FORT COLLINS UTILITIES

Water and Wastewater Design Criteria Manual

Effective: May 1, 2026

City of Fort Collins

Fort Collins Utilities Water and Wastewater Design Criteria Manual

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SECTION 1 – GENERAL PROVISIONS

1.01 INTENT

A. These Design Criteria, hereinafter referred to as the "Criteria", shall be known as the Fort Collins Utilities (FCU) Water and Wastewater Design Criteria and shall be the governing Criteria for the public water distribution and wastewater collection improvements that are designed and installed in conjunction with the City's development review process and are within areas wherein FCU owns and operates such systems.

B. These Criteria, with all future amendments, establish minimum design standards for providing and maintaining the public water distribution and wastewater collection systems. Whenever the requirements of these Criteria are found to be inconsistent with any other adopted standards, regulations, or codes, the more restrictive criteria, standards, regulations, or codes shall control.

C. The Design Engineer is responsible for compliance with these Criteria as well as other applicable design and construction standards in the preparation of engineering and construction documents for review and acceptance by FCU. The provisions of these Criteria are minimum requirements that do not preclude the use of more restrictive standards by the Design Engineer.

D. The design of all public improvements shall be by or under the direction of a Professional Engineer duly registered and licensed by the State of Colorado.

E. Adherence to these Criteria does not remove the Developer's responsibility to investigate and obtain any other regulatory permits or approvals from local, regional, state, or federal agencies that may be required for a particular project.

1.02 REVISIONS AND UPDATED CRITERIA

The Criteria may be amended as new technology is developed or as a need for revision is demonstrated and proven through experience and use. FCU will maintain these Criteria and any amendments thereto and will post these Criteria and amendments on the City's website. FCU does not keep a database of holders of these Criteria. It shall be the responsibility of each holder to verify the most current Criteria are being used for any Development Project.

1.03 OTHER RELATED STANDARDS

A. Chapter 26 of City Code and these Criteria set forth the minimum standards for designing public improvements in the FCU water and wastewater service areas.

B. All public water and sanitary sewer improvements shall comply with the FCU plans for the water distribution system and wastewater collection system.

C. Materials and installation of the water and wastewater improvements shall comply with FCU's Development Construction Standards.

D. The Planning Department administers the Fort Collins Land Use Code which defines the various processes required for development projects within the City.

E. Engineering Development Review administers the Larimer County Urban Area Street Standards (LCUASS) which set forth standards for certain public improvements within City R.O.W. and public easements.

1.04 DEFINITIONS

AASHTO – American Association of State Highway and Transportation Officials.

AWWA – American Water Works Association.

City - City of Fort Collins.

City Code - The latest officially adopted City Code of Fort Collins, Colorado

Collection Main – The portion of the wastewater system that conveys wastewater to the trunk mains and is located on a neighborhood scale. A collection main is a pipe size of 12 inches or smaller.

Contractor - A person, partnership or corporation duly licensed and bonded in the City of Fort Collins in accordance with the requirements of the City Code.

Control Valve - A FCU-owned valve located on a water or fire service where the transition from public to private ownership occurs.

CP – Cathodic Protection or Cathodically Protected.

Design Engineer - The partnership, corporation, or individual who is registered as a Professional Engineer according to Colorado Statutes, who is hired by the Developer/Owner to conduct engineering design services and who may be empowered by the Developer/Owner to act as his/her agent for the project.

Developer or Developer/Owner – This includes the person or persons, public or private, legally responsible for construction of improvements within a specific development.

Development Construction Standards – The manual which includes specifications for water, wastewater, and stormwater infrastructure construction.

Development Project – The development of any site or lot located in the City of Fort Collins.

DI / DIP – Ductile iron / ductile iron pipe.

Distribution Main – The portion of the water system that conveys water from the transmission mains for use at a neighborhood scale. A distribution main is a pipe size of 12 inches or smaller.

Easement – A right granted by the fee title owner permitting all or part of the land to be used by others for specific use or purpose.

FCU – Fort Collins Utilities

FDP (Final Development Plan) – Final plans submitted after the public hearing as outlined in the City's development review process.

GPM – Gallons per minute.

HDPE – High-density polyethylene.

Inspector - The authorized representative of the City assigned to make detailed inspections for contract performances, standards, and contract compliance.

Interceptor Main – Typically, a sanitary sewer main 24 inches in diameter or larger used to divert sewage in high flow situations.

LCUASS – Larimer County Urban Area Street Standards.

May - A permissive condition. No requirement for design or application is intended.

MJ – Mechanical joint.

Non-Potable – Water that is not treated to drinking water standards. Such is not suitable or intended for human consumption.

Owner – Any person having title or rights of ownership in the surface of real property.

PDP - Project Development Plan

Professional Engineer – A registered engineer licensed by the State of Colorado with expertise and qualifications in the areas covering the scope of work.

PSI – Pounds per square inch of pressure.

PVC – Polyvinyl chloride.

Record Drawings - Detailed drawings which have been prepared by a Professional Engineer registered and licensed by the State of Colorado, upon completion and prior to final acceptance, and show actual construction and contain field dimensions, elevations, details, changes made to the construction drawings by modification, details which were not included on the construction drawings, and horizontal and vertical locations of underground utilities which have been impacted by the utility installation. Record Drawings are usually construction drawings which have been modified to contain the information listed above.

R.O.W. or **Right-of-Way** - A general term denoting land, property, or interest therein, usually in a strip acquired for or devoted to a street or utility.

Sanitary Sewer Main – Collection, trunk, or interceptor main.

Sewer – In these Criteria, sewer shall refer to sanitary sewer.

Shall - A mandatory condition. Where certain requirements in the design or application are described with "shall", it is mandatory that these requirements be met.

Should - An advisory condition. Where the word "should" is used, it is considered to be advisable usage, recommended be not mandatory. Deviations may be allowed when reasons are given which show that the intent of the standard is met.

Street - A general term denoting a public way for purposes of vehicular travel, including the entire area within the R.O.W. (including alleyways).

Storm Drain - Any conduit and appurtenance intended for the reception and transfer of stormwater.

Transmission Main – Typically, a water main 16 inches in diameter or larger used to convey water to the distribution system

Trunk Main – Typically, a sanitary sewer main 15 inches in diameter or larger used to convey sewage to the wastewater treatment plant.

Utility Plans - Details and working drawings including plan, profile and detail sheets of proposed improvements for any Development Project approved by FCU.

Utility Standard Construction Details – Standard construction details for water, wastewater, and storm water infrastructure.

Water Main – A distribution or transmission main.

1.05 VARIANCES

A. Any design that does not conform to these Criteria must be approved by the FCU Engineering Infrastructure Senior Director, or such other persons designated by the FCU Executive Director. Variances from these Criteria will be considered administratively on a case-by-case basis following a written request for a variance prepared by a Professional Engineer and submitted to the FCU One Water Development Review Manager. To assist with plan preparation, designers may submit variance requests, along with documentation to support the variance, for informal advisory consideration prior to formal submittal of utility plans. Such advisory consideration shall not be binding on FCU but may help guide the designer in the preparation of plans.

B. Variances requested as part of the formal submittal of utility plans shall be shown on the plans and shall also be specifically substantiated and justified in a letter addressed to FCU Water Utilities Development Review Manager. A summary of all approved variances shall be listed in the general notes on the approved plans.

C. The variance request shall include, at minimum, the following:

    1. Identifying Issue: Identification of the standard to be varied and the reason that the standard is not feasible or not in the public interest.

2. Proposed Alternate Design: Identification of the proposed alternate design or construction criteria.
3. Comparison to FCU Criteria: A thorough description of the variance request including the impact on capital and maintenance requirements, costs, and how the proposed design compares to the Criteria.
4. Justification: The Professional Engineer must determine and state that the variance will not: be detrimental to public health, safety, and welfare; reduce the design life of the improvement; or cause FCU additional maintenance costs. The proposed plan must advance the public purpose of the Criteria sought to be varied equally or better than would compliance with these Criteria.

D. Approval or Denial of Variance: Based upon review of the utility plans and additional information submitted and an analysis of the process set forth in this Subsection 1.05 C., the FCU Engineering Infrastructure Senior Director, or such other persons designated by the FCU Executive Director, may approve, approve with terms and conditions, or deny the variance request if they determine and find that the standards of Subsection 1.05 C 4 are met. If the request is approved or approved with terms and conditions, the plans will continue to be reviewed and approved within the typical review process. If the request is denied, the Developer shall subsequently submit revised plans in compliance with these Criteria. A written response outlining the basis for all approvals, approvals with terms and conditions, or denials of variance requests will be provided by the FCU.

1.06 ENFORCEMENT AND INSPECTION

A. These Criteria are enforceable by the City at any point in the City's development review process, including installation and inspection of the public improvements.

B. Inspection services during construction are provided by FCU.

1.07 PUBLIC WATER AND WASTEWATER EXTENSION AND OVERSIZING

A. As set forth in City Code Section 26-369 (d), Developer shall install water mains and sanitary sewers to the farthest point or points of the property to be served when in the opinion of the FCU such extension is desirable to provide for future extensions of the water and wastewater systems.

B. If FCU requires a Developer to install water mains and sanitary sewers for a subdivision or development of a size or capacity greater than necessary to serve the new development, if greater than the minimum size required as outlined in this Manual, FCU will pay the extra expense caused by the oversizing pursuant to City Code. See, e.g., City Code Sections 26-371, 26-372.

1.08 EASEMENTS

A. All City-owned public utilities, including water and wastewater facilities, shall be located in public R.O.W. or public utility easement.

B. Minimum easement widths are listed in the table below. In certain limited situations when a sanitary sewer is less than 10 feet deep, the sanitary sewer easement width **may** be reduced

to 20 feet if approved by FCU with the variance procedure outlined above. At the discretion of FCU, wider easements may be required where the depth of a utility or the number of utilities occupying the easement necessitates additional width to satisfy standards for utility separations, trenching excavations, maintenance access, and safety.

Minimum Easement Requirements for Water Mains and Sanitary Sewer Mains

Utility	Minimum Easement Width
Water Main	20 feet (centered on the main)
Sanitary Sewer Main	30 feet (centered on the main)
Combined Water and Sewer	35 feet

SECTION 2 – UTILITY PLAN AND RECORD DRAWING REQUIREMENTS

2.01 GENERAL

A. Utility plans for public water and wastewater improvements shall be prepared and submitted in accordance with these Criteria.

B. To assist with preparation of the utility plans, Appendix A includes a checklist outlining the information required. Refer to the checklist for additional requirements. This checklist is required to be completely filled out by the Engineer who prepared the Utility Plan and submitted with the Utility Plan submittal.

C. As a minimum, the utility plan set shall include:

1. Cover sheet

2. General and construction notes

3. Overall utility plan

4. Plan and profile sheets as required

5. Applicable standard construction details

2.02 UTILITY PLANS

A. Refer to Utility Plan Checklist in Appendix A for Project Development Plan (PDP) and Final Development Plan (FDP) submittal items.

B. Scale on the plan views shall be 1 inch = 20 feet, 30 feet, 40 feet or 50 feet. These sheets may also include details and designs for lowerings, crossings or special items to clarify the intent of the information shown on that particular sheet.

C. Plan and profile sheets are required for all water mains and for all sanitary sewer mains. On minor projects, the water main profile may be omitted if approved by the FCU. A specific profile view or design detail shall be included for each lowering or crossing as noted in Section 3.06 G. of these Criteria.

D. All projects must use benchmarks documented in the current City of Fort Collins vertical control network. Assumed vertical datums or adjustment equations are not allowed.

E. All construction or sequence phasing shall be clearly noted such that each phase is depicted in a “stand alone” manner. In some cases, water mains or sanitary sewers may be required to extend beyond a particular phase to provide acceptable redundancy for water or discharge points for sewer. In these cases, the plan sheets shall clearly show the applicable phase lines, design, details, R.O.W., easements, etc. to accommodate such extensions beyond a particular phase.

F. On plan and profile drawings, longitudinal stationing based upon centerline of main shall be included for all water and sanitary sewer mains and related appurtenances (e.g. service connections, valves, fittings, fire hydrants, manholes, vaults, blow-offs, air release/vacuum valves, etc.). Stationing for water mains shall generally read in ascending order in the direction of the north arrow or from left to right and for sanitary sewers shall be from downstream to upstream.

G. Existing structures, wet and dry utilities, and ground surfaces shall be included on all plan views (shown as phantom lines and shapes). These existing items shall be dimensioned in a manner that clearly shows the relationship to the proposed water mains and sanitary sewers. This shall include:

1. All water, wastewater, storm drainage, electric, cable television, communications lines, and any related appurtenances.

2. Drainage and irrigation ditches or swales

3. Fence lines and gates

4. Bridges and culverts

5. Curb lines and other roadway features

6. Existing landscape features

7. Other items required by FCU

8. FCU requires pothole locate information for utility main crossings, unless otherwise directed by FCU. This information shall be documented on the Utility Plans.

2.03 WATER SYSTEM PLANS

A. The following shall be clearly shown and labeled:

1. Pipe material, diameter, lengths between fittings, valves, fire hydrants, and appurtenances, etc.

2. All fittings and water main appurtenances

3. Services with size and control valve locations

4. Location and size of all water meter pits and vaults

5. Casings including material, diameter, thickness, and length

6. All lowerings and vertical sweeps

7. Match lines with sheet numbers

8. Phase lines

9. Hatching or labeling to indicate beginning and end of all portions of the water main being restrained with restrained lengths clearly shown and labeled

B. Water main profiles shall include the following:

1. Existing ground profile shown as dashed line

2. Proposed ground profile shown as solid line

3. All items required in Subsection 2.03 A. of these Criteria with longitudinal stationing and design elevations for each item noted

4. Depths of water main relative to proposed ground profile

5. All utility crossings (existing and proposed) with longitudinal stationing and elevations noted

5. Groundwater barriers based upon groundwater levels

2.04 WASTEWATER SYSTEM PLANS

A. The following items shall be clearly shown and labeled:

1. Size, type, and class of all portions of sanitary sewer with lengths between manholes

2. Manholes with diameter, longitudinal stationing, and any special features

3. Service lines with diameter and longitudinal stationing

4. Casings with material, diameter, thickness or class of pipe, longitudinal stationing of beginning and ending points

5. Sewer joint encasements and longitudinal stationing

6. Grease interceptors

7. Sand and oil interceptors

8. Match lines with longitudinal stationing and sheet numbers

9. Phase lines with longitudinal stationing

B. Profiles are required for all sanitary sewers and shall include the following:

1. Existing ground profile shown as dashed line

2. Proposed ground profile shown as solid line

3. All items required in 2.04 A. of these criteria with the design elevations of each item noted

4. All manhole rim and inflow/outflow invert elevations

5. All utility crossings (existing and proposed) with elevations noted

6. Pipe joint encasements with type of encasement and longitudinal stationing noted

7. Groundwater barriers based upon groundwater levels

2.05 UTILITY STANDARD CONSTRUCTION DETAILS

A. A copy of each applicable Utility Standard Construction Detail shall be included on the Utility Plan detail sheet. All construction details by FCU and shall not be altered without first obtaining written approval from the FCU.

1. If alteration is approved by FCU, the construction detail must clearly show "Revised – *Project Name*" in bold letters near the title block of the detail.

B. All other non-standard details (e.g. lowerings, special construction items, crossings, etc.) shall be included on the appropriate plan or plan and profile sheet.

C. Lists of the Utility Standard Construction Details are available on the City of Fort Collins website.

2.06 FINAL UTILITY PLANS

A. An electronic version, in a format acceptable to the City, of the final utility plans shall be provided to FCU at the time of Utility Plan approval. The electronic plans shall include all approval signatures and Design Engineer's seal and signature.

2.07 RECORD DRAWINGS

A. Utility plans shall be updated per the currently approved Development Construction Standards with all design and construction changes that occurred after plan approval.

B. Record drawings shall be prepared with a cooperative effort of a Professional Engineer and the Contractor as follows:

1. Document dimensions, grades/slopes, lengths, elevations and details that in the opinion of FCU were substantially different from the approved utility plans.

2. Include horizontal and vertical locations of underground utilities not shown on the original approved utility plans.

3. Drawings are prepared in a manner that shows changes legibly and denotes the change by clouding or similar means to clarify the change or revision that was made.

4. Drawings are clearly labeled RECORD DRAWING in bold font and be signed and sealed by the Professional Engineer.

5. Submit one copy to the FCU Inspector for review and approval.

C. Following approval of the Record Drawings, the Professional Engineer completing the Record Drawings shall provide the following to FCU: Horizontal coordinates, elevations, utility linework and other pertinent information for the purposes of FCU revising and maintaining the utility mapping system.

SECTION 3 – WATER DISTRIBUTION DESIGN CRITERIA

3.01 GENERAL

These Criteria typically apply to water distribution mains 12-inch diameter and smaller. Mains 16-inch diameter and larger are considered transmission mains. If a development project includes any construction of or modification to a transmission main, contact the FCU for design and construction requirements.

3.02 WATER DEMAND ANALYSIS REPORT

In conjunction with the City's development review process, FCU requires the Design Engineer to submit a water demand analysis report for all multi-unit and commercial development at the time of PDP. FCU will determine the outline and scope of the report.

3.03 WATER SYSTEM MODELING

If, during the development review process, FCU determines that a hydraulic is needed for proper sizing of water mains, FCU will assist with the necessary modeling to evaluate the proposed project and associated demands with detailed information provided by the Design Engineer.

3.04 FCU WATER SERVICE AREA

A. FCU provides water service to a portion of the area inside City limits and areas beyond City limits including parts of the community of Laporte, Colorado. Service areas are subject to change and inquiry with FCU is needed to confirm the boundaries at time of development. (See Water Utility Service Areas Map in Appendix B for a map current as of the date of the adoption of this manual.)

B. Other portions of Fort Collins receive water service from the following water districts:

East Larimer County Water District (ELCO)
232 S Link Lane
Fort Collins, CO 80524
Telephone: 970-493-2044

Fort Collins-Loveland Water District
5150 Snead Drive
Fort Collins, CO 80525
Telephone: 970-226-3104

Northern Colorado Water Association
4389 E Co Rd 70
Wellington, CO 80549
Telephone: 970-568-3975

Sunset Water District
Telephone: 970-491-3237

West Fort Collins Water District
2711 N Overland Trail
Laporte, CO 80535
Telephone: 970-484-4881

C. When designing water main extensions, it is important to identify water main ownership and to avoid designing and constructing mains which would interconnect with these various utilities.

3.05 PRESSURE ZONES

Within the FCU water service area, there are two pressure zones. The Foothills Pressure Zone is located in the western part of the city and extends northwest to the Laporte, Colorado area. The Primary Pressure Zone covers the remainder of the Fort Collins Utility's water service area. (See Water Pressure Zones Map in Appendix B) It is important to avoid interconnecting water mains serving the two distinctly separate pressure zones.

3.06 WATER DISTRIBUTION SYSTEM DESIGN AND LAYOUT

A. General

1. Each development shall have redundant routing of water supply to provide a combination of adequate fire flow, uninterrupted customer service, and acceptable water quality. Redundancy is typically achieved by making at least two separate and distinct connections to the existing public water system. Based upon the magnitude and water demands of a proposed development project, FCU may require a greater number of connections.

2. All Distribution Mains shall be looped into the existing and proposed public water system to ensure at least two feed sources and to maintain system reliability except where allowed as follows. Permanent dead-end mains are discouraged and will only be allowed with approval from the FCU. The most common exceptions are cul-de-sacs. If FCU authorizes a dead-end main (temporary or permanent), there must be a fire hydrant at the end for flushing. Where allowed, the length of permanent dead ends shall be limited to a maximum of 660 feet.

3. Additionally, it is critically important within each development that the site layout be designed in a manner that accommodates acceptable access for maintenance and replacement of the system by FCU, including adequately designed all-weather access for mains installed outside of a public roadway. Access shall be designed with a minimum width of 15 feet and driving surface shall be constructed with asphalt, concrete, or compacted road base to support maintenance trucks weighing at least 80,000 lbs. The Design Engineer shall also make adequate provisions for utility separation requirements and easements outlined in these Criteria.

B. Hydraulic Parameters

1. Pressure – The distribution system shall be designed to provide a minimum pressure of 40 psi under maximum hour demand flow and a residual pressure of 20 psi at ground surface elevation under maximum demand condition plus fire flow required by Poudre Fire Authority.
2. Velocity – All water mains (with the exception of fire hydrant laterals) shall be designed for a maximum velocity of 10 feet per second at peak hour demand plus design fire flow.

C. Water Main Size

1. Allowable Distribution Main Sizes: 6, 8, and 12 inch. Minimum size is typically 8-inch with the exception of short cul-de-sacs and fire hydrant laterals which typically are 6-inch.

2. Section Lines and Quarter Section Lines: Minimum size is 12-inch unless a larger main is included in FCU plans.

3. All public water main sizes shall comply with the FCU Plans.

4. Plan and profile drawings are required in the utility plans for all water mains. On minor projects, the water main profile may be omitted if approved by the FCU.

D. Pipe Material

1. Water mains shall be polyvinyl chloride (PVC) pipe in accordance with AWWA C900.

2. If FCU directs the use of ductile iron pipe (DIP), water mains shall be cement-mortar lined ductile iron pipe (DIP) in accordance with AWWA C100

3. All ductile iron pipe (DIP) shall be installed with polywrap in accordance with AWWA C105.

4. All polyvinyl chloride (PVC) pipe shall be installed with tracer wire.

E. Alignment

1. Within platted streets, sanitary sewers are typically on the centerline of the street and water mains are a minimum of 10 feet from the sanitary sewer. In addition, the water main shall be a minimum of 5 feet from the face of curb.

2. Straight Alignment - In general, water mains shall be laid with straight alignments with manufactured, ductile iron, mechanical joint bends.

3. Curved Alignment – If allowed, water mains installed in curved portions of street R.O.W.s or easements may be designed utilizing pipe joint deflection.

    a. DIP – Pipe joint deflection for DIP shall not exceed 80% of the manufacturer's recommended allowable joint deflection.

b. PVC – Pipe joint deflection for PVC pipe shall not exceed 1 degree per section of pipe. Bending of the pipe is not allowed.

F. Water Main Depth

Normal depth of cover for all distribution mains is a minimum 4.5 feet to a maximum of 5.5 feet measured from finished grade to top of water main. Depths of cover outside of this range require approval from the FCU. If FCU authorizes less than 4.5 feet of cover, the Design Engineer must design the thickness and extent of the insulation to be provided to mitigate the shallower depth of cover and include a detail showing the placement and dimensions of the insulation and the specifications for the insulation which is suitable for underground applications.

G. Lowerings

1. In cases where the normal water main depth results in a conflict with other utilities, the water main shall be lowered to mitigate the conflict. Combination air valves shall be required at high points that are created by the lowering of 12-inch and larger water mains and may be required on smaller mains at the discretion of FCU.

2. When the lowering is crossing below another pipeline 18-inch or larger, a bank of multiple pipelines or a box culvert, the water main shall be installed in a casing. Refer to Section 3.06 P. of these Criteria for details regarding the casing materials.

    a. Casing shall extend a minimum of 10 feet beyond each side of the pipeline or other utility above.
    b. 18” of vertical separation is required between the top of the casing pipe and the bottom of the other utility.
    c. Water main shall be restrained through the casing utilizing restrained joint pipe or approved joint restraint devices. The use of tie-rods is not allowed.
    d. Isolation valves are required at both ends of these lowerings 40 feet back from the end of the casing and shall be restrained in accordance with the FCU Development Construction Standards Section 02713 to prevent the valve from “blowing off” when the piping in the lowering area is disassembled for repair or replacement.
    e. No services or connections are allowed between the isolation valves.

3. All lowerings are subject to the clearance standards contained in these Criteria.

4. Lowerings may be designed utilizing manufactured bends or pipe joint deflections.

    a. Manufactured bends shall be mechanical joint fittings restrained by approved mechanical joint restraints with restrained lengths in accordance with the FCU Development Construction Standards Section 02713.
    b. Pipe joint deflection for DIP shall not exceed eighty percent (80%) of the pipe manufacturer’s recommendation for maximum joint deflection.
    c. Pipe joint deflection for PVC pipe shall not exceed one degree per section of pipe. Bending of the pipe is not allowed.

5. All lowerings shall be labeled on the utility plans

6. When fittings are used, a detail for each lowering is required on the utility plans showing size and elevation of both utilities, fittings, valves, distance between fittings, casing diameter and thickness (if applicable) and other pertinent information.

7. When pipe joint deflection is used, indicate on the utility plans the water main station where the deflection starts and ends.

8. Valves may be required at both ends of lowerings other than those noted in Section 3.06 G. 2. D. and, if required, shall be restrained or located sufficiently back from lowering to prevent the valve from "blowing off" when the piping in the lowering area is disassembled for repair or replacement.

9. No water services, fire hydrants, or fire lines shall be connected to the water main within the lowering area.

H. Connections to Existing Distribution System

1. FCU seeks to achieve a reliable and redundant water supply for its customers and to minimize interruptions of service. A service interruption for the purpose of installing a new water main connection to the existing distribution system must be closely coordinated with and approved by FCU. Each request for a service interruption will be evaluated from the standpoint of the impacts on customer water needs, water quality, fire protection requirements, and other pertinent factors that may arise for a particular development proposal.

2. Connections to the existing system may be made by installing a wet tap or by cutting in a tee. The preferred approach is to install a wet tap. Each connection will be reviewed by FCU to determine which method will be required.

3. At the discretion of FCU, a valve may be required at each new connection point to allow for isolation from the existing system.

I. Valves

1. Gate valves shall be used on all mains up to and including 12-inch.

2. Butterfly valves shall be used on all mains 16-inch and larger and shall be installed in a valve vault. See Utility Standard Construction Details for butterfly valves.

3. Valves are required at all crosses and tees. The minimum number of valves at these locations is generally the number of connections minus one. For example, a cross fitting has four connections; therefore, the design should include a minimum of three valves.

4. No more than 600 feet of water main shall be located between isolation valves. On transmission water mains with no service connections, valve placement will be evaluated on a case-by-case basis.

5. No more than one fire hydrant shall be located between isolation valves.

6. Valves are required on both sides of stream crossings, railroad crossings and bored crossings. Valves shall be located back from the crossing or restrained in such a manner as to prevent the valve from "blowing off" when the pipe is disassembled between the valves for maintenance or replacement. No water services shall be connected to the water main between these valves.

7. Valves may be required on both sides of water main lowerings (See Section 3.06 G. of these Criteria).

8. FCU may require installation of additional valves not shown on the plans when determined necessary in the field with coordination of the Owner/Developer and/or Design Engineer.

9. Valves shall be located to provide maximum accessibility and shall not be placed in areas subject to routine parking and storage operations.

10. Combination air valves are required at high points on all water mains 12-inch and larger and at all other locations as required by FCU.

J. Fire Hydrants

1. All fire protection, fire flow, and fire hydrant requirements are subject to the approval of the Poudre Fire Authority.

2. Hydrant Spacing
   a. For single-unit residential developments, maximum distance between hydrants shall be 800 feet.
   b. For multi-unit residential & commercial developments, maximum distance between hydrants shall be 600 feet.
   c. Where water mains are extended along streets through areas that will not be developed (open space, parks, etc.), hydrants shall be provided at spacing not to exceed 1,000 feet.
   d. In all cases, the distance measured is on the path of vehicle travel.

3. Hydrants shall be located at intersections whenever possible. Mid-block hydrants shall be installed at the extension of a property line at a location that avoids conflicts with dry utility service lines.

4. Fire hydrants shall be placed at the end of all cul-de-sacs. The hydrant valve shall be located in the paved street a minimum of 5 feet from the curb and gutter. The hydrant,

gate valve, all pipe joints and fittings from the hydrant to a point a minimum of 100 feet upstream of the valve shall be restrained in accordance with the FCU Development Construction Standards.

5. Hydrants laterals must be restrained at connection to main (swivel tee with gate valve or wet tap with gate valve), at hydrant and at all joints between the distribution main and the hydrant with approved joint restraint devices.

6. Fire hydrant assemblies are required on all permanent or temporary dead end water mains. The hydrant lateral shall be at a right angle to the distribution main installed with a swivel tee. See Utility Standard Construction Details for fire hydrant installation.

7. A 4-foot radius in all directions around the hydrant shall be free of all obstructions.

8. Where hydrants are vulnerable to vehicular damage, hydrant shall be protected by fire hydrant guard posts if directed by FCU.

9. All fire hydrants to be installed with bury line stem matching finished grade.

10. Hydrants shall be located within the public R.O.W. or utility easement.

K. Thrust Restraint

1. The method of thrust restraint shall be accomplished by restraining pipe joints and fittings with approved joint restraint devices on all water main fittings and appurtenances to provide reaction support due to unbalanced thrust forces. The minimum required restrained joint lengths shall be in accordance with the FCU. The Design Engineer is responsible for determining the minimum lengths listed in the standard details are adequate to provide the necessary thrust restraint for situations encountered on the project.

2. The basis for the restrained joint length calculations is listed on the Utility Standard Construction Details. If the circumstances are different than those listed, the Design Engineer shall submit revised calculations to FCU for approval.

3. Restrained pipe lengths shall be clearly shown and detailed on the utility plans and final Record Drawings.

4. Approved joint restraint devices shall be used on all joints and fittings for fire hydrant installations from the connection at the water main to the connection of the hydrant to the fire hydrant lateral, unless otherwise instructed by FCU. See Utility Standard Construction Details.

5. Approved joint restraint devices shall be used on all joints and fittings for fire service installations, unless otherwise instructed by FCU.

6. Approved joint restraint devices shall be used on all pipe joints within a casing pipe.

7. Approved joint restraint devices are listed in the FCU Development Construction Standards.

8. With prior approval from FCU, concrete thrust blocks may be used when conditions make it impractical to use restrained joints for thrust restraint or if requested by the Contractor, at the discretion of FCU.

9. When a new connection is installed on the existing FCU distribution system by cutting in a tee or installing a wet tap, a concrete thrust block shall be used for thrust restraint behind the tee or tapping saddle. This applies to connections for fire hydrants, fire lines, distribution mains, or domestic services 2-inches and larger.

L. Services

1. General

   a. Water services shall be located a minimum of 10 feet from sewer services, sanitary sewers, storm sewers, and other non-potable pipelines.
   b. Water services shall not be installed in the same trench with other utilities. The only exception will be a fire line that will serve the same building. In this situation, the domestic water service and the fire line shall be a minimum of 5 feet apart.
   c. All portions of service lines shall be installed with a minimum of 4.5 feet of cover and a maximum of 5.5 feet of cover from final finished grade.
   d. Service taps shall be connected directly to FCU water system distribution mains and shall not be connected to any fire hydrant lateral or fire service line.
   e. Services shall be perpendicular to the main from the location of connection to a point beyond the control valve (and meter pit where applicable).
   f. Service shall be the same size as the meter from the location of connection at the main to a point 5 feet beyond the meter unless otherwise approved by the FCU. At the point 5 feet beyond the meter, the size of the service line may be increased to reduce hydraulic losses.
   g. All services ¾-inch through 2-inch shall have a curb stop as the control valve located within R.O.W. or utility easement adjacent to the R.O.W.
   h. The control valve for all services larger than 2-inch shall be an approved gate valve at the point of connection to the distribution system water main. The valve shall be restrained to the main at the point of connection with a swivel tee, tapping sleeve, or other approved joint restraint device.
   i. Connection for a 3-inch service shall be 4-inch tap with a 4-inch valve and a 4-inch by 3-inch reducer located at the point of connection at the water main.
   j. Services from a property shall connect directly to a public water main without crossing another private property. This requirement does not apply to the common, private service lines serving single-unit attached dwellings.
   k. Materials:
      (1) ¾-inch & 1-inch services shall be Type K copper.
      (2) 1½-inch & 2-inch services shall be Type K copper or HDPE with tracer wire.
      (3) Services larger than 2-inch shall be DI or PVC with tracer wire.
   l. No service connections are allowed within a water main lowering.
   m. No service connections are allowed within 10 feet of a utility crossing.
   n. No service connections are allowed on transmission mains unless approval by FCU.
   o. Domestic water services and fire lines for a given lot shall be connected the FCU water main within the confines of the property lines extended.

p. The final capacity of a water service/meter is dependent on the system pressure and water tap size. There is no guarantee of available flow based on meter size.

q. Domestic water services and fire lines that are not used with the development shall be abandoned at the main in accordance with Section 3.11 of these Criteria.

2. Domestic Services

a. General
   (1) Control valves shall be located within R.O.W. or utility easement approximately 1 foot from the property line or back of easement boundary.
   (2) Mixed-use buildings must have separate water services for the residential and commercial portions of the building.
   (3) Sizing of water service lines for multi-unit and commercial buildings shall be done by the Design Engineer. The sizing calculations shall be submitted to FCU for review and approval.

b. Single Unit
   (1) Each single unit lot shall have a separate ¾-inch water service line connecting directly to a FCU distribution system water main without crossing another property, unless a 1-inch combined water/fire service is approved by the FCU.
   (2) A shared water service serving two or more lots may be allowed, per City Code, to serve multiple single unit residences. This will be considered on a case-by-case basis.

c. Single Unit with Accessory Structure(s)
   (1) On a single unit lot, water service may be extended from the principal residence to an accessory structure(s) if approved by FCU, if the water service has adequate capacity for the buildings and if the buildings are on a single platted lot under single ownership, and as otherwise consistent with City Code. A covenant agreement requiring separate services if the lot is ever subdivided will also be required.

d. Duplex
   (1) Each dwelling unit in a duplex shall have a separate water meter.
   (2) A Duplex may be served with a separate water service for each unit or by a duplex combo water service with each option extending from an FCU water main.

e. Multi-Unit
   (1) Each multi-unit building shall have a separate water service connecting directly to a FCU distribution system main without crossing another property; however, FCU may require a multi-unit building to have more than one service.

f. Single Unit Attached Dwellings
   (1) For single unit attached dwellings where each dwelling unit is on a separate platted lot, each unit must have a separate control valve and meter; however, if approved by FCU, a common, private water service can be extended across property lines to serve the entire building with each unit having a separate shut-off and meter connecting to the common, private water service line. (See City Code Section 26-94)

(2) For a common, private water service 2-inches or larger, a 4-inch tap and gate valve, as the control valve, is required at the connection to the main.

g. Non-Residential
   (1) Each non-residential building shall have a separate water service connecting directly to a FCU distribution system main without crossing another property; however, FCU may require a non-residential building to have more than one service.
   (2) An approved backflow device in compliance with all applicable City regulations will be required on all commercial services.

3. Irrigation Services

   a. Separate irrigation services and meters connecting to distribution system mains are required per City Code subject to fees and charges included in Chapter 26 of City Code.
   b. Each separate irrigation service must connect directly to an FCU distribution system main and must not cross another property to reach the property being irrigated.
   c. An approved backflow device in compliance with all applicable City regulations will be required on all irrigation services.
   d. Sizing of water service lines for irrigation services shall be done by the Design Engineer. When requested, the sizing calculations shall be submitted to FCU for review.

4. Fire Services

   a. All fire sprinkler lines shall have a minimum 4-inch gate valve at the point of connection to the FCU distribution system water main and then reduced to desired service line size, if necessary.
   b. No domestic water service taps are allowed to connect to a fire line.
   c. For single-unit attached dwellings where each dwelling unit is on a separate lot, a common, private fire service can be utilized to serve the entire building with a covenant agreement.
   d. An approved backflow device in compliance with all applicable City regulations will be required on all fire services.

M. Meters

1. All domestic and irrigation water services connected to the FCU water distribution system shall be metered.
2. All multi-unit and commercial water services shall be subject to meter sizing requirements. The sizing calculations shall be submitted to FCU for review and approval.

3. Water meter sizes allowed include ¾, 1, 1½, 2, 3, and 4-inch. 6 and 8-inch meters are allowed with prior approval from the FCU.

4. Single unit residences shall be limited to one ¾-inch meter and service, unless a 1-inch meter and combined water/fire service is approved by the FCU.

5. Meter locations:

   a. ¾-inch meters may be installed within a building or outside in a water meter pit. (See Standard Detail Drawings for interior and exterior meter settings.)
   b. Meters 1-inch and larger shall be installed outside in meter pits/vaults.
   c. Modifications to the meter locations may be approved by the Utilities Executive Director or his/her assigned delegate during the Development Review process.

6. Interior meters shall be located where the water service enters the building and shall not be in crawl spaces. In commercial buildings, interior meters must be installed in a mechanical or fire riser room.

7. Exterior meters (¾-inch through 2-inch) shall be installed within 2 feet of the control valve.

8. Exterior meters shall be located in landscaped areas, unless otherwise approved by the FCU.

9. Modification, alteration or relocation of metering equipment must be approved by FCU before any such modification, alteration or relocation occurs.

10. The Design Engineer/Developer is responsible for determining the potential loadings on meter pits/vaults and shall provide adequate structural strength for these loadings. FCU may require AASHTO HS-20 loadings at its option.

11. Meter installations must be located to provide protection from freezing and frost damage.

N. Borings

1. Water mains through City of Fort Collins or another agency's R.O.W. or easement may require a bored casing pipe to facilitate main installation. The type of bored casing material and its properties will be specified by the agency granting permission for the crossing. Such crossings are subject to the approval of FCU to avoid conflicts between the requirements or standards between the City and the agency granting permission to cross.

   a. A letter, permit or approved crossing application from the agency granting permission to cross must be provided to FCU prior to boring.
   b. The City will not accept any crossings that require an annual user or crossing fee be paid to the agency granting permission to cross. All bored crossing fees, if applicable, shall be paid by the developer prior to boring.
   c. Valves are required at each end of the boring.

O. Corrosion Control and Cathodic Protection

1. Certain existing water mains within the FCU water transmission and distribution system are equipped with cathodic protection (CP) systems.

   a. All existing CP test stations shall be shown on the utility plans with notes to protect in place.

b. When a new DIP water main is being connected to an existing CP main, the new main must be isolated from the CP main by installing a short section of PVC pipe. See Utility Standard Construction Details.
c. When a new DIP water main is installed and is crossing a CP main, a CP test station may be required to monitor the integrity of the CP system.

2. If the use of DIP water main or steel casing is proposed, the Design Engineer shall have a soil resistivity survey of the construction area performed by a certified Geotechnical Engineer to evaluate the corrosion potential of the soil and to make recommendations on any corrosion protection measures such as pipe type or cathodic protection. The FCU will review the soil resistivity report, the Design Engineer's recommendations and the service history for the water system corrosion in the area and will determine the type of pipe to be used or the type of corrosion protection to be provided prior to approval of the utility plans.

a. The distance between the soil sample locations for the survey shall be at the discretion of FCU; however, testing frequency shall not be less than one test for every 400 feet of pipe.
b. Soil samples shall be taken at pipe depth.

3. All joints on the proposed DIP water main shall be bonded with the use of copper wire exothermically welded to the sections of DIP main.

P. Casing Pipe

1. Casing pipe shall be utilized as per the direction of FCU.

2. Casing pipe shall be steel unless otherwise approved by the FCU; however, FCU reserves the right to require a specific casing pipe material for any public water main installation.

3. Each casing pipe installation shall be specifically designed by the Design Engineer.

4. If steel casing pipe is to be used, a soil resistivity analysis shall be performed and the need for cathodic protection shall be evaluated in accordance with Section 3.06 O. 2. of this Criteria.

a. An anode and CP test station are required on both ends on a steel casing pipe. The anode wire and the test station wire shall be exothermically welded to the steel casing pipe.

b. The size of the anode bag shall be determined by FCU.

Q. Phased Installations and Stub-outs

1. If phasing of the water distribution system improvements is proposed by the developer, the phasing shall be clearly defined and shown in the utility plans.

2. The proposed phasing shall maintain looping integrity within the system.

3. The phased system design shall meet all water demands and fire flow requirements for the portion of the development being served.

4. An inline valve and fire hydrant (temporary or permanent) shall be required at the end of each phase or stub-out. The fire hydrant assembly shall be constructed with the hydrant off the side of the street. See Utility Standard Construction Details for fire hydrant installation.

5. Phased water mains/stub-outs shall be valved such that only one valve needs to be closed when the main is extended and no customers are without service. The valve must be appropriately restrained to prevent the valve from "blowing off" when the water line is exposed and the thrust blocking is removed for extension of the main.

6. Stub-outs not utilized shall be abandoned in accordance with these Criteria.

3.07 SEPARATION FROM OTHER UTILITIES AND BUILDINGS

A. Horizontal

1. Wet Utilities: Sanitary sewers, storm sewers, non-potable/reclaimed pipelines, etc. running parallel to a public water main or related appurtenance shall not be closer than 10 feet to each other.

2. District Water Mains: If a City-owned water main is proposed to be installed parallel to a water main owned by another entity, the FCU separation requirement is 10 feet; however, the other entity should also be contacted to determine if it has any additional requirements.

3. Dry Utilities: Natural gas, electric, cable TV, telephone/communication, etc. running parallel to a public water main or related appurtenance shall be no closer than 10 feet. In certain situations, there may be some flexibility to this requirement; however, this would be an exception to the normal requirement and would only be allowed with the approval of the FCU.

4. Buildings and Structures: Water mains and appurtenances shall be a minimum of 15 feet from all buildings and structures.

5. No water mains, services, or appurtenances are allowed underneath underground storm water detention or water quality systems.

B. Vertical – When a water main crosses another public or private utility, irrigation or drainage ditch, or natural stream, the crossing design shall protect the water main and other utility's structural integrity, prevent contamination of the main and mitigate future system impacts and costs of repair. The entity responsible for the utility, ditch, railroad, or other structure crossed may also impose additional criteria.

1. FCU requires pothole information for utility main crossings.

2. All crossings shall be clearly identified and dimensioned on the plan view and profile view on the utility plans.

3. Water Crossing **over** Wastewater/Stormwater/Other non-potable Systems – When a public water main crosses these types of systems, the water main shall cross above with a minimum of 18-inches vertical clearance from the system and maintain the minimum depth of cover required by these Criteria.

    a. A vertical clearance of less than 18-inches may be allowed with prior approval of the FCU. In these cases, all joints of the non-potable utility within 10 feet of the water main shall be wrapped with butyl adhesive tape or all piping of the non-potable system within 10 feet of the water main shall be C900 PVC as required by the FCU Development Construction Standards.

4. Water Crossing **under** Wastewater/Stormwater/Other Non-Potable Systems - When a public water main crosses under these types of systems, the water main shall maintain 18-inches of vertical clearance from such systems. All joints of the wastewater/stormwater/other non-potable utility within 10 feet of the water main shall be wrapped with butyl adhesive tape or the piping of the non-potable system within 10 feet of the water main shall be C900 PVC as required by the FCU Development Construction Standards.

    a. A vertical clearance of less than 18-inches may be allowed with prior approval of the FCU. In these cases, all joints of the non-potable utility within 10 feet of the water main shall be wrapped with butyl adhesive tape or all piping of the non-potable system within 10 feet of the water main shall be C900 PVC as required by the FCU Development Construction Standards.

    b. For wastewater, stormwater or other non-potable pipelines 18-inch and larger, the water main may need to be installed in a casing pipe. FCU will have final determination if a casing pipe is required. If required, the casing shall extend a minimum of 10 feet beyond each side of the crossing.

3.08 DITCH CROSSINGS

A. When a water main is crossing a ditch, the Developer shall contact the owner(s) of the ditch (normally a ditch company) and obtain all permits and approvals for each crossing. In addition to the requirements of these Criteria, the ditch owner may impose additional requirements that are more stringent. All permit/crossing fees and costs shall be paid by the Developer.

1. Steel Casing – The casing shall be of sufficient length so that the ends of the casing may be exposed without excavating in the ditch R.O.W. or easement and a minimum of 10 feet beyond any toe or top of slope to ditch. The steel casing pipe shall be in accordance with Section 3.06 P. of these Criteria.

2. Cut-off Walls – A clay or concrete cut-off wall shall be placed on both ends of the casing pipe. The cut-off wall shall extend to 1 foot above the maximum free surface water elevation of the ditch (or as required by the ditch owner). Refer to Utility Standard Construction Details.

3. Cover – Cover over the casing shall be 3 feet or more from flowline of ditch to top of casing.

4. Ditch Repair – All ditches shall be restored according to the ditch owner's requirements.

B. Valves are required on both sides of the ditch crossing. Valves shall be located back from the crossing or restrained in such a manner as to prevent the valve from "blowing off" when the pipe is disassembled between the valves for maintenance or replacement. No water services shall be connected to the water main between these valves.

3.09 ROUNDABOUT CROSSSINGS

A. Where an existing or proposed water main crosses a roundabout, the following design criteria shall apply:

1. All valves, fittings, fire hydrants, services and appurtenances shall be located outside the center median of the roundabout. It shall be the Developer's responsibility to relocate any of these existing facilities outside of the center median.

a. If there are no water mains connecting from a perpendicular alignment, the water main may be installed in a casing pipe through the roundabout median. It shall be the Developer's responsibility to re-construct and install any existing water main in a casing.
(1) If the water main is installed in a casing, isolation valves shall be installed on both sides of the roundabout 40 feet from each end of the casing and shall be restrained in accordance with the FCU to prevent the valve from "blowing off" when the piping in the roundabout area is disassembled for repair or replacement.
(2) Approved joint restraint devices shall be used on all pipe joints within a casing pipe.
(3) No services or connections are allowed between the isolation valves.

b. If there are water mains connecting from a perpendicular alignment, all water mains shall be routed around the center median. It shall be the Developer's responsibility to re-locate any existing water mains.

2. Water service taps shall be located a minimum of 5 feet outside the roundabout center median. It will be the Developer's responsibility to relocate any service taps outside of the median.

3.10 LANDSCAPE SEPARATION DISTANCES

A. Trees – Trees, including deciduous, evergreen, and all junipers, shall be a minimum of 10 feet from all water mains and fire hydrants and 6 feet from water services including control valves and meter pits/vaults.

B. Shrubs – Shrubs shall be a minimum of 6 feet from center of shrub to water mains, fire hydrants, water meters and control valves.

C. Fences/Walls/Boulders/Posts – These shall be a minimum of 10 feet from water mains and fire hydrants and 4 feet from water meters and curb-stops.

3.11 ABANDONMENT OF MAINS AND SERVICES

A. Any water mains or water services that were installed and will not be used (such as in the case of a replat or change in project layout) shall be abandoned. Services will be required to be abandoned at the main, unless otherwise directed by FCU. This shall include excavating at the main and disconnecting the line to be abandoned as directed by FCU Field Operations Staff. Each situation will be evaluated on a case-by-case basis to determine if the valve at the connection point is to be removed. For a main abandonment, the main shall be abandoned to the last water main connection point or to the last remaining in-service portion of the water main, as determined by FCU. All fire hydrants, valve boxes, control valves and meter pits/vaults associated with the main being abandoned shall be removed.

B. When a water main is to be abandoned and the main will not be under a proposed building, the main may be abandoned in place and left in the ground if approved by FCU and labeled accordingly on the City-approved utility plans. The abandoned main shall be drained and both ends shall be plugged with concrete. Mains 12-inch and larger shall be flash filled in accordance with the FCU Development Construction Standards.

C. Any existing water services within or adjacent to a site being re-developed that are not being used shall be abandoned at the main as directed by FCU. This shall include the removal of the control valve box or valve box on the abandoned service and removal of any meter pits/vaults.

D. The abandonment of mains and services shall be identified and documented on the utility plans during the development review process.

SECTION 4 – WASTEWATER COLLECTION DESIGN CRITERIA

4.1 GENERAL

These Criteria typically apply to sanitary sewers 12-inch diameter and smaller, which are Collection Mains. Larger sanitary sewers are classified as either Trunk Mains or Interceptor Mains. If a development project includes any construction of or modification to an Interceptor Main or Trunk Main, contact the FCU for design and construction requirements.

4.2 WASTEWATER DEMAND ANALYSIS REPORT

In conjunction with the City's development review process, FCU **may** require the Design Engineer to submit a wastewater demand analysis report at the time of PDP. If the analysis report is required, a meeting with FCU must be held to determine the outline and scope of the report.

4.3 WASTEWATER SYSTEM MODELING

If hydraulic analysis is needed for proper sizing of sanitary sewers, FCU will provide available modeling data to evaluate the proposed project and associated demands with detailed information provided by the Design Engineer.

4.4 FCU WASTEWATER SERVICE AREA

A. FCU provides wastewater service to a portion of the area inside City limits and areas beyond City Limits including parts of the community of Laporte, Colorado. Service areas are subject to change and inquiry with FCU is needed to confirm the boundaries at time of development. (See Wastewater Utility Service Areas Map in Appendix B for a map current as of the date of adoption of this manual.)

B. Certain portions of Fort Collins receive wastewater service from the following districts:

Boxelder Sanitation District
3201 E Mulberry, Suite Q
Fort Collins, CO 80524
Telephone: 970-498-0604

Cherry Hills Sanitation District
512 N Link Lane
Fort Collins, CO 80524
Telephone: 970-493-6130

South Fort Collins Sanitation District
5150 Snead Drive
Fort Collins, CO 80525
Telephone: 970-226-3104

C. When designing sanitary sewer extensions, it is important to avoid designing/constructing mains which would interconnect with these various utilities.

4.5 WASTEWATER COLLECTION SYSTEM DESIGN AND LAYOUT

A. General

1. Each property or lot shall have frontage on public R.O.W. so that any service lines will not cross another property or have access via a utility easement.

2. The design and layout of the system must provide for the extension of the sanitary sewers to adjacent properties that may develop in the future.

3. Utility locations, alignments, and separations noted herein are required for new developments and redeveloping areas.

4. Additionally, it is critically important within each development that the site layout be designed in a manner that accommodates acceptable access for maintenance and replacement of the system by FCU, including adequately designed all-weather access for mains installed outside of a public roadway. Access shall be designed with a minimum width of 15 feet and driving surface shall be constructed with asphalt, concrete, or compacted road base to support maintenance trucks weighing at least 80,000 lbs. The Design Engineer shall also make adequate provisions for utility separation requirements and easements outlined in these Criteria.

5. Sanitary sewers shall extend across the entire frontage of a property unless otherwise approved by FCU.

6. No connections to the wastewater collection system are allowed which would add surface water or groundwater to the wastewater system. This includes roof drains, drainage tiles, foundation drains, area drains, etc.

7. Floor drains internal to covered parking that collect drainage from drippings off parked vehicles or water used for washing down internal floors shall be connected to the sanitary sewer using appropriate sand and oil interceptors. The drainage from the top floor of a parking facility which is subject to runoff caused by precipitation events shall not be discharged to the sanitary sewer system.

B. Hydraulic Design

1. Design Flows: Wastewater design flows shall be the peak daily flow plus wet weather infiltration and inflow (I&I). The per capita or per acre flow contributions and I&I flow contributions are subject to the approval of the FCU.

2. Manning's Equation using Manning's Coefficient of n = 0.013 shall be used for sizing sewers.

3. Minimum sizes: Minimum size for public sanitary sewers is 8-inch. Minimum size for private sewer services is 4-inch. The minimum size shall be utilized unless design flows dictate a larger diameter or otherwise directed by the FCU.

4. Depth of Flow: The maximum allowable depth to diameter ratio for sanitary sewer flows at peak flow conditions is d/D = 0.8 for sewers up to and including 12-inch. For sewers larger than 12-inch, contact the FCU.

5. Velocity: Sanitary sewers shall be designed so that the design flow velocity is at least 2 feet per second and does not exceed 10 feet per second.

6. Slope: The following table gives the minimum and maximum allowable slopes for sanitary sewers. All sanitary sewers shall be designed and constructed with constant slope between manholes. Any deviation from these values requires a variance by the FCU.

Diameter (Inches)	Minimum Slope (Percent)	Maximum Slope (Percent)
Services		
4	2.0%	21.0%
6	1.0%	12.2%
Mains		
8	0.40%	8.4%
10	0.28%	6.1%
12	0.22%	4.9%
15	0.15%	3.6%

C. Pipe Material

1. The only pipe material for gravity sanitary sewers currently included in the FCU Development Construction Standards is polyvinyl chloride (PVC) pipe. If an alternate material is proposed, it shall be evaluated in accordance with Section 01000 and Section 01600 of the City of Fort Collins - Water, Wastewater, Stormwater Development Construction Standards and Section 1.05 of these Criteria.

D. Alignment

1. Within platted streets, sanitary sewers are typically on the centerline of the street and water mains are a minimum of 10 feet from the sewer. If this location is not possible, the sanitary sewer should be aligned such that the manholes are in the center of a travel lane so as to not be in a wheel path. In those situations, the sanitary sewers must also be a minimum of 5 feet from the curb and gutter.

2. No curvilinear sanitary sewers are allowed.

E. Sewer Depth

1. Minimum cover without insulation above top of sanitary sewers shall be 4 feet.
2. Minimum cover with insulation above top of sanitary sewers shall be 3 feet. Insulation requires 2-inch thick closed-cell insulation board suitable for use in contact with soil and water.

3. Depths greater than 20 feet require approval of the FCU and may require greater separation distances from other utilities, structures and landscaping as well as requiring additional easement width.

F. Groundwater Barriers

1. In situations where groundwater is known or found to be above the elevation of the sanitary sewer or if there is a possibility that groundwater may be diverted by the construction of the new water mains and sanitary sewers, groundwater barriers shall be constructed within the sanitary sewer trench to prevent groundwater migration or diversion along the sewer main.

2. Groundwater barriers are typically located upstream of manholes and shall be spaced a maximum of 400 feet apart.

3. Groundwater barriers shall extend through the full depth of the granular bedding/pipe zone material and project 1 foot beyond each side of the trench wall. In addition, the groundwater barrier shall extend to a point 1 foot above the maximum peak wet season subsurface groundwater level but not less than 3 feet above the top of pipe.

4. Groundwater barriers shall be installed on both sides of all natural waterways, ponds, lakes or irrigations ditches.

5. Groundwater barriers shall be shown and labeled on the sanitary sewer plan and profile sheets of the utility plans.

G. Manholes

1. Manholes are required at any change in size, slope, or direction of a sanitary sewer, at connecting points with other sanitary sewers and at the end of a sanitary sewer line.

2. When a pipe is stubbed out of a manhole for a future sewer connection, the stub-out shall be no more than 2 feet long.

3. Manholes shall not have less than 90 degrees between incoming and outgoing sanitary sewers.

4. Manholes are required at points where services larger than 6-inch diameter connect to Collection Mains. Service connections into Trunk or Interceptor Mains are per the direction of the FCU.

5. Maximum spacing between manholes shall be 500 feet with typical spacing at 400 feet.

6. Manholes shall have a minimum 0.1 foot drop in invert elevation for straight through manholes. Manholes with change in horizontal flow direction greater than 30 degrees shall have 0.2 foot drop between incoming invert elevation(s) and outgoing invert elevation.

7. Manholes with more than 2 feet between inlet and outlet invert elevations shall be constructed with an outside drop connection.

8. No inside drop connections are allowed.

9. When there is a change in size of sanitary sewer at a manhole, the crowns of the two sewers shall be set at the same elevation. However, if a lateral sanitary sewer is connecting to an Interceptor Main (24-inch or larger in diameter), the invert of the lateral sewer should be set at the crown of the interceptor.

10. Minimum diameters for manholes are listed in the Utility Standard Construction Details. Larger manholes may be required to accommodate multiple incoming mains or large radius horizontal flow channel bends.

11. Manhole invert channels shall be formed with smooth curves having as large a radius as the manhole will permit to minimize turbulence. The flow channel shall be U-shaped with a height equal to three-fourths the diameter of the outgoing sanitary sewer.

12. Manholes shall maintain a minimum clearance of 5 feet from curb and gutter and 10 feet from cross pans to the outside edge of the manhole.

13. If subject to flooding, manhole shall have a bolted, water-tight ring and cover. Bolted, water-tight ring and covers shall be noted and labeled on the sewer plan and profile drawings.

14. When connection is proposed to an existing manhole, FCU will assess the condition of the manhole to determine if special construction, repair or replacement by developer will be required.

15. All connections to existing manholes shall be made by core drilling and grout sealing the opening into the manhole above the manhole bench. The Design Engineer shall use the elevation of the top of the bench as the starting elevation for the new sewer, or if connecting to an interceptor sewer, use the criteria contained in 4.06 G. 9. When connection is above the manhole bench, add a note to construct/form a new invert to direct the flow to the existing, main channel.

16. All weather access roads shall be required to manholes located outside of street R.O.W. Access roads shall be a minimum of 15 feet wide and designed and constructed to support maintenance vehicles weighing 40 tons. Carsonite marker posts (provided by FCU) shall be placed at all manholes outside of street R.O.W.

H. Services

1. General

a. Within the R.O.W. and any associated utility easement, services shall be perpendicular to the sanitary sewer main.
b. Sanitary sewer services shall be a minimum of 10 feet from all water services.
c. Sanitary sewer services shall not be installed in trenches with other utilities.
d. Sanitary sewer services for a given property must be installed on the sanitary sewer main within the confines of the property lines extended.
e. Cleanouts are required at all changes in vertical or horizontal alignment and at 100' maximum intervals.
f. Mixed-use buildings must have separate sewer services for the residential and commercial portions of the building.
g. Sanitary sewer services are not allowed to connect at manholes unless approved by FCU.
h. For sanitary sewer services larger than 6-inch diameter, a manhole is required at the point of connection.
i. Connection of 6-inch service to an 8-inch sewer must be made by cutting in a tee or wye fitting or installing a manhole.
j. Sanitary sewer services that are not used shall be abandoned at the main in accordance with Section 4.11 of these Criteria.

2. Residential

a. Single Unit
(1) Each single unit lot shall have a separate sewer service line connecting directly to a FCU sanitary sewer without crossing another property.
(2) A shared sewer service serving two or more lots may be allowed, per City Code, with an administrative variance by FCU to serve multiple single unit residences. This will be considered on a case-by-case basis.
(3) Services shall be located a minimum of 10 feet from the water service until beyond the control valve and/or water meter, if meter is exterior.

b. Single Unit with Accessory Structure(s)
(1) On a single Unit lot, sewer service may be extended from the principal residence to accessory structures if approved by FCU, if the sewer service has adequate capacity for the buildings and if the buildings are on a single platted lot under single ownership, and as otherwise consistent with City Code. A covenant agreement will also be required.

c. Duplex
(1) Each dwelling unit in a duplex shall have a separate sewer service extending from an FCU sanitary sewer main for any new construction, unless otherwise directed by FCU.

d. Multi-Unit
(1) Each multi-unit building shall have a separate sewer service connecting directly to a FCU sanitary sewer without crossing another property; however, FCU may require a multi-unit building to have more than one service.

f. Single Unit Attached Dwellings
(1) For single unit attached dwellings where each dwelling unit is on a separate platted lot, each unit must have a separate sewer service with

cleanout; however, if approved by FCU, a common, private sewer service can be extended across property lines to serve the entire building. (See City Code Section 26-256)

g. Non-Residential
   (1) Each non-residential building shall have a separate sewer service connecting directly to a FCU sanitary sewer without crossing another property; however, FCU may require a non-residential building to have more than one service.
   (2) Monitoring manholes may be required on services from non-residential facilities with high-strength waste.
   (3) Grease interceptors are required on the services for all restaurants and facilities with commercial kitchens.
   (4) Sand and oil interceptors are required on services from facilities with indoor auto service bays and from services from the portions of parking garages that do not collect runoff from rainfall or snow melt.
   (5) Details for grease interceptors and sand and oil interceptors are included in the FCU Development Construction Standards.

I. Subdrains

1. Subdrains shall not be connected to the wastewater collection system. Subdrains shall only discharge to the storm drainage system or designed detention areas.

2. Subdrains may be permitted in public R.O.W. If allowed, the Developer shall be required to submit a soils investigation and report as outlined in Chapter 5 of the LCUASS for review and approval by the City Engineering Department.

3. Subdrains built in the public R.O.W. for private drainage shall be private improvements and shall include provisions for maintenance by the local homeowners association or other private entity.

4. Subdrains shall meet the requirements contained in Chapter 12 of the LCUASS.

J. Borings

1. Sanitary sewers through City of Fort Collins or another agency's R.O.W. or easement may require a bored casing pipe to facilitate main installation or replacement. The type of bored casing material and its properties will be specified by the agency granting permission for the crossing. Such crossings are subject to the approval of FCU to avoid conflicts with the requirements or standards between FCU and the agency granting permission to cross.

   a. A letter, permit or approved crossing application from the agency granting permission to cross must be provided to FCU prior to boring.
   b. FCU will not accept any crossings that require an annual user or crossing fee be paid to the agency granting permission to cross. All bored crossing fees, if applicable, shall be paid by the developer prior to boring.

K. Casing Pipe

1. Casing pipe shall be utilized as per the direction of the FCU.

2. Casing pipe shall be steel unless otherwise approved by the FCU; however, FCU reserves the right to require a specific casing pipe material for any public sewer main installation.

3. Each casing pipe installation shall be specifically designed by the Design Engineer.

4. If steel casing pipe is to be used, a soil resistivity analysis shall be performed and the need for cathodic protection shall be evaluated in accordance with Section 3.06 O. 2. of these Criteria.

    a. An anode and CP test station are required on both ends on a steel casing pipe. The anode wire and the test station wire shall be exothermically welded to the steel casing pipe.

    b. The size of the anode bag shall be determined by FCU.

L. Phased Installations and Stub-outs

1. If phasing of the wastewater collection system improvements is proposed by the developer, the phasing shall be clearly defined and shown in the utility plans.

2. The phased system shall be designed for full build out of the development being served including any additional offsite flows that must be passed through the development per any master plan or otherwise directed by FCU.

3. The stub-out design and installation shall maintain the vertical and horizontal alignment in accordance with these Criteria and with the FCU approved utility plans.

4. The system shall be designed such that a manhole is located at the phase line between portions of the development or the sanitary sewer shall be extended to the next manhole with the phase under construction

5. Sanitary sewer main stub-outs not utilized shall be abandoned in accordance with these Criteria.

4.6 SEPARATION FROM OTHER UTILITIES AND BUILDINGS

A. Horizontal

1. Water mains and storm drains shall be a minimum of 10 feet horizontally from any part of the FCU wastewater collection system.

2. Dry Utilities (Natural gas, electric, cable TV, telephone/communication, etc.) shall be a minimum of 10 feet horizontally from any part of the public wastewater collection system.
3. Buildings and Structures: Sewer mains shall be a minimum of 15 feet from all

buildings and structures.

4. No sewer mains or services are allowed underneath underground storm water detention or water quality systems.

B. Vertical – When a sanitary sewer crosses anther public or private utility, irrigation or drainage ditch, or natural stream, the crossing design shall protect the sanitary sewer and other utility's structural integrity, prevent contamination of the main and mitigate future system impacts and costs of repair. The entity responsible for the utility, ditch, railroad or other structure crossed may also impose additional criteria.

1. All crossings shall be clearly identified and dimensioned on the plan view and profile view on the utility plans.

2. Sanitary Sewer **Over or Under** a Water Main – See Section 3.07 of these Criteria.

3. Sanitary Sewer Crossing **Over** Storm Drainage Systems – When a public sanitary sewer crosses over a storm sewer, the sanitary sewer should cross above with a minimum of 18-inches vertical clearance from the storm drain system and maintain the minimum depth of cover required by these Criteria.

   a. A vertical clearance of less than 18-inches may be allowed with prior approval of the FCU.

4. Sanitary Sewer Crossing **Under** Storm Drainage System - When a public sanitary sewer crosses under a storm drain, the sanitary sewer should have a minimum of 18-inches of vertical clearance from the storm drain.

   a. A vertical clearance of less than 18-inches may be allowed with prior approval of the FCU.
   b. For storm drains 24-inch and larger, the sanitary sewer shall be installed in a casing pipe.

4.7 DITCH CROSSINGS

A. When a sanitary sewer is crossing a ditch, the Developer shall contact the ditch owner (often a ditch company) and obtain all permits and approvals for each crossing. In addition to the requirements of these Criteria, the ditch owner may add additional requirements are more stringent. All permit/crossing fees and costs shall be paid by the Developer.

1. Steel Casing – The casing shall be of sufficient length so that the ends of the casing may be exposed without excavating in the ditch R.O.W. or easement and a minimum of 10 feet beyond any toe or top of slope to ditch. The steel casing pipe shall be in accordance with Section 4.06 K. of these Criteria.

2. Cut-Off Walls – A clay or concrete cut-off wall shall be placed on both ends of the casing pipe. The cut-off wall shall extend to 1 foot above the maximum free surface water elevation of the ditch (or as required by the ditch company). Refer to FCU Utility Standard Construction Details.

3. Cover – Cover over the casing shall be 3 feet or more from flowline of ditch to top of casing unless a variance is approved by the FCU.

4. Ditch Repair – The ditch being crossed shall be restored in accordance with the ditch owner's requirements.

4.8 ROUNDABOUT CROSSINGS

A. Where an existing or proposed sanitary sewer crosses a roundabout, the following design criteria shall apply:

1. Manholes shall be located outside of the center median of the roundabout and in the center of a travel lane.

   a. If there are no sanitary sewers connecting from a perpendicular alignment, the sewer shall be installed in a casing pipe through the roundabout median. It shall be the Developer's responsibility to re-construct and install any existing sewers in a casing. Approved joint restraint devices shall be used on all pipe joints within a casing pipe.
   b. If there <u>are</u> sanitary sewers connecting from a perpendicular alignment, all sewers shall be routed around the center median with all manholes located in the center of a travel lane. It shall be the Developer's responsibility to re-locate any existing sewers.

2. Sewer service taps shall be located a minimum of 5 feet outside the roundabout. It will be the Developer's responsibility to relocate any existing service taps outside of the roundabout.

4.10 LANDSCAPE SEPARATION DISTANCES

A. <u>Trees</u> – Trees, including deciduous, evergreen, and all junipers, shall be a minimum of 10 feet from sanitary sewers and 6 feet from sewer services.

B. <u>Shrubs</u> – Shrubs shall be a minimum of 6 feet from center of shrub to sanitary sewers and any sewer service cleanouts.

C. <u>Fences/Walls/Boulders/Posts</u> – These shall be a minimum of 10 feet from sanitary sewers and 4 feet from any sewer service cleanouts.

4.11 ABANDONMENT OF MAINS AND SERVICES

A. Any sanitary sewers that were installed and will not be used (such as in the case of a replat or change in project layout) shall be abandoned at a manhole. This shall include excavating at an existing manhole, disconnecting and plugging the line to be abandoned as directed by FCU. Each situation will be evaluated on a case-by-case basis to determine if other special requirements will apply.

B. All manholes on an abandoned sanitary sewer shall be removed, and the ends of the sanitary sewer shall be plugged with concrete.

C. When a sanitary sewer is to be abandoned and will not be under a proposed building, the sanitary sewer may be abandoned in place and left in the ground if approved by FCU and labeled accordingly on the City-approved utility plans. The ends of the sanitary sewer shall be plugged with concrete. Sanitary sewers 12-inch and larger shall be flash filled in accordance with the FCU Development Construction Standards.

D. Any existing sewer services within or adjacent to a site being re-developed that are not being used shall be abandoned at the main as directed by FCU.

E. The abandonment of mains and services shall be identified and documented on the utility plans during the development review process.

4.12 WASTEWATER LIFT STATIONS

A. General

(1) A gravity-based wastewater collection system is required, except as authorized by City Code. If a gravity sewer configuration that meets City design standards for minimum slope and the allowable drop across manholes is not possible, a lift station(s) may be considered by FCU if it is specifically designated in any City utility or sewer plan or on a case-by-case basis. It must, however, be a regional lift station serving a sewer drainage area within FCU wastewater district boundary, rather than a station serving an individual subdivision or development. All lift stations and associated pressurized wastewater systems must be approved by the Fort Collins Utilities (FCU).

(2) Before the City will consider development submittals or other utility designs including a wastewater lift station, the Developer must first submit a utilities feasibility evaluation report for FCU review. This shall include a discussion of gravity sewer options and analysis showing that these are not possible while meeting City design standards for a gravity sewer system. The Developer may only proceed with design of a site or system requiring a lift station with FCU prior approval.

(3) All lift stations meeting these standards will become the property of the City once complete.

(4) The minimum lift station service area to be considered is 100 single unit occupancy.

(5) Any proposed lift station shall be located on property owned by the Developer and transferred to City ownership upon acceptance unless specifically agreed to by the City. The lift station lot shall be adequate to house all required infrastructure while providing space to park and turn City vehicles around (0.25 Ac min).

(6) The lift station and all required appurtenances, including three phase power and potable water service, shall be provided by the Developer.

(7) A lift station design report shall be submitted for FCU review and approval. This shall include (at minimum):

(a) Presentation of lift station design criteria.

(b) Presentation of process for permitting of the lift station including any required updates to the City Utility Plan, approval by the North Front Range Water Quality Planning Association (NFRWQPA) per Water Quality Control Commission Regulation 22, 5

CCR 1002-22, and approval by the Colorado Department of Health and Environment (CDPHE).

(c) Presentation and calculation of anticipated wastewater loading rates for proposed and future development including the larger lift station service area (gravity drainage area).

(d) Discussion of hydraulic design of the pump system including wet well sizing.

(e) Discussion of the design of lift station site and force main alignment including property ownership.

(f) Local control system, and SCADA system plan with alarms.

(g) Monitoring and maintenance plan.

(h) Cyber security plan.

(i) 50-year net present value of the cost to operate and maintain the system, including odor control media replacement and replacement of pumps at life span; and

(j) Discussion of the energy consumption and costs and their relationship to competing requirements of the City's Climate Action Plan.

(k) Discussion of receiving wastewater system including capacity and corrosion protection.

(8) Water Quality Control Commission Regulation 22, 5 CCR 1002-22, requirements are included in these design standards by reference.

(9) CDPHE Design Criteria for Wastewater Treatment Works (Chapter 4) are also included in these design standards. In case of conflict between those standards and this Criteria, the more stringent of the two standards will govern.

(10) All lift stations are subject to review and approval by the North Front Range Water Quality Planning Association (NFRWQPA) per Water Quality Control Commission Regulation 22, and the Colorado Department of Health and Environment (CDPHE) The Developer shall be responsible for taking the lift station design through the review and approval process of these agencies.

(11) The Developer shall be solely responsible for all costs associated with the permitting, design, and construction of the lift station and force mains. This includes the cost of any easements, land acquisition, documents associated with permitting approval through CDPHE and NFRWQPA, review by third party reviewer, and any other cost associated with the project.

(12) In general, lift stations shall be designed in accordance with pump standards published by the Hydraulic Institute.

(13) Lift station shall meet all applicable standards including architectural, landscaping, building, City land use, and City collection system standards (pipe, valves, and fittings).

B. Lift Station Structures

(1) Lift stations with separate dry and wet wells are required. Dry wells must be designed to not be considered a confined space.

(2) Lift station site and at least one access road to the lift station must be designed to be accessible and operational during the 100-year flood.

(3) Lift station must be designed to prevent unauthorized access. Provide securing fencing, a security camera, and security intrusion alarms as part of SCADA system.

(4) Wet Wells

(a) General

i. Configuration and geometry of the wet well shall prevent accumulation of grit and other settleable solids and provide for control and removal of floatable solids.

ii. The minimum interior plan area shall be 50 square feet and meet pump manufacturer intake spacing requirements.

iii. The structural design shall accommodate external loading, internal pressure and buoyancy forces and loadings based on the findings of the required site geotechnical evaluation.

iv. The wet well shall be designed to prevent vortexing or air binding at the pump suction.

v. Watertight construction must be provided to prevent infiltration and exfiltration. Exterior damp proofing of concrete shall be provided.

vi. The wet well shall be protected from deterioration from hydrogen sulfide corrosion through use of polymer concrete materials or conventional concrete with a protective interior coating. Coating materials shall be approved by FCU. Use of carbon steel wet wells will not be allowed.

vii. Common wall construction with a dry well is acceptable provided the design documents provide for watertight and gastight construction at penetrations in the dry well walls conforming with National Electric Code (NEC) and National Fire Protection Association (NFPA).

viii. The minimum water level shall exceed the Net Positive Suction Head Requirements (NPSHR) of the pump manufacturer by at least 5 feet.

ix. Provisions shall be made for continued operation if the wet well is taken out of service for cleaning or other maintenance.

x. Access hatches shall be aluminum with mill finish. The frame and door shall support HS-20 loading where subject to traffic loading conditions or a minimum of 300 psf live load at other locations as approved by the City. The aluminum covered shall be equipped with a flush drop handle with a frame drain and staples for padlocks. An orange safety grate shall be installed at any access hatch.

(b) Floor Slope

i. The wet well floor should have a minimum slope of one to one (1:1) to the

hopper bottom. The horizontal area of the hopper bottom should be no greater than necessary for proper installation and function of the pump inlet.

ii. Concrete fillets at an angle of forty-five (45°) degrees up from horizontal shall be included in the wet well to channel solids to the pump intake. The volume of the fillets shall be accounted for in the wet well capacity. The weight of the fillets may be used in buoyancy calculations.

(c) Maximum Holding Period

i. The pump operation setpoints for the wet well should result in a holding period not to exceed sixty (60 min) minutes for the design average daily flow unless otherwise approved by FCU.

ii. Upstream pipeline storage shall not be used to satisfy wet well volume and/or emergency storage requirements for normal operating conditions

(d) Size

i. Volumetric wet well capacity shall be designed by Developer to meet all City requirements from initial startup flows to full buildout flows, subject to City approval.

ii. The design maximum number of starts per hour for pumps shall not exceed 6.

(e) Emergency Storage

i. Designs that release wastewater to the environment are prohibited. Provisions must be made for enclosed watertight emergency storage of wastewater in the event of an extended power outage or electrical/ mechanical failure.

ii. Emergency storage shall be sized to hold a minimum of 2 hours of the peak-hour influent flow. Pursuant to the variance procedures above, the City may approve a variance to reduce required emergency storage if determined to be warranted by faster FCU response time.

iii. The maximum liquid level of the emergency storage volume shall be below the influent pipe to the wet well to prevent surcharging upstream wastewater service lines. Emergency storage shall not be designed to utilize the upstream collection system, however an analysis quantifying how much storage is available upstream is required.

(5) Dry Wells

(a) Suitable and safe means of access shall be provided to the dry well for operation, maintenance, or removal of equipment.

(b) Minimum equipment/facilities shall include:

i. Redundant hydrogen sulfide monitoring sensors.

ii. Stairs or mechanical elevator meeting OSHA/IBC requirements.

iii. Lifting equipment, including hoists, capable of removal and replacement of all dry well equipment without maintenance staff bearing any pump weight.

iv. Space within the structure for future odor control chemical storage and dosing equipment

v. Lighting operated with lockout switch near entry hatch or door.

vi. Light fixtures, conduit, junction boxes and other apparatus of design, construction and materials shall be suitable for high humidity space to provide for satisfactory performance through the service life of the lift station.

vii. A dedicated duplex sump pump system shall be provided to remove any accumulated seepage into the dry well and drainage from maintenance work and cleanup.

viii. The minimum clear distance between any equipment and the wall of the dry well shall be 36 inches.

(c) Buoyancy calculations shall be performed with all tanks empty and maximum groundwater level. Minimum factor of safety is 2.0.

(d) Dry Wells that will be placed in locations of known or suspected high groundwater shall evaluate the following:

i. Potential of relocating the dry well away from groundwater path.

ii. External coatings to prevent any intrusion of groundwater

(6) Ventilation

(a) General

i. As a minimum the lift station shall be ventilated and heated and conform to the City's planning and building department requirements and applicable structural and building codes.

(b) Wet Well

i. Ventilation shall be provided that meets CDPHE and NFPA requirements.

ii. Wet well may be required to be mechanically ventilated for odor and corrosion control as determined by City staff.

(c) Dry Well

i. Adequate ventilation and heating shall be provided for all lift stations to mechanically ventilate the dry well.

ii. An automatically operated ventilating blower shall be provided, capable of

delivering thirty (30) air exchanges per hour while occupied with the discharge going to the atmosphere.

iii. Dry well pits over fifteen (15′) feet deep shall have multiple ventilation inlets and outlets.

(7) Odor Control

(a) All lift stations shall have an active odor control mitigation system as approved by the City.

C. Pumping Equipment

(1) General

(a) In all cases pumping systems shall be designed to meet all lift station criteria and accommodate initial low flows and peak hour flows from the fully developed contributing areas with adequate redundancy as defined by CDPHE Regulation 22 and Chapter 4 of the CDPHE Design Standards and in these criteria. If future build-out conditions require pumps that are not needed for near term flow conditions, the lift station shall be designed to add additional pumps, piping, valves, electrical and control without the need for a major system shutdown.

(b) Pumps shall be Flygt n-series jacketed (dry pit submersible pumps) or approved equal.

(c) At least three (3) pumps shall be provided, and each shall all have the same capacity with the ability to meet peak influent flows with one pump out of service. One additional “shelf spare” pump and motor assembly shall be provided.

(d) Pumps shall be capable of passing spheres of at least three (3″) inches in diameter. Intake screens and grinders are not acceptable substitutions for solids handling pumps. Grinders may also be required at FCU discretion.

(e) Pump suction and discharge openings shall be at least four (4″) inches in diameter. Pumps shall be non-clogging type.

(f) Individual intakes shall be provided for each pump.

(g) Pumping equipment shall have flooded suction and positive suction head under all conditions. Pumps that require vacuum priming systems will not be allowed.

(h) Pumps must operate automatically, based on the water level in the wet well, with provision for manual operation.

(i) Pump vibration shall not exceed the limits set forth in Hydraulic Institute Standard 9.6.4. City may require vibration monitoring for larger pump installations.

(j) Pump motors shall be of the highest efficiency available.

(k) All pump equipment shall have a minimum 5-year warranty.

(2) Dry Well Pumping Equipment

(a) Cleanout and inspection access shall be provided on the pump suction and discharge. Adequate access (minimum of 3 feet of working space must be provided on all sides for maintenance of the pump (e.g., access to internal workings, pump removal and replacement).

(b) Suitable pump support and management of vibration at all operating conditions shall be provided.

(3) Submersible Pumping Equipment

(a) Submersible pumps are not allowed. If FCU grants a variance pursuant to Section 1.05 to allow the use of submersible pumps, the following additional standards shall apply:

i. Arrangement of pumps in the wet well shall conform to pump manufacturer's recommendations for pump spacing and minimum low water depth to accommodate motor cooling and control of floatables with consideration of satisfactory hydraulic operation with adjacent pump(s) operating at the same time.

ii. The connection to the lift station discharge piping design must be capable of being maintained or repaired without operating personnel entering or dewatering the wet well.

iii. Isolation and check valves shall be located in a separate valve vault that shall be designed to not be a confined space.

iv. Pump removal must be possible without requiring operating personnel to enter or dewater the wet well. A corrosion resistant (stainless steel or FRP) guiderail system shall be provided for each pump in the wet well. Guiderails and lifting chairs or cables shall be constructed of a material that has corrosion resistance equal to or better than Series 300 stainless steel.

v. Pumps shall be Flygt n-series or approved equal.

vi. Wet well mixing technology may be required at FCU discretion.

(4) Discharge piping/valving

(a) Pump discharge valving shall allow for full isolation from wet well and discharge piping. Valves shall be plug valves with eccentric operators.

(b) Each pump shall have a dedicated check valve with adjustable outside lever arm and weight suitable for wastewater service.

D. Monitoring Equipment and Emergency Controls

(1) All instrumentation, controls, and communication protocols must be consistent and compatible with FCU standards.

(a) Controls shall use a programmable logic controller (PLC). FCU must approve the brand and model to be used.

(2) Local System Monitoring

(a) A local human machine interface (HMI). shall be provided to monitor the status and alarms of the lift station.

(b) FCU must approve the brand and model of the HMI

(3) The local control station is to be integrated into the FCU SCADA system.

(a) Connection to be done in accordance with FCU and City information technology standards for remote connections.

(4) The control system shall provide:

(a) FCU SCADA with alarms for high and low wet well level, pump fail, power failure, high motor temperature, HVAC failure, fire protection systems, hydrogen sulfide monitoring, equipment status (on/off, run times), and power monitoring.

(b) Programmable alternation of pump operation to provide even pump wear.

(5) Visible exterior alarm systems will be present to prevent entry when hazardous conditions exist.

(6) All instrumentation and comm protocol must be consistent and compatible with Fort Collins standards.

(7) Flow Meter

(a) Each pump shall be equipped with a run time meter. An Endress+Hauser electromagnetic flow meter shall be provided on the force main for indicating, totalizing, and recording flows. The flow meter shall be sized to record the peak pumping capacity, with acceptable accuracy at anticipated minimum flows. The flow meter shall output direct readings in gallons per minute, totalizing in million gallons per day.

(8) Level Mechanism

(a) Liquid level controllers shall be located so that they will not be affected by flows entering the wet well or by the suction of the pumps.

(b) The primary liquid level controller to control pump operations and alarms shall be either radar or submersible pressure transducer with 4-20mA output.

(c) A backup system of four (4) float switches shall be included to provide control in the event of a primary level control failure. Functions include High shutoff, High alarm, Low alarm, Low shutoff.

(9) Alarm

(a) A self-activated alarm shall be provided on all lift stations and all pump instrumentation must be fully integrated with FCU SCADA systems. Alarm systems shall be activated in cases of power failure, pump failure, high water, or any cause of lift station malfunction including those previously listed.

i. FCU and Water Operational Technologies Division shall review and accept alarm plans prior to installation.

ii. The City shall determine, on a case-by-case basis, if the installation of an audiovisual device (i.e. horn or light) shall be required at the lift station site for external observation.

(10) Back-up Power Supply and Emergency Operations

(a) All lift stations shall have backup generation capable of providing at least enough electrical power to pump sewage at the estimated peak flow rate (i.e. enough power to start and run two (2) pumps in a typical three pump lift station) and ancillary equipment in the event of a power outage. Back-up power generators shall be fueled by natural gas, include sound attenuation enclosures and be located in a separate room of the electrical building.

(b) All instrumentation, controls, networking, and SCADA equipment power shall have an Uninterrupted Power Supply (UPS). The UPS must be sized to allow no bump switchover to backup generation as well as enough power to maintain monitoring to the SCADA server in case of backup failure to notify of failure and last status.

(c) The force main(s) shall be provided with a connection point within the pump station enclosure for emergency operation using a portable pump. The connection shall consist of a wye on the force main, valve, and a riser with a six (6″) inch flange with cam lock fitting set in a meter pit.

(d) The system maintenance plan shall include a clear diagram for FCU maintenance crews illustrating how to set up and operate the manual bypass pump.

E. Electrical

(1) An above grade electrical building shall be provided for all lift stations.

(a) The building shall include a 3-foot access door, and roll up door 1 foot larger than the generator skid.

(b) Building shall be designed by a Colorado licensed architect or professional engineer and meet all relevant City and other applicable building code and architectural standards.

(c) Building footprint shall be a minimum of six (6) feet larger than the equipment footprint in each direction (three feet clear on any side).

(d) As a minimum, building shall be split face concrete masonry block with standing seam metal roof or as approved by City.

(2) Electrical equipment in enclosed places where gas may accumulate, shall comply with the latest National Fire Protection Association (NFPA) Codes or the latest National Board of Fire Underwriters' specifications for hazardous locations or submersible locations. All electrical enclosures shall be NEMA Type 4

(3) An adequate number of LED light fixtures with guard shall be mounted in the electrical building and dry well (or valve vault if submersible lift station is allowed) to provide ample illumination for all areas. A manual switch shall be conveniently located near access points to control the light fixtures.

(4) A minimum of three (3), one hundred fifteen (115 v) volt outlets, with appropriate National Electrical Manufacturer Association (NEMA) protection, shall be provided.

(5) A mini-split heat pump/air conditioner with automatic thermostat control shall be supplied. The unit shall be permanently mounted above the floor. Power and wattage requirements shall be as determined by the Engineer.

(6) All lift stations shall have a cathodic protection system designed and installed as needed to protect ferrous materials.

(7) All pumps shall be equipped with variable frequency drives (VFD). VFD programming shall allow full speed pump operation at pump start up to flush any accumulated material from the discharge piping.

(8) NFPA 70E arc flash hazard assessment shall be required for all new lift station control panels.

(9) The control panels shall be mounted on the inside of the electrical building. Enclosures must be NEMA 4 rated or above, service entrance rated, lockable by a single rotary handle, fan heated and situated a minimum of 30" above ground level. Submit control panel shop drawings to City for approval.

F. Site

(1) Location

(a) The lift station and site location shall be designed and constructed to limit disturbance to the surrounding properties both aesthetically and during construction activities.

(b) The lift station site shall be designed to provide adequate drainage away from the lift station and building and conform to the Fort Collins Stormwater Criteria Manual.

(c) Lift station sites shall be located outside of both the City and FEMA 100-year floodplains. The finished floor elevation of the lift station shall be a minimum of two (2) feet above the 100-year base flood elevation (BFE). All sites shall have at least one access road elevated a minimum of 6-inches above the 100-year BFE.

(d) All lift station site locations are subject to review and approval by FCU and Water Quality Control Commission Regulation 22.

(e) A 1" water service including frost free hydrant shall be provided for washdown purposes.

(2) Access

(a) The site shall allow adequate access to the site from existing public right-of-way.

i. Access road and easement required if lift station cannot be accessed from public

ROW.

(b) Site access shall be by all-weather concrete or asphalt paved surface roads capable of accommodating maintenance trucks from public right of way to the lift station site.

(c) The access shall at a minimum support HS-25 loading with a minimum width of 15-feet. The access points and site shall be designed to allow WB-50 trucks to maneuver within the site and exit the site without backing into public right of way.

i. Access road shall meet Poudre Fire Authority (PFA) standards.

(d) The site layout shall allow for vacuum/jet truck access to the wet well for cleaning the wet well. All hard or concrete surfaces shall be designed for the expected vehicle and equipment loads.

(3) Security

(a) The lift station site shall contain perimeter security fencing minimum 6-feet in height. The fencing is subject to City Code and shall be reviewed and approved by the City.

(b) The lift station site access gate shall have a minimum size full width opening of 18- feet and of lockable type.

i. Access gate shall be sized for Poudre Fire Authority (PFA) access

(c) Lighting shall be provided at the lift station site to allow for necessary activities during night and times of low visibility. The lighting system shall be designed to provide illumination to all areas of the station layout and may include suspended, wall, or ceiling mounted fixtures, suitable for routine maintenance activities and inspections. Site lighting equipped with photocells shall not be allowed. Refer City Code for more information, as applicable.

(d) Closed Circuit Televising (CCTV) coverage of the entire lift station site shall be provided.

G. Force Main Design

(1) General

(a) A minimum of two parallel force mains are required.

(b) The force main length shall be as short as possible. Siting of the lift station, high point manhole, and force main route shall be approved by the City.

(c) The force main shall have isolation valves immediately before and following the bypass connection.

(d) Normal operating force main velocities shall range from 3 to 5 fps. At no time shall velocities fall below 2 fps or above 7.5 fps.

(e) A pig launching station shall be provided at the lift station. Pigging ports shall be located at a maximum spacing of 1000 feet, subject to FCU requiring them at more

frequent intervals. Provisions shall be made for pig capture at the terminal manhole.

(2) Hydraulic Design

(a) Force mains shall be minimum 4-inch diameter.

(b) Force mains shall be sized appropriately for a minimum fluid velocity of 2 feet per second and maximum velocity of 7.5 feet per second through all phases of development. Sizing shall also conform to CDPHE design requirements, whichever is most limiting.

(c) Force mains shall connect to the gravity wastewater system at a manhole.

i. All concrete surfaces within both the terminating manhole and next manhole downstream shall be epoxy coated.

ii. The crown elevation of the force main shall match the crown elevation of the wastewater main leaving the manhole.

iii. The hydraulic design must be such that flow into the terminating manhole is not pressurized in any flow scenario.

(d) The force main shall be installed with appropriate separation to potable water lines as required under this Criteria.

(e) Air release or air vacuum valves must be appropriately incorporated into the force main design at high points or otherwise warranted by force main hydraulics. Isolation valves shall be provided on air release or air vacuum valves to minimize spills during maintenance or replacement. All valves shall be designed specifically for wastewater service. Air release/vacuum release valve assemblies shall connect to the force main using a ductile iron tee.

(f) Pressure testing of the constructed pipelines at 150 percent of working pressure shall be specified to confirm watertightness of the completed force main.

(g) A transient (surge) analysis shall be performed for all lift station/force main designs.

(3) Pipe Materials and Appurtenances

(a) Force mains shall have a pressure rating of at least 150% of maximum operating pressures, including surge conditions.

(b) Pipe shall be C-900 PVC with ductile iron fittings that are epoxy lined and coated. Cathodic protection for external corrosion control may be required depending on site geotechnical conditions.

(c) All force mains shall be installed with tracer wire.

(d) All force main pipe shall be provided with restrained joints.

(4) Odor Control

(a) A manhole vent with passive odor control (carbon filter or other approved device) is required at a minimum. Additional odor control will be required by FCU on a case-by-case basis.

H. Workmanship and Project Closeout

(1) General Workmanship

(a) The Developer is responsible for means and methods to excavate, dewater, and install the structure on firm foundation material. Excavation shall be performed in accordance with OSHA, City, and CDPHE requirements (latest versions).

(b) Backfill materials and compaction shall meet the city requirements for structural backfill. (Imported backfill may be required, coordinate with Geotech report).

(c) Pumps shall be installed in strict accordance with the manufacturer's instructions and recommendations. The piping adjacent to the pumps shall be supported such that no weight is carried on the pump casings. The Developer shall verify alignment of the pump and piping prior to start up.

(d) The Design Engineer shall be responsible for reviewing shop drawings and equipment submittals. Approved submittals shall be provided to City. Receipt of approved submittals does not imply acceptance of submittals.

(2) Electrical Workmanship

(a) All electrical work shall be executed in strict accordance with the National Electrical Code, State of Colorado, and local rules and regulations. If there is any conflict between the electrical drawings and specifications and the applicable codes, rules and regulations, the codes, rules and regulations apply.

(b) The Developer shall completely test the electrical system to assure that circuits are wired as called for on the drawings, and shall test the system for grounds and short circuits.

(c) All equipment and material supplied shall be UL 508/913 listed or appropriate listing acceptable to the jurisdictional authority.

(3) System Start-Up. Developer shall:

(a) General.

i. Notify the design engineer and the City five (5) days prior to start-up of each item.

ii. Clean wet well to remove all construction debris and grit prior to starting pumps to prevent damage.

iii. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

iv. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

v. Verify wiring and support components for equipment are complete and tested.

vi. Execute startup under supervision of responsible manufacturer's representative and Contractor's personnel in accordance with manufacturer's instructions

(b) Demonstration and Instruction

i. Coordinate with and demonstrate operation and maintenance of the system to FCU personnel prior to final acceptance including a minimum of one (1) day of live training from the manufacturer's representative. Training shall be video-taped for future reference by FCU personnel.

ii. Secure sufficient water to demonstrate lift station operation at start-up for a minimum of five (5) cycles.

iii. Utilize operation and maintenance manuals as basis for instruction, reviewing contents of manual with City personnel in detail to explain all aspects of operation and maintenance.

iv. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at equipment location.

v. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

(4) Lift Station Completion Requirements. Developer shall:

(a) Final Cleaning

i. Execute final cleaning prior to final inspection including cleaning site, sweeping paved areas, and raking clean landscaped surfaces.

ii. Remove waste, surplus materials and construction debris from the site

(b) Adjust equipment to ensure smooth and unhindered operation

(c) Provide Record Documents and Shop Drawings in digital AutoCAD drawings showing the "as constructed" facility including:

i. Measured depths of foundations in relation to finish floor datum.

ii. Measured horizontal and vertical locations of underground utilities and appurtenances referred to permanent surface improvements.

iii. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.

iv. Field changes of dimension and detail.

v. Details not on original, approved construction drawings.

vi. Submit documents to design engineer and City with written request for final approval and acceptance.

vii. Product substitutions or alternates utilized.

(d) Provide Operation and Maintenance Data in the following format

i. Three (3) Operation and Maintenance Manuals, bound in 8-1/2 x 11-inch pages, D-size three-ring binders with durable plastic covers titled "OPERATION AND MAINTENANCE INSTRUCTIONS," and title of project

ii. Internally subdivide the binder contents with permanent page dividers, logically organized as described below with tab titling clearly printed under reinforced laminated plastic tabs with the following general layout.

a. Part 1: Directory listing names, addresses, and telephone numbers of design engineer, Contractor, subcontractors, and major equipment suppliers

b. Part 2: Operation and maintenance instructions including

i. Significant design criteria

ii. List of equipment

iii. Parts list for each component

iv. Operating instructions

v. Maintenance instructions for equipment and systems

vi. Electrical including: switchgear, manufacturer's recommended maintenance and operation instructions, parts list with name, address and phone number of local source of replacement parts

c. Part 3: Project documents and certificates including:

i. Shop drawings and product data

ii. Certificates

iii. Photocopies of warranties

iii. Submit one (1) copy of completed volumes in final form fifteen (15) days prior to final inspection.

a. Submit final three revised volumes prior to final acceptance. Also submit electronic pdf CD of final O&M Manuals.

(e) Provide duplicate notarized copies of product warranties

(f) All manufacturer's recommended spare parts, maintenance materials, and other required products shall be provided and delivered to the City

Appendix A – Utility Plan Checklist

Fort Collins Utilities Water and Wastewater Design Criteria

Water/Wastewater Utility Plan Checklist

Items below specified with **"FDP"** are only required at the time of Final Development Plans. All other items are required to be provided in both the PDP and FDP plan submittals.

Overall Utility Plan

Included	N/A	Requirements
_____	_____	R.O.W. lines, property lines and easements
_____	_____	Curb and gutter, cross-pans, sidewalks (attached or detached) and medians
_____	_____	Water: Existing and proposed distribution system facilities including valves, hydrants, bends, lowerings, crossings, services, meter pits/vaults, sizes of all mains/services with detailed labeling for all items
_____	_____	Wastewater: Existing and proposed collection system facilities including manholes, services, crossings, sizes of all mains/services With detailed labeling for all items
_____	_____	Dry Utilities: Existing and proposed gas, electric, telephone, cable, etc.
_____	_____	Proposed private subdrains (where applicable)
_____	_____	Irrigation ditches
_____	_____	Match lines with corresponding sheet numbers referenced
_____	_____	Water/sanitary sewer main abandonments
_____	_____	**FP** – Development/construction phasing lines

__/__/____

Water Plan (and Profile when applicable)

Included	N/A	Requirements
_____	_____	R.O.W. lines, property lines and easements with dimensions
_____	_____	Existing and proposed streets, curb and gutter, sidewalks, medians, cross-pans, intakes and other structures
_____	_____	Existing and proposed water mains, services/control valves/meter pits (including irrigation), valves, fittings, fire hydrants, connections to existing system and all appurtenances with detailed labeling for construction
_____	_____	Existing and proposed sanitary sewer mains, services and all appurtenances
_____	_____	Existing and proposed storm sewers and all appurtenances
_____	_____	Proposed private subdrains and cleanout locations
_____	_____	Existing and proposed dry utilities (e.g. gas, electric, telephone, cable, etc.)
_____	_____	Locations of fixed objects (e.g. trees, poles, fences, etc.)
_____	_____	Irrigation ditches
_____	_____	Match lines with corresponding sheet numbers referenced
_____	_____	Utility crossings labeled with sizes, elevations and clearances
_____	_____	Lowerings showing fittings or sweeps with dimensions and elevations
_____	_____	Casing pipes with material, diameter, thickness and length noted
_____	____	Abandonment of water mains
_____	_____	Cathodic Protection (CP) systems on existing mains including the location of CP test stations
_____	_____	**FP** - Lengths of water main between valves, fittings, hydrants, etc.
_____	_____	**FP** - Restrained pipe lengths for thrust restraint at all fittings, lowerings, dead ends, etc.
_____	_____	**FP** - Pipe or street centerline longitudinal stationing
_____	_____	**FP** - For water mains 12-inch and larger, provide water main profile drawings showing existing and proposed ground surfaces with water main depths labeled, existing and proposed utility crossings and all pertinent underground features or information
_____	_____	**FP** - Development/construction phasing lines

Wastewater Plan and Profile

Included	N/A	Requirements
_____	_____	R.O.W. lines, property lines and easements with dimensions
_____	_____	Existing and proposed streets, curb and gutter, sidewalks, medians, cross-pans, storm intakes and other structures
_____	_____	Existing and proposed sanitary sewers, services, connections to existing system and all appurtenances
_____	_____	Existing and proposed water mains, services/control valves/meter pits (including irrigation), valves, fittings, fire hydrants, connections to existing system and all appurtenances
_____	_____	Existing and proposed storm sewers and all appurtenances
_____	_____	Proposed private subdrains and cleanout locations
_____	_____	Existing and proposed dry utilities (e.g. gas, electric, telephone, cable, etc.)
_____	_____	Locations of fixed objects (e.g. trees, poles, fences, etc.)
_____	_____	Irrigation ditches
_____	_____	Match lines with corresponding sheet numbers referenced
_____	_____	Abandonment of sewers
_____	_____	Utility crossings labeled with sizes, elevations and clearances
_____	_____	Casing pipes with material, diameter, thickness and length noted
_____	_____	**FP** – Profile of all sanitary sewers
_____	_____	**FP** - Length of sewer between manholes and longitudinal stationing on manholes and services with detailed labeling for construction
_____	_____	**FP** - Manhole rim and inflow/outflow invert elevations
_____	_____	**FP** - Existing and proposed ground surface
_____	_____	**FP** - Encasement as required when sanitary crosses above a water main
_____	_____	**FP** - Groundwater barriers where applicable
_____	_____	**FP** - Development/construction phasing lines

Detail Sheets

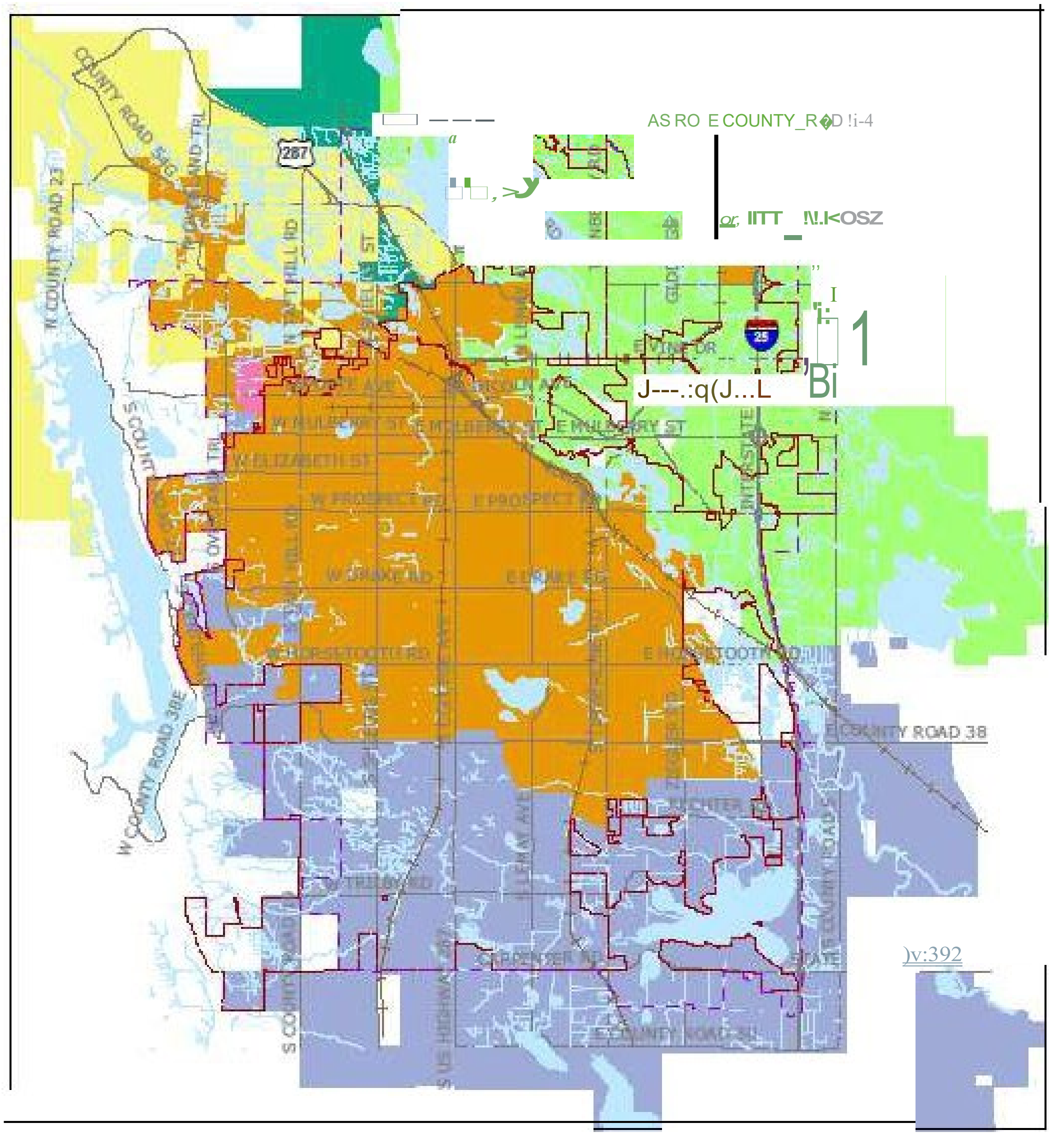
Included	N/A	Requirements
_____	_____	Applicable City of Fort Collins Utilities water, sanitary sewer and stormwater details
_____	_____	Details of special connections, crossings or construction specific to this project

Effective Date: __/__/_____

Appendix B - Utility Maps

Water Utility Service Areas
Water Pressure Zones
Wastewater Utility Service Areas

\Water Utility Service Areas



Water Districts

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Water Features

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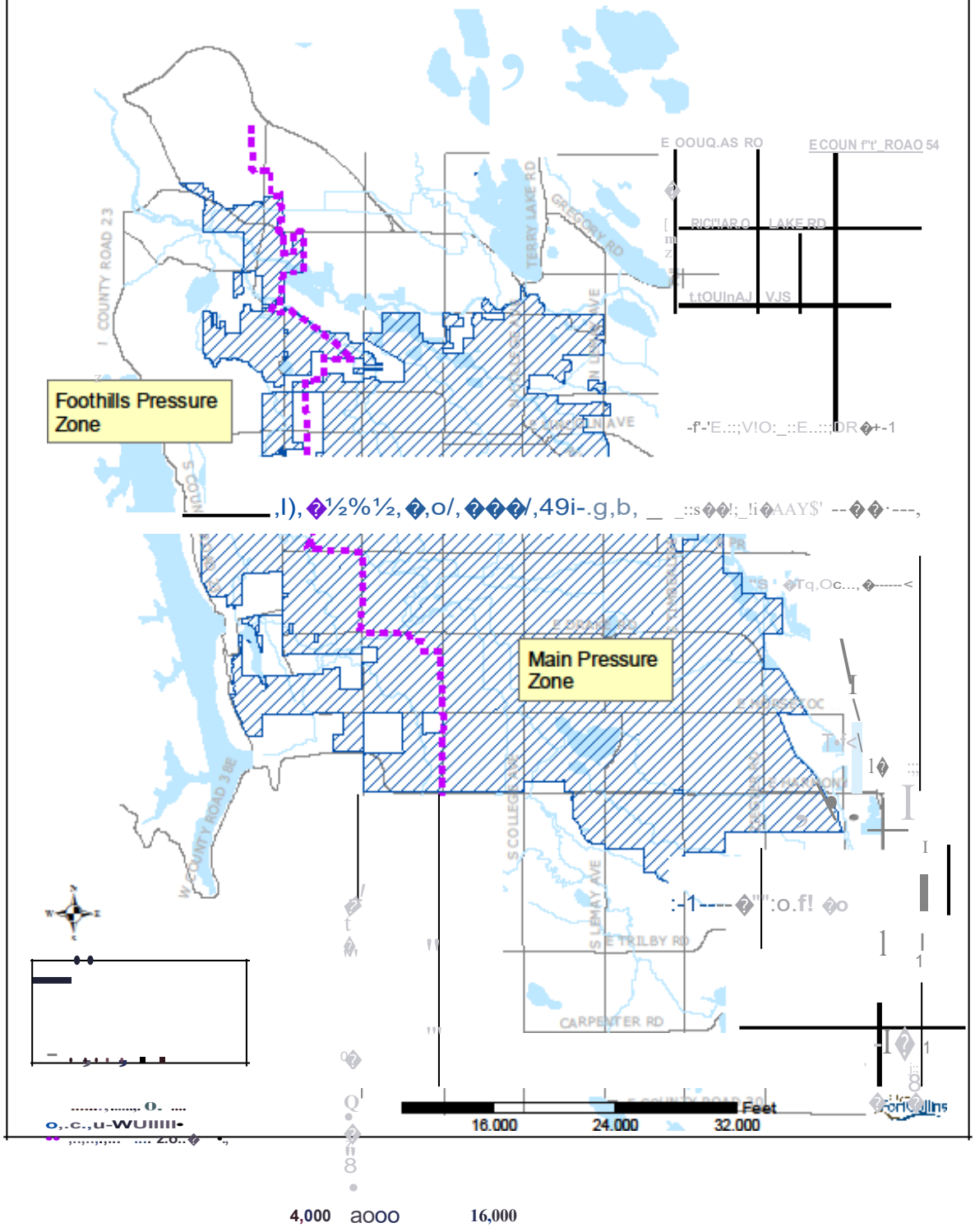
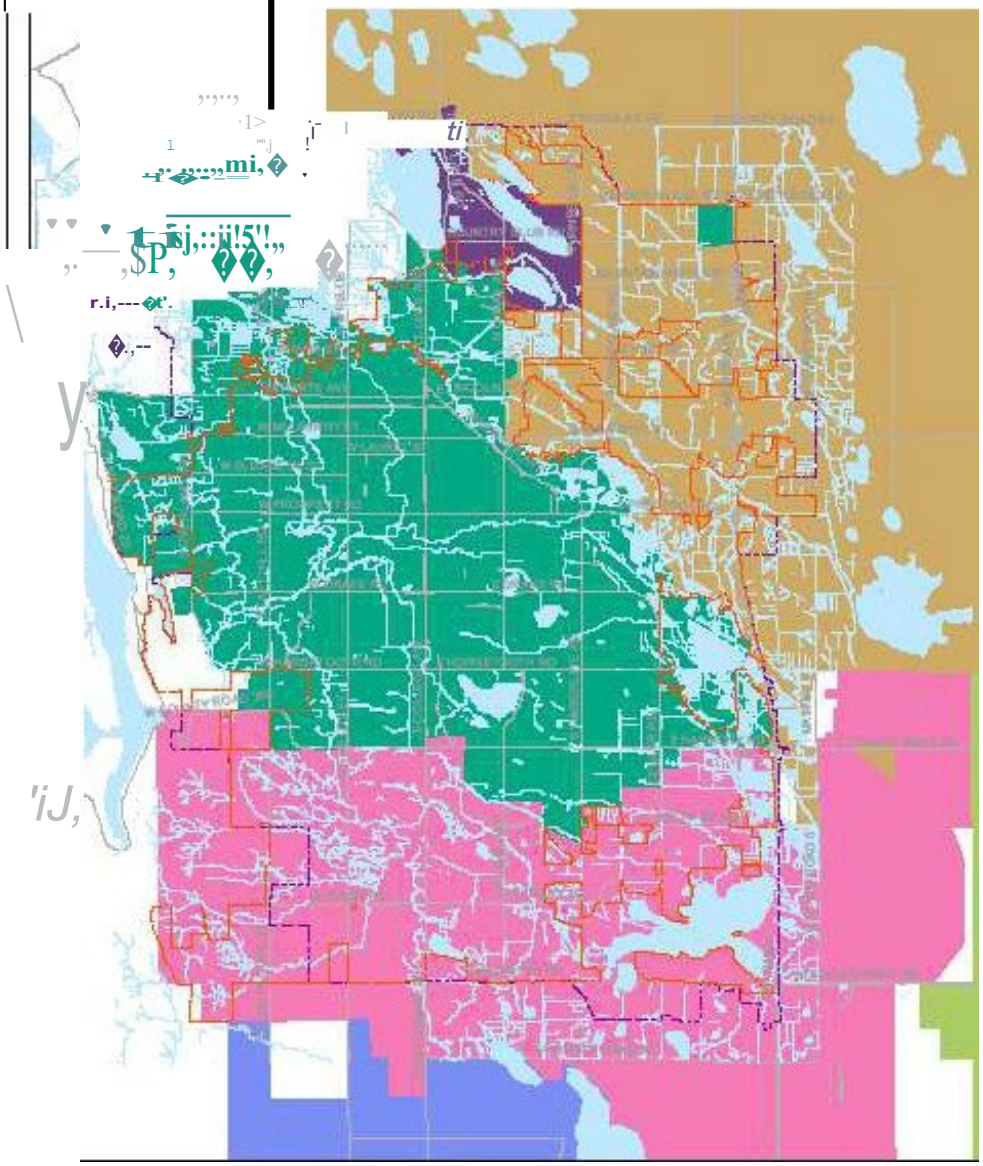
Water Pressure Zones



Wastewater Utility Service Areas



Sewer Districts
- Boxelder
- ChenyHills
- FortColins
- Loveland
- South FortCoUins
- Welington
- Wr1dsor

water Featll°es
- CityLimits
- GrowthManagement Area
- Major Streets

0 6.()00 12.000 24.000 36,000 '8.000 Feet