Section 1 – General Information

1.1 Concept

Water main systems are designed to supply users with sufficient water for daily use plus required fire flows at adequate pressure and to maintain the quality of potable water delivered by the treatment plant. It is important in its design to consider maintenance aspects. The performance of a water main depends on the design, construction, and the Jurisdiction's ability to maintain the system at an affordable cost.

Planning considerations related to a new system development or system expansion require the designer to consider factors such as future growth, cost, system layout and water quality. For system layout, all major demand areas should be serviced by an arterial-loop system. High demand areas are served by distribution mains tied to an arterial-loop system to form a grid without dead-end mains. Areas where adequate water supply must be maintained at all times for health and fire control purposes should be tied to two arterial mains where possible. Minor distribution lines or mains that make up the secondary grid system are also an integral part of the grid since they supply the fire hydrants and domestic and commercial consumers.

1.2 Conditions

1. General

   Water main requirements are stipulated by local Water Boards and Water Departments. For uniformity, the Project Engineer should contact the Jurisdictional Engineer if there are questions on where to submit reports, plans and specifications for review and acceptance. All water main projects shall meet the requirements of the Iowa Department of Natural Resources.

2. Plans

   Water main plans shall show all appropriate physical features adjacent to the proposed water main along with horizontal and vertical alignments, services, and hydrant coverage. Other utilities such as sanitary and storm sewers, manholes, etc. shall be shown on the plans with horizontal and vertical separation distances.

3. Design Standards

   The design for water mains shall conform to the following:

   A. Uniform Fire Code or International Fire Code as adopted by Jurisdiction.

   B. Design Standards Manual.

   C. Jurisdiction's Plumbing Code.

D. "Recommended Standards for Water Works" from the Committee of the Great Lakes – Upper Mississippi River Board of State Sanitary Engineers.

E. In case of a conflict between the above standards, the more restrictive requirements shall apply.

4. Construction Standards

Construction standard shall be the most recent revision of the Cedar Rapids Metropolitan Area Standard Specifications and Details.

5. Iowa Department of Natural Resources (IDNR) Project Submittals

Submittals shall be made according to Recommended Standards for Water Works (10 State Standards), Chapter 1.

Construction Permit

Applications for construction permits shall be submitted for review and acceptance. A permit to construct minor water main extensions may be obtained from a local public works department when permitting authority has been delegated to the local Jurisdiction. If a water main extension project meets the following criteria, the local jurisdiction may have authority to issue the permit for the IDNR. The criteria are:

- The project is limited to a water main extension;
- The water main would serve primarily residential consumers;
- The project will not result in an increase in more than 5% capacity of the treatment works; and
- The project will serve no more than 250 dwelling units.

All projects that do not meet all of the above criteria must obtain a permit from the IDNR directly. If the local government has not been designated by the IDNR for issuing a permit, all permit requests must be submitted to the IDNR.

Engineering Report

An engineering report shall be submitted for all water supply projects except minor water main extensions. Engineering reports are required for projects such as water supply sources, treatment plants, storage facilities, pumping facilities, major water main extensions and new water supply distribution systems.

6. Local Project Submittals

The following Jurisdictions or Water Boards have been delegated by the

IDNR to issue permits for minor water main extensions:

Permit Authority	Jurisdiction
Iowa Dept Natural Resources	Marion, Hiawatha
Cedar Rapids Water Dept	Cedar Rapids, Robins

Section 2 – Size Determination

2.1 General

Domestic usage requirements for a service area can be determined either from past records or from general usage figures as provided in Section 2.5. This data should then be adjusted for commercial, industrial, and projected growth factors, to ensure that the system's design capacity will meet future demand.

A factor in sizing main facilities is the need for fire protection. Fire-flow requirements are set by the Uniform Fire Code or International Fire Code as currently adopted by the Jurisdiction. The fire code determines the minimum flow that 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.

2.2 Network Analysis

Pipe carrying capacity depends on pipe size, pressure, pipe roughness and length of pipe. The required pipe size can be calculated when the other requirements and characteristics are known. The Hazen-Williams formula is used for this purpose. Nomographs have been developed for various sizes and types of pipe to help in selecting proper pipe size.

When the distribution system or system expansion is extensive, it will 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 and may be accomplished using the Sparse Matrix Solution, Hardy-Cross Method, Newton-Raphson Method or other recognized methods. Computer programs based upon such methods, when properly calibrated, may also be used to analyze the pipe network and to select new pipe sizes.

2.3 Velocity Requirements

Velocity of flow is also a factor in determining the required pipe size. Velocities at the peak day demand rate should be 5 fps or less, due to high friction losses that occur at greater velocities. This may be difficult to obtain under normal operating conditions, and velocities can significantly exceed this guideline under fire-flow conditions.

2.4 Minimum Criteria

1. Minimum Design Period Requirements: - Water mains shall have a minimum size based on a hydraulic analysis utilizing 20-year design for a specified water demand. The specified water demand will depend on the area to be serviced and the type of water main (transmission, arterial or distribution) and must be confirmed by the Jurisdictional Engineer.

2. Minimum Size Requirements:

   A. Water Service Stub:

      The water service stub within the Jurisdiction's right of way shall be in accordance with the Cedar Rapids Metropolitan Area Standard Specifications and Jurisdiction regulations. The Project Engineer will size the water service stub as necessary to provide adequate design flows. Reference AWWA Manual M22 " Sizing Water Service Lines and Meters" for additional guidance.

   B. Distribution Mains

      All urban water mains shall be sized to provide existing and future domestic, irrigation, commercial, industrial, and fire protection flows to the service area. The minimum water main size shall be eight (8) inches in diameter, unless otherwise approved by the Jurisdictional Engineer. The Jurisdiction reserves the right to size mains adequately to supply future needs.

   C. Arterial or Feeder Mains

      Arterial or feeder mains 12" and larger shall conform to an existing grid pattern or as directed to meet long-range plans of the Jurisdiction system. The Project Engineer must check with the Jurisdictional Engineer on all projects for specifics on arterial or feeder mains.

3. Minimum Pressure Requirements:

   1. The minimum static pressure required at all fire hydrants is 35 psi or higher at peak hour conditions on the day of maximum demand. The Jurisdiction may require stricter requirements in specific situations. The residual pressure required under fire flow conditions should not drop below 20 psi at any hydrant or any point in the system. When static pressure exceeds 100 psi, individual pressure reducing devices may be required.

   2. Refer to Chapter 8, Section 8.11 of Recommended Standards for Water Works (10 State Standards) regarding pressure booster pumps for individual residences or other types of service.

2.5 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. Peak day demands plus fire flow demands must also be met.

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, will not be considered.

   When no actual figure for maximum daily consumption is available it will be estimated on the basis of consumption in other similar service areas. Such estimates will be at least 2.0 times greater than the average daily demand for more than 500 people and 2.5 times greater for 500 people or less. When a system is in two or more service levels, consider the total maximum daily consumption that must pass through the service level being reviewed.

   B. Average Day Demand (Minimum)

   Equation 1: Area x Area Density x Rate = Average Daily Demand

   Equation 2: Number of Units x Unit Density x Rate = Average Daily Demand

Density Table:

LAND USE	AREA DENSITY	UNIT DENSITY	RATE
Low Density (Single Family) Residential	10 people/Ac.	3.3 people/unit	100 gpd
Medium Density (Multi-family) Residential	12 to 15 people/Ac.	3.3 people/unit 6.0 people/duplex	100 gpcd
High Density (Multi-family) Residential	20 to 75 people/Ac.	2.5 people/unit	100 gpcd

If the Project Engineer uses values different than the above table, approval by the Jurisdictional Engineer is required.

Office &Institutional	Special Design Density
Commercial	Special Design Density
Industrial	Special Design Density

Special design densities shall be subject to approval by the Jurisdiction Engineer based on methodology provided by the Project Engineer.

3. Instantaneous Peak Demands

Based on the assumption that the instantaneous peak flows for water supply should be greater than the extreme peak wastewater flow the following has been set as the Instantaneous Peaking Factor:

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.

4. Fire Flows

Fire flows shall be in accordance with Uniform Fire Code Appendix III-A or International Fire Code Appendix B depending upon adopted code of Jurisdiction. The Project Engineer must confirm which code the Jurisdiction currently has adopted.

A. Hydrant Distribution

Hydrant distribution shall be in accordance with the Uniform Fire Code Appendix III-B or International Fire Code Appendix C depending upon adopted code of Jurisdiction. The Project Engineer must confirm what code the Jurisdiction currently has adopted.

Section 3 – Facility Design

3.1 General

Except for well systems, water mains, hydrants and valves will be provided along all streets including connections to and extensions from existing water systems. Figures 3.1 through 3.3 show standard locations for these fixtures.

3.2 Water Mains

1. Water main pipe shall meet the Cedar Rapids Metropolitan Area Standard Specifications.
2. Water mains will be extended to the plat or property boundaries or to the next street or as directed by the Jurisdiction.

3. New main installation shall be located in the parking area (between the curb and the sidewalk) of the right of way.

   A. Cedar Rapids default location shall be 9 feet from the right of way line unless otherwise required by the jurisdictional Engineer.

4. Where it is necessary to install a water main in an easement, the easement width shall be a minimum of 20 feet wide centered on the water main. However, if the water main shares an easement with and is parallel to a sewer, the easement width shall be increased to meet minimum separation requirements from the sewer. Valves and appurtenances should be located near the edge of the easement and within public right-of-way where possible.

5. Dead ends shall be minimized by looping mains whenever possible. Dead ends shall terminate with an approved flushing device (blow off, hydrant, flushing hydrant). They may terminate with an approved fire hydrant when adequate pressure is available at required flows. For maintenance considerations and when adequate fire flows are not available, flushing hydrants may be allowed by the Jurisdiction with the hydrant outlet sized and arranged to prevent the attachment of fire hoses.

6. Water mains and extensions shall be designed with a minimum cover of 5.5 feet for all PVC pipe and ductile iron pipe under twelve (12) inches in diameter, unless otherwise approved by the Jurisdictional Engineer. For ductile iron pipe of twelve (12) inches or larger refer to Section 2500- 3.02 B. of the Cedar Rapids Metropolitan Area Specifications for Public Improvements. Greater depths of cover, surface loading, or unusual trench conditions may require a stronger class of pipe. Where vertical offset must be placed in a main in order to pass under another utility, the length of the deeper main shall be kept to a minimum, and no greater than 45 degree bends shall be considered to effect the desired offset.
7. Tracer wire shall be included in the design of all public water main improvements.
8. Polyethylene wrap shall be included in the design of all ductile iron water mains

3.3 Blowoffs

A valve and blowoff or approved flushing device will be required on all dead end

mains where a hydrant is not installed. The minimum riser assembly size shall be 2 inches. When the water main is extended the blowoff will be removed.

3.4 Valves

1. As a minimum, valves shall be located at intersections, such that no unvalved pipe exists at the intersection. Valves shall be placed at equal spacing where possible, but no greater than 800' apart in residential areas, and no more than 400' apart in high-density areas. Valves in rural areas shall be located at intervals as specified by the Jurisdiction and no greater than 1 mile (DNR).

   A. Where three or more water mains intersect at a street intersection situate valves to include a fire hydrant placed within the grouping of valves to enable uni-directional flushing

2. Valves shall generally be located such they will not be in the sidewalk line or in driveways.

3. Default valve box shall be adjustable screw type. When no option exists to locate valves outside of sidewalks and/or driveways, then a slip type valve box may when approved by the Jurisdiction.

4. Intermediate valve locations between the end of a dead end main and last valved street intersection may be required by the Jurisdiction to provide required valve spacing. A valve shall be installed between the existing main and new main when the main is extended, unless otherwise approved by the Jurisdiction.

5. Connections of new mains to mains in service shall generally be provided with a tapping sleeve and valve under pressure. However, the Jurisdiction may require a cut-in tee or cross when additional main line valves are requested at the connection point. Requirements for taps are specified in Section 2500-2.08D and 3.09 of the Cedar Rapids Metropolitan Area Specifications for Public Improvements.

3.5 Hydrants

1. The connecting pipe between the supply main and the hydrants shall be a minimum six inches in diameter and be equipped with an auxiliary valve. Fire hydrants shall not be installed on water mains not providing minimum pressure.

2. Hydrant drains will not be connected to or located within 10 feet of sanitary sewers or storm sewers as required by the Iowa Department of Natural Resources (DNR).

3. Locations of fire hydrants are governed by the rules and regulations of the

IDNR 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 return. Locate fire hydrants outside street paving returns. Avoid conflicts with storm sewers, intakes, driveways and sidewalks. Whenever possible, locate fire hydrants at the high point of the intersection.

B. Locate fire hydrants between street intersections to provide spacing of not more than 500 feet in single-family residential districts. Refer to applicable fire code for hydrant spacing in other types of districts.

Vary spacing 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. If a fire hydrant is installed at a high point and the size of the water main is greater than eight (8) inches, an air relief assembly shall be installed in addition to the fire hydrant.

When street curvature or grid patterns place a proposed protected structure at an unusual distance from the fire hydrant, the coverage radius shall not exceed 300 feet in single-family residential districts and 150 feet in all other districts. The Jurisdiction's Fire Chief may have additional private site fire protection requirements.

Hydrants shall be situated or turned such that the steamer nozzle faces the street.

C. Locate hydrants outside of the roadway clear zone. See Chapter 5.

4. On cul-de-sac streets, the hydrant shall be located at the entrance of the cul-de-sac. For maintenance purposes, Jurisdictions may require a hydrant at the end of all cul-de-sacs, or the following shall apply.

A. For cul-de-sacs between 200' and 400' in length, a hydrant shall be at either the mid-block or at the end of the cul-de-sac, depending on Jurisdictional requirements.

B. For cul-de-sacs greater than 400' in length, hydrants should be placed at near equal spacing. Refer to the applicable fire code for maximum distance from any point on street or road frontage to a hydrant. The Jurisdiction may exercise the option of placing a hydrant at the end of the cul-de-sac.

5. Design hydrant connection tees and hydrant lead piping at appropriate depth of bury to avoid the need for barrel extensions.

3.6 Water Services

1. Water service stub for each building or platted lot will be required, including corporation cock, service line and curb stop (shut off) with box. Exceptions may be made for service stubs in commercial developments on the same side of the street as the main. If it is probable that the size or location of required commercial service may change, and subject to jurisdiction's approval, installation of the stub should be deferred until site development plans are approved. Note that the Jurisdiction may require that unused service stubs be cut off at the main at the owner's expense. The service stub from the water main to the shut off will be within the right-of-way per local Jurisdictional requirements. In no case will the shut off be in the sidewalk or driveway. Requirements for water service stubs for Cedar Rapids Jurisdiction are specified in Chapter 12, Section 12.06 through 12.14 of Cedar Rapids Municipal Code.

2. Each building shall be provided with a separate service line shut off valve located outdoors in an area accessible to Jurisdiction's authorized personnel.

3. Where a single building houses multiple tenant spaces, the service to each space shall be separately valved and metered in a common mechanical space where individual shut off valves and meters are accessible to Jurisdiction's authorized personnel without need of a key for access. If such access cannot be provided, then individual shut off valves shall be provided outdoors per section 2 above.

3.7 Protection of Water Mains (DNR)

Separations of water mains from gravity sewers, force mains, and manholes are specified in Chapter 8, Section 8.8 of Recommended Standards for Water Works (10 State Standards).

3.8 Water Crossings

Requirements for surface water crossings and underwater crossings are specified in Chapter 8, Section 8.9 of Recommended Standards for Water Works (10 State Standards).

3.9 Air Relief Facilities

1. Water mains shall be laid to avoid high points where air can accumulate. Air relief valves should be located at all high points where air can accumulate. Requirements for air relief facilities are specified in Chapter 8, Section 8.5 of Recommended Standards for Water Works (10 State Standards). For water mains eight (8) inches in diameter or less, a fire hydrant may be placed at a

high point in lieu of an air relief valve. Where a new water main extension is to be installed downgrade from an existing isolation valve, an air release assembly must be provided to enable the initial fill of the new main.

2. One (1) inch taps and air release assemblies will be sufficient on water main up to and including sixteen (16) inch diameter. Two (2) inch air releases are to be specified for larger mains.

3. Where the local Jurisdiction approves disinfection by the direct chlorine injection method the design must include a chlorine injection tap immediately on the new construction side of each isolation valve. Injection taps may be utilized as permanent air release assemblies where permitted by the jurisdictional Engineer. Where such use is not approved, the injection tap shall be removed, and the tap plugged upon completion of the disinfection process.

3.10 Chambers

Requirements for chambers are specified in Chapter 8, Section 8.6 of Recommended Standards for Water Works (10 State Standards).

3.11 Backflow Prevention

All private/non-municipal water systems shall be equipped with a suitable backflow preventer in compliance with the Jurisdiction where they are connected to the public Water Supply System. Requirements for backflow prevention for Cedar Rapids Jurisdiction are specified in Chapter 12, Section 12.33 of Cedar Rapids Municipal Code.

3.12 Special Requirements For Fire Protection Systems

An approved backflow prevention device of the type designated shall be installed on each fire protection service to any premises where the fire protection system contains any of the following components unless the water utility determines that no real or potential health, pollution, or system hazard to the public water system exists.

All fire protection systems will require a minimum protection of a testable double check valve assembly.

Fire protection systems having any of the following will require a reduced pressure principle backflow preventer:

1. Direct connection from public water mains with an auxiliary water supply on or available to the premises for pumper connection;

2. Interconnected with auxiliary supplies such as pumps taking suction from reservoirs exposed to contamination, or rivers and ponds; driven wells; mills or other industrial water systems;

3. Where antifreezes or other additives are used;

4. Combined industrial and fire protection systems supplied from the public water mains only, with or without gravity storage or pump suction tanks;

5. Any other facility, connection, or condition which will, in the opinion of the water utility, create a health hazard.

Those fire protection services requiring double check valve assemblies will be required to be brought into compliance when they are upgraded.

3.13 Thrust Restraint

1. Provide concrete thrust blocks at points where piping changes directions. Bearing area of thrust blocks shall be based on 2,000 psf soil pressure. Guidelines for thrust restraint are shown in Detail 2500-021 of the Cedar Rapids Metropolitan Area Standard Details for Public Improvements.

2. Mechanical joint retainer glands and / or CorTen steel threaded rod restraints may be used where concrete thrust blocks are impractical. Method of restraint is subject to Jurisdiction's approval.

3. At dead ends where future extension is likely, provide sufficient length of restrained joint pipe and fittings n lieu of thrust blocks as approved by the Jurisdictional Engineer. Design of restraints shall consider forces that must be resisted when the dead end is excavated for future extension of the main. Appropriate length of restrained pipe must be determined in consideration of system pressure, soil type, laying conditions, depth of bury, and polyethylene wrap. Where restrained section is less than three full pipe lengths, mechanical joint pipe / fittings with restraining glands will be acceptable. Gripper gaskets may be specified only with permission of the Jurisdiction. Manufacturer's standard restrained joint pipe shall be specified for longer restrained sections.

3.14 Railroad Crossings

The railroad company involved will determine when a water main can be installed under railroad tracks. The casing pipe shall be steel if jacked under the tracks and shall be a minimum of six inches in diameter greater than the carrier pipe, or as required by the railroad. The casing pipe shall extend a minimum of 25 feet from the outer rail of the railroad tracks.

3.15 Flushing, Disinfection, and Pressure Tests

New mains will not go into service until they have been adequately flushed, pressure tested and disinfected according to the Cedar Rapids Metropolitan Area Standard Specifications and the Iowa Department of Natural Resources. The procedures shall be conducted under the supervision of the Jurisdiction. Special precautions for de-chlorination may apply while flushing in environmentally

sensitive watersheds. Consult with the Jurisdiction to verify requirements.

3.16 Abandonment of Existing Water Main/ Service Lines

Requirements for water main and water service line abandonment are specified in Section 2500- 3.17 through 3.18 of the Cedar Rapids Metropolitan Area Standard Specifications for Public Improvements.

3.17 Design Reference Material

1. Iowa Department of Natural Resources Design Standards
2. American Society of Civil Engineer Books and Manuals
3. American Water Works Association Standard, Three Volumes
4. Recommended Standards for Water Works (10 State Standards)
5. Environmental Protection Agency Guidelines
6. Uniform Fire Code or International Fire Code depending on the currently adopted Jurisdiction code.
7. AWWA Manual of Practice M22 Sizing of Water Service Lines and Meters