallic materials are used, be sure to provide polyethylene encasement for fittings and valves. All metal pipe and appurtenances shall be wrapped in two layers of polyethylene encasement. In severe instances, cathodic protection may be required.

C. **Valves**

1. As a minimum, valves should be located at water main intersections, such that valves exist on all water main branches at the intersection. Valves should be equally spaced, if possible, with spacing no more than 800 feet in residential areas and no more than 400 feet in high density residential, commercial, and industrial areas. Additional valves may be required for testing and connection purposes.

2. Resilient-seated gate valves shall conform to AWWA C509. Butterfly valves shall conform to AWWA C504, for buried service. Use of butterfly valves is required for valves 16-inch diameter and larger.

3. All valves shall be installed with valve boxes. Use lids marked "water."

4. A tapping sleeve and valve shall be used when making a perpendicular connection to an existing main, unless a tee is requested by the Jurisdiction. All private service connections shall be tapped, unless express written permission from Jurisdictional Engineer is given for a different connection type.

5. If the project area has high water pressure, usually exceeding 100 psi, it may be appropriate to install system pressure relief valves as opposed to individual building controls. The potential for using a system pressure reducing valve is limited by the interconnected nature of a distribution system. Check with the Jurisdiction to determine the potential need for use of pressure reducing valves.

6. All valves connected to pipe 4-inch diameter and larger shall be restrained to the pipe.

7. Valves should be placed so there is a minimum of 2 feet clearance space to any other above ground structure. This allows access for valve operation and maintenance.

D. **Fire Hydrants**

1. Hydrants should comply with AWWA C502. The connecting pipe between the supply main and the hydrants should be a minimum of 6

inches in diameter and be independently valved. Fire hydrants should not be installed on water mains that do not provide a minimum pressure.

2. Hydrant drains shall not be connected to, or located within 10 feet of, sanitary sewers.

3. Locations of fire hydrants are governed by the rules and regulations of the Iowa DNR and the local Jurisdiction and by the following principles. Satisfy each principle in the order they are listed.
a. Locate fire hydrants within 25 feet of each street intersection, measured from an end of a street paving radius return. Locate fire hydrants outside street paving radius returns. Avoid conflicts with storm sewers, intakes, and sidewalks. Whenever possible, locate fire hydrants at the high point of the intersection.
b. Locate fire hydrants between street intersections to provide spacings of no more than 400 feet in single family residential districts and no more than 300 feet in all other districts. Coverage radii for structures as noted below should be checked when determining hydrant placement. Vary spacings slightly to place fire hydrants on extensions of property lines. When hydrants are required between intersections, they should be located at the high point of the main for air release or at a significant low point for flushing on the downhill side of an in-line valve. When street curvature or grid patterns places a proposed protected structure at an unusual distance from the fire hydrant, the coverage radius should not exceed 300 feet in single family residential districts and 150 feet in all other districts. The Jurisdiction's fire marshall may have additional private fire protection requirements.
c. On cul-de-sac streets, hydrants should be located at the intersection of the cul-de-sac street and cross-street and the end of the cul-de-sac.
d. Hydrants must be located to provide the required fire flows. ISO evaluates fire hydrant locations within 1,000 feet of the test location, measured along the streets as fire hose can be laid, to evaluate the availability of water for fire protection. Hydrant capacity is credited as shown in the following table:

Hydrant Location	**Credited Capacity**
Within 300’ of location	1,000 gpm
Within 301’ to 600’ of location	670 gpm
Within 601’ to 1,000’ of location	250 gpm

4. Hydrant shall be placed so there is a minimum 3-foot radial clearance space to any other structure(s). This allows access for maintenance and hose connections.

E. **Separation of Water Mains from Sewer Mains:** There shall be no physical connection between a public or private potable water supply system and a sewer appurtenance which would permit the passage of any sewage or polluted water in the potable supply.

1. **Horizontal Separation of Gravity Sewers from Water Mains:** Separate gravity sewer mains from water mains by a horizontal distance of at least 10 feet unless:
   - the top of a sewer main is at least 18 inches below the bottom of the water main, and
   - the sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.
   - When it is impossible to obtain the required horizontal clearance of 3 feet and a vertical clearance of 18 inches between sewers and water mains, the sewers must be constructed of water main materials meeting the requirements of the City of Iowa City Water Distribution specifications. However, provide a linear separation of at least 2 feet.

2. **Separation of Sewer Force Mains from Water Mains:** Separate sewer force mains and water mains by a horizontal distance of at least 10 feet unless:
   - the force main is constructed of water main materials meeting a minimum pressure rating of 150 psi and the requirements of Sections 8.2 and 8.4 of these standards, and
   - the sewer force main is laid at least 4 linear feet from the water main.

3. **Separation of Sewer and Water Main Crossovers:** Vertical separation of sanitary and storm sewers crossing under any water main should be at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, the sewer may be placed not closer than 6 inches below a water main or 18 inches above a water main. Maintain the maximum feasible separation distance in all cases. The sewer and water pipes must be adequately supported and have watertight joints. Use a low permeability soil for backfill material within 10 feet of the point of crossing. Where the sanitary sewer crosses over or less than 18 inches below a water main, locate one full length of sewer pipe of water main material so both joints are as far as possible from the water main.

   Where the storm sewer crosses over or less than 18 inches below a water main, locate one full length of sewer pipe of water main material or reinforced concrete pipe (RCP) with flexible O-ring gasket joints so both joints are as far as possible from the water main.

F. **Surface Water Crossings:** Comply with the Recommended Standards for Water Works, 2012 Edition. Surface water crossings, whether over or under water, present special problems. The reviewing authority should be consulted before final plans are prepared.

1. **Above-water Crossings:** Ensure the pipe is adequately supported and anchored; protected from vandalism, damage, and freezing; and accessible for repair or replacement.

2. **Underwater Crossings:** Provide a minimum cover of 5 feet over the pipe unless otherwise specified in the contract documents. When crossing water courses that are greater than 15 feet in width, provide the following.
a. pipe with flexible, restrained, or welded watertight joints,
b. valves at both ends of water crossings so the section can be isolated for testing or repair; ensure the valves are easily accessible and not subject to flooding, and
c. permanent taps or other provisions to allow insertion of a small meter to determine leakage and obtain water samples on each side of the valve closest to the supply source.

G. **Chambers, pits, or manholes**: Chambers, pits, or manholes containing meters for private water services, water main or private service pipe, or valves are not allowed.

H. **Thrust Blocks and Restrained Joints:** Concrete thrust blocks and restrained joints are used to counteract joint movement at points where piping changes directions or at dead-ends.

1. **Thrust Blocks:** Thrust blocks may be used on pipes independently or in combination with restrained joints. Thrust blocks shall be required for all pipe 12-inch diameter and larger. Table 4C-1.01 assumes a bearing area of thrust blocks based on 1,000 psf soil pressure and 150 psi water pressure. Where water pressures are higher and/or soil conditions are poor, the designer should design the correct block size using the equation below Table 4C-1.01. No bolts should come into contact with the concrete thrust blocks. If necessary, polyethylene wrap should be wrapped around the pipe, including the bolt circle, before the concrete is placed. Concrete should have a minimum compressive strength of 4,000 psi at 28 days. Fire hydrant assemblies and precast solid concrete blocks shall be installed as indicated on approved standard water details accompanying this standard and City of Iowa City Water Distribution Specifications-Section 02660.

Table 4C-1.01: Thrust Block Minimum Bearing Surface (SF)

Pipe Size (inches)	Bends				Tee or Dead-end
	11.25°	22.5°	45°	90°	
12	4.0	8.0	16.0	29.0	21.0
16	7.0	14.0	27.0	50.0	36.0
20	11.0	21.0	42.0	78.0	55.0
24	15.0	31.0	60.0	111.0	78.0
30	24.0	47.0	92.0	171.0	121.0

Note: Areas based upon water pressure of 150 psi and allowable soil pressure of 1,000 psf.

Required Area, ft^2 = (2) (water pressure, psi)(cross-sectional area of pipe outside diameter, in^2)(sin(angle of bend / 2))/(allowable soil pressure, psf)

2. **Restrained Fittings:** All fittings shall be restrained.

3. **Restrained Joints:** For all pipe 4-inch diameter and larger, pipe joints shall be restrained a calculated distance upstream and downstream from any changes in the horizontal alignment, vertical alignment, or cross-sectional area of the pipe. Parameters for calculating restrained length along the pipe shall include a minimum safety factor of 1.5, and a minimum test or design pressure of 150 psi. Accepted equations and design information may be found in "Thrust Restraint Design for Ductile Iron Pipe, Seventh Edition" by DIPRA and "Thrust Restraint Design Equations and Soil Parameters for Ductile Iron and PVC Pipe" by EBAA Iron Sales, Inc. Calculations for restrained lengths shall be submitted to the Jurisdictional Engineer with all water pipe designs.

I. **Crossings**

1. **Railroad Crossings:** The regulations of the railroad company involved will govern when a water main is installed under or over any railroad tracks.

2. **Roadway Crossings:** The jurisdiction responsible for the roadway should have regulations for crossing a roadway. For primary and interstate highways, the Iowa DOT is the responsible jurisdiction. For non-primary, federal-aid roadways use the most recent version of the "Policy for Accommodating Utilities on the County and City Non-Primary Federal-Aid System." For all other roadways, contact the responsible jurisdiction.

7.07 PERFORMANCE AND TESTING

A. Before placed into service, all new mains shall be adequately flushed, pressure tested, disinfected, and traced according to the rules and regulations of the

Jurisdiction and Iowa DNR. The procedures, once approved by the Jurisdiction, should be conducted under the supervision of the Jurisdictional Engineer or designated representative. If requested, the design engineer shall be required to submit a testing plan for approval as part of the plan review process. The plan shall include a drawing and written procedure of all significant steps necessary to connect to the existing water distribution system and/or conduct the filling, flushing, and testing of the new pipe.

1. **Disinfection:** Disinfect the water main according to AWWA C651. Verify requirements and acceptable methods with the Jurisdictional Engineer. Three methods of disinfecting new water mains are available. They include the tablet method, the continuous feed method, and the slug method. The goal for disinfection is to obtain a concentration in the new main of 25 mg/L free chlorine. The chlorine is to be retained in the pipe for a minimum of 24 hours, but no more than 48 hours.

   All mains shall pass bacteriological testing before pressure testing is allowed. Testing segments shall be no longer than 1200 feet along one main. All legs/lateral mains shall be tested as separate segments. Long main lines over 1200 feet in length shall be tested in discrete testing segments, and adjoining in-line testing segments shall not be tested together in any manner. Water mains must pass all testing before any main or service taps are allowed.

2. **Flushing:** Once the main has passed the chlorination tests, it is to be flushed according to the requirements of AWWA C651 until the water in the new main is at the same chlorine level as the other sections of the distribution system. The velocity in the main should be at least 2.5 feet per second for adequate flushing. If there is any potential threat the highly chlorinated water will damage the environment, a neutralizing chemical should be added to the water to render it acceptable, or flush water into the sanitary sewer upon approval of the Jurisdiction.

3. **Hydrostatic Pressure Testing:** Pressure test according to AWWA C600, excluding the addition of makeup water. All air must be expelled from the new main. The test pressure should be 1.5 times the working pressure of the system or 150 psi, whichever is greater. The test should continue for a minimum of 2 hours. Pressure must remain within 5 psi of beginning recorded pressure, and at or above 150 psi, without the addition of makeup water.

4. **Water Distribution System and Service Locating:** Locating system (tracer wire and associated attachments) shall be tested by Jurisdictional personnel to verify operation.

B. Valves shall be located and turned to verify operation. Valve boxes shall be straight and true.

C. Fire hydrants shall be opened and closed to verify operation.