CHAPTER 6
WASTEWATER DESIGN

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6.01 General

(A) Intent

The Wastewater Design Standards establish minimum design standards for providing and maintaining the public wastewater utility collection system.

(B) Wastewater Master Plans

All improvements proposed to the City's public wastewater utility system shall conform with the goals, policies, and standards adopted in the Wastewater Collection System Master Plan.

(C) Reference Standards

Where not specified in these Standards or the B.R.C. 1981, to protect the public health, safety, and welfare, the Director of Public Works will specify the standards to be applied to the design and construction of public wastewater utility improvements and may refer to one or more of the references listed in the References Section of these Standards.

6.02 Utility Report

(A) Requirement

The Director of Public Works may require the preparation of a utility report in order to assess the impacts and service demands of any project or development proposal connecting to the public waterwater collection system. The utility report shall be prepared by the Engineer and include a technical report and preliminary plan as outlined in the following subsections.

(B) Report

The utility report shall provide an overview of the proposed project or development, proposed wastewater utility improvements, wastewater service demands, system impact and feasibility, and basic design requirements, and include the following information:

(1) **Wastewater Demands:** Include estimated wastewater demands based on projected land use, occupancy and building type for the following conditions:

  (a) Average-Day (gallons-per-minute),

  (b) Peak Flow or Maximum-Day (gallons-per-minute),

  (c) Minimum-Day (gallons-per-minute), and

  (d) Infiltration/Inflow (gallons-per-minute).

(2) **Compatibility with Wastewater Collection System Master Plan:** Describe how the proposed wastewater utility improvements conform with the adopted Wastewater Collection System Master Plan.

(3) **Service Area:** Describe the initial and ultimate area, measured in acres, that could be served by the new wastewater facilities.

(4) **Population Density:** Define the initial and ultimate population densities that could be served by the new wastewater facilities.

(5) **Industrial Wastes:** Define the estimated quantities and quality of any industrial wastes that could be discharged to the wastewater system.

(6) **System Layout:** Describe the proposed collection system layout, including locations for connections with the existing wastewater utility system.

(7) **Collection System Analysis:** Include a collection system analysis as required by the Director, identifying any system impacts based on proposed demands and providing design solutions to ensure perpetuation of future wastewater utility system growth and maintain system capacity and flow rates.

(8) **Main Sizing:** Indicate the required sizing of proposed collection mains based on wastewater demands.

(9) **Design Alternatives:** Discuss alternative system layouts and methods of providing wastewater service, including an evaluation of each alternative and reasons for selecting the recommended design.

(10) **Special Conditions:** Identify any special conditions, such as conflicts with other utilities, unusual installation depths or oversizing requirements, that require special provisions for improvements construction.

(11) **Wastewater Classification Survey:** Include all information requested in the City's "Wastewater Classification Survey."

(12) **Wastewater Effluent Characteristics:** Include information concerning the characteristics of proposed wastewater effluent, as described in 40 C.F.R., Part 122, Appendix D, Tables 2-5, at each connection to the City's wastewater collection system as required by the Director, including the following:

(a) Acidity-alkalinity,

(b) Phosphorus,

(c) pH,

(d) Sulfates and sulfides,

(e) Synthetic and organic compounds,

(f) Hazardous constituents,

(g) BOD_5 (total and soluble fraction, carbonaceous and nitrogenous demand),

(h) COD (total and soluble),

(i) TSS,

(j) Nitrogen (TNK, NO_3, NO_4, NH_4, organic), and

(k) Inorganics (salts, metals)

(C) Preliminary Plan

A preliminary plan shall be included in the utility report to provide a plan view and reference for the proposed improvements, and identify issues addressed in the report. The preliminary plan is to include the following:

(1) **Preliminary Design:** Illustrate proposed methods and alternatives for providing site wastewater collection and service.

(2) **Property Boundaries:** Reflect legal boundaries of the proposed project or development site, including existing and proposed property and lot lines, existing and proposed rights-of-way

and utility easements, and boundaries of abutting properties.

(3) **Topography:** Include site topography at 2-foot interval contours, and the elevation and location of City-recognized benchmarks with reference to local, USGS and NGVD data.

(4) **System Area:** Define and delineate the system area included in the network analysis.

(5) **Existing Utilities:** Illustrate existing utilities, including manholes, within 400 feet of the proposed development.

(6) **Unusual Features:** Identify unusual features, such as creeks, drainage facilities, railroads, and irrigation ditches, that might influence the location of underground utilities.

(7) **Proposed System Layout:** Illustrate the general layout of the proposed wastewater collection mains and manhole locations, including construction phasing.

(8) **Emergency Maintenance Access:** Identify methods and routes for providing emergency and maintenance access to all proposed manholes.

6.03 Wastewater Main Extensions

(A) Treated Water Master Plan

Where major wastewater collection mains, 12 inches or larger in diameter, are proposed to be constructed in the Wastewater Collection System Master Plan, an applicant for construction approval shall provide for the construction of the main as part of any development proposal, when the major collection main is:

(1) Located within a proposed development.

(2) Located within 1,000 feet of a proposed development and it is feasible to include construction of this main in the proposed development.

(3) Required to provide adequate collection service for the proposed development.

(B) Main Extension Agreements

(1) When construction of a major collection main is required, and the diameter of the major collection main is larger 12 inches and the minimum diameter required for local distribution mains to serve the proposed development, an applicant for construction approval may enter into a "main extension agreement" with the City for reimbursement of public improvements costs associated with the over-size construction of the major distribution main, as prescribed under Sections 11-2-26, “Agreement to Extend Sanitary Sewer Mains,” and 11-2-27, “Reimbursement of Costs for Sanitary Sewer Main Extension,” B.R.C. 1981.

(2) When construction of an offsite major or local wastewater collection main is required to extend collection service to a proposed development, an applicant for construction approval may enter into a "main extension agreement" with the City for reimbursement of offsite public improvements, as prescribed under Sections 11-2-26, “Agreement to Extend Sanitary Sewer Mains,” and 11-2-27, “Reimbursement of Costs for Sanitary Sewer Main Extension,” B.R.C. 1981.

6.04 Design Flow

(A) Wastewater Collection Mains

(1) Wastewater collection mains shall be designed to convey the peak flow.

(2) Wastewater collection mains shall be designed to ensure transport of suspended materials and preclude material deposits considering minimum-day flows.

(3) The peak flow shall be determined using average-day forecasts adjusted by a peaking factor and including the allowed and any existing system infiltration or inflow.

(4) Flow capacity and loading data of existing and future conditions for the City's major wastewater collection system shall be obtained from the Utilities Division for use in designing and analyzing proposed improvements. This information is compiled using the City's standard Hydra hydraulic analysis program, and is available in both hard copy and electronic formats.

(5) The minimum-day flow shall be determined using average day-forecasts adjusted by a minimum flow factor and including the allowed and any existing infiltration or inflow.

(6) Average-day flow forecasts shall include the ultimate area, population density, existing wastewater flow, anticipated industrial discharge, and any allowed infiltration/inflow, that produces the greatest wastewater flow rates.

(7) Surface water, ground water, or cooling water shall not be discharged into the wastewater collection system. Prohibited connections include roof drains, storm inlets, foundation perimeter drains, area drains for open patios or driveway entrances to parking structures, and ground water sump systems.

(8) Floor drains internal to covered parking structures, that collect drainage from rain and ice drippings from parked cars or water used to wash-down internal floors, shall be connected to the sanitary sewer using appropriate grease and sediment traps.

(9) Table 6-1 indicates wastewater discharge forecasting for average-day conditions:

Table 6-1: Average Day Load by Development Type

Development Type	Average Day Load
Residential	100 gpcd
Average Persons per Single-Family Unit	3.2
Average Persons per Multi-Family Unit	2.0
Non-Residential	
Commercial	5000 gpad
Industrial	4500 gpad
Infiltration	200 gidm**

NOTES: * The Industrial Average-Day Load Indicates Non-Water Intensive Industrial Development
** Gallons Per Inch-Diameter-Mile

(10) The average-day forecast loads indicated in Table 6-1 represent minimum forecast loads in determining design flows. Where proposed development is known (based on specific applications or use), and the anticipated wastewater loads exceed the minimum forecast demands, the greater load shall be used to determine design flows.

(11) Table 6-2 indicates the wastewater peaking and minimum flow factors for forecasting discharges. These flow factors are, used to determine minimum required wastewater main capacity:

Table 6-2: Factors for Forecasting Wastewater Discharges

Collection Main Diameter	Minimum Factor	Peaking Factor
10 inches and smaller	0.25	4.0
12 to 15 inches	0.30	3.5

18 to 27 inches	0.33	3.0
30 inches and larger	0.40	2.5

(12) Final design flow determinations shall include any documentation and calculation of initial and ultimate areas, population densities, existing wastewater flow rates, existing or anticipated industrial discharges, and average-day, peak flow, minimum-day, and infiltration/inflow flow rates.

(B) Wastewater Services

Design flows for wastewater services shall be determined in conformance with the most current Uniform Plumbing Code (UPC), adopted by the City.

6.05 Materials and Installation

Construction of wastewater-related public improvements shall be in compliance with these Standards. All pipe shall be of adequate strength to support trench and AASHTO HS-20 highway loadings. The type of pipe to be installed shall comply with these Standards, and shall be based upon applicable design flows, pressures, site conditions, corrosion protection, and maintenance requirements

6.06 Collection Mains

(A) System Design

(1) **Gravity Flow:** The wastewater collection system shall be designed for gravity (open) flow conditions, using a "Mannings" roughness coefficient of 0.013 to account for various pipe materials and joints, service connections, and future interior pipe conditions.

(2) **Peak Flow Depth:** Collection mains shall normally be designed to carry the peak flow with a flow depth of one-half of the full pipe.

(3) **Pressurized Flow Prohibited:** Pressurized surcharged or depressed (inverted siphon) wastewater mains are prohibited in the City's wastewater collection system.

(B) Size

(1) **Minimum Diameter:** Collection mains shall be a minimum eight (8) inches in diameter.

(2) **Size Changes:** All changes in pipe size shall require a manhole at the size change.

(C) Locations

(1) **Easements:** All wastewater mains shall be installed in public rights-of-way or easements, as prescribed under Section 4.02 of these criteria.

(2) **Lot Frontage:** All platted lots, whether existing or proposed as part of a subdivision, shall front on a collection main.

(D) Depth

(1) **Minimum and Maximum Cover:** All collection mains shall have a minimum depth of cover of three (3) feet, and a maximum depth of cover of eighteen (18) feet, measured from the top of pipe to the final surface grade.

(2) **Shallow Cover Protection:** Where collection main depths are less than four (4) feet, and the main is located under a right-of-way, street, driveway, parking lot, or other areas where live loading is a concern, special pipe materials (such as ductile iron pipe) or other structural measures (such as concrete encasement) shall be provided.

(3) **Provision for Basements:** Proposed collection mains shall be designed with adequate depth to provide wastewater service to basements, where possible and appropriate.

(E) Slope

(1) **Minimum and Maximum Slopes:** Table 6-3 indicates minimum and maximum allowable collection main slopes:

Table 6-3: Minimum and Maximum Allowable Collection Main Slopes

PIPE DIAMETER (Inches)	MINIMUM SLOPE (%, ft/100 ft)	MAXIMUM SLOPE (%, ft/100ft)
8"	0.332	8.299
10"	0.247	6.164
12"	0.193	4.833
15"	0.144	3.590
18"	0.113	2.815
21"	0.092	2.292
24"	0.077	1.918

(2) **Velocities:** Collection mains shall be designed with an adequate slope to provide flow velocities of two (2) feet per second during peak flow conditions. Minimum allowable slope shall provide half-full or full pipe flow velocities of two (2) feet per second. Maximum allowable slope shall provide half-full or full pipe flow velocities of 10 feet per second. The design slope will usually be greater than the minimum allowable slope, where less than half-full or full pipe peak flow conditions occur.

(3) **Slope Between Manholes:** All collection mains shall be laid at a constant slope between manholes.

(4) **Slope Changes:** All changes in slope shall require a manhole at the slope change connection.

(F) Alignment

(1) **Straight Alignment Required:** All collection mains shall be laid in a straight alignment between manholes.

(2) **Alignment Changes:** All changes in alignment require a manhole at the alignment change connection.

(3) **Curvilinear Mains Prohibited:** Curvilinear collection mains will not be allowed.

(G) Separations and Crossings

All collection main separations and crossings of other City utilities shall be designed in compliance with Section 4.05, “Separation of Utilities,” of these Standards.

(H) Taps

All taps approved onto an existing collection main will be made by the City of Boulder Utilities Division, and

shall be paid for by the applicant.

(I) Ground Water Barriers

(1) **Required:** Where there exists a possibility that ground water may be diverted by the construction of new water or wastewater collection mains, ground water barriers shall be constructed within the collection main trench to prevent ground water migration or diversion along the water or wastewater main.

(2) **Placement:** The Engineer shall determine the location and number of ground water barriers that will be necessary to mitigate any ground water impacts, subject to review and approval by the Director. Any necessary support material required to address ground water concerns, such as soils investigations, engineering calculations and design details, shall be provided by the design engineer.

(J) Extensions

(1) **Standards:** Wastewater collection mains are subject to the requirements of Section 11-2-25, "Extensions for Sanitary Sewer Mains," B.R.C. 1981, and these Standards.

(2) **System Perpetuation:** Wastewater mains shall extend to the far edge of the property being served or to the edge of the platted subdivision, whichever is greater, to ensure perpetuation of the water distribution system. The location, size, and configuration of the proposed development or subdivision, with respect to the existing wastewater collection system, may dictate that wastewater mains be extended to the far edge of more than one property or subdivision boundary to accommodate system perpetuation.

(3) **Exceptions:** Exceptions to this subsection may be granted only if development of the adjacent property is not contemplated within 5 years or is classified as Area III under the Boulder Valley Comprehensive Plan. In these cases, an easement for extending the system shall be granted by the property owner.

6.07 Manholes

(A) Location

(1) **Where Required:** Manholes shall be required at the upper end of each collection main line, and at all changes in grade, slope and alignment. Where feasible, manholes are to be installed at street intersections, or aligned with an extension of property lines in midblock and easement locations and should be located outside of bike lanes, sidewalks, multi-use paths and wheel lines of streets

(2) **Maximum Separation:** Manholes shall be required along collection mains at distances not greater than:

(a) 400 feet, for mains 15 inches in diameter or less,

(b) 450 feet, for mains 18 inches and 21 inches in diameter, and

(c) 500 feet, for mains 24 inches in diameter or larger.

(3) **Service Connections:** Manholes shall be required at all service connections for wastewater service lines eight (8) inches in diameter and larger.

(4) **Monitoring Facilities:** Manholes for monitoring facilities shall be required on service lines for industrial users or non-residential users, as prescribed under Section 11-3-14,

"Monitoring Facilities," B.R.C. 1981. Where monitoring facilities are required, service lines shall be a minimum of 6 inches in diameter to facilitate sampling.

(5) **Avoidance of Submerged Conditions:** Manholes should not be located in areas subject to flooding, from floodplains, surface runoff, or ponding.

(B) Flow Channels

(1) **Required:** Flow channels shall be required in all manholes, connecting the inverts of the upstream and downstream pipe sections. The flow channel shall be U-shaped, and shall meet the following minimum heights:

(a) One-half of the diameter (or to pipe centerline) on collector pipes less than 15 inches in diameter.

(b) Three-fourths of the diameter on collector pipes 15 inches and larger in diameter.

(2) **Slope:** The slope of the flow channel shall be:

(a) The design slope through the manhole, for continuous slope, straight alignment pipe lines.

(b) The slope (approximately five (5) percent) resulting from a two-tenths (0.2) feet drop through the manhole (to account for energy losses inside the manhole), for manholes at changes in alignment and grade.

(c) The slope resulting in the manhole by matching the eight-tenths (0.8) depth point of the upstream and downstream pipe sections, for manholes at changes in pipe size.

(C) Drop Manholes

(1) **Avoidance:** Drop manholes shall be avoided whenever possible.

(2) **Where Provided:** Where there are no available alternatives, drop manholes shall be required where the invert of the upstream pipe section entering the manhole is greater than two (2) feet above the invert of the downstream pipe section exiting the manhole.

(D) Maintenance Access

Direct access by maintenance vehicles shall be provided to each manhole. The access drive shall be an all-weather surface, such as asphalt or concrete paving, adequate gravel base or turf block, and shall be capable of supporting maintenance vehicles weighing up to 14 tons.

(E) Covers

(1) **Where Required:** Manholes that are not located within a public street, alley or driveway section shall be installed with a bolting-type cover, to ensure safety and prevent vandalism.

(2) **Submerged Conditions:** Where manholes must be located within the 100-year floodplain, or in a location where runoff may accumulate and pond, they shall be installed with a watertight, bolting-type cover, to prevent inflow/outflow. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge.

6.08 Wastewater Services

(A) General

(1) **Standards:** Wastewater services are private wastewater system extensions that are connected or tapped onto the wastewater collection main to provide wastewater service to the consumer, and are subject to the requirements of Section 11-2-13, "Taps or Connections to Sanitary Sewer Mains" and 11-2-14, "Sanitary Sewer Service Lines," B.R.C. 1981, and these Standards.

(2) **Industrial and Prohibited Discharges:** Wastewater services and discharges are subject to the requirements of Chapter 11-3, "Industrial and Prohibited Wastewater Discharges," B.R.C. 1981.

(3) **Separate Services to Lots:** All platted lots, whether existing or proposed as part of a subdivision, shall front on and have a separate wastewater service connection to a collection main without crossing adjacent lots.

(4) **Service Alignment:** Wastewater services shall be installed perpendicular to the collection main, for that portion of the service line that is located in the public right-of-way or easement. Where this is not possible, the wastewater service alignment shall be subject to the determination of the Director.

(5) **Separation from Water Service:** Wastewater services shall maintain a minimum separation of ten (10) feet from water services, for that portion of the service line that is located in the public right-of-way or easement.

(6) **Prohibited Connections:** No surface water or ground water, may be discharged into the wastewater service. Prohibited connections include roof drains, storm inlets, foundation perimeter drains, area drains for open patios or driveway entrances to parking structures, and ground water sump systems.

(7) **Floor Drains in Parking Garages:** Floor drains internal to covered parking structures, that collect drainage from rain and ice drippings from parked cars or water used to wash-down internal floors, shall be connected to the wastewater service using appropriate grease and sediment traps.

(B) Connections

(1) **Tap:** Wastewater service connections to newly constructed collection mains shall require the installation of a tee or wye, in conformance with these Standards. A directional fitting shall be used at all tap connections.

(2) **Installation:** All connection taps approved onto an existing wastewater collection main shall be made by the City of Boulder Utilities Division, and shall be paid for by the applicant.

(3) **Standard Connections:** Wastewater service connections shall be tied into the collection main between manholes, and shall be spaced a minimum of eighteen inches apart and a minimum two feet away from any manhole.

(4) **Manhole Connections:** Service connections to manholes shall be avoided, except where:

(a) The service size is eight inches in diameter or larger (which requires the installation of a manhole).

(b) The service connection is tied to a terminal manhole, located at the end of a cul-de-sac or easement, and there is no possibility of extending the collection main in the

future.

(c) The service connection elevation cannot be tapped above the springline of the sanitary sewer main.

NOTE: Under these conditions, a flow channel shall be provided in the manhole from the service connection to the manhole flow channel, and the service shall enter the manhole at no greater than 6 inches above the manhole base.

(C) Service Lines

(1) **Separate Services to Structures:** Each principal structure shall be served by a separate wastewater service line connected to the collection main. Where more than one principal structure is proposed on a single lot, an additional wastewater service line will be required for each additional principal structure.

(2) **Accessory Buildings:** An accessory building or structure, as defined under Section 9-1-3, "Definitions," B.R.C. 1981, may receive limited service from a principal building or structure without a separate wastewater service, subject to the following:

(a) The accessory structure is limited to the following plumbing fixtures, and contains no water closet (toilet) or bathtub/shower fixtures:

(i) Sink (one fixture),

(ii) Clothes washer connection (one set),

(iii) Hose bib or sill cock (one fixture),

(iv) Floor drain (one (1) fixture), and

(v) Interceptor (one (1) fixture)

(b) The accessory structure is proposed to have a sink and toilet, contains no bathtub/shower fixtures, may not be used as a separate dwelling unit, and is located on a property that cannot be further subdivided into separate lots, except in an approved owner's accessory unit.

(c) The Director of Public Works may permit wastewater hookups separate from a principal detached dwelling unit upon finding that topography or other physical circumstances make utility connections to the principal structure impractical.

(3) **Services Crossing Lots:** Wastewater service lines crossing one lot to provide service to an adjacent lot may be approved, if all of the following conditions are met:

(a) The service crossing is part of a proposed subdivision creating only two lots.

(b) A utility easement at least 10 feet wide is provided across, and situated entirely within, the boundaries of the proposed subdivision. The easement is to be granted to the City for the benefit of the property owner being served and is to be occupied by the wastewater service line only, or by the water and wastewater service lines only if the water and wastewater service lines are installed in compliance with the IPC.

(c) The Director determines that a wastewater main extension is not necessary to perpetuate the system, or that future development of abutting properties cannot benefit from a main extension.

(d) The wastewater service line is to be centered in the easement and be at least 5 feet from other utilities, except for a combined water/wastewater service installation as

allowed under the IPC.