



**CITY OF BOULDER  
CITY COUNCIL AGENDA ITEM**

**MEETING DATE: May 7, 2019**

**AGENDA TITLE**

Ordinances to conform with state stormwater requirements and updating the City of Boulder Design and Construction Standards:

1. Introduction, first reading and consideration of a motion to order published by title only Ordinance 8323, implementing stormwater quality management requirements of the City's Colorado Municipal Separate Storm Sewer System (MS4) Permit and updating other utilities infrastructure best practices by amending Chapter 11-5, "Stormwater and Flood Management Utility," and Chapter 8-5, "Work in the Public Right of Way and Public Easements," B.R.C. 1981, and setting forth related details; and
2. Introduction, first reading and consideration of a motion to order published by title only Ordinance 8324, updating utilities standards generally and implementing stormwater quality management requirements of the City's Municipal Separate Storm Sewer System (MS4) Permit by amending the City of Boulder Design and Construction Standards adopted by Ordinance 5986, and setting forth related details.

**PRESENTERS**

Jane S. Brautigam, City Manager  
Tom Carr, City Attorney  
Mary Ann Weideman, Interim Director of Public Works  
Jeff Arthur, Director of Public Works for Utilities  
Trish Jimenez, Deputy Director of Public Works for Development Services  
Edward Stafford, Development Review Manager for Public Works  
Candice Owen, Stormwater Quality Supervisor, Utilities  
Pieter Beyer, Engineering Services Manager, Utilities  
Amanda Bevis, Project Coordinator for Public Works

## EXECUTIVE SUMMARY

This memorandum provides information and a summary of proposed updates to the city's Design and Construction Standards (DCS) that are being made to comply with the requirements of the city's State of Colorado Municipal Separate Storm Sewer System (MS4) permit and to align the standards with industry best practices for utilities. Changes to the Boulder Revised Code (BRC) are proposed in order to comply with the requirements of the state permit. This memorandum includes an attachment of detailed proposed changes to the DCS and BRC. The city must comply with the state requirements of the MS4 permit by implementing regulatory changes by July 1, 2019, or the city may be considered out of compliance with the state requirements.

The State of Colorado MS4 permit was created in 2003 and is generally updated by the state every five years. This term's permit expands requirements in four main topic areas related to city regulation:

- Post-construction stormwater maintenance
- Allowable non-stormwater discharges
- Construction and post-construction stormwater development requirements
- Expanded enforcement capabilities for illicit discharges, construction and post-construction stormwater violations

The city has limited flexibility in codifying and implementing the permit's control measures that address the topic areas above. The proposed changes related to the permit and other utilities best practices are included in a detailed description outlined below.

Updates to the transportation and landscape sections of the DCS are not proposed in these changes and will be presented later in 2019.

## STAFF RECOMMENDATION

### **Suggested Motion Language:**

Staff requests council consideration of this matter and action in the form of the following motions:

1. Motion to introduce on first reading and order published by title only Ordinance 8323, implementing stormwater quality management requirements of the City's Colorado Municipal Separate Storm Sewer System (MS4) Permit and updating other utilities infrastructure best practices by amending Chapter 11-5, "Stormwater and Flood Management Utility," and Chapter 8-5, "Work in the Public Right of Way and Public Easements," B.R.C. 1981, and setting forth related details; and
2. Motion to introduce on first reading and order published by title only Ordinance 8324, updating utilities standards generally and implementing stormwater quality management requirements of the City's Municipal Separate Storm Sewer System (MS4) Permit by amending the City of Boulder Design and Construction Standards adopted by Ordinance 5986, and setting forth related details.

## COMMUNITY SUSTAINABILITY ASSESSMENTS AND IMPACTS

- Environmental - The implementation of updated MS4 permit requirements provides a higher level of protection and oversight of stormwater in the city through additional water quality design requirements, enforcement mechanisms and construction oversight and continues to protect our water and environment.
- Social – there are no significant social impacts.

## OTHER IMPACTS

- Fiscal and staff time– Compliance with the MS4 permit and implementation of proposed DCS and BRC changes require additional staff resources to manage compliance and permits. Planning and Development Services in the Public Works Department manages compliance and is funded by fees, therefore a fee change has been incorporated into proposed changes to cover costs. A request for an additional full-time equivalent (FTE) for inspection and compliance is included in the first adjustment to base in 2019.

## BOARD AND COMMISSION FEEDBACK

### Water Resources Advisory Board

The WRAB approved a motion (5-0) on February 25, 2019, to recommend approval of the proposed changes related to utilities and the MS4 permit. The motion followed an information item regarding the DCS on January 28, 2019, and a public hearing on February 25, 2019. There was no public comment. The motion language is as follows:

*“The Water Resources Advisory Board (WRAB) recommends approval of the proposed changes and updates to the Design and Construction Standards (DCS) as identified in Attachment A of the February 25, 2019, memo to WRAB.”*

Since the WRAB motion, minor updates to the proposed changes have been made such as non-substantive, grammar and consistency updates.

### Planning Board

The Planning Board approved a motion (7-0) on April 18, 2019, to recommend approval of the proposed changes related to utilities and the MS4 permit in the DCS and BRC. There was no public comment. The motion language is as follows:

*“Motion to recommend City Council adopt an ordinance to amend Section 11-5-5, “Discharges to the Storm Water Utility System” and Section 11-5-6 “Master Drainage Plan, Land Development and Discharges Into the Storm Water System”, B.R.C. 1981, and an ordinance repealing and reenacting, by reference, the City of Boulder Design and Construction Standards, regarding the city’s compliance with the State of Colorado’s Municipal Separate Storm Sewer System (MS4)*

*permit and to update other utilities best practices, and setting forth related details.”*

## **PUBLIC FEEDBACK**

Staff held a stakeholder meeting on March 25, 2019, for design engineers and landscape architects in the community who wanted to learn more about the proposed changes. The purpose of the meeting was to share information about the proposed changes and receive feedback from stakeholders.

Attendees provided helpful feedback and asked questions about how the changes impact their work, clarifying areas of change, and understanding the intent of changes. Generally, attendees seemed to have a positive reaction to the opportunity to provide input and understood the process.

## **BACKGROUND**

The Clean Water Act of 1970, which aims to reduce water pollution nationwide, requires states to implement permit programs that regulate the collection and discharge of municipal stormwater to waters of the state. The State of Colorado updates the general Phase II Municipal Separate Storm Sewer System (MS4) permit program through five-year permit cycles with each new iteration adding compliance requirements for municipalities.

The city obtained its initial MS4 permit in 2003. To stay in compliance with the current permit, the city is required to make updates to the city’s DCS and BRC, as well as make updates to standard operating processes regarding the management and discharge of stormwater. The city’s flexibility in implementing the MS4 permit requirements is limited, as it’s operationalizing the compliance requirements within the Clean Water Act (see graphic below). The current permit requires that permit holders align their regulations and processes by July 1, 2019. This is the primary purpose of the proposed DCS and BRC updates.

The DCS prescribes minimum standards used in the design and construction of public infrastructure located in public right-of-way and easements in the city of Boulder, as well as private transportation and utility improvements that connect to or impact public infrastructure. The DCS includes standards for infrastructure related to the MS4 permit requirements. The BRC Section 11-5 includes regulations related to the implementation of the MS4 permit and penalty capabilities that also need to be updated to comply with the permit.

Along with updates for MS4 compliance requirements, staff also proposes updates to other utilities standards that represent current utilities best practices and associated updated technical details. These updates also align with other adopted policy documents, such as the Stormwater Master Plan and Boulder Valley Comprehensive Plan.

More information regarding the proposed changes is described below. In addition, the proposed changes are located in attachments:

- Attachment A – Proposed changes to the BRC in ordinance form
- Attachment B – Proposed changes to the DCS in ordinance form
- Attachment C – Proposed changes to the DCS in red-line form for reference

Updates to the transportation and landscape sections of the DCS are not proposed in these changes and will be presented later in 2019.

## **ANALYSIS**

### **MS4 Permit Compliance**

The City of Boulder obtained its latest MS4 permit through the State of Colorado Department of Public Health and Environment in 2016. This permit allows the city to discharge stormwater from the municipal storm sewer system to waters of the state. The definition of “waters of the state” includes Boulder’s surface waters, including water courses that are usually dry. The state permit is not optional for municipalities and is required by the state under the United States Clean Water Act. The permit includes requirements that the city must implement to prevent stormwater pollution through requiring best practices for prevention and clean-up of spills, construction, development and municipal operations.

The MS4 permit has a rolling timeline to comply with various permit requirements for the duration of permit coverage, which is five years (current permit is 2016 – 2021). To implement and enforce additional permit requirements in the latest MS4 permit, the city must update its regulatory mechanism through the DCS and BRC by July 1, 2019.

Staff worked closely with a team of consultants, local experts, and legal staff to develop proposed changes to be in compliance with the MS4 permit requirements. Changes were compared to language and policies used in other Colorado communities.

Attachment C includes Chapter 7 Stormwater Design of the DCS and shows draft changes in red-line form. A summary of changes is provided below:

- DCS Ch. 7.13 - Updates to Chapter 7 construction stormwater requirements including the addition of MS4 permit language related to required practices and addition of language to reference the city’s Erosion Control Permit.
- DCS Ch. 7.14 through 7.18 - Updates to post-construction stormwater requirements to align with MS4 permit requirements and best practices. These updates include addition of MS4 permit required stormwater quality control measure design and sizing methodologies and clarification of requirements for sites under one acre. The requirements focus on the assessment of a site’s capability to infiltrate stormwater and provide the most feasible and impactful treatment option.
- DCS Ch. 7.2 through 7.4 and 7.12 - consistency updates to detention and drainage report sections to provide additional clarity and to match permit requirements and Urban Drainage Flood Control District published criteria.

Attachment A includes parts of Section 11-5 of the BRC that shows draft changes in underline/strikeout form. A summary of changes is provided below:

- B.R.C. 11-5-2 – Revises and adds definitions to align with permit requirements
- B.R.C. 11-5-5 – Clarifies language related to allowable non-stormwater discharges in the city to align with permit language.
- B.R.C. 11-5-7 – Removes language that requires a city Groundwater Discharge permit for construction and subterranean discharges. This process is duplicative with the current state permitting process and will be moved to a review item within the development review process.
- B.R.C. 11-5-6 – Adds language to provide clearer references to and charging language for construction and post-construction stormwater sections of DCS Chapter 7 for better enforcement capabilities.
- B.R.C. 11-5-6 – Adds language on the requirements for Erosion Control permits.
- B.R.C. 11-5-6 – Adds language to provide civil penalty capabilities to B.R.C.11-5 for stormwater violations that ties back to permit requirements for enforcement escalation capabilities.
- B.R.C. 11-5-21 through 11-5-23: Adds language specific to enforcement

The MS4 permit also requires additional inspection and compliance monitoring and documentation be completed by the city for all projects that require stormwater management and erosion control plans. An additional FTE for an inspector position in the Planning and Development Services fund is being requested in the first adjustment to base to support the additional on-going efforts to comply with the MS4 permit. To cover the costs of this additional position fee changes are included in this ordinance, which will increase the monthly erosion control permit fee from \$338 to \$592 and the Water Quality Feature / Detention Pond facility inspection fee from \$507 to \$718 per facility.

### **Other Utilities-Related Standards**

Staff also proposes changes to the water, wastewater and stormwater utility standards in the DCS that represent industry best practices and associated technical details. Attachment C includes Chapters 1, 4, 5, 6, 7, 9, and 11 of the DCS and shows draft changes using tracked changes.

A summary of changes is provided below:

- Incorporate standards to improve the city's ability to maintain utilities infrastructure, such as clarification of manhole spacing, easement access requirements, and increase of separation between city and private utilities. A summary of changes:
  - o Ch. 4.04 – Explanation of property owner responsibility to maintain access along easements.
  - o Ch. 4.06 – Increase minimum separation between city utilities and private electric, gas, and telecommunications utilities from 6 inches to 12 inches.

- Ch. 4.06 – Clarification of placement of trees in easements and separation of utilities work from existing trees.
  - Ch. 6.07 and 7.08 – Reduction of maximum allowable manhole spacing for sewer maintenance purposes and prohibit placement of manholes in areas prone to flooding.
  - Ch. 6.08 – Require the installation of maintenance access points (clean-outs) on sewer services on the exterior of the building.
  - Ch. 7.07 – Prohibit roadside ditches from discharging to piped systems where possible because this causes significant debris build up in the piped system.
  - Ch 6.08 and 7.08 – Require manholes at all sewer service connections to be 6 inches or larger (previously 8 inches).
- Clarify areas of the DCS that are redundant or missing; eliminate redundant explanation of calculations; clarify abandonment of private utilities services; and clarify the role of streets as a part of the drainage system. A summary of changes is provided below:
- Ch. 4.08 – Addition of a new section providing details on the abandonment of sewer and water services.
  - Ch. 7 – Removal of hydraulic calculation details as these are already incorporated by reference from the Urban Drainage Flood Control District Criteria Manual.
  - Ch. 7.01 – Clarification that streets shall be designed to accommodate surface drainage and convey it to downstream drainage systems.
  - Ch 7.08 – Require that all drainage systems be continuous and not end in a sump condition as well as avoid discharging to irrigation ditches.
  - Ch 7.09 – Clarification of where stormwater inlets are required.
  - Ch 9.14 – Prohibit the construction of curvilinear sewer lines.
- Update specifications, infrastructure and material requirements to accommodate the transition from city-supplied parts for private projects to contractor-acquired parts as well as incorporate new industry standards and technologies. A summary of changes is provided below:
- Ch. 9 – Updates throughout to provide the necessary details for contractors to supply standard items such as valves, hydrants, meters, and pipe saddles, instead of the city providing these parts.
  - Ch. 9 – Updates throughout to reflect current industry standards for pipe and pipe appurtenance materials.
  - Ch. 9.02 – Updates to pipe bedding materials details to current industry standard and reflect locally available materials.
  - Ch 9.07 – Updates to post-construction sewer inspection methods to current industry standard.

- Update references, figures, and technical drawings where appropriate (throughout the chapters).
- Updates to Chapter 1 – General Requirements and Chapter 11 – Technical Drawings, Glossary and References are also proposed to implement the changes noted above and clean-up process language to align with current practices.
  - o Ch 11 Drawing 5.17 B – revised
  - o Ch 11 Drawing 5.18 A – revised
  - o Ch 11 Drawing 5.18 B – revised
  - o Ch 11 Drawing 5.18 C – revised
  - o Ch 11 Drawings 7.20 – 7.30 – removed, as these drawings are now referenced in Chapter 7 to the Urban Drainage Manual.

## **NEXT STEPS**

If City Council makes a motion to approve the first reading of the proposed changes on May 7, then second reading is scheduled for the consent agenda at the May 21 council meeting.

Should the City Council adopt the proposed changes, the changes will go into effect 30 days after their adoption.

## **ATTACHMENTS**

Attachment A – Proposed Ordinance 8323 (B.R.C. Ordinance)

Attachment B – Proposed Ordinance 8324 (DCS Ordinance)

Attachment C – Proposed DCS Changes in redline form



ORDINANCE 8323

AN ORDINANCE AMENDING CHAPTER 11-5, “STORMWATER AND FLOOD MANAGEMENT UTILITY,” AND CHAPTER 8-5, “WORK IN THE PUBLIC RIGHT OF WAY AND PUBLIC EASEMENTS,” B.R.C. 1981, TO IMPLEMENT STORMWATER QUALITY MANAGEMENT REQUIREMENTS OF THE CITY’S STATE OF COLORADO MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT; AND SETTING FORTH RELATED DETAILS.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF BOULDER, COLORADO:

Section 1. Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981, is revised as follows, and Section 11-5-7, “Permit,” has been repealed and replaced:

**11-5-1. - Legislative Intent.**

(a) *Purpose:* The purpose of this chapter is to protect the public health, safety and welfare:

- (1) From damage from ~~storm-water~~stormwater runoff and floods by requiring that property owners in the city pay for a share of the cost of the drainage facilities necessary to manage such ~~storm-waters~~stormwaters and floods; and
- (2) By protecting and enhancing the water quality of the local receiving waters in a manner consistent with the federal Water Pollution Control Act, 33 U.S.C. § 1251, et seq., and the state Water Quality Control Act, § 25-8-101 et seq., C.R.S. section through the regulation of non-~~storm-water~~stormwater discharges to the municipal storm sewer system.

(b) *Intent:* It is the intent of the city council in enacting this chapter:

- (1) To promote public health, safety and welfare by permitting the movement of emergency vehicles during flooding periods and minimizing flood losses and the inconvenience and damage resulting from uncontrolled and unplanned ~~storm water~~stormwater runoff in the city;
- (2) To establish a master plan for ~~storm-water~~stormwater and flood management and its implementation, including, without limitation, a coordinated program of creating upstream ponding or temporary detention of ~~storm-waters~~stormwaters;
- (3) To establish a ~~storm-water~~stormwater and flood management utility to coordinate, design, construct, manage, operate and maintain the ~~storm-water~~stormwater and flood management system;
- (4) To establish reasonable ~~storm-water~~stormwater and flood management fees based on the use of ~~storm-water~~stormwater and flood drainage facilities;

- (5) To encourage and facilitate urban water resources management techniques, including, without limitation, detention of ~~storm-water~~stormwater and floods, reduction of the need to construct storm sewers, reduction of pollution and enhancement of the environment;
- (6) To prevent the introduction of pollutants to the municipal storm sewer system; that may adversely affect the environment or may cause a violation of the city's MS4 permit or may contribute to the need for modification of that permit;
- (7) To establish standards for permanent ~~storm-water~~stormwater runoff controls; and
- (8) To establish requirements for the long-term responsibility for maintenance of structural ~~storm-water~~stormwater control improvements and nonstructural ~~storm-water~~stormwater management practices to ensure that they continue to function as designed, are maintained, and do not threaten public safety.
- (c) *Findings:* The city council finds and determines that the city has historically provided and will continue to provide ~~storm-water~~stormwater and flood management services by means of an enterprise, as that term is defined by Colorado law. The city council further declares its intent that the city's ~~storm-water~~stormwater and flood management utility enterprise be operated and maintained so as to exclude its activities from the application of article X, section 20 of the Colorado Constitution.

#### **11-5-2. - Definitions.**

The following words used in this chapter have the following meanings, unless the context clearly indicates otherwise:

Applicable development site means (1) any new development or redevelopment site resulting in land disturbance of greater than or equal to one acre, including a site that is less than one acre that is part of a larger common plan of development or sale that would disturb or has disturbed one acre or more, or (2) any development site for which a stormwater detention pond is required.

Common plan of development or sale means a plan or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules in a contiguous area, within 1/4 mile, but remain related through such plan or sale.

Construction activity means an activity that disturbs the ground surface and associated activities that include, without limitation clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. Activities from initial ground breaking through final stabilization are construction activities regardless of ownership. Construction activities do not include routine maintenance to maintain the original line and grade, hydraulic capacity, or original purpose of a facility. Activities to conduct repairs that are not part of routine maintenance, activities for replacement, and activities for repaving where underlying or surrounding soil is exposed, cleared, graded, or excavated are all construction activities for the purposes of this chapter.

Control measures means any activity, practice, or structural control used to prevent or reduce the discharge of pollutants to waters of the state. The two categories of control measures are:

1       (a) Control measure for post-construction water quality, also referred to as stormwater  
2       control measure (SCM) means a permanent device, practice, or method for  
3       removing, reducing, retarding, or preventing targeted stormwater runoff  
4       constituents, pollutants, and contaminants from reaching receiving waters.

5       (b) Control measure for erosion and sediment control means a device, practice, or  
6       method implemented on a construction site to remove, reduce, retard, or prevent  
7       pollutants or pollutant laden water from discharging off the site. These control  
8       measures may be structural or non-structural.

9       (c) Discharge means, including without limitation, any spilling, leaking, pumping,  
10       pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping  
11       or disposing into the stormwater utility system.

12       ....

13       Illicit Discharge means any discharge to the stormwater utility system that is not composed  
14       entirely of stormwater, including without limitation any discharge of pollutants, except as  
15       exempted under Section 11-5-5, "Discharges to the Stormwater Utility System," B.R.C. 1981.

16       MS4 permit means the Municipal Separate Storm Sewer System Phase II discharge permit  
17       issued by the Colorado Department of Public Health and Environment pursuant to Regulation 61,  
18       Colorado Permit Discharge System, 5 CCR 1002-61, and the Colorado Water Quality Control Act,  
19       C.R.S. § 25-8-101, et seq., as that permit may be amended in the future.

20       New development means a vegetative or non-vegetative change in the existing land surface,  
21       including without limitation construction activities, compaction associated with stabilization of  
22       structures, road construction, construction or installation of a building or other structure, and  
23       creation of impervious surfaces, and land subdivision for a site that does not meet the definition of  
24       redevelopment.

25       One hundred-year floodplain means the area that would be inundated by a flood having a  
one percent or greater chance of ~~being equalled or exceeded~~ occurring in ~~one~~ any given year.

Pollutant means dredged spoil, dirt, sediment, slurry, solid waste, incinerator residue,  
sewage, ~~biosolids~~ sewage sludge, garbage, trash, chemical waste, biological nutrient, biological  
material, radioactive material, heat, wrecked or discarded equipment, rock, sand or any industrial,  
municipal or agricultural waste.

Redevelopment means the creation or addition of impervious area or paved surface on a  
site that is already substantially developed with 35% or more existing imperviousness, including  
without limitation expansion of a building footprint, addition or replacement of a structure,  
structural development, and construction or replacement of paved surface area.

~~Storm water~~ Stormwater and flood management utility enterprise means the ~~storm~~  
~~water~~ stormwater and flood management utility business owned by the city, which business  
receives under ten percent of its annual revenues in grants from all Colorado state and local  
governments combined and which is authorized to issue its own revenue bonds pursuant to this  
code or any other applicable law.

~~Storm water quality best management practices means practices intended to prevent or reduce the discharge of pollutants directly or indirectly to storm water including, without limitation, schedules of activities, prohibitions of practices, pollution prevention and educational practices, maintenance procedures, operating procedures and practices to control site runoff, spillage or leaks, sludge or water disposal, drainage from raw materials storage and other receiving waters, or storm water conveyance systems. Storm water quality best management practices include the practices, facilities or improvements identified in the City of Boulder Design and Construction Standards.~~

Stormwater utility system means the municipal storm sewer system that includes without limitation the conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels, or storm drains) that discharge to state waters and is owned or operated by the city and designed or used for collecting or conveying stormwater, and is not a combined sewer or part of a publicly owned treatment works.

....

#### **11-5-4. - Connections to the ~~Storm Water~~Stormwater and Flood Management Utility System.**

- (a) Connections by Authorized Personnel: No person not authorized by the city manager shall tap or connect to any part of the ~~storm water~~stormwater and flood ~~control~~management utility.
- (b) Connections Made in Compliance With Approval: No person shall fail to make authorized connections to the ~~storm water~~stormwater and flood ~~control~~management utility in accordance with the terms and conditions of the permit or approval issued therefor and the City of Boulder Design and Construction Standards.
- (c) Costs of Connection: No person requesting or required to make connections to the ~~storm water~~stormwater and flood ~~control~~management utility shall fail to pay the costs for such connections.
- (d) Prohibited Connections: No person shall make, maintain or use any illicit connection to the city's ~~storm water~~stormwater and flood ~~control~~management utility, including, without limitation, illicit connections made in the past. No person shall fail to remove any such prior connection within sixty days of adoption of this section.

#### **11-5-5. - Discharges to the ~~Storm Water~~Stormwater Utility System.**

- (a) Illicit Discharges Prohibited: No user or other person shall discharge any ~~sewage, other polluted waters or other deleterious substance from any premises within the city~~illicit discharge into or upon the stormwater utility system, any public highway, street, sidewalk, alley, land, public place, stream, ditch or other watercourse or into any cesspool, storm or private sewer or natural water outlet, except ~~where suitable treatment has been as~~specifically provided in this chapter and in accordance with provisions of applicable federal, state and local laws. the MS4 permit.
- (b) Cleaning of Hard Surfaces: The owner of any paved parking lot, street or drive shall clean the pavement as necessary to prevent the buildup ~~and discharge of pollutants and to prevent an illicit discharge.~~ Paved surfaces shall be cleaned by dry sweeping, wet vacuum sweeping, collection and treatment of wash water or other methods in compliance with this chapter, or other applicable federal, state and local laws.

- 1 (c) Material Storage: No person shall store materials including, without limitation, stockpiles  
2 used in construction and landscaping activities, in a manner which may cause an illicit  
3 ~~discharge or threatened discharges of pollutants~~illicit discharge into the ~~storm~~  
4 ~~sewer~~stormwater utility system or receiving water.
- 5 (d) Exemptions: The following discharges are exempt from the ~~discharge permit~~ requirements  
6 established by this chapter:
- 7 (1) Landscape irrigation and lawn watering associated with single-family detached or  
8 duplex development, ~~uncontaminated groundwater from an individual single-~~  
9 ~~family residential detached or duplex foundation drainage system, individual~~  
10 ~~residential car washing or car washing of less than two consecutive days in duration~~  
11 ~~for charity or nonprofit fundraising, dechlorinated swimming pool discharges,~~  
12 ~~water line and fire hydrant flushing, firefighting activities or street cleaning~~  
13 ~~operations conducted by the city; or~~
- 14 (2) Uncontaminated groundwater or surface water pumped from a foundation drainage  
15 or crawl space system in accordance with the regulations of the Colorado  
16 Department of Public Health and Environment,
- 17 (3) Individual residential car washing,
- 18 (4) Discharges that comply with the Colorado Water Quality Control Division's *Low*  
19 *Risk Policy Discharge Guidance* or other applicable Division policies or guidance  
20 documents including:
- 21 (A) Dechlorinated swimming pool discharges;
- 22 (B) Water line and fire hydrant flushing;
- 23 (C) Uncontaminated groundwater infiltration;
- 24 (D) Discharges from potable water sources that have not been used in any  
25 additional process, including without limitation any type of washing, heat  
exchange, manufacturing, or hydrostatic testing of pipelines not associated  
with treated water distribution systems; or
- (E) Discharges where the Colorado Water Quality Control Division has stated  
that it will not pursue permit coverage or enforcement,
- (5) Emergency firefighting activities,
- (6) Street cleaning operations conducted under the supervision of or authorized by the  
city,
- (7) Diverted stream flows,
- (8) Irrigation return flow,
- (9) Springs,
- (10) Flows from riparian habitats and wetlands,
- (11) Air conditioning condensation,

(12) Dye testing in accordance with manufacturers recommendations,

(13) Stormwater runoff with incidental pollutants,

(14) Discharges authorized by a Colorado Discharge Permit System permit or National Pollutant Discharge Elimination System permit,

(15) Agricultural runoff; or

~~(2)~~(16) Any discharge that is authorized by the city manager consistent with the MS4 permit.

**11-5-6. –Master Drainage Plan, Stormwater Quality Management for Land Development and Discharges Into the Storm Water System.**

(a) Drainage Facilities Required: No developer of land in the city person engaged in new development or redevelopment shall fail to provide on such person's property all reasonably necessary drainage facilities to ensure adequate drainage and management of storm watersstormwaters and floods falling on or flowing onto the property.

(b) Erosion Control Permit Required: No person shall commence construction activities before obtaining an erosion control permit.

(1) Compliance With Permit Required: No person shall fail to conduct construction activities consistent with the approved erosion control permit and the requirements of this chapter and the City of Boulder Design and Construction Standards.

(2) Permit Application: An applicant for an erosion control permit shall file a completed application on a form provided by the city manager that shall include, without limitation, the following:

(A) If the construction activities result in a land disturbance of greater than or equal to one acre, or if less than one acre are part of a larger common plan of development or sale that would disturb or has disturbed one acre or more:

(i) A copy of a Colorado Discharge Permit System General Permit for Stormwater Discharges Associated with Construction Activities issued by the Colorado Department of Public Health and Environment;

(ii) A stormwater management plan consistent with the requirements of Section 7.13 of the City of Boulder Design and Construction Standards and using forms provided by the city manager;

(B) If the construction activities result in a land disturbance of less than one acre and is not part of a common plan of development or sale, an erosion control plan consistent with Section 7.13 of the City of Boulder Design and Construction Standards;

1           (C) Any additional information the city manager deems necessary to determine  
2           whether the requirements of this chapter and the City of Boulder Design  
3           and Construction standards for construction activities have been met; and

4           (D) The fee described by Section 4-20-71, “Erosion Control Permit Fee,”  
5           B.R.C. 1981.

6           (3) Expiration: All construction activities covered by the permit shall be completed by  
7           the date approved in the permit. Permits shall expire and be void if the activities  
8           authorized by the permit have not commenced within 180 days after its issuance,  
9           or if the activities authorized by the permit are suspended or abandoned for a period  
10           of 180 days. The city manager may grant in writing one or more extensions of time  
11           for periods not to exceed 180 days each if the applicant demonstrates justifiable  
12           cause in writing.

13           (4) Control Measures for Erosion and Sediment Control Required: Control measures  
14           for erosion and sediment control shall be selected, designed, installed and  
15           maintained in conformity with the approved erosion control permit and the City of  
16           Boulder Design and Construction Standards. No person shall violate the inspection  
17           and maintenance requirements established in the City of Boulder Design and  
18           Construction Standards for such control measures approved in the erosion control  
19           permit.

20           ~~(b)(c) Storm Water and Flood Control Management Plan~~Final Drainage Report Required: Before  
21           the city manager issues a city building permit for ~~the construction of any building or~~  
22           ~~structure other than a single family dwelling and appurtenant structures~~ the applicable  
23           development site, the property owner or building permit applicant shall submit to the  
24           manager a detailed ~~storm water and flood management plan~~final drainage report that meets  
25           state and federal requirements, this chapter, and the City of Boulder Design and  
Construction Standards. A permit will not be issued until the manager determines, based  
upon generally accepted engineering principles in storm and drainage control, that the  
~~plan~~report meets the requirements of this chapter and the provisions of the master drainage  
plan that relate to the drainage basin in which the property is located.

~~(1) Storm Water and Flood Management Plan Required: The storm water and flood~~  
          ~~management plan shall establish, locate or otherwise define the alignment and~~  
          ~~boundary of any natural drainage way, drainage facility or subdrainage area on the~~  
          ~~property; include drawings, profiles and specifications for the construction and~~  
          ~~installation of channels, conduits, reservoirs, culverts, bridges, easements, storm~~  
          ~~water quality improvements and storm water quality best management practices,~~  
          ~~and all other drainage facilities reasonably necessary to ensure that storm waters~~  
          ~~and floods (including drainage from other lands that will contribute runoff to the~~  
          ~~property) will be controlled, as provided in the City of Boulder Design and~~

~~Construction Standards; and contain a schedule of the estimated dates of completion of construction for all drainage facilities shown on the plan.~~

(21) ~~Compliance With Approved Plan~~Report Required: No person shall fail to comply with an approved ~~storm water and flood management plan~~final drainage report submitted under this section.

(32) ~~Plan~~Report Required With Development Application: No person shall receive an approval for a subdivision, or site review under this code or any ordinance of the city unless the person submits and obtains approval of the ~~storm water and flood management plan~~final drainage report required by this section.

(43) ~~On-Site Detention and Control Measures for Post-Construction Water Quality Improvements~~ Required: On-site detention storage and control measures for post-construction water quality improvements shall be ~~provided~~designed, installed, and implemented in accordance with the reasonable requirements of urban hydrology and the standards established in the City of Boulder Design and Construction Standards.

(A) No owner of SCMs shall fail to maintain in operational condition any on-site detention facility or control measure for post-construction water quality that is required as part of a final drainage report or other approval, in accordance with the City of Boulder Design and Construction Standards or any inspection requirements or conditions of approval.

(B) No owner of SCMs shall fail to inspect any on-site detention facility or control measure for post-construction water quality at least once per year or as required in the City of Boulder Design and Construction Standards or any conditions of approval.

(C) No owner of SCMs shall fail to keep on file all records of maintenance and service of any on-site detention facility or control measure for post-construction water quality for a minimum of five years. The city manager may change the duration of the record keeping requirements based upon the needs of the development. All records shall be made available for review by the city manager immediately upon request.

~~(c) General Requirements for All Construction Activities: No person shall fail to follow or otherwise violate the erosion control practices in the City of Boulder Design and Construction Standards. All such controls shall be installed and maintained in conformity with the standards in the City of Boulder Design and Construction Standards.~~

~~(d) Maintenance of Water Quality Improvements: No person shall fail to maintain any improvement that is required as part of a storm water and flood management plan. Any improvement associated with storm water quality best management practices shall be properly inspected and serviced, if necessary, at least once per year or as approved in the storm water and flood management plan to ensure proper function of such improvement.~~



1 ~~Records of maintenance and service shall be kept on file by the owner for a minimum of~~  
2 ~~three years and shall be made available for review by the city manager.~~

3 (ed) Waiver of Requirements: The city manager may waive any or all of the requirements of  
4 this section ~~for particular developments~~ or impose additional requirements, if such waiver  
5 or additional requirement is reasonably necessary due to the existence of special geological  
6 or topographical conditions and meets the purposes of this chapter prescribed by section  
7 11-5-1, "Legislative Intent," B.R.C. 1981, or as may be allowed under the City of Boulder  
8 Design and Construction Standards.

9 (fe) Easement for Drainage Way ~~Requirements~~: No owner of a parcel of land through which  
10 a natural drainage way flows as shown on the master drainage plan shall obtain a building  
11 permit to develop the property, unless the person first grants to the city at no charge a  
12 permanent easement to construct, maintain or reconstruct the channel along the drainage  
13 way.

14 (gf) Financial Guarantee: In order to guarantee the construction of any ~~drainage on-site~~  
15 detention facility or control measure for post-construction water quality shown on an  
16 approved ~~storm water and flood management plan~~ final drainage report submitted under  
17 this section, the owner of the land shall submit to the city a financial guarantee in a form  
18 satisfactory to the ~~office of the city attorney-manager~~ for the construction of the facility,  
19 before any building permit is issued— that meets the requirements of Section 9-2-21,  
20 "Financial Guarantees," B.R.C. 1981.

#### 21 **11-5-7. Inspections Authorized.**

22 In order to ensure compliance with the requirements of this chapter, the City of Boulder  
23 Design and Construction Standards, or any approval granted under this chapter, or action taken to  
24 remedy any violation of such requirements or approval, the city manager has the authority, subject  
25 to the provisions and search warrant requirements in Section 2-6-3, "Creation, Jurisdiction, and  
Powers of the Municipal Court," B.R.C. 1981, to inspect any property, structure, or improvement.

#### 26 **11-5-8. - Special Agreements and Permits.**

27 (a) Agreements or Permits: No statement contained in this chapter shall be construed as  
28 prohibiting special written agreements, contracts or permits between the city and any  
29 person allowing wastes to be admitted to the ~~storm water sewer~~ stormwater utility system.

30 (1) A special written agreement or permit may include groundwater, but shall not  
31 include domestic wastes.

32 (2) Except as set forth below, the agreement or permit shall require monitoring and  
33 treatment consistent with, or similar to, federal, state and local laws and regulations.

34 (3) The applicant shall demonstrate to the city manager that there is adequate capacity  
35 in the ~~storm water drainage~~ stormwater utility system, considering, without  
limitation, the design capacity for storm events and present and future development  
in areas served by the ~~storm water drainage~~ stormwater utility system.

- (4) The user or beneficiary of such agreement or permit shall compensate the city for any additional costs of treatment and for any other costs incurred by the city as determined by the city manager, including, without limitation:
- (A) Costs associated with review and issuance of the permit or agreement consistent with hourly review rates for city staff as outlined in section 4-20-43, “Development Application Fees,” B.R.C. 1981;
  - (B) Costs associated with ongoing monitoring; and
  - (C) Indemnification of the city, its officers, employees and agents, for any costs to such parties, including staff time and attorney's fees, for damages, judgments, fines, settlements, costs and expense which may in any manner accrue against such party as a consequence of the grant of such agreement or permit.
- (b) Polluted Discharge Agreement or Permit: The city manager may execute an agreement or issue a permit to exceed any specific pollutant limitations required by federal, state or local law only if the manager finds that:
- (1) The user is making reasonable progress toward eliminating the violation;
  - (2) Compliance with the specific pollutant limitation during a time period agreed upon for installation of proper pretreatment equipment would impose undue hardship; and
  - (3) Acceptance of the discharge does not adversely affect the ~~storm-water~~stormwater utility system nor cause violation of the city's ~~National Pollutant Discharge Elimination System~~ MS4 permit and applicable federal and state laws.
- (c) Violation of Agreement or Permit Prohibited: No person shall violate the terms and conditions of an agreement or permit issued under this section.
- (d) Nothing contained in a special agreement or permit shall limit the ability of the city manager to enforce violations of the agreement or permit or of this chapter.

**11-5-9. - ~~Storm Water~~Stormwater and Flood Management Utility.**

- (a) There is hereby created a ~~storm-water~~stormwater and flood management utility in the department of public works under the control of the city manager, empowered to implement the provisions of this chapter.
- (b) Except as provided in subsection (c) of this section, the owner of each parcel of land in the city shall pay the ~~storm-water~~stormwater and flood management fee prescribed by section 4-20-45, “~~Storm Water~~Stormwater and Flood Management Fees,” B.R.C. 1981, for the construction, operation, maintenance and replacement of the ~~storm-water~~stormwater and flood management ~~system~~ utility.
- (c) Since the basis of the fee is determined according to the anticipated use of drainage facilities according to improvements made on the property, no fee will be charged for any parcel of land that is entirely undeveloped.

....

**11-5-14. - Charges Are Lien on Property.**

- (a) No owner of a parcel of land in the City using the ~~storm-water~~stormwater and flood management ~~system-utility~~ shall fail to pay any ~~storm-water~~stormwater and flood management fee prescribed by this chapter.
- (b) All fees, interest and the cost of collecting them, if any, are a lien that is prior and superior to all other liens, claims, titles and encumbrances, whether prior in time or not, except liens for general taxes, and remain a lien upon the property from the date that the fees, interest and collection costs, if any, are due until the time they are paid.
- (c) The City may enforce the lien against the property or the liability against the owner in an action at law or an action to enforce the lien.

....

**11-5-21. – Violations**

- (a) No person shall fail to follow or otherwise violate any provision of this chapter or any condition of any approval granted under this chapter or the City of Boulder Design and Construction Standards.
- (b) No person shall commence any construction activity, new development, or redevelopment except in conformity with all of the provisions of this chapter and the City of Boulder Design and Construction Standards and with the conditions of any approval granted under this chapter.
- (c) No person shall commence any construction activity, new development, or redevelopment except in conformity with any construction plans approved under the City of Boulder Design and Construction Standards.
- (d) No owner of SCMs shall fail to maintain in operational condition any on-site detention facility or control measure for post-construction water quality that is required as part of a final drainage report or other approval.
- (e) No person shall tamper with, modify, disable or in any way damage any fixture or control measure required under this chapter.
- (f) No person shall violate the terms and conditions of any special agreement or permit issued under this chapter.
- (g) No person shall fail to comply with any order of the city manager issued under this chapter.

**11-5-22.- Administrative Enforcement Remedies.**

- (a) Notice of Violation: Whenever the city manager finds that any person has violated or is violating any provision of this chapter, or any approval granted under this chapter or the City of Boulder Design and Construction Standards, the city manager may serve upon such person a written notice stating the nature of the violation and providing a reasonable time necessary to cure the violation for the satisfactory correction thereof.
- (1) If the person so notified fails to correct the violation as required by the notice in this section, or if the city manager determines that an emergency exists, the city

manager may correct the violation or cause the violation to be corrected and charge the costs thereof to the person violating the provisions of this chapter.

(2) If any person fails or refuses to pay when due any charge imposed under this section, the city manager may, in addition to taking other collection remedies, certify due and unpaid charges to the Boulder County Treasurer for collection as provided by Section 2-2-12, "City Manager May Certify Taxes, Charges and Assessments to County Treasurer for Collection," B.R.C. 1981.

(b) Remedies: If the city manager finds that a violation of any provision of this chapter, the City of Boulder Design and Construction Standards, or any approval granted under this chapter exists, the manager, after notice and an opportunity for hearing under the procedures prescribed by Chapter 1-3, "Quasi-Judicial Hearings," B.R.C. 1981, may take any one or more of the following actions to remedy the violation:

(1) Impose a civil penalty of up to \$1,000.00 for each violation. Each day on which violations continue shall be deemed to be separate and distinct violations. The civil penalty shall be assessed according to the following schedule:

(A) For the first violation of the provision of approval, \$100.00;

(B) For the second violation of the same provision or approval, \$300.00; and

(C) For the third violation of the same provision or approval, \$1,000.00;

(2) Issue an order reasonably calculated to ensure compliance with the provisions of this chapter or any approval granted under this chapter.

(c) Prior to the hearing, the city manager may issue an interim order that no person shall perform any work on any structure or land until the violation is corrected with respect to such structure or land.

(d) If notice is given to the city manager at least forty-eight hours before the time and date set forth in the notice of hearing on any violation that the violation has been corrected, the manager will reinspect the structure or land. If the manager finds that the violation has been corrected, the manager may cancel the hearing.

(e) Hearings: Any person that has been served with an administrative order may request, within fourteen days of receipt of such order, an administrative hearing to be conducted by the city manager. The city manager shall hold a hearing pursuant to chapter 1-3, "Quasi-Judicial Hearings," B.R.C. 1981, within twenty-one days of such request.

### **11-5-23. - Criminal Sanctions.**

The city attorney, acting on behalf of the people of the city, may prosecute any violation of this chapter, the City of Boulder Design and Construction Standards or any approval granted under this chapter in municipal court in the same manner that other municipal offenses are prosecuted, as provided in Section 5-2-4, "General Penalties," B.R.C. 1981.

**11-5-24. – Other Remedies.**

The city attorney may maintain an action for damages, declaratory relief, specific performance, injunction or any other appropriate relief in the District Court in and for the County of Boulder for any violation of any provision of this chapter or any approval granted under this chapter.

Section 2. Chapter 8-5, “Work in the Public Right of Way and Public Easements,”

B.R.C. 1981 is amended as follows:

....

**8-5-3. - Permit Required for Work in the Public Right of Way and Public Easements.**

- (a) Work in Right of Way or Public Easement Prohibited Without Permit: No person shall undertake or permit to be undertaken any work in the public right of way or a public easement without first obtaining a permit from the city as set forth in this chapter, unless such work is exempt under the provisions of Section 8-5-17, “Work in the Public Right of Way or Public Easement Exempt from Required Permit,” B.R.C. 1981, or involves sidewalk construction as permitted under Section 8-2-18, “Permit for Sidewalk Construction Required,” B.R.C. 1981.
- (b) Display of Permit: No person shall fail to maintain applicable permits, including, without limitation, a right of way permit, state highway access or utility permit, floodplain development permit, wetland permit, erosion control permit, and temporary traffic closure authorization, along with associated project documents, including, without limitation, approved engineering construction drawings or site plans, a temporary traffic control plan and ~~a stormwater quality best management practices~~ an erosion control plan, on the job site. All documents shall be made available for inspection upon request by any officer or employee of the city.
- (c) Work Consistent With the Permit: No permittee shall work in an area larger or at a location different from that specified in the approved permit. If it becomes necessary to work in a larger or different area than originally requested under the application, the permittee shall obtain authorization from the city manager, prior to proceeding with the work. The permittee shall submit a supplementary application for the additional work within twenty-four hours.
- (d) Permits Are Not Transferrable: Permits shall not be transferable or assignable. The permittee may subcontract the work to be performed under a permit, provided that the holder of the permit shall be and remain responsible for the performance of the work under the permit and provide all insurance and financial security as required.

**8-5-4. - Permit Application.**

An applicant for a permit to work in the public right of way or public easement under this section shall file a written application on a form provided by the city manager that includes the following:

- (a) The date of application; the name and address of the applicant; the name and address of the developer, contractor, or subcontractor licensed to perform work in the public right of way; the exact location of the proposed work; the type of existing public infrastructure, including, without limitation, street pavement, curb and gutter, sidewalks, bicycle facilities, transit facilities, parking meters or kiosks, traffic signs, or pavement markings or utilities impacted by the work; the purpose of the proposed work; the dates for beginning and ending the proposed work; the measurements, quantities, itemization and total cost, including labor and materials, of the construction improvements and excavations for improvements that are to be owned and operated by the City of Boulder; and type of work proposed.
- (b) Engineering construction drawings or site plans for the proposed work.
- (c) A temporary traffic control plan and ~~a stormwater quality best management practices~~ an erosion control plan that comply with the requirements of the City of Boulder Design and Construction Standards for the proposed work.
- (d) Evidence that the applicant has an effective license, including, without limitation, required insurance, deposits, bonding, and warranty to perform work in the public right of way or public easement, as prescribed under Chapter 4-6, "Contractor in the Public Right of Way License," B.R.C. 1981.
- (e) A satisfactory plan of work, showing protection of the subject property and adjacent properties including the protection of shade and ornamental trees and the restoration of turf.
- (f) Evidence that the applicant or its contractor is not delinquent in payments due the city on prior work, and that all orders issued by the city to the applicant, requiring the applicant to correct deficiencies under previous permits issued under this chapter, have been satisfied.
- (g) Evidence that any financial guarantee required under Section 9-2-20, "Required Improvements and Financial Guarantees," or 9-12-13, "Subdivider Financial Guarantees," B.R.C. 1981, have been provided in connection with the approved subdivision, site plan, or engineering construction drawings.
- (h) Documentation that all permits required for the proposed work have been obtained including, without limitation, floodplain development permits, wetland permits, state highway access or utility permits, revocable right of way permits, erosion control permit, and sewer and water utility permits.
- (i) Pay the fees prescribed by Section 4-20-6, "Public Right of Way Permit and Contractor License Fees," B.R.C. 1981.

#### **8-5-5. - Permit Contents.**

A permit issued under this section should state the right of way permit number, the date of issue and expiration; the name and address of the permittee, the name and address of the developer, contractor, or subcontractor licensed to perform work under the permit; the location, nature, and purpose of the proposed work permitted; any conditions of approval, including, without limitation, inspection, testing, certification, and provision of as-built drawings; the type of existing public infrastructure including, without limitation, street pavement, curb and gutter, sidewalks, trees and landscaping, or utilities impacted by the permit; references to the approved engineering

1 construction drawings or site plans; references to any supplemental permits including, without  
2 limitation, wetland, floodplain development, state highway access or utility, revocable right of  
3 way, erosion control and water and sewer utility permits required; and the amount of fees and  
4 deposits paid, and bonds filed by the permittee.

5 ....

6 Section 3. Subsections 4-20-6 (k) and (l), B.R.C. 1981 are amended as follows and  
7 remaining subsections renumbered:

8 **4-20-6. - Public Right of Way Permit and Contractor License Fees.**

9 ....

10 ~~(k)~~ — An applicant for any permit that includes disturbance of greater than one acre of land (and  
11 thus is required by Subsection 11-5-6(e), B.R.C. 1981, to install erosion controls) shall pay  
12 an erosion control/storm water management site inspection fee of \$338 per month until  
13 such time as the land has been stabilized in accordance with the Design and Construction  
14 Standards.

15 ~~(H)(k)~~ An applicant for a permit to construct a ~~storm water~~stormwater detention or ~~storm~~  
16 ~~water~~stormwater quality facility required by Paragraph 11-5-6(b)(4), B.R.C. 1981, shall  
17 pay a fee of ~~\$507~~718 per facility.

18 ....

19 Section 4. A new Section 4-20-71, “Erosion Control Permit Fees,” B.R.C. 1981, is  
20 added, to read as follows:

21 **4-20-71. – Erosion Control Permit Fees.**

22 An applicant for an erosion control permit shall pay an erosion control/stormwater  
23 management site inspection fee of \$592 per month until such time as the land has been stabilized  
24 in accordance with the City of Boulder Design and Construction Standards.

25 Section 5. Section 1-2-1, “Definitions,” B.R.C. 1981, is revised to amend the definition  
of “Stormwater.”

**1-2-1. – Definition**

....

~~Storm water~~Stormwater means any flow occurring during or following any form of  
normal precipitation and resulting therefrom, including without limitation stormwater runoff,  
snow melt runoff, surface runoff and drainage.

....

Section 6. Section 5-2-2, “Application of Code,” B.R.C. 1981, is revised to add a new  
subsection (e) as follows:

**5-2-2. – Application of Code.**

....

1 (e) Ordinance as used in this chapter includes the City of Boulder Design and Construction  
2 Standards.

3 ....

4 Section 7. In addition to such changes contained in the revisions above, all remaining  
5 references to “storm water” are replaced with “stormwater” throughout the entire B.R.C.

6 Section 8. This ordinance is necessary to protect the public health, safety, and welfare of  
7 the residents of the city, and covers matters of local concern.

8 Section 9. The city council deems it appropriate that this ordinance be published by title  
9 only and orders that copies of this ordinance be made available in the office of the city clerk for  
10 public inspection and acquisition.

11 INTRODUCED, READ ON FIRST READING, AND ORDERED PUBLISHED BY  
12 TITLE ONLY this 7th day of May 2019.

13  
14  
15 \_\_\_\_\_  
16 Suzanne Jones  
17 Mayor

18 Attest:

19 \_\_\_\_\_  
20 Lynnette Beck  
21 City Clerk  
22  
23  
24  
25



1 READ ON SECOND READING, PASSED AND ADOPTED this 21st day of May 2019.

2  
3  
4 \_\_\_\_\_  
Suzanne Jones  
Mayor

5 Attest:

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Lynnette Beck  
City Clerk  
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ORDINANCE 8324

AN ORDINANCE UPDATING UTILITIES STANDARDS GENERALLY AND IMPLEMENTING STORMWATER QUALITY MANAGEMENT REQUIREMENTS OF THE CITY'S MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT BY AMENDING THE CITY OF BOULDER DESIGN AND CONSTRUCTION STANDARDS (D.C.S.), ORIGINALLY ADOPTED PURSUANT TO ORDINANCE 5986, AND SETTING FORTH RELATED DETAILS.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF BOULDER, COLORADO:

Section 1. The city council hereby repeals and re-enacts the following chapters and technical drawings in Chapter 11 of the *City of Boulder Design and Construction Standards*, originally adopted pursuant to Ordinance 5986 (and amended by Ordinance 7088, 7400, 7688, and 8006), to read as shown in **Exhibit A** attached to and hereby incorporated into this ordinance:

- Chapter 1, General Requirements;
- Chapter 4, General Utilities Design;
- Chapter 5, Water Design;
- Chapter 6, Wastewater Design;
- Chapter 7, Stormwater Design;
- Chapter 9, Utilities Standards;
- Chapter 11, Technical Drawings;
- Glossary;
- References; and
- Technical Drawings: 5.17B, 5.18A, 5.18 B, and 5.18C.

1        Section 2. Chapter 11 of the *City of Boulder Design and Construction Standards* is  
2 further amended by the deletion of the following technical drawings: 7.20, 7.21, 7.22, 7.23, 7.24,  
3 7.25, 7.26, 7.27, 7.28, 7.29, and 7.30.

4        Section 3. This ordinance is prospective in nature and shall apply to all technical  
5 document review and permit applications submitted to the city on or after the effective date of  
6 this ordinance. Technical document review applications are administrative in nature and the  
7 application date shall be the date that the fee required by Section 4-20-43, “Development  
8 Application Fees,” B.R.C. 1981, has been paid. Complete site review and form-based code  
9 review applications that have been submitted to the city prior to the effective date of this  
10 ordinance will be permitted to continue through the process under the standards in effect at the  
11 time such application is made. Such applicants shall be required to pursue such approvals and  
12 meet all requirements and deadlines set by the city manager and the Boulder Revised Code.  
13 Technical document review applications and permits applied for prior to the effective date of this  
14 ordinance may proceed under the standards in effect at the time of application. The city council  
15 intends that any project approved under the standards of the *City of Boulder Design and*  
16 *Construction Standards* effective prior to the effective date of this ordinance be built and  
17 otherwise constructed and maintained in accordance with those standards.

18  
19        Section 4. The city council orders and directs the city manager to make any additional  
20 citation, reference, and formatting changes to the *City of Boulder Design and Construction*  
21 *Standards* not included in this ordinance that are necessary to properly implement these  
22 amendments to the *City of Boulder Design and Construction Standards*.

23        Section 5. This ordinance is necessary to protect the public health, safety, and welfare of  
24 the residents of the city and covers matters of local concern.  
25

Suzanne Jones  
Mayor

Lynnette Beck  
City Clerk

Suzanne Jones  
Mayor

Lynnette Beck  
City Clerk

## Exhibit A

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

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CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS

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CHAPTER 1  
GENERAL REQUIREMENTS

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## **1.01 General**

### **(A) Intent**

The Design and Construction Standards (“Standards”) are intended to protect the public health, safety, and welfare in the provision and maintenance of public improvements within the City of Boulder “City”). These Standards apply to the comprehensive design and construction of adequate and functional public improvements associated with developing, redeveloping and subdividing lands and providing necessary right-of-way, transportation, and utility services.

### **(B) Scope**

The City will review, approve, and monitor the design and construction of all public improvements within the public right-of-way or public easements to ensure compliance with these Standards. The City has the sole authority for approving, accepting, or denying the design and construction of any public improvement.

### **(C) Minimum Standards**

- (1) These Standards prescribe minimum requirements that shall be met or exceeded when designing and constructing all public improvements. Whenever the requirements of these Standards are found to be inconsistent with any other adopted standards, regulations, or codes, the more restrictive standards, regulations, or codes shall control. Reference to any code, regulation, standard, criterion, or manual of any technical society, organization, or association, or to any law or regulation of any governmental authority, whether such reference be specific or by implication, shall mean the most recently adopted or current law, code, regulation, standard, criterion, or manual in effect at the time of City approval of any project.
- (2) The design of all public improvements shall be prepared by or under the direct supervision of a professional Engineer duly registered and licensed in the State of Colorado. The construction of all public improvements shall be performed in a professional and workmanlike manner by a contractor licensed by the City as set forth in Chapters 4-6, “Contractor in the Public Right of Way License,” and 8-5, “Work in the Public Right-of-Way and Public Easements,” Boulder Revised Code, 1981. The City assumes no responsibility for supervising or directing construction activities performed by a licensed contractor.
- (3) All materials and equipment used for public improvements shall be of new and good quality. Recycled materials and equipment may be used if they meet the quality standards and conditions equivalent to new materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the instructions of the applicable supplier or manufacturer, except as otherwise prescribed.

### **(D) Terminology**

Terms, words, and abbreviations used in these Standards are defined in the Glossary (Appendix B).



Exhibit A

## **1.02 Description and Use of These Standards**

### **(A) Using these Standards**

- (1) These Standards are to be used when designing and constructing all public improvements and infrastructure within the City. For the purposes of this document, public improvements and infrastructure include without limitation: streets, sidewalks, trails, curb and gutter, curb cuts, streetscaping, water mains, fire hydrants, water services and meters, wastewater mains and services, manholes, stormwater mains, inlets, drainage swales and channels, and other improvements intended for public purposes or for the benefit of the community located within dedicated public rights-of-way and public easements.
- (2) These Standards also provide design and construction requirements to be used when developing private lands that create an impact on public rights-of-way and public easements. The required private improvements associated with property development include without limitation: traffic mitigation, site access and driveway design, stormwater site drainage and detention ponding improvements, and stormwater quality and erosion control measures.

### **(B) Restrictions**

The descriptions in this Chapter provide the reader with a general guide to using these Standards. Nothing in this Chapter is intended to be a substitute for the requirements, criteria, and procedures contained in these Standards.

### **(C) Public Improvements Design**

- (1) These Standards prescribe minimum requirements and specifications for designing adequate and functional public improvements. However, the design of public improvements also depends on the land use zoning and comprehensive planning requirements for the City, as well as the specific site geography of the land to be improved or developed.
- (2) The City review for approval of submitted design plans for public improvements occurs as part of the development review process that distributes design applications to staff in multiple departments, divisions, and agencies. The Department of Public Works development review staff has the primary responsibility for the review and approval of construction plans for public improvements. An applicant for construction approval would be well advised to consult with the Department of Public Work's development review staff prior to submitting designs for public improvements.

### **(D) Construction Approvals**

- (1) An applicant seeking approval to construct public improvements in the City will need to develop engineering designs and construction plans that comply with the design and construction standards provided in this manual. In addition to complying with these Standards, an applicant will need to file the necessary applications and meet the requirements of the City's land use regulations, permit standards, and fee assessments as prescribed in the Boulder Revised Code (B.R.C.), 1981.
- (2) An applicant seeking construction approval will need to consult local master plans and the

## Exhibit A

location of existing public infrastructure to develop specific project designs.

- (3) In order to develop project designs that comply with these Standards, an applicant for construction approval will need to enlist the services of a professional civil Engineer and professional land surveyor to meet the requirements for certifying acceptable designs for public improvements. An applicant may consult local directories for listings of professional engineering and surveying service providers.

**(E) Public Improvements Construction**

- (1) **Right-of-Way Permit:** The construction of public improvements in the City public rights-of-way and public easements requires a right-of-way permit, as set forth in Chapter 8-5, “Work in the Public Right-of-Way and Public Easements,” B.R.C., 1981. An applicant for construction approval will need to enlist the services of a contractor licensed with the City, as set forth in Chapter 4-6, “Contractor in the Public Way License,” B.R.C. 1981, in order to obtain a permit to construct public improvements.
- (2) **Variances**
  - (a) When practical difficulties are involved in meeting the provisions of these Standards, the Director of Public Works (“Director”) may alter, modify, or waive the strict application of these Standards to allow for the reasonable use of land or accommodate special circumstances peculiar to such land as set forth in Section 1.04, “Alternate Materials and Methods of Construction,” and Section 1.05, “Alterations, Modifications, and Waivers,” of these Standards.
  - (b) Alterations, modifications, or waivers are intended only for the special purposes described, and are not to be routinely considered or approved. Where it is necessary to vary from these Standards, an applicant for construction approval must clearly demonstrate that the provisions of these Standards cannot be met and the alteration, modification, or waiver will create the minimum variance necessary to accomplish the intended purpose.

**(F) Standards**

- (1) **Transportation:** The transportation standards prescribed in Chapter 2, “Transportation Design,” and Chapter 8, “Transportation Standards,” provide for the study, design, and construction of site accesses, streets, sidewalks, bicycle facilities, and trails. A traffic impact study may be required as part of construction approvals to demonstrate adequate design and mitigation for traffic impacts associated with new streets and driveways.
- (2) **Streetscapes:** The streetscape standards prescribed in Chapter 3, “Streetscape Design and Tree Protection,” and Chapter 10, “Streetscaping Standards,” provide for the selection, design, placement, and protection of trees and landscaping along public streets throughout the community. The City places high value on and strongly encourages the use of streetscapes as a means to calm automobile traffic, address environmental concerns for clean air and water quality, and enhance neighborhood qualities. General criteria are also included related to subsurface work impacting transportation infrastructure.
- (3) **Water and Wastewater Utilities:** The utility standards prescribed in Chapter 4, “General Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” and Chapter 9, “Utilities Standards,” provide for the study, design, and construction of water

## Exhibit A

and wastewater service facilities. These Standards detail required forecasting for sizing water distribution and wastewater collection mains, specific construction requirements for ensuring public health standards, and requirements for installing domestic water and sewer service lines.

- (4) **Stormwater:** The stormwater standards prescribed in Chapter 7, “Stormwater Design,” and Chapter 9, “Utilities Standards,” provide for the study, design, and construction of stormwater drainage, stormwater quality and flood control improvements. Detention ponding, storm sewer and drainageway systems, stormwater quality, and erosion control measures may be required as part of construction approval to mitigate the impacts of increased runoff resulting from land development and to comply with the city’s Phase II Municipal Separate Stormwater System Permit.
- (5) **Technical Drawings:** The standards for construction detail drawings prescribed in Chapter 11, “Technical Drawings,” provide design requirements for specific construction features associated with the general construction of public improvements and infrastructure. These drawings are intended to supplement the design and approval of construction plans and ensure consistency in project construction to promote long-term dependability and maintenance of public improvements and infrastructure.

### 1.03 Submittal Requirements for Construction Approval

#### (A) Documentation

- (1) An applicant for construction approval shall submit required engineering reports, rights-of-way and easement dedications, ancillary permits and agreements, and construction plans in compliance with these Standards. Construction approvals are subject to the Director’s review, approval, and acceptance.
- (2) Prior to approving construction plans, the Director may require an applicant to submit the following documentation:
  - (a) Engineering reports
  - (b) Rights-of-way and easement dedications
  - (c) Permits and agreements
  - (d) Financial guarantees
- (3) Prior to issuing a right-of-way permit or building permit, the Director may require an applicant to submit the following documentation:
  - (a) Documents listed in Section 1.03, Paragraph (A)(1), above
  - (b) Construction plans
  - (c) City land use approvals
  - (d) Financial guarantees
  - (e) Documents required by Section 8-5-4, “Permit Application,” B.R.C., 1981.
- (4) Prior to the final acceptance of public improvements, the Director may require an applicant to submit the following documentation:

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- (a) Documents listed in Section 1.03, Paragraphs (A)(1) and (A)(2), above
- (b) As-built drawings
- (c) Testing results
- (d) Inspection approvals
- (e) Financial guarantees and warranties

**(B) Engineering Reports**

- (1) Engineering reports required for construction approval shall be prepared as follows:
  - (a) In compliance with these Standards.
  - (b) Under the direct supervision of the Engineer certified as an expert in areas covered in the report, and it shall be signed, sealed, and dated by the Engineer.
  - (c) Containing adequate information to evaluate submitted findings and designs, including calculations, details, and references.
- (2) Engineering reports required for construction approval may include the following:
  - (a) Geotechnical Soils Report, which provides geotechnical conditions and design requirements based on soils investigation and testing and geologic site conditions in compliance with standard engineering practices for soil mechanics and groundwater analysis.
  - (b) Pavement Design Report, which provides geotechnical soils conditions and adequate pavement design requirements and structural cross-sections for roadway, sidewalks, trails, and parking lot construction. Pavement design shall be in accordance with CDOT standards.
  - (c) Drainage Report and Stormwater Plan, which addresses stormwater conditions, impacts, and design requirements in compliance with Section 7.04, “Final Drainage Report and Stormwater Plan.”
  - (d) Utility Report, which addresses water and wastewater utilities service impacts, demands, and design requirements in compliance with Sections 5.02, “Utility Report,” and 6.02, “Utility Report.”
  - (e) Traffic Study, which identifies traffic impacts from proposed developments or roadway modifications and proposes transportation design requirements and mitigation measures in compliance with Section 2.02, “Traffic Study.”
- (3) The Engineer shall be responsible for correcting any error or omission in the engineering report. City approval of the report in no way relieves the Engineer of any responsibility for errors or omissions in the report.
- (4) An applicant for construction approval shall submit at least three copies of any required engineering report to the Director for review and approval. If acceptable, a City approval stamp signed and dated by the Director will be placed on each copy of the report. The City will retain one copy as a record set, one copy as a field copy for construction inspection, and one copy will be returned to the applicant.
- (5) Engineering report approval expires 1 year following the date of approval, unless

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construction of improvements under the report has been initiated.

**(C) Rights-of-Way and Easement Dedications, Permits, and Agreements**

- (1) Rights-of-way and easements required for construction approval shall be described by a licensed professional land surveyor registered in the State of Colorado and dedicated as follows:
  - (a) In compliance with these Standards; and
  - (b) By subdivision platting or by a separate legal instrument that describes a specific legal description of the dedication.
- (2) Agreements required for construction approval shall be executed and may include without limitation:
  - (a) Development agreement
  - (b) Public improvements agreement
  - (c) Public improvements extensions agreement
  - (d) Subdivision agreement
  - (e) Utility oversizing reimbursement agreement
- (3) Permits required for construction approval shall be of approved and issued status and may include without limitation:
  - (a) City of Boulder floodplain development permit
  - (b) City of Boulder right-of-way construction permit
  - (c) City of Boulder revocable right-of-way permit
  - (d) City of Boulder wetland permit
  - (e) City of Boulder erosion control permit
  - (f) Colorado Department of Transportation access permit
  - (g) Colorado Department of Transportation utility permit
  - (h) Railroad right-of-way encroachment permit
  - (i) State of Colorado Public Health and Environment Department 401 permit
  - (j) State of Colorado general permit for stormwater discharges associated with construction activities
  - (k) United States Corps of Engineers 404 permit

**(D) Construction Plans**

- (1) **Preparation Standards:** Construction plans required for construction approval shall be prepared as follows:
  - (a) In compliance with these Standards;
  - (b) Under the direct supervision of the Engineer certified as an expert in areas covered in the report, and it shall be signed, sealed, and dated by the Engineer;

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and

- (c) With adequate information and detail to evaluate submitted designs and ensure accurate and functional construction of public improvements.
- (2) **Drafting Standards:** All construction plans shall meet the following minimum drafting standards to ensure legibility and consistency; to facilitate review, construction, and public inspection; and to provide a clear public record.
- (a) Drawings shall be submitted in both hard copy and electronic, computer-aided design and drafting (CADD) formats to allow information to be transferred to the City’s geographic information system and facilitate clear microfilming or digital scanning.
  - (b) Electronic drawing format, or electronic CADD files, shall be in “.DXF” or “AutoCad.DWG” format on computer media specified by the Director of Public Works. Construction plan drawings are to be layered in electronic CADD format by improvement type in a manner acceptable to the Director of Public Works. Separate layers shall be provided for individual improvement categories including without limitation base mapping, transportation, landscaping, water, wastewater, and stormwater.
  - (c) Hard-copy drawing format shall measure 24 inches by 36 inches and be clean, clear, and free from objectionable background.
  - (d) Symbols and line types shall comply with Technical Drawing 1.01 in Chapter 11, “Drafting Standards,” and shall graphically distinguish between existing and proposed items.
  - (e) All drawings are to be numbered in consecutive order.
  - (f) Abbreviations reflected on the construction plans are to correspond to those presented in the Glossary.
  - (g) No hand-drawn or adhesively attached information, such as Kroy lettering, adhesive backed reproductive film, or tape, may be placed on construction plans.
- (3) **Cover Sheet:** Construction plans required for obtaining construction approval shall include a cover sheet with the following elements:
- (a) Project name, with legal description of the project parcel;
  - (b) Vicinity map, on a scale reflecting the location of the project and all streets within 1 mile of the project;
  - (c) Key map, on drawing sets of three sheets or more, of a scale reflecting the entire project, separate drawing numbers, and street names;
  - (d) Index of drawings presenting the title of each drawing and drawing number; and
  - (e) The following standard construction notes:
    - (i) “All work shall be performed in accordance with the “Design and Construction Standards” of the City of Boulder, and shall be completed to the satisfaction of the Director of Public Works. In the event that a design element does not reflect City standards, the matter must be immediately brought to the attention of the Engineer and the Director of Public Works.

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The Engineer shall be responsible for recommending a solution or alternative solutions to the City for review and approval.”

- (ii) “The approval of a Construction Plan does not relieve the Contractor of the responsibility of constructing workable public improvements. All revisions and/or corrections required will be solely the Contractor's responsibility, and at their expense.”
- (iii) “These Plans have been checked by the City of Boulder only for conformance with the “Design and Construction Standards,” compliance with development agreement conditions, and for general conceptual approval of public improvements as shown. The City’s review does not verify or ensure the accuracy of existing or proposed dimensions, lines, coordinates, or grades shown, including all existing utilities shown or not shown.”
- (iv) “Utility locations shown reflect available record data. The Contractor shall take precautionary measures to protect all utility lines shown and other utility lines otherwise located. The Contractor shall contact the “Utility Notification Center of Colorado” at 1-800-922-1987 or 811 for utility locates 24 hours prior to beginning construction.”
- (v) “Before work begins, the Contractor shall obtain a permit to work in the right-of-way from the City and must notify the City Right-of-Way Inspection staff at least 24 hours in advance of commencing construction activities.”
- (vi) “The Contractor shall obtain and maintain a complete and approved set of Construction Plans. These drawings, and any required permits, shall be available at the project site at all times and shall be made available to City staff upon request. If construction plans are not readily available at the project site, the Director of Public Works may issue a stop work order and halt all construction activities pending compliance by the Contractor.”
- (vii) “The Contractor agrees to comply with the provisions of the Traffic Control Plan and the current edition of the “Manual on Uniform Traffic Control Devices,” “Temporary Traffic Control” section, for construction signage and traffic control.”
- (viii) “All surplus materials, tools, and temporary structures, furnished by the Contractor, shall be removed from the project site by the Contractor. All debris and rubbish caused by the operations of the Contractor shall be removed, and the area occupied during construction activities shall be restored to its original condition, within 48 hours of project completion, unless otherwise directed by the Director of Public Works.”
- (ix) “The Contractor shall provide tree and landscape protection as set forth in Chapter 6-6, “Protection of Trees and Plants,” Boulder Revised Code (B.R.C.) 1981 and the City of Boulder Design and Construction Standards (DCS). All landscaping shall be provided and maintained in compliance with the approved Landscaping Plan, B.R.C. and DCS.”
- (x) “The Contractor is required to provide and maintain erosion and sediment control measures in accordance with the Urban Drainage and Flood

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Control District “Urban Storm Drainage Criteria Manual Volume 3”, the M-Standard Plans of the Colorado Department of Transportation, and the approved stormwater management plan. The Director of Public Works may require the contractor to provide additional erosion control measures due to unforeseen erosion problems or if the plans do not function as intended.”

- (xi) "The City of Boulder requires that sidewalks constructed have a cross slope of less than 2%. Sidewalks shall be designed and constructed with cross slopes sufficiently less than 2% to ensure that they do not exceed the 2% maximum."

(4) **Plan Sheets:** Construction plans required for construction approval may include without limitation the following plan sheets:

- (a) Stormwater Management Plan, prepared in compliance with Subsection 7.13, “Construction Stormwater Management.”
- (b) Utility Plan, prepared in compliance with Section 4.03, “Utility Plan.”
- (c) Final Stormwater Plan, prepared in compliance with Section 7.04, “Final Drainage Report and Stormwater Plan.”
- (d) Traffic Control Plan, when construction plans have an impact on existing transportation facilities, such as utility or access construction within existing public streets, sidewalks, or trails. The plan is to be prepared in compliance with Section 8.04, “Temporary Traffic Control Plan,” of these Standards, the current edition of the “Manual on Uniform Traffic Control Devices,” “Temporary Traffic Control” section and as set forth in Section 8-5-10, “Temporary Traffic Control,” B.R.C., 1981. Plans shall include adequate provision for the detour of vehicular, bicycle, and pedestrian traffic.
- (e) Transportation Striping and Signage Plan, when construction plans include transportation traffic control measures, such as stop signs, centerline striping, and trail signage. The plan is to be prepared in compliance with the current edition of the “Manual on Uniform Traffic Control Devices,” and should include the following standard construction notes:
  - (i) Contact the City of Boulder Sign Shop (303-413-7122) for location of all signs prior to installation and for sign layout/details prior to ordering.
  - (ii) All sign sheeting to be Class XI (DG3 material) with 3M 1150 overlay film.
  - (iii) All signs shall be 0.100 gauge aluminum.
  - (iv) All sign posts to be 12 gauge 2 inch unistrut.
  - (v) All sign bases to be 12 gauge 2-1/4 inch unistrut.
  - (vi) Sign post lengths will vary, but 7 foot minimum clearance from bottom of sign to ground level is required.
  - (vii) All sign mount hardware to be Gator Lock System.
- (f) Construction Phasing Plan, when projects are planned to be constructed in phases. The plan is to illustrate the entire project site and delineate and label each separate phase.
- (g) Landscaping Plan, when construction plans include streetscaping improvements



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or landscaping that has an impact on public rights-of-way or public easements. The plan is to be prepared in compliance with Subsection 3.02, “Landscaping Plan.”

- (5) **Survey Information:** Construction plans shall refer horizontally to the Colorado State Plane Coordinate System NAD83, and are to include at least two horizontal and two vertical control points presenting appropriate *x*, *y*, and *z* coordinates. Electronic base map and survey control monument information is available from the City and should be used as a basis for construction plan drawings.
- (a) Horizontal control monuments reflected on drawing sheets and survey lines are to correspond to City-recognized horizontal control points. Horizontal locations for design features are to be presented in terms of survey line stationing and offset or *x*, *y* coordinates.
  - (b) Vertical elevation control points reflected on drawing sheets are to be tied to City-recognized benchmarks with reference to the City’s vertical control network. Vertical elevations for design features are to be presented as a *z* coordinate.

**(E) Plan and Profile Drawings**

- (1) **Required Elements:** Plan and profile drawings are required as part of the construction plan to ensure accurate and functional construction by the contractor when the construction is for public improvements. Plan and profile drawings are to be prepared on standard engineering plan and profile grid sheets and shall contain the following elements:
- (a) Drawing border at least one-half inch from all edges of the drawing;
  - (b) Title block located inside the border in the lower portion of the sheet that includes the following information:
    - (i) Project name, location, and sheet title;
    - (ii) Name, address, and telecommunication numbers of the engineering consultant preparing the drawing, and the name of the supervising professional Engineer;
    - (iii) Date designed, drawn, surveyed, and checked;
    - (iv) Date prepared, and dates of all revisions;
    - (v) Drawing number and total number of drawings; and
    - (vi) Name of electronic file;
  - (c) North orientation arrow and scale;
  - (d) Certification space: a 2-inch by 2-inch space near the title block reserved for the seal and signature of the Engineer;
  - (e) Approval space: a 3-inch by 3-inch space in the lower-right corner of each drawing sheet reserved for the City’s approval stamp;
  - (f) Revisions information space: space for noting all revisions, separate from the original plan preparation date, that includes revision numbers, a brief description of what was revised, and the date of the revision;

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- (g) Survey information;
  - (h) Property boundaries, lot lines, public rights-of-way, and public easements, which are to be clearly labeled by type and dimension. Dedications previously recorded are to be referenced by applicable film and reception numbers;
  - (i) Subdivision block, and lot numbering; and
  - (j) Street names.
- (2) **Plan Drawing:** The “plan view” is to be located on the upper half of the drawing sheet and drawn to a scale of 1 inch equals 20 feet. This view contains the following information:
- (a) Existing and proposed public improvements and structures, including without limitation all grading, transportation, landscaping, City-operated and non-City-operated public utilities (including telephone, gas, electric, cable television, fiber optics), irrigation ditches, and other significant features.
  - (b) Match lines connecting information between drawings.
  - (c) Utility information required in Section 4.03, “Utility Plan,” and the following:
    - (i) Pipe type, size, class and joint restraint.
    - (ii) Separation distance between existing and proposed water and wastewater mains and services, with horizontal and vertical location of sewer crossings requiring special construction.
    - (iii) Angles at alignment changes.
    - (iv) Horizontal and vertical locations and sizing of water service lines and meters with ties to property lines.
    - (v) Horizontal and vertical locations, sizing, and types of valves, fittings, control devices, and fire hydrants.
    - (vi) Horizontal and vertical locations and sizing of manholes, cleanouts, and service lines for sanitary sewers.
    - (vii) Horizontal locations of soil borings.
    - (viii) Horizontal locations of structures.
  - (d) Stormwater information required in Section 7.04, “Final Drainage Report and Stormwater Plan,” and the following:
    - (i) Existing and proposed contours of at least 2-foot intervals.
    - (ii) Existing and proposed storm drainage facilities and details, including storm sewers, inlets, manholes, culverts, swales, detention ponds and drainageways.
    - (iii) Horizontal and vertical locations and sizing of manholes and inlets for storm drainage.
    - (iv) Horizontal and vertical location of existing and proposed drainage outfall points.

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- (e) Survey, transportation, and surface improvements information including without limitation:
  - (i) Survey lines and stations based on center line or flowline stationing, and equated to flowline at bubbles, cul-de-sacs, horizontal curves, and other departures from normal street cross sections.
  - (ii) Stations and elevations of flowlines at all existing and proposed curb returns, such as horizontal points of curvature (PC's), points of tangency (PT's), and points of compound curvature (PCC's); at the high or low point on all vertical curves; at inlets (including invert); and at intervals of no more than 50 feet along the streets.
  - (iii) Existing and proposed curb return radii.
  - (iv) Handicap access ramps.
  - (v) Complete horizontal curve data: radius ( $R$ ), delta ( $D$ ), arc length ( $L$ ), and tangent length ( $T$ ).
  - (vi) All crown lines, where they depart from the normal cross sections (transitions to existing roadways), with appropriate transition starting elevation.
  - (vii) Centerline stations at all intersecting streets.
  - (viii) Stations of drainage facilities, including inlets, manholes, and storm water outfalls, and directional drainage flow arrows.
  - (ix) Full width of right-of-way, intersecting roadways, street cross sections, sidewalks and trails, existing curb cuts, and other relevant features along all roadways abutting the project.
  - (x) Traffic control devices, including striping, markings, signage, and signals.
- (3) **Profile Drawing:** The “profile view” is to be located directly below the plan view along a matching survey line and stationing and is to be drawn at a horizontal scale of 1 inch equals 20 feet and a vertical scale of 1 inch equals 5 feet. This view shall contain the following information:
  - (a) Original and proposed ground elevations.
  - (b) Stationing sequence, left to right.
  - (c) Elevations labeled on both left and right sides of the drawing sheet.
  - (d) Match lines.
  - (e) Elevations based on center line, flow line, or invert of pipe. (Top of pipe is acceptable only for existing utilities.)
  - (f) Stations and elevations of existing and proposed grade breaks.
  - (g) Crossings of existing and proposed utilities.
  - (h) Elevations of manhole inverts and rims, and service line inverts.
  - (i) Elevations of inlets, top of curb, flowline, inverts, and connection locations.

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- (j) Slopes or grades of wastewater and stormwater sewers.
- (k) Existing and proposed finished grades over utilities.
- (l) Street profiles, including:
  - (i) Stations and elevations of existing and proposed horizontal PC, PT, PCC, PRC.
  - (ii) Vertical curves with VPI, VPC, VPT, high point or low point (not middle ordinate) stations and elevations.
  - (iii) Center line stations of all intersecting streets.
  - (iv) Grades for all profiles.
  - (v) Curb flowlines at 25-foot minimum intervals, and at all vertical sags or crests.
  - (vi) Curb return profiles to ensure positive drainage at ramp locations.
- (4) **Detail Drawings:** Detail drawings are required for construction details not provided in Chapter 11, “Technical Drawings.” Detail drawings illustrate construction details for critical design features such as concrete paving sections, mechanical pipeline connections, and detention ponding release structures. Detail drawings are to include dimensioning, materials, specifications, and specific construction notes appropriate to each construction detail.
- (5) **Cross-Sectional Drawings:** These drawings are required with all construction plans that include varying or transitional features, such as street sections, fill slopes, and drainage channels. Cross-Sectional drawings reflect dimensions, elevations, stationing, and any other detailed information necessary to ensure accurate construction.

**(F) Submittal and Approval of Construction Plans and Drawings**

- (1) **Submittal:** An applicant for construction approval shall submit at least three drawing sets of any required construction plans to the Director for review and approval, including:
  - (a) Original black-lined drawing set prepared by the Engineer to be stamped and approved by the City and returned to the Engineer
  - (b) 2 Sets of black-lined prints drawing set signed, sealed, and dated on each drawing sheet by the Engineer to be maintained on file with the City as the record set of the construction plan approval documents and for use by the City right-of-way inspector.
- (2) **Approval:** The Director will review construction plans for compliance with these Standards. If acceptable, a City approval stamp signed and dated by the Director will be placed on each drawing sheet of the construction plans.
- (3) **Effective Period:** Construction plan approval expires 1 year following the date of approval, unless construction has been initiated. An applicant for construction approval may resubmit the construction plan for reapproval, subject to review for compliance with standards in effect at the time of resubmittal.
- (4) **Errors and Omissions:** The Engineer shall be responsible for correcting any error or

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omission in the construction plans or drawings. City approval of the construction plans in no way relieves the Engineer of any responsibility for errors or omissions in the plans.

**(G) As-Built Drawings**

- (1) **Requirements:** As-built drawings reflect the actual in-place construction of public improvements.
  - (a) The applicant shall submit as-built drawings for final construction approval within 60 days from the date construction was completed and prior to City acceptance of any public improvements.
  - (b) The applicant shall ensure that every sheet of the approved construction plans reflects the as-built drawings conditions.
- (2) **Preparation:** As-built drawings shall be prepared by the Engineer responsible for the original construction plan approved by the City. Drawings shall be prepared as follows:
  - (a) In compliance with the requirements in Sections 1.03(D), “Construction Plans,” and 1.03(E), “Plan and Profile Drawings.”
  - (b) In compliance with the requirements in Section 7.17(B), “Stormwater As-Built Drawings.”
  - (c) Based on completed field inspections, accurate measurements, survey data, and testing results, materials, and equipment records.
  - (d) To reflect any variations from the approved construction plans in the public improvements actually constructed.
- (3) **Transfer of Responsibility:** If the Engineer responsible for the original construction plan is replaced prior to preparing as-built drawings, the replacement Engineer shall agree in writing to accept the responsibility for the design certified by the original Engineer under the approved construction plan prior to City acceptance of the constructed public improvements.

**(H) Submittal and Approval of As-Built Drawings**

- (1) **Submittal:** An applicant for construction approval shall submit at least two drawing sets of any required as-built drawings to the Director of Public Works for review and approval. As-built drawing sets shall contain a complete black-lined print drawing set of the as-built drawing set reflecting the as-built conditions and signed, sealed, and dated on each drawing sheet by the Engineer.
- (2) **Approval:**
  - (a) The Director will review the as-built drawings for compliance with these Standards. If acceptable, a City approval stamp, signed and dated by the Director, will be placed on each drawing sheet of the as-built drawings.
  - (b) The Director will not approve any construction, place in service, release financial guarantees, or issue utility connections for any public improvements for which acceptable as-built drawings have not been submitted.
- (3) **Variations and Discrepancies:** If any substantial variations or discrepancies, particularly with respect to location, design slopes, grades, dimensions, capacities and clearances, are

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discovered between the approved construction plans and the public improvements actually constructed, the Engineer shall propose and recommend a solution or alternative solutions to the City for review and approval. If no proposed alternative will satisfy the requirements of these Standards, the contractor shall reconstruct the deficient public improvements to comply with the approved construction plans.

- (4) **Errors and Omissions:** The Engineer shall be responsible for the correction of any error or omission in the as-built drawings. City acceptance of the as-built drawings in no way relieves the Engineer of any responsibility for errors or omissions in the drawings.

## 1.04 Alternative Materials and Methods of Construction

### (A) Use

The provisions of these Standards are not intended to prevent the use of any materials or methods of construction, design, or compliance not specifically prescribed in these Standards, provided that the alternative materials or methods of construction, design, or compliance have been approved and their use authorized by the Director.

### (B) Approval

The Director may approve an alternate material or method of construction, design, or compliance, provided the proposed design is satisfactory and complies with the provisions of these Standards and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in these Standards in suitability, strength, effectiveness, durability, safety, and sanitation.

### (C) Proof of Claims

The Director will require that sufficient evidence be submitted to substantiate any claims that may be made regarding an alternate material or method of construction, design, or compliance. The details of any action granting approval of an alternate material or method will be recorded and entered in the files of the City.

## 1.05 Alterations, Modifications, and Waivers

### (A) Practical Difficulties

When practical difficulties are involved in executing the provisions of these Standards, the Director may alter, modify, or waive the strict application of these Standards, according to the process described herein.

### (B) Criteria

No alteration, modification, or waiver of the strict application of any provision of these Standards shall be granted unless the applicant clearly demonstrates and the Director finds that the following conditions exist:

- (1) The strict application of the provisions of these Standards would deprive an individual of

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the reasonable use of land or structure, and

- (2) Special circumstances peculiar to such land or development justify the requested alteration, modification, or waiver, and
- (3) Any alteration, modification, or waiver would result in a solution consistent with the goals of the underlying zoning district, a Boulder Valley Comprehensive Plan goal, a specific neighborhood plan, or an adopted design guideline, and
- (4) Any alteration, modification, or waiver represents the minimum variance from these Standards that will accomplish the intended purpose, and
- (5) Any alteration or modification will at least equal the suitability, strength, effectiveness, fire resistance, durability, safety, and sanitation performance requirements prescribed in these Standards, and
- (6) Any alteration, modification, or waiver will not harm the adjacent land owners, the neighborhood, or the welfare of the public at large, and
- (7) Any alteration, modification, or waiver will not create an additional maintenance or financial burden for the affected property owners or the City.

**(C) Application Requirements**

- (1) An applicant for an alteration, modification, or waiver to these Standards shall submit a written request to the Director. The request shall state in detail the specific sections and subsections of these Standards requested to be altered, modified, or waived, and the request shall describe in detail why the requested waiver, alteration, or modification meets the criteria in Section 1.05(B), above.
- (2) The Director may require additional documentation to support the request and shall require that sufficient evidence be submitted to substantiate any claims that may be made regarding alterations, modifications, or waivers to these Standards. Sufficient evidence may include verification by a Colorado registered professional Engineer, possessing relevant expertise in the area.

**(D) Decision**

- (1) The Director will advise the applicant, in writing, of the decision on the requested alteration, modification, or waiver. The Director's decision is a final action that is administrative and may be appealed through the judicial process. In granting any alteration or modification to these Standards, the Director may impose specific conditions necessary to ensure that the criteria described in Section 1.05(B), above, are, and will remain, satisfied.
- (2) The Director of Public Works will consult with the Planning Director when evaluating issues that potentially impact urban design. The details of any decision granting approval of an alteration, modification, or waiver to these Standards will be entered in the form of written findings. A written log of all decisions granting alterations, modifications, or waivers to these Standards will be kept current in the office of the Director of Public Works and will be available for public inspection.

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**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

**CHAPTER 4**  
**GENERAL UTILITIES DESIGN**

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## 4.01 General

### (A) Intent

The General Utilities Design Standards are intended to provide for an integrated public utilities system for all public utilities, including water, wastewater, storm drainage, gas, electric and telecommunications systems.

### (B) Utilities Master Plans

All improvements proposed to the City’s public utilities system shall conform with the goals, policies, and standards adopted in the Water Utility Master Plan, Wastewater Utility Master Plan, and Comprehensive Flood and Stormwater 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 utilities improvements and may refer to one or more of the references listed in the References Section of these Standards.

## 4.02 Utility Connection Plan

### (A) Required

The Director of Public Works may require the preparation of a Utility Connection Plan in order to assess the feasibility of providing utility service to any project or development and identify impacts of any development application on the existing and planned public utility systems. A Utility Connection Plan may be prepared in lieu of a Utility Plan for projects or developments that meet all of the standards below:

- (1) City utilities required to serve the site are located directly adjacent to the subject property.
- (2) No extension, enlargement, or improvement of public mains is required to serve the site.
- (3) No change in use is proposed which may alter the utility needs of the site.

### (B) Plan Requirements

The Utility Connection Plan shall include the following project or development information:

- (1) **Title Block:** Include the label “Utility Connection Plan” and name of project or development application, and the original preparation date and dates of any revisions.
- (2) **Site Location Data:** Include vicinity map and north arrow,
- (3) **Drawing Scale:** The drawing scale shall be between 1 inch equals 20 feet and 1 inch equals 100 feet, placed on the minimum number of plan sheets possible.
- (4) **Property and Street Information:** Include the location of existing and proposed lot lines, block and lot numbers, and street names.
- (5) **Construction Note:** Include the statement that “Utilities shall comply with the City of Boulder Design and Construction Standards.”
- (6) **Existing and Proposed Utilities:** Include the location, type and size of all existing and

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proposed utilities mains and service lines. Utilities to be identified include without limitation: water, wastewater, storm drainage, flood control, gas, electric, telecommunications, drainageways, and irrigation ditches within and adjacent to the project or development site. Include and assign identification numbers to all existing and proposed manholes, inlets, fire hydrants, meter settings and pits, and provide “direction of flow” arrows on gravity pipelines.

- (7) **Easements and Rights-of-Way:** Include the location, dimensions, and dedication type of all existing and proposed easements and rights-of-way for all utilities improvements. If available, reference existing easements to appropriate recorded film and reception numbers.
- (8) **Structures and Trees:** Include the location and dimensions of all existing and proposed structures, including without limitation buildings and fences, trees 1½ inch caliper or greater, and major landscape features.
- (9) **Floodplain:** Delineate any 100-year floodplain boundaries that impact the project or development site and identify the floodplain designation, base flood elevations and floodplain mapping source used to determine the floodplain.
- (10) **Storm Water Plan Combination:** The Director may approve a combined “Utility Connection and Storm Water Plan,” reflecting storm water design information, prepared in compliance with the requirements outlined in Chapter 7, “Storm Water Design,” of these Standards.
- (11) Applications for Annexation or Out-of-City Utility Service for a single family residential dwelling may provide the required information on a scaled Improvement Location Certificate or Improvement Survey Plat.

### 4.03 Utility Plan

#### (A) Required

The Director may require an applicant to submit a Utility Plan as a condition of any development application in order to adequately assess the availability of utility service and impacts of any development application on the existing and planned public utility systems. The Utility Plan shall provide an overview of the proposed project or development application and identify whether the proposal is:

- (1) Eligible for utility service and has access to available public utility systems.
- (2) Consistent with current Utilities Master Plans, meets the minimum design standards for system layout, and is compatible with and allows for the perpetuation of the existing utility systems.
- (3) Located within any mapped 100-year floodplain.

#### (B) Plan Requirements

The Utility Plan shall include the following project or development information:

- (1) **Title Block:** Include the label “Utility Plan” and name of project or development application, and the original preparation date and dates of any revisions.
- (2) **Site Location Data:** Include vicinity map, north arrow, relationship of the property to range, township, and section lines.

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- (3) **Survey Information:** Include the elevation and location of City-recognized benchmarks with reference to local, USGS and NGVD data.
- (4) **Drawing Scale:** The drawing scale shall be between 1 inch equals 20 feet and 1 inch equals 100 feet, placed on the minimum number of plan sheets possible.
- (5) **Property and Street Information:** Include the location of existing and proposed lot lines, block and lot numbers, and street names.
- (6) **Construction Note:** Include the statement that “Utilities shall comply with the City of Boulder Design and Construction Standards.”
- (7) **Existing and Proposed Utilities:** Include the location, type and size of all existing and proposed utilities mains and service lines. Utilities to be identified include without limitation: water, wastewater, storm drainage, flood control, gas, electric, telecommunications, drainageways, and irrigation ditches within and adjacent to the project or development site. The locations of existing underground utility mains and service lines and the invert and surface grade elevations of all manholes, inlets and culverts shall be field verified to the Director’s satisfaction (by “pothole” excavations, if necessary) and accurately delineated and dimensioned. Include and assign identification numbers to all existing and proposed manholes, inlets, fire hydrants, valves, pipe lengths, meter settings and pits, and provide “direction of flow” arrows on gravity pipelines. Proposed invert and surface grade elevations shall be provided for all proposed manholes, inlets and culverts.
- (8) **Site Topography:** Include existing and proposed contour lines showing at least 2-foot contour intervals, and reflecting spot elevations at various locations, “cut and fill” areas, and surface drainage systems.
- (9) **Easements and Rights-of-Way:** Include the location, dimensions, and dedication type of all existing and proposed easements and rights-of-way for all utilities improvements. If available, reference existing easements to appropriate recorded film and reception numbers.
- (10) **Structures and Trees:** Include the location and dimensions of all existing and proposed structures, including without limitation buildings and fences, trees 1½ inch caliper or greater, and major landscape features.
- (11) **Maintenance Access:** Include the location and dimensions for existing and proposed “all-weather” maintenance access drives for 14-ton maintenance equipment to reach manholes and inlets not located in existing or proposed streets.
- (12) **Floodplain:** Delineate any 100-year floodplain boundaries that impact the project or development site and identify the floodplain designation, base flood elevations and floodplain mapping source used to determine the floodplain.
- (13) **Storm Water Plan Combination:** The Director may approve a combined “Utility and Storm Water Plan,” reflecting storm water design information, prepared in compliance with the requirements outlined in Chapter 7, “Storm Water Design,” of these Standards.

**(C) Utility Plan Approvals**

- (1) The Utility Plan shall reflect proposed utility infrastructure and utility service to development applications and may serve as the basis for approving site review and preliminary subdivision proposals.
- (2) A final version of the Utility Plan shall be included in all Construction Plans proposing the

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construction of utility infrastructure to reflect overall system layout and design configurations.

- (3) The Utility Plan may serve as the Construction Plan under the following conditions:
  - (a) The proposed utility improvements include only private service line (water, wastewater, or storm sewer) or fire line connections to individual properties.
  - (b) The proposed utility improvements include only water main extensions or fire hydrant runs on individual properties.
  - (c) Standard construction notes are included on the Utility Plan, and no other Construction Plans for other public improvements are required.
- (4) The Director may waive the requirement that the Utility Plan be prepared by an Engineer for development applications that include only private utility (water, wastewater and storm drainage) service lines or fire lines to individual properties.

## 4.04 Utilities Easements

### (A) General

- (1) All City-operated public utilities, including without limitation, water, wastewater and storm drainage systems, shall be located within public rights-of-way or public utility easements.
- (2) Public utility easements shall be at least 25 feet wide. Wider easements may be required where the depth of a utility, or number of utilities occupying the easement, requires additional width to satisfy standards for utility separations, trenching excavations, or adequate maintenance access.
- (3) Public utility easements shall provide a minimum parallel separation of 6 feet between the edge of any utility line and the easement boundary.
- (4) Public utility easements are to be placed longitudinally along one side of any property line in a manner that no portion of any easement falls on both sides of a parallel property line.
- (5) Structures and landscaping proposed in public utility easements shall comply with the standards as set forth in Chapter 8-5, “Work in the Public Right-of-Way and Public Easements,” and Chapter 8-6, “Public Right-of-Way and Easement Encroachments, Revocable Permits, Leases, and Vacations,” B.R.C. 1981.
- (6) The Director may allow water service taps from water mains in easements only if free and unobstructed vehicle access is permanently guaranteed for all-weather water meter reading, valve access, and maintenance. Where the Director allowed a service tap from a water main in an easement, the property owners shall ensure all city owned and maintained utilities are accessible and surface features such as valve covers, manholes, and meter pits are visible and not covered by landscape materials, concrete or asphalt. Proposals will be reviewed on a case-by-case basis and are subject to prior approval by the Director.

### (B) Easements Crossing Single-Family Residential Lots

Public utility easements crossing single-family residential lots may be allowed only for the following:

- (1) Completing required water system looping in cul-de-sac type applications where water

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mains would otherwise dead-end.

- (2) Installation of fire hydrants.
- (3) Continuing a wastewater main that would otherwise dead-end in cul-de-sac type applications.
- (4) Conveying storm water drainage and overflows from back-draining cul-de-sac or street sump type applications.

## 4.05 Pipe Strength

All utility pipe shall be of adequate strength to support the trench and AASHTO HS-20 highway loadings.

## 4.06 Separation of Utilities

### (A) Parallel (Horizontal) Separation

Parallel separations between utility mains and services to provide for adequate trench excavations and maintenance operations shall be as follows. All distances are measured from outside of pipe to outside of pipe:

**Table 4-1: Utility Separation Requirements**

	Water	Sewer	Storm	Electric, Telecommunications, and/or Gas
Water		10-ft	5-ft	5-ft
Sewer	10-ft		10-ft	10-ft
Storm	5-ft	10-ft		5-ft
Electric, Telecommunications, and/or Gas	5-ft	10-ft	5-ft	

### (B) Pipe Crossings (Vertical) Separation

- (1) The minimum vertical separation between water and wastewater line crossings, as measured outside of pipe to outside of pipe, shall be 18 inches. The water line shall be constructed above the wastewater line.
- (2) The minimum vertical separation between water and storm drainage line crossings shall be 18 inches, measured from outside of pipe to outside of pipe.
- (3) The minimum vertical separation between wastewater and storm drainage line crossings, as measured outside of pipe to outside of pipe, shall be 6 inches. In addition, the following applies:
  - (a) If the storm drainage line is constructed below the wastewater line, pressure-class pipe will be required for both utility lines to prevent possible wastewater contamination of storm drainage.
  - (b) If the vertical separation between the wastewater and storm drainage line is less than 18 inches, structural support will be required, subject to the Director's approval.
- (4) The minimum vertical separation between City public utility pipelines or conduits and all

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gas, electric, and telecommunications utilities shall be 12 inches.

**(C) Drainageway and Irrigation Ditch Crossings**

Utility crossings of natural and improved drainageways and irrigation ditches listed in Table 4-2, “Local Drainageways and Irrigation Ditches,” shall meet the following conditions:

- (1) **Water Main Crossings:** The water main shall be placed at least 4.5 feet below the invert of the drainageway or irrigation ditch and shall be placed in a steel sleeve in conformance with the applicable standard drawings in Chapter 11, “Technical Drawings” of these Standards.
- (2) **Wastewater and Storm Drainage Main Crossings**
  - (a) The wastewater or storm drainage main shall be placed at least 3 feet below the invert of an open drainageway or irrigation ditch or at least 18 inches below the invert of a drainageway or irrigation ditch culvert, and the main shall be placed in a steel sleeve in conformance with the applicable standard drawings in Chapter 11, “Technical Drawings,” of these Standards.
  - (b) In open drainageway or irrigation ditch crossings, the Director may allow the wastewater or storm drainage main to be encased in concrete instead of placement in a steel sleeve, and the concrete encasement shall conform with the applicable standard drawings in Chapter 11, “Technical Drawings,” of these Standards.
  - (c) When a drop manhole is used to obtain the required vertical separation for a drainageway or irrigation ditch crossing, the drop manhole shall be located at least 20 feet from the end of a steel sleeve.
- (3) **Other Utility Line Crossings**
  - (a) Other utility lines, including without limitation, gas, electric, and telecommunications lines, shall be placed at least 30 inches below the invert of a drainageway or irrigation ditch.
  - (b) Other utility lines shall be placed in a Schedule-40 steel casing, extending horizontally at least 10 feet beyond each side of the drainageway or irrigation ditch, measured from top of bank to top of bank.

**Table 4-2: Local Drainageways and Irrigation Ditches**

Anderson Ditch	Elmer’s Two Mile Creek	Skunk Canyon Creek
Bear Canyon Creek	Farmer’s Ditch	South Boulder Creek
Bluebell Creek	Fourmile Canyon Creek	Sunshine Creek
Boulder Creek	Goose Creek	Two Mile Canyon Creek
Boulder and Whiterock Ditch	Gregory Creek	Viele Channel
Boulder and Left Hand Ditch	Howard Ditch	Wellman Canal
Dry Creek	King’s Gulch	Wonderland Creek
Dry Creek #2	New Anderson Ditch	
Dry Creek #2 Ditch	North Boulder Farmer’s Ditch	

**(D) Separation of Utilities from Trees**

Trees proposed to be planted in public utility easements and rights-of-way shall be located at least

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10 feet away from existing and proposed utilities and shall not block vehicle access along the easement. All utility construction near existing trees shall abide by the tree protection requirements specified in Chapter 3, “Streetscape Design,” of these Standards.

**(E) Special Conditions for the Separation of Utilities**

If the required horizontal or vertical separation of utilities cannot be obtained as required in this section, the Director may apply special conditions to the design of utilities separations, to ensure the safety, protection and integrity of the utility system, as follows:

**(1) Parallel Separation**

- (a) If 10 feet of parallel separation between water and wastewater lines cannot be obtained, the wastewater line may be laid closer to the water line, provided the following conditions exist:
  - (i) The wastewater line is constructed of pressure-class pipe, in conformance with these Standards, until the required horizontal separation is obtained, and
  - (ii) The water line is located at least 18 inches above the wastewater line, as measured from the top of the wastewater pipe to bottom of the water pipe.
- (b) If 5 feet of parallel separation between water and storm drainage lines cannot be obtained, the storm drainage line may be laid closer to the water line, provided the storm drainage line is constructed of pressure-class pipe, in conformance with these Standards, until the required horizontal separation is obtained. The storm drainage line does not need to be pressure tested.

**(2) Crossings Separation**

- (a) If 18 inches of vertical separation between either water and wastewater line crossings, or water and storm drainage line crossings, cannot be obtained, the wastewater or storm drainage line shall be constructed of pressure-class pipe, in conformance with these Standards, for at least 10 feet beyond each side of the water line crossing. This distance shall be measured along the wastewater or storm drainage line from the center of the water line. The storm drainage line does not need to be pressure tested.
- (b) If the water line cannot be constructed above the wastewater line at water and wastewater line crossings, the wastewater line shall be constructed of pressure-class pipe, in conformance with these Standards, for at least 10 feet beyond each side of the water line crossing. This distance shall be measured along the wastewater line from the center of the water line.
- (c) If either 18 inches of vertical separation between water and wastewater line crossings, and water and storm drainage line crossings, or 6 inches of vertical separation between wastewater and storm drainage line crossings cannot be obtained, special structural support shall be required to prevent settlement and potential pipe damage at the crossing. Structural support design shall be subject to the Director’s approval.

**(3) Pressure-Class Pipe for Crossings:** When pressure-class pipe is required to satisfy the requirements prescribed in this section, the following will apply:

- (a) Pipe materials and quality shall be suitable for water main construction in accordance with specifications prescribed in these Standards.



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- (b) Individual pipe sections shall be at least 18 feet long and placed at the crossing so that the ends are located 9 feet beyond each side of the water line crossing.
- (c) The inside diameter of the pressure-class crossing pipe shall be of equal size or nearest diameter larger than the non-pressure-class wastewater or storm drainage pipe inside diameter for the length until the required separation between utilities is obtained. Pressure-class pipe installations shall include watertight transition couplings.
- (d) Both the water and wastewater lines shall be pressure tested.

#### 4.07 Undergrounding of Utilities

New, replacement, or relocated electrical utilities and telecommunication and cable television systems shall be installed underground as set forth in Section 9-12-12, “Standards for Lots and Public Improvements,” B.R.C. 1981.

#### 4.08 Abandonment, Repair and Upgrade of Service Lines and Taps

##### (A) General

Inactivity, damage, age of materials, redevelopment, or changes in service requirements for the premises may require repair, removal or abandonment of a utilities service line or stub-in. Repair, removal and abandonment of a utilities service line or stub-in shall comply with the standards of this section.

##### (B) Abandonment

An abandoned service line shall be disconnected at the corporation with the main.

##### (C) Witnessing

Service line abandonments and repairs shall be witnessed by City inspection staff.

##### (D) Tap Upgrade

When an existing service line must be upgraded, the existing main tap shall be upsized and re-used wherever possible.

##### (E) Water Services

When a water service line is abandoned or repaired, the following will apply:

- (1) **Services 2 Inches and Smaller:** For a water service line that is a 2-inch line or smaller, the water service connection shall be excavated where the corporation stop is inserted into the water main. The corporation stop shall be closed, the service tubing or piping shall be removed from the corporation stop, and a section of the water service line at least 12 inches long shall be cut off. A plug or cap shall be placed on the corporation stop to prevent leakage. If the service line has a meter, the meter shall be returned to the City for final testing and reading. The meter pit/vault, if present, shall be removed in its entirety, or, if left in place, shall be cut off at least 18 inches below finished grade and filled with sand or other fill material. If the corporation stop is leaky or corroded, the corporation stop shall be removed and a “Ford” FS1 repair sleeve or an equivalent sleeve, approved by the Director, shall be installed while the main is shut off.

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- (2) **Services Larger than 2 Inches:** For a water service line that is larger than 2 inches, the water service connection shall be excavated over the service tee on the water main. The tapping valve shall be closed, a length of service pipe at least 12 inches long shall be removed, and the tapping valve shall be plugged or capped. The valve box shall be removed in its entirety or, if left in place, shall be cut off at least 18 inches below finished grade and filled with granular pipe bedding material (squeegee) as specified in Chapter 9, “Utilities Standards,” of these Standards. If the service line has a meter, the meter shall be returned to the City for final testing and reading. The meter vault, if present, may be removed in its entirety, or abandoned in place by filling it with sand or granular pipe bedding material (squeegee) as specified in Chapter 9, “Utilities Standards,” of these Standards. If practicable, the manhole shall be cut off at least 18 inches below grade. In the event a wet tapped valve is leaky or corroded, the valve shall be removed and a “Ford” FS1 repair sleeve or an equivalent sleeve, approved by the Director, shall be installed while the main is shut off. Valves on tees that are leaky or corroded shall be removed and replaced with a blind flange.
- (3) **Copper Lines:** Water service line repairs and connections on copper lines may use flare to flare or grip-tite compression fittings as specified in Chapter 9, “Utilities Standards,” of these Standards.

**(F) Sewer Services**

When a sewer service line is abandoned or repaired, the following will apply:

- (1) **Abandonment:** A sewer service line shall be abandoned by excavation of the connection with the main, removal of the section of main with the connection tap, and replacement of that section of the main with PVC non-pressure pipe and couplings as specified in Chapter 9, “Utilities Standards,” of these Standards. Manhole taps may be plugged at the manhole with the service line left intact.
- (2) **Repair:** Sewer service line repairs that require the coupling of two pipe sections to create a joint shall use couplings for non-pressure pipe as specified in Chapter 9, “Utilities Standards,” of these Standards.

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**CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS**

**CHAPTER 5  
WATER DESIGN**

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## 5.01 General

### (A) Intent

The Water Design Standards establish minimum design standards for providing and maintaining the public water utility distribution system.

### (B) Water Utility Master Plan

All improvements proposed to the City's public water utility system shall conform with the goals, policies, and standards adopted in the Water Utility 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 water utility improvements and may refer to one or more of the references listed in the References Section of these Standards.

## 5.02 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 water distribution system. The utility report shall be prepared by the Engineer and include a technical report, preliminary plan, and connection and isolation plan as outlined in the following subsections.

### (B) Report

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

- (1) **Water Demands:** Include estimated water demands based on occupancy and building type for the following conditions:
  - (a) Peak Hour (gallons-per-minute),
  - (b) Peak Day (gallons-per-minute),
  - (c) Insurance Service Office (ISO) Fire Flows (gallons-per-minute), and
  - (d) Irrigation (gallons-per-minute).
- (2) **Conformance with Water Utility Master Plan:** Describe how the proposed water utility improvements conform with the adopted Water Utility Master Plan.
- (3) **System Layout:** Describe the proposed distribution system layout, including locations for connections with the existing water utility system.
- (4) **Network Analysis:** Include a distribution network analysis as required by the Director, performed through an EPANet or MWH InfoWater computer simulation, identifying any

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systems impacts based on proposed demands and providing design solutions to ensure perpetuation of future water utility system growth and maintain system pressures and flow rates.

**NOTE:** Computer simulations of hydraulic analyses are to be performed using electronic input data for the existing water system provided by the City on EPANet software. Computer analyses are to be submitted in both hard copy and electronic format.

- (5) **Main Sizing:** Indicate the required sizing of proposed distribution mains based on water demands.
- (6) **Design Alternatives:** Discuss alternative system layouts and methods of providing water service, including an evaluation of each alternative and reasons for selecting the recommended design.
- (7) **Special Conditions:** Identify any special conditions, such as the presence of erosive soils, conflicts with other utilities, unusual installation depths or oversizing requirements, that require special provisions for improvements construction.

**(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 water distribution 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 water utilities, including fire hydrants and valves, 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 water distribution mains, valves, and fire hydrant locations, including construction phasing.

**(D) Connection and Isolation Plan**

A connection and isolation plan shall be provided in the utility report to identify proposed connection points with the existing water systems and design conditions for providing required system isolation for maintenance and flushing. The connection and isolation plan is to include the following:

- (1) **Valve Locations:** Identify all valves necessary to isolate a point of connection for the proposed water system onto the existing system. Existing system valves should be inspected for location and accessibility.

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- (2) **Thrust Restraint:** Determine and include design and construction requirements for sufficient thrust restraint for existing water mains and valves at proposed connection points (“stub outs” and terminal extensions) to allow construction while the existing water system remains in service.
- (3) **System Isolation:** Identify water main sections that can be isolated within the proposed and existing water systems that provide for emergency maintenance and identify discharge points for system flushing.

## 5.03 Water Main Extensions

### (A) Water Utility Master Plan

Where major water distribution mains, 12 inches or larger in diameter, are proposed to be constructed in the Water Utility Master Plan, an applicant for construction approval shall provide for the construction of the main as part of any development proposal, when the major distribution 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 distribution service for the proposed development.

### (B) Main Extension Agreements

- (1) When construction of a major distribution main is required, and the diameter of the major distribution 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 11-1-42, “Agreement to Extend Water Mains,” and 11-1-43, “Reimbursement of Costs for Water Main Extension,” B.R.C. 1981.
- (2) When construction of an offsite major or local water distribution main is required to extend water 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 11-1-42, “Agreement to Extend Water Mains,” and 11-1-43, “Reimbursement of Costs for Water Main Extension,” B.R.C. 1981.

## 5.04 Design Flow

### (A) Water Distribution Mains

- (1) The water distribution system (mains and looping) shall be designed to provide a minimum residual pressure of 20 pounds per square inch (psi), at ground surface, under peak day demand flow, plus the required ISO fire flow.
- (2) The water distribution system shall be designed to provide a minimum of 40 psi under peak hour demand flow, without fire flow.
- (3) The water distribution system shall be designed so that water main flow velocities do not exceed 4 feet per second under peak hour demand without fire flow and 8 feet per second

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under peak day demand with fire flow.

- (4) Pressure and flow capacity data for both existing and future conditions for the City's major water distribution system is to be obtained from the Utilities Division for use in the design and analysis of proposed improvements.
- (5) Table 5-1 indicates water demand forecasting for peak day conditions.

**Table 5-1: Peak Day Water Demands**

Development Type	Peak Day Demand
Residential	
Low Density	180 gpcd
Medium Density	150 gpcd
High Density	75 gpcd
Commercial	10,000 gpad
Industrial	12,000 gpad

- (6) Table 5-2 indicates water demand peaking factors for forecasting demands.

**Table 5-2: Peak Hour Factors**

Development Type	Maximum Hour	Maximum/Day
Residential		
Low Density	5.1	5.1
Medium Density	5.0	2.5
High-Density	5.0	2.0
Commercial	2.5	2.5
Industrial	1.5	1.5

- (7) Water design flows that reduce the water system pressures below the acceptable levels or increase water system flow velocities above the acceptable levels specified in this section or elsewhere in these Standards are considered detrimental to the overall system. In these situations, the Director will deny project approval, or require the developer to provide additional water system improvements, both onsite and offsite, to ensure no reduction in levels of service.

**(B) Water Services**

Design flows for water services shall be determined in conformance with the most current International Plumbing Code as adopted by the City.

**5.05 Materials and Installation**

Construction of water-related public improvements shall be in compliance with these Standards. All pipe shall be of adequate strength to support the 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.



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## 5.06 Corrosion Protection

Corrosion protection will be required for all water system improvements where corrosive soil conditions are encountered. The Engineer shall perform a soils resistivity survey to evaluate the corrosion potential of soils in proposed projects or developments, and recommend any necessary corrosion protection measures, such as alternative pipe type or cathodic protection. The Director will review the soils resistivity survey and Engineer's recommendations and the service history for water system corrosion in the area and determine the pipe type or protection to be used prior to construction plan approval.

## 5.07 Transmission Mains

### (A) Specifications

- (1) **Size:** All water mains 16 inches or larger in diameter shall be classified as “transmission mains.”
- (2) **Location:** All transmission mains shall be installed in public rights-of-way or easements, as prescribed in Section 4.04, “Utilities Easements,” of these Standards.
- (3) **Depth:** All transmission mains shall have no less than 4.5 feet and no more than 10 feet of cover, measured from the top of pipe to the final surface grade.
- (4) **Separations and Crossings:** All transmission main separations and crossings of other City utilities shall be designed in compliance with Section 4.06, “Separation of Utilities,” of these Standards.

### (B) Taps

- (1) **Minimum Tap Size:** No main extension or fire hydrant taps smaller than 6 inches in diameter shall be installed in any transmission main.
- (2) **Service Line Taps Prohibited:** Service line taps shall not be installed in any transmission main.
- (3) **Pressure Taps:** Unless approved by the Director, all taps installed onto a transmission main shall be made under “wet tap” conditions, using a tapping tee and valve, to allow the transmission main to remain in service.

### (C) Valves

- (1) **Separation:** Valve separation along transmission mains shall be no greater than 1,200 feet, measured along the alignment of the transmission main.
- (2) **Valve Locations:** Valves shall be installed at the following locations:
  - (a) At all connections with transmission mains. Where a distribution main connects with a transmission main, a valve shall be installed on the distribution main at the transmission main.
  - (b) Where necessary to ensure that no more than three valves must be closed to isolate any section of a transmission main. Two valves shall be installed at all tee-type connections, and three valves shall be installed at all cross-type connections.
  - (c) Where possible, valves shall be aligned with extensions of property lines or right-

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of-way lines. Valves shall not be placed in locations that may be subject to routine parking or storage and shall not be placed within public sidewalks, multi-use paths, or on-street bike lanes.

**(D) Relief Valves**

- (1) **Air and Vacuum Release Valves:** Air and vacuum release valves shall be installed in transmission mains at all high points where an elevation differential of 20 feet exists along the main.
- (2) **Pressure Blow-Off Assemblies:** Pressure blow-off assemblies shall be installed in transmission mains at all low points where an elevation differential of 20 feet exists along the main.

**(E) Ground Water Barriers**

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

**5.08 Distribution Mains****(A) Specifications**

- (1) **Size:** Distribution mains shall be at least 8 inches in diameter.
- (2) **Locations**
  - (a) All water mains shall be installed in public rights-of-way or easements, as prescribed under Section 4.04, “Utilities Easements,” of these Standards.
  - (b) All platted lots, whether existing or proposed as part of a subdivision, shall front on a distribution main.
- (3) **Depth:** All distribution mains shall have no less than 4.5 feet and no more than 10 feet of cover, measured from the top of pipe to the final surface grade. Where final grades have not been established, mains shall be installed deep enough to ensure acceptable cover below the future grade based on the best available information. Under no condition shall a main be installed with less than 4.5 feet of cover.
- (4) **Separations and Crossings:** All distribution main separations and crossings of other City utilities shall be designed in compliance with Section 4.06, “Separation of Utilities,” of these Standards.

**(B) Taps**

- (1) **Pressure Taps:** All taps approved onto a distribution main shall be installed under “wet tap” conditions, using a tapping tee and valve, which allows the distribution main to

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remain in service at all times.

- (2) **Tap Installation:** All taps approved onto an existing distribution main will be made by the City of Boulder Utilities Division and shall be paid for by the applicant.

**(C) Valves**

- (1) **Where Required:** Valves shall be installed as necessary on distribution mains to ensure that:
  - (a) No more than 600 feet of water main will be located between isolation valve zones (i.e., sections of main that may be taken out of service for maintenance activities).
  - (b) No more than two fire hydrants will be located between isolation valve zones.
  - (c) No more than three valves will require closure to isolate any section of a distribution main. Two valves shall be installed at all tee-type connections, and three valves shall be installed at all cross-type connections.
  - (d) Valves are to be aligned with extensions of property lines or right-of-way lines where possible. Valves shall not be placed within public sidewalks, multi-use paths, or on-street bike lanes.
- (2) **Emergency Access:** Valves shall be located to provide maximum accessibility for emergency access. Valves shall not be placed in locations that may be subject to routine parking or storage operations.

**(D) Looping and Terminal Mains**

- (1) **Looping Required:** All distribution mains shall be looped into the existing and proposed water distribution system to ensure at least two feed sources and to maintain system strength, except as allowed under Section 5.08(E) below.
- (2) **Maximum Terminal Length:** Where allowed, terminal (dead-end) distribution mains shall not be more than 600 feet long, measured along the entire centerline length of the terminal main from the connection main to the terminus.
- (3) **Fire Hydrant on Terminal Mains:** All terminal mains shall have a fire hydrant at the terminus and no more than two fire hydrants in total. Fire hydrant installations shall be offset from the terminus to ensure that the hydrant can be removed for maintenance while the terminal main remains in service.
- (4) **Service Taps:** Service taps along terminal mains shall not be located closer than 3 feet to the terminus nor located between the fire hydrant connection and the terminus.

**(E) Extensions**

- (1) **Standards:** Water distribution main extensions are subject to the requirements in Section 11-1-41, "Extensions of Water Mains," B.R.C. 1981, and these Standards.
- (2) **System Perpetuation:** Water 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 water distribution system, may dictate that water mains be extended to the far edge of more than one

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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.

**(F) Future Connections**

- (1) **Isolation Valve Required:** When future main extensions are provided for by “stub out” or terminal connections, the stub out or terminal main extension shall be valved so that only one valve must be closed when the future main is extended. The valve shall be restrained to the existing distribution main to allow closure of the stub out or terminal main section without creating a pressure separation of the valve from the in-service distribution main.
- (2) **Valve Restraint:** Valve restraint may be ensured by the use of a direct swivel connector or adapter, or by providing a pipeline extension that can restrain the valve through frictional resistance. All future connections designed at perpendicular angles to the existing distribution main shall include a valve on the extension that is directly attached to the existing main. Where valve restraint through frictional resistance of extended pipe line sections is proposed, the Engineer shall determine the necessary pipe length required to provide adequate frictional resistance, subject to review and approval by the Director.
- (3) **Testing:** When future connections are made, the entire main beyond the stub out or terminal main extension shall be flushed, chlorinated, and pressure tested.
- (4) **Service Taps Prohibited:** No service taps shall be allowed on a stub out or on a terminal main beyond the isolation valve.

**(G) Ground Water Barriers**

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

**5.09 Water Services****(A) General**

- (1) **Standards:** Water services are water system extensions that are tapped onto the distribution system to provide water to consumers. Water services are subject to the requirements of these Standards and Section 11-1-20, “Taps or Connections to Water Mains,” and Section 11-1-21, “Water Service Lines,” B.R.C., 1981.
- (2) **Water Meters:** Water services shall include the installation of a meter and shall be subject to the requirements of these Standards and the conditions of Sections 11-1-34,

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“Meter and Appurtenances to be Purchased by User,” Section 11-1-35, “Meter Size Requirements,” and Section 11-1-36, “Location and Installation of Meters; Maintenance of Access to Meters,” 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 water service connection to a distribution main without crossing adjacent lots.
- (4) **Service Alignment:** When the water service is located in the public right-of-way or easement, the service shall be installed perpendicular to the distribution main, up to and including the meter and pit. Where this is not possible, the water service alignment shall be subject to the determination of the Director.
- (5) **Pressure Boosters Prohibited:** No pressure booster of any kind is allowed on any water service.

**(B) Domestic Services**

- (1) **Separate Services to Structures:** Each principal structure shall be served by a separate water service line and meter connected to the distribution main. Where more than one principal structure is proposed on a single lot, an additional water service line and meter will be required for each additional principal structure.
- (2) **Accessory Buildings or Structures:** An accessory building or structure, as defined under Subsection 9-16-1(c), “General Definitions,” B.R.C. 1981, may draw limited service from a principal building or structure without a separate water service, subject to the following:
  - (a) If the accessory structure contains no toilet and no bathtub or shower fixtures, the accessory structure is limited to the following plumbing fixtures:
    - (i) Sink (one fixture),
    - (ii) Clothes washer connection (one set),
    - (iii) Hose bib or sill cock (one fixture),
    - (iv) Floor drain (one fixture), and
    - (v) Interceptor (one fixture).
  - (b) If the accessory structure is proposed to have a sink and toilet, the accessory structure shall not contain any additional sinks or toilets nor a bathtub or shower fixture, shall not be used as a separate dwelling unit, may not be located on a property that can be subdivided into separate lots, and shall be limited to the following additional plumbing fixtures:
    - (i) Sink (one fixture),
    - (ii) Toilet (one fixture),
    - (iii) Floor drain (one fixture), and
    - (iv) Interceptor (one fixture).
  - (c) An approved detached accessory dwelling unit, as defined under Subsection 9-16-1(c), “General Definitions,” B.R.C. 1981, is not subject to this section’s plumbing fixture limitations.
  - (d) The Director of Public Works may permit water hookups and meters separate

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from a principal detached dwelling unit only upon finding that topography or other physical circumstances make utility connections to the principal structure impractical.

- (3) **Services Crossing Lots:** Domestic water services 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 water service line only, or by the water and wastewater service lines only if the water and wastewater service lines are installed in compliance the IPC, as adopted by the City.
  - (c) The Director determines that a water main extension is not necessary to perpetuate the system, or that future development of abutting properties cannot benefit from a main extension.
  - (d) The water 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, as adopted by the City.

**(C) Irrigation Services**

- (1) **Separate Service:** With the exception of single-family residential properties, all irrigation services shall have a separate service line and meter.
- (2) **Property to be Served:** Irrigation service lines shall serve no more than one individual property, unless approved by the Director under the provisions of a homeowners association. Where irrigation services serve more than one individual property, the plant investment fee (PIF) and associated credit shall apply to the individual property where the water meter is located and the service originates.
- (3) **Building Connection Prohibited:** Irrigation service shall not connect with any building or structure or with any other consumptive-use water service.
- (4) **Reduced Pressure Assembly Required:** All irrigation systems with a separate, metered service line shall have a reduced pressure principle assembly installed in compliance with all applicable City regulations and standards.

**5.10 Fire Protection****(A) Fire Hydrants**

- (1) **Standards:** All fire hydrants shall be installed in compliance with these Standards.
- (2) **Easements:** All fire hydrants shall be installed within public rights-of-way or easements as prescribed in Section 4.04, “Utilities Easements.” Easements shall be a minimum of 25 feet in width and extend at least 10 feet beyond the hydrant assembly.
- (3) **Placement:** The placement of fire hydrants shall comply with the International Fire Code, as adopted with local amendments under Chapter 10-8, “Fire Code,” B.R.C. 1981, and the following requirements:

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- (a) Fire hydrants shall be placed at the entrance or intersection for each street, with a hydrant place on each side of any divided roadway.
- (b) In a single-family residential area, there shall be no more than 500 feet of fire access distance between hydrants. No dwelling unit shall be over 250 feet of fire access distance from the nearest hydrant.
- (c) In all other areas, there shall be no more that 350 feet of fire access distance between hydrants. No exterior portion of any building shall be over 175 feet of fire access distance from the nearest hydrant.

**NOTE:** Fire access distance means the distance between two hydrants, or the distance from a hydrant to any external portion of any building, measured along public or private (but accessible to fire equipment) roadways or fire lanes, as would be traveled by motorized firefighting equipment.

- (4) **Alignment with Property Lines:** Hydrants shall be aligned with an extension of the property line when located midblock.
- (5) **Horizontal Clearances:** Hydrants shall be placed no farther than 5 feet behind the curb, outside of any fenced area, and have a 10-foot radius of clearance to adjacent obstacles (fences, walls, shrubs, trees, etc.).
- (6) **Vertical Clearances:** Hydrants shall have the lowest water outlet not less than 18 inches or more than 30 inches above the final ground elevation.
- (7) **Colors:** The hydrants' color shall be Rustoleum No. 831 "restful green" or "KWAL" hydrant green except for bonnet, weather caps, and nozzle caps, which must be Rustoleum No. 2766 "reflectorized white" unless otherwise specified by the Director of Public Works.

**(B) Fire Sprinkler Lines**

- (1) **Dedicated Line:** A fire sprinkler line for any structure or building, other than a single-family or duplex residential structure, which is either required to be installed by the Boulder Fire Department or installed voluntarily by the applicant, shall be a separate dedicated fire sprinkler line tapped at the water distribution main. The minimum tap and valve diameter size for a dedicated fire sprinkler line shall be 4 inches. The property owner may choose to reduce the line diameter, as needed, beyond the City-maintained valve in the property owner-maintained portion of the fire sprinkler line. The City shall not be responsible for maintenance beyond the first valve on the line.
- (2) **Maintenance Responsibility:** The property owner shall be responsible for maintaining all dedicated fire sprinkler lines beyond the valve at the main distribution line. It is the property owners' responsibility to ensure all City owned and maintained valves are visible and not covered by landscape materials, concrete or asphalt.
- (3) **Service Taps Prohibited:** No taps will be approved onto a fire sprinkler line for any purpose other than the fire sprinkler system. Combination fire sprinkler/service lines for domestic or irrigation services will not be approved, except as allowed in Subsection (B)(4), below.
- (4) **Combination Line:** A single-family or duplex residential structure may have a combination fire sprinkler/domestic service line from the City's water distribution main to the water meter, if the following conditions are met:

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- (a) The combination line shall be sized to convey maximum domestic service and fire sprinkler protection service flows. The combination line size shall be 1 inch in diameter; otherwise, the combination line shall be separated into a dedicated fire sprinkler line and separate domestic service line, each tapped at the distribution main.
- (b) The combination line shall separate at the water meter pit into a domestic service line (with meter) and a dedicated fire sprinkler line (without meter, but with oriseal shutoff).
- (c) Beyond the water meter pit, both the domestic and fire sprinkler water service lines may be placed in the same trench. However, they may not be tied back together in any manner, and they may not have any type of cross-connection either inside or outside the structure.
- (d) The property owner is responsible for maintaining the domestic service and the fire sprinkler lines beyond the water meter pit.

**NOTE:** Section 5.11, “Cross-Connection Regulations,” of these Standards, identifies the requirements for cross-connection control and backflow prevention as they apply to fire sprinkler systems.

## 5.11 Cross-Connection Regulations

### (A) Purpose

The purpose of these standards is to protect the City water system from contamination or pollution by backflow due to cross connections from owner water systems, and to a continuing program of cross connection control to prevent the contamination or pollution of the City water system. For the purpose of this section, "Contamination" means any impairment of the quality of the potable water by pollution from sewage, industrial fluids or waste liquids, compounds or other materials to a degree which may create a hazard to the public health through poisoning or through the spread of disease.

### (B) Additional Regulations

- (1) Sections 11-1-3, “Rules and Regulations,” and 11-1-25, “Duty to Maintain Backflow Prevention Assembly and Prevent Cross-Connection,” B.R.C. 1981.
- (2) The Colorado Cross Connection Control Manual

### (C) General Requirements

- (1) If a backflow prevention assembly is required by the City, the Director of Public Works may give notice in writing to the owner to install an approved backflow prevention assembly at each service connection to the premises. The owner shall install an approved assembly at each service connection to the premises at the owner's own expense.
- (2) No provision of this section exempts the owner from the cross-connection control provisions for internal water distribution systems as contained in the International Plumbing Codes and other plumbing standards adopted by the B.R.C. 1981, or state or federal regulations regarding cross-connections.
- (3) No person shall operate an industrial fluids system, auxiliary water supply, or an owner water system that allows for the occurrence of a cross connection to the water utility.



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- (4) There shall be no unprotected branches from the service line ahead of any meter or backflow prevention assembly located at the point of delivery to the owner's water system.
- (5) No person owning, managing, installing or repairing any water system shall fail to comply with any of these rules.

**(D) Installation Required**

- (1) A backflow prevention assembly approved by the Director of Public Works shall be installed immediately inside the structure being served, after the meter on private property, and before the first branch line leading off the service line wherever any of the following conditions exist:
  - (a) If a property has an auxiliary water supply which is not or may not be of safe bacteriological or chemical quality and which is not acceptable as an additional source by the Director of Public Works, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line appropriate to the degree of hazard.
  - (b) If a non-residential property that contains any liquid processes or fluids system or any other unapproved water system, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line appropriate to the degree of hazard.
  - (c) In all premises that contain internal cross connections that cannot be permanently corrected and controlled, or that contain intricate plumbing and piping arrangements, or where entry to all portions of the premises is not readily accessible for inspection purposes making it impracticable or impossible to ascertain whether or not dangerous cross connections exist, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line.
- (2) Installation shall be as approved by FCC and URC, USC list including vertical and horizontal assembly orientation.
- (3) Backflow prevention assemblies shall be installed in an accessible location to facilitate inspection, testing and maintenance without removal of the device. An adequate drainage area for the assembly must be provided for in the event that water is released. Installation clearance requirements shall meet requirements of the Colorado Cross-Connection Control Manual and allow removal of all parts from the assembly. Pit and vault installations are prohibited.

**(E) Duty to Inspect, Test and Repair**

The owner shall have certified inspections and operational tests made on the backflow prevention assembly upon installation and at least once per year thereafter. The Director of Public Works may require certified inspections at more frequent intervals. These inspections and tests shall be made at the expense of the owner. A backflow prevention assembly shall be repaired or replaced at the expense of the owner whenever an assembly is found to be defective.

**(F) Specifications**

- (1) After written notification by the Director of Public Works, any property with a backflow incident shall be responsible for installation, inspection and testing, or repair of a backflow prevention assembly within 10-days. Backflow prevention devices shall be air-gap (“AG”) or

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reduced pressure principle assembly (“RP”) except for Solar heating systems with make-up water which shall be “RP” devices.

- (2) After written notification by the Director of Public Works, the owners and operators of the following types of existing facilities shall be responsible for installation, inspection and testing, or repair of a backflow prevention assembly within 30-days of such written notice. Backflow prevention devices shall be air-gap (“AG”), or reduced pressure principle assembly (“RP”) unless otherwise noted.

- |   |   |   |
|---|---|---|
| • Automotive service station or repair shop               | • Laboratory - clinical and chemical  | • Sewage treatment plant                              |
| • Auxiliary water supply                                  | • Laundry or dry cleaning service   | • School with laboratory                              |
| • Commercial service line greater than four-inch diameter | • Manufacturing and industrial facility (to be determined on an individual basis) | • Shell business development space                    |
| • Carwash   | • Medical office  | • Solar heating system with make-up water (“RP Only”) |
| • Food processing and Packing plant                       | • Morgue and mortuary   | • Swimming pool                                       |
| • Greenhouse  | • Multi-storied buildings (4 stories or more)                                     | • Veterinary office or clinic                         |
| • Hospital, inpatient and outpatient care                 | • Photographic studio and laboratory  | • Water treatment plant                               |
| • Hotel or lodging facility                               |   |   |
| • Kennel - boarding only                                  |   |   |

- (3) Prior to final inspection of any new structure or alteration requiring a building permit, the owners and operators of the following types of facilities shall be responsible for installation, inspection, testing, or repair of a backflow prevention assembly. Backflow prevention devices shall be air-gap (“AG”), or reduced pressure principle assembly (“RP”) unless otherwise noted. Double Check Valve Assembly (“DC”) devices shall only be permitted where specifically approved below.

- |  |   |  |
|--|---|--|
| • Any establishment with a backflow incident           | • Hospital, outpatient care and long-term facility                                | (4 stories or more)  |
| • Automotive Service station or repair shop            | • Hotel and lodging   | • Photographic studio and lab                                |
| • Auxiliary water supply                               | • Kennel - boarding only  | • Sewage treatment plant                                     |
| • Commercial service line greater than 4-inch diameter | • Laboratory -- clinical and chemical   | • School with laboratory                                     |
| • Carwash  | • Laundry and cleaning service  | • Shell business development space                           |
| • Fire line -- no chemicals added (AG, RP, or DC)      | • Manufacturing and industrial facility (to be determined on an individual basis) | • Solar heating system with make-up water system (“RP” Only) |
| • Fire line -- chemicals added                         | • Medical office  | • Swimming pool  |
| • Food processing and packing plant                    | • Morgue and mortuary   | • Veterinary office  |
| • Greenhouse   | • Multi-storied building  | • Water treatment plant                                      |

- (4) Any building or facility not listed in the foregoing table may be required by the Director of

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Public Works to install a backflow prevention assembly. The compliance period and assembly required shall be determined by the Director of Public Works based on the degree of hazard.

- (5) The compliance periods listed above may be modified by the Director of Public Works for good cause shown, and after submittal and approval by the Director of Public Works of a compliance plan.
- (6) Compliance plans shall be enforceable against subsequent owners of non-residential property. If no approved compliance plan exists, then the property must be in compliance with this rule prior to any sale of the property.

**(G) Records and Reports**

A certified tester shall record the results of all inspections, tests and maintenance on a form prescribed by the Director. This report shall be submitted to the Director and the owner within ten days following the completion of the inspection, test, or maintenance of the assembly. The certified tester shall also attach a card to the backflow prevention assembly following each inspection, test, or maintenance activity to document and date the activities performed. Records of all inspections, test, or maintenance activities, including materials and parts changed, shall be kept by the certified inspector and the owner.

**(H) Backflow Prevention Assemblies**

- (1) The term "approved backflow prevention assembly" or "approved assembly" means any of the following:
  - (a) an assembly that is in conformance with the laboratory and field performance specifications of the Foundation for Cross Connection Control and Hydraulic Research (FCC and HR) of the University of Southern California; or
  - (b) an assembly which has been approved, inspected and installed to the satisfaction of the Director of Public Works.
- (2) All backflow prevention assemblies shall have a unique serial number attached to the assembly by the manufacturer.
- (3) Backflow prevention assemblies currently installed which are not approved shall be replaced with an approved assembly within 30 days of written notice by the City. If the assembly fails an annual operational test or inspection, it shall be repaired or replaced with an approved assembly within 30 days of written notice by the City.

**(I) Certified Tester Criteria**

- (1) Testing of backflow prevention assemblies on fire sprinkler systems shall require the certified Cross Connection Control and Backflow Prevention Device Tester to also be a certified Fire Sprinkler System Installer, or be supervised by a certified Fire Sprinkler System Installer registered with the City of Boulder Fire Department.
- (2) Certified Cross Connection Control and Backflow Prevention Device Testers shall also be required to provide the following information in order to be listed on the Backflow Prevention Program's list of certified testers in the area. Such information shall be sent or faxed directly from the laboratory to the Backflow Prevention Program office at 5605 N. 63rd St., Boulder, Colorado 80301; FAX: 303-530-1137.

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- (a) Copy of a current Cross Connection Control and Backflow Device Tester certificate.
- (b) Test kit calibration certificate from an authorized manufacturers calibration/ repair laboratory or an ISO 9002 certified calibration/repair laboratory for instrument repairs or measurements. Documented calibration must be National Institute of Standards and Technology (NIST) traceable and meet the current ASME/ANSI B40.01 standards. The certified calibration report shall include the following:
  - (i) Indicate minimally the descending reading at 10, 7, 5, 2, 1 and 0 PSID with a minimum required tolerance range of  $\pm 0.1$  PSID,
  - (ii) Data as found (data prior to any adjustment of the test kit), and
  - (iii) After calibration data or returned information documented (data after adjustment, if required).
- (c) Provide a certificate signed by a qualified agent of an insurance company that meets minimum limits required by Section 4-1-8(a) and (b), B.R.C. 1981.

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**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

**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 Utility 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 Utility 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 wastewater 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 Utility Master Plan:** Describe how the proposed wastewater utility improvements conform with the adopted Wastewater Utility 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.

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- (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<sub>5</sub> (total and soluble fraction, carbonaceous and nitrogenous demand),
  - (h) COD (total and soluble),
  - (i) TSS,
  - (j) Nitrogen (TNK, NO<sub>3</sub>, NO<sub>4</sub>, NH<sub>4</sub>, 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



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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) Wastewater Utility Master Plan

Where major wastewater collection mains, 12 inches or larger in diameter, are proposed to be constructed in the Wastewater Utility 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.

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**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.
- (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**

<b>Development Type</b>	<b>Average Day Load</b>
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 peak flow and minimum flow factors for forecasting discharges. These flow factors are used with the preceding average day load estimates as defined in Section 6.04 A(10) of these Standards to determine minimum required wastewater main capacity:

**Table 6-2: Factors for Forecasting Wastewater Discharges**

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Collection Main Diameter	Minimum Flow Factor	Peak Flow 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 population densities, building areas, pumped discharge flow rates, existing wastewater flow rates, existing or anticipated industrial discharges, peak flow, minimum flow, and infiltration/inflow flow rates.

**(B) Wastewater Services**

Design flows for wastewater services shall be determined in conformance with the most current International Plumbing Code (IPC), 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 manning's 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 no more than 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 4.04 of these Standards.
- (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

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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"	0.400	7.5
10"	0.332	5.5
12"	0.247	4.5
15"	0.193	3.5
18"	0.144	2.5
21"	0.113	2.0
24"	0.092	1.8

- (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 pipe flow velocities of two (2) feet per second. Maximum allowable slope shall provide half-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 4.06, "Separation of Utilities," of these Standards.

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**(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 wastewater collection mains, ground water barriers shall be constructed within the collection main trench to prevent ground water migration or diversion along the 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 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 wastewater collection 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 400 feet.
- (3) **Service Connections:** Manholes shall be required at all service connections for wastewater service lines six (6) 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 11-3-16, “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.

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- (5) **Avoidance of Submerged Conditions:** Manholes shall not be placed in detention basins, drainage ditches, or areas subject to localized ponding. Placement of manholes in floodplains should be avoided if possible.

**(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. The access drive shall be free of obstructions and landscaping.

**(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 hinged, gasketed, and locking frame and cover assembly. The assembly shall be an “East Jordan Iron Works” ERGO or ERGO XL assembly. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge.

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## 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 storm water, 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.
- (8) **Maintenance Access:** Wastewater services shall be provided with a two-way cleanout outside and adjacent to the building being served and where there is a change in alignment of the service. Cleanouts shall be constructed as follows:
  - (a) No cleanouts shall be installed within the public right-of-way.
  - (b) Cleanouts shall be constructed of the same diameter pipe as the wastewater service.
  - (c) Cleanouts shall not be located in detention ponds, ditches, swales, or other areas of stormwater runoff or ponding.
  - (d) Cleanouts shall be fitted with a threaded watertight cap that prevents the inflow of stormwater or irrigation water.
  - (e) The cleanout shall allow maintenance access for cleaning and inspection in both the upstream and downstream direction.

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**(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 any of the following conditions exist:
  - (a) The service size is six 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) If the accessory structure contains no toilet and no bathtub or shower fixtures, the accessory structure is limited to the following plumbing fixtures:
    - (i) Sink (one fixture),
    - (ii) Clothes washer connection (one set),
    - (iii) Hose bib or sill cock (one fixture),
    - (iv) Floor drain (one fixture), and
    - (v) Interceptor (one fixture).
  - (b) If the accessory structure is proposed to have a sink and toilet, the accessory structure shall not contain any additional sinks or toilets nor a bathtub or shower fixture, shall not be used as a separate dwelling unit, may not be located on a property that can be subdivided into separate lots, and shall be limited to the following additional plumbing fixtures:



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- (i) Sink (one fixture),
    - (ii) Toilet (one fixture),
    - (iii) Floor drain (one fixture), and
    - (iv) Interceptor (one fixture).
  - (c) An approved detached accessory dwelling unit, as defined under Subsection 9-16-1(c), “General Definitions,” B.R.C. 1981, is not subject to this section’s plumbing fixture limitations.
  - (d) 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.

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**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

# CHAPTER 7

## STORMWATER DESIGN

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## **7.01 General**

### **(A) Intent**

The Stormwater Design Standards are intended to provide for a comprehensive and integrated stormwater utility system to convey and manage stormwaters in order to mitigate safety hazards and minimize property losses and disruption due to heavy storm runoff and flooding, maintain travel on public streets during storm events, enhance water quality of storm runoff by mitigating erosion, sediment and pollutant transport, control and manage increased runoff due to local development, establish effective long-term management of natural drainageways, and provide for ongoing and emergency maintenance of public stormwater systems. These standards are intended to prevent pollution and degradation of state waters.

The City is an operator of a Phase II Municipal Separate Storm Sewer System (MS4) and is required by the State of Colorado to hold a permit to discharge stormwater from its municipal separate storm sewer system to the waters of the State. The Stormwater Design Standards establish standards implementing the requirements of the MS4 Permit and Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981.

### **(B) Comprehensive Flood and Stormwater and Greenways Master Plans**

All improvements proposed to the City’s stormwater system shall conform with the goals, policies, and standards outlined in adopted Comprehensive Flood and Stormwater and Greenways Master Plans.

### **(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 will specify the standards to be applied to the design and construction of stormwater improvements and may refer to one or more of the references listed in the References Section of these Standards.

### **(D) Floodplains**

Where improvements are proposed within a designated 100-year floodplain, as defined on the current FEMA Flood Insurance Rate Map (FIRM) or floodplain mapping adopted by the City, an applicant for construction approval shall satisfy and comply with all applicable regulations and requirements as set forth in Chapter 9-3, “Overlay Districts,” B.R.C. 1981.

### **(E) Stormwater Quality and Erosion Control**

The USDCM, Volume 3, “Best Management Practices,” “Colorado Department of Transportation M-Standards, and/or City of Boulder, “Wetlands Protection Program Best Management Practices” manual shall be applied to address stormwater quality management and erosion control for all proposed projects and developments. An applicant for construction or development approval shall also satisfy and comply with all applicable regulations and requirements as set forth in Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981. All stormwater reports and plans shall include necessary analyses, mitigation measures, and improvements needed to meet these stormwater quality and erosion control standards.

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**(F) Wetlands Protection**

Where improvements are proposed within a delineated wetland or wetland buffer area, as defined under the City's wetland protection ordinance, an applicant for construction approval shall satisfy and comply with all applicable regulations and requirements as set forth in Section 9-3-9, "Stream, Wetlands, and Water Body Protection," B.R.C. 1981, including any necessary identification, analyses, avoidance and mitigation measures, and improvements needed to address wetlands protection requirements.

**(G) Streets**

The primary function of streets is for safe traffic movement; therefore, streets shall be designed and constructed to accommodate runoff and convey it to downstream drainage facilities in order to minimize its interference with traffic. When the stormwater runoff accumulation in the street exceeds allowable limits, storm sewers or other drainage facilities are required to collect and convey the excess runoff.

**(H) Irrigation Ditches and Laterals**

Where a project or development is proposed adjacent to or impacts an existing irrigation ditch, an applicant for construction approval shall meet the following standards:

- (1) No storm runoff shall be conveyed into an irrigation ditch or lateral without written approval and permission from the affected irrigation ditch company or lateral owner.
- (2) An adequate right-of-way or drainage easement for maintaining the affected irrigation ditch shall be dedicated to the City.
- (3) The irrigation ditch or lateral shall not be relocated, modified, or altered without written approval and permission from the affected irrigation ditch company or lateral owner.
- (4) The irrigation ditch or lateral shall not be used for the following purposes:
  - (a) Basin boundaries to eliminate the contribution of the upper basin area in the evaluation of runoff conditions. Irrigation ditches shall not be assumed to intercept stormwater runoff.
  - (b) Outfall points for new development where runoff into irrigation ditches and laterals has increased in flow rate or volume, or where historic runoff conditions have been changed, without written approval and permission from the affected irrigation ditch company or lateral owner.

**(I) Multiple Functions of Major Drainageways**

Boulder Creek's numerous tributaries are part of a comprehensive natural open drainageway system. These drainageways provide open corridors and serve multiple functions, including without limitation, stormwater drainage and flood conveyance, wetlands and water quality enhancement, environmental protection and preservation, open space and wildlife areas, and recreational activities and trail corridors. Stormwater improvements impacting these drainageways shall be designed and constructed to respect, restore and enhance these functions in order to maintain the creek corridor ecology, environment and aesthetic value of such drainageways.

**(J) Definitions**

The words defined in this subsection and used in this Chapter have the meanings established in

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this section unless the context clearly indicates otherwise:

*Applicable development site* means (1) any new development or redevelopment site resulting in land disturbance of greater than or equal to one acre, including a site that is less than one acre that is part of a larger common plan of development or sale that would disturb or has disturbed one acre or more, or (2) any development site for which a stormwater detention pond is required under these Standards.

*Common plan of development or sale* means a plan or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules in a contiguous area, within 1/4 mile, but remain related through such plan or sale.

*Construction activity* means an activity that disturbs the ground surface and associated activities that include, without limitation clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. Activities from initial ground breaking through final stabilization are construction activities regardless of ownership. Construction activities do not include routine maintenance to maintain the original line and grade, hydraulic capacity, or original purpose of a facility. Activities to conduct repairs that are not part of routine maintenance, activities for replacement, and activities for repaving where underlying or surrounding soil is exposed, cleared, graded, or excavated are all construction activities for the purposes of this chapter.

*Control measure* means an activity, practice, or structural control used to prevent or reduce the discharge of pollutants to waters of the State. The two categories of control measures are:

*Control measure for post-construction stormwater quality*, also referred to as a stormwater control measure (SCM), means a permanent device, practice, or method for removing, reducing, retarding, or preventing targeted stormwater runoff constituents, pollutants, and contaminants from reaching receiving waters.

*Control measures for erosion and sediment control* means a device, practice, or method implemented on a construction site to remove, reduce, retard, or prevent pollutants or pollutant-laden water from discharging off the site. These control measures may be structural (e.g., wattles/sediment control logs, silt fences, earthen dikes, drainage swales, sediment traps, subsurface drains, pipe slope drains, inlet protection, outlet protection, gabions, sediment basins, temporary vegetation, permanent vegetation, mulching, geotextiles, sod stabilization, slope roughening, maintaining existing vegetation, protection of trees, and preservation of mature vegetation) or non-structural (e.g., schedules of activities, prohibitions of practices, pollution prevention and educational practices, and maintenance procedures).

*Detention pond* means a structural control intended to store increased runoff from developed property and release this runoff at the historic rate that existed prior to development or redevelopment.

*LID technique* means low impact development technique.

*Low Impact Development (LID) technique* means a non-structural land development planning and site layout strategy intended to reduce stormwater volume, peak discharge, and pollutant load.

*MS4 Permit* means the Municipal Separate Storm Sewer System Phase II discharge permit issued by the Colorado Department of Public Health and Environment pursuant to Regulation 61, Colorado Permit Discharge System, 5 CCR 1002-61, and the Colorado Water Quality Control Act, C.R.S. § 25-8-101, *et seq.*, as that permit may be amended in the future.

*New development* means a vegetative or non-vegetative change in the existing land surface, including without limitation construction activities, compaction associated with stabilization of structures, road

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construction, construction or installation of a building or other structure, and creation of impervious surfaces, and land subdivision for a site that does not meet the definition of redevelopment.

*Receiving Pervious Area (RPA)* means a vegetated pervious area that receives stormwater from an impervious area, thus un-connecting the impervious area from directly discharging stormwater to a local stream, lake, or to the public stormwater utility system.

*Redevelopment* means the creation or addition of impervious area or paved surface on a site that is already substantially developed with 35% or more existing imperviousness, including without limitation expansion of a building footprint, addition or replacement of a structure, structural development, and construction or replacement of paved surface area.

*Stormwater utility system* means the municipal storm sewer system that includes without limitation the conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels, or storm drains) that discharge to state waters and is owned or operated by the City and designed or used for collecting or conveying stormwater, and is not a combined sewer or part of a publicly owned treatment works.

*Stormwater Quality Design Standard* means a performance metric from the MS4 Permit that must be demonstrated to be achieved to document compliance with City of Boulder stormwater requirements for applicable development sites. Stormwater Quality Design Standards are volume reduction, Water Quality Capture Volume (WQCV), pollutant removal, and constrained redevelopment site standards, as defined in Subsection 7.16(D).

*Treatment area* means a single drainage basin or group of drainage basins for which a proposed design completely satisfies a single Stormwater Quality Design Standard.

*Unconnected Impervious Area (UIA)* means an impervious area that discharges to a RPA and, therefore, does not discharge directly to a local stream, lake, or the stormwater utility system.

*Water Quality Capture Volume (WQCV)* means the volume equivalent to the runoff from an 80<sup>th</sup> percentile storm, meaning that 80 percent of the most frequently occurring storms are fully captured and treated and larger events are partially treated.

## 7.02 Conceptual Drainage Report and Stormwater Plan

### (A) General

- (1) If a project is determined to be of sufficient size or complexity, the Director may require the preparation of a Conceptual Drainage Report and Stormwater Plan by the Engineer to assess feasibility of stormwater utility system improvements. The purpose of the Conceptual Drainage Report and Stormwater Plan shall be to demonstrate that required stormwater utility system facilities can be accommodated on the development site and to identify and plan for impacts to neighboring properties and stormwater utility systems.
- (2) The Director reviews Conceptual Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.
- (3) Measured or calculated parameters provided in all submitted Conceptual Drainage Reports and Stormwater Plans shall be reported using the English System of Measurement unless Metric System units are the standard expression for the parameter.
  - (a) Land or surface area shall be reported in square feet (ft<sup>2</sup>, sf, or sq.ft.) for projects



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having a land disturbance area less than one acre and shall be reported to the nearest tenth of an acre (acre or ac.) for projects having a land disturbance of one acre or greater.

- (b) Water volume shall be provided in cubic feet (ft<sup>3</sup> or cu.ft.).
- (c) Soil volume shall be provided in cubic yards (yd<sup>3</sup> or cu.yd.).
- (d) Water discharge (also stated as flow rate or flow) shall be provided in cubic feet per second (ft<sup>3</sup>/s or cfs).
- (e) Infiltration rate shall be reported in inches per hour (in/hr).

**(B) Conceptual Drainage Report**

The Conceptual Drainage Report shall provide a response for each of the elements listed in the Preliminary Drainage Report narrative requirements, as set forth in Subsection 7.03(B) of these Standards, or if more data is necessary identify the data collection efforts necessary to complete the Preliminary Drainage Report.

**(C) Conceptual Stormwater Plan**

The Conceptual Stormwater Plan shall address each of the elements listed in the Preliminary Stormwater Plan requirements, sufficient to provide an overall drainage plan, as set forth in Subsection 7.03(C) of these Standards, or if more data is necessary identify the data collection efforts necessary to complete the Preliminary Stormwater Plan.

**7.03 Preliminary Drainage Report and Stormwater Plan****(A) General**

- (1) The Director may require the preparation of a Preliminary Drainage Report and Stormwater Plan by the Engineer. The Preliminary Drainage Report and Stormwater Plan will be used to assess the impacts and public improvement needs of any proposed project or development site. Approval of the Preliminary Drainage Report and Stormwater Plan shall not be construed as approval of specific design details.
- (2) The Director reviews Preliminary Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.
- (3) Measured or calculated parameters provided with the Preliminary Drainage Report and Stormwater Plan shall be consistent with Subsection 7.02(A)(3) of these Standards.

**(B) Preliminary Drainage Report**

The Preliminary Drainage Report shall define the proposed development site, describe existing conditions, and propose needed stormwater facilities to meet the requirements of these Standards. The Preliminary Drainage Report shall include, at a minimum, narratives addressing the items listed in this subsection except for those items not applicable to the proposed development site. The Preliminary Drainage Report shall include visual representations and/or refer to the Preliminary Stormwater Plan sheet with the corresponding content (see Subsection 7.03(C) of these Standards for Preliminary Stormwater Plan requirements). The Preliminary Drainage Report

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narrative shall include the following information:

- (1) **Cover Page:** Provide a cover page that includes the site name, site address, submittal and revision dates as applicable, site owner, and preparing Engineer.
- (2) **Site Description**
  - (a) Site Location Description
    - (i) County, city, township, range, section, and ¼ section.
    - (ii) Site vicinity and legal boundaries map.
    - (iii) Adjacent developments and associated land use.
    - (iv) Roadways located within or adjacent to the site.
  - (b) Property Description
    - (i) Site area and proposed area of disturbance in acres.
    - (ii) Existing and proposed site use.
    - (iii) Land surface (vegetation type, topography, slope, buildings, etc.)
    - (iv) Easements within or adjacent to the site.
  - (c) Drainage Description
    - (i) Major and minor drainageways.
    - (ii) Natural drainage features (e.g., streams, lakes, ponds, wetlands, and buffer areas).
    - (iii) Irrigation ditches.
    - (iv) Regulatory floodplain extents.
    - (v) Known drainage issues.
    - (vi) Hydrologic soil group map and description.
    - (vii) Geotechnical and groundwater site investigation results.
    - (viii) Preliminary Infiltration Feasibility Screening results and map (see Subsection 7.16(A) of these Standards).
- (3) **Drainage Basin Description**
  - (a) Major Drainage Basin
    - (i) General description of major drainage basin characteristics and flow patterns.
    - (ii) Flow conveyance from site to receiving major drainageway.
    - (iii) Reference to all applicable planning studies for the major drainageway and, if applicable, describe requirements of these plans for the development site.
    - (iv) Impact of site development on upstream and downstream properties.
    - (v) Impact of site development on downstream natural and constructed open channels and piped stormwater utility systems and the measures proposed to reduce or eliminate those impacts.

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- (b) Site Drainage Basin(s)
  - (i) Existing and proposed basin and sub-basin characteristics for the site, including land cover, area, flow patterns, and discharge points for each basin/sub-basin.
  - (ii) Acceptance and conveyance of off-site stormwater into and through the proposed development site.
  - (iii) Overview of all existing and proposed conveyance, detention, and water quality facilities, including rationale, for each basin/sub-basin.
- (4) **Drainage Design Criteria**
  - (a) Regulation Applicability
    - (i) Detention requirements (see Section 7.12 of these Standards).
    - (ii) Construction stormwater management requirements (see Section 7.13 of these Standards).
    - (iii) Post-construction stormwater quality requirements (see Section 7.15 of these Standards).
    - (iv) Stream, Wetland, and Waterbody Protection Requirements as set forth in Chapter 9-3, “Overlay Districts,” B.R.C. 1981.
    - (v) Other applicable criteria and permits.
  - (b) Site Planning and Constraints
    - (i) Description of previous drainage studies or master plans for the site and adjacent areas and influence on proposed stormwater utility system design.
    - (ii) Description of site constraints caused by structures, utilities, etc. and influence on proposed stormwater utility system design.
    - (iii) Description of Low Impact Development (LID) techniques utilized for stormwater management with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.14 of these Standards).
  - (c) Hydrologic and Hydraulic Criteria
    - (i) Design storm(s).
    - (ii) Runoff calculation methods.
    - (iii) Detention storage and discharge calculation method.
    - (iv) Velocity and capacity calculation method(s) for inlets and conveyances.
    - (v) Water surface profile and hydraulic grade line (HGL) calculation methods.
  - (d) Post-Construction Stormwater Quality Criteria
    - (i) Selected treatment approach and design standards (see Section 7.16 of these Standards).
- (5) **Stream, Wetland, and Waterbody Impacts**

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- (a) Description of floodplain impacts.
- (b) Required modification studies.
- (6) **Stormwater Conveyance Design**
  - (a) Description of proposed conveyance system.
  - (b) Conveyance path to major drainageway and capacity evaluation.
- (7) **Detention and Post-Construction Stormwater Quality Design**
  - (a) Description of each proposed facility (identifier, type, drainage area, size, treatment volumes, components, and function).
  - (b) Description of design compliance with detention and post-construction stormwater quality requirements with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.15 of these Standards).
- (8) **Conclusions**
  - (a) Drainage plan effectiveness.
  - (b) Compliance with requirements.
  - (c) Exclusions and variances.
- (9) **References:** Reference all standards, criteria, guidance documents, master plans, and technical reports used.
- (10) **Appendices**
  - (a) Completed form(s) documenting post-construction water quality compliance (Section 7.15 of these Standards).
  - (b) Completed form(s) documenting low impact development approaches (Section 7.14 of these Standards).

**(C) Preliminary Stormwater Plan**

The purpose of the Preliminary Stormwater Plan is to provide visual representations of existing and proposed site conditions to support the Preliminary Drainage Report narrative. The Preliminary Stormwater Plan shall be included with the Preliminary Drainage Report, submitted as a single PDF document. All Preliminary Stormwater Plan sheets shall be prepared on 24-inch by 36-inch paper with appropriate scale ranges. The Preliminary Stormwater Plan shall include plan sheets addressing, at a minimum, the following items, except for those items not applicable to the proposed development site:

- (1) **Overall Drainage Plan**
  - (a) Title block, legend, north arrow, and scale.
  - (b) Existing topographic contours.
  - (c) Property boundary.
  - (d) Major drainage basin boundaries with area, design point, and existing flow rate labels.
  - (e) Drainage flow arrows depicting flow patterns to, from, and within the site.

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- (f) Existing stormwater detention and water quality facility boundaries.
  - (g) Easement boundaries.
  - (h) Existing waterways (streams, lakes/ponds, wetlands, and irrigation facilities).
  - (i) Land cover (vegetation and impervious surfaces).
  - (j) Key map depicting extents of detailed drainage plan sheets.
- (2) **Detailed Drainage Plan/s**
- (a) Title block, legend, north arrow, and scale (scale range of 1 inch = 20 feet to 1 inch = 100 feet).
  - (b) Existing (screened) and proposed (solid) topographic contours (2 feet max interval).
  - (c) Location and elevation of all waterways, regulated buffer areas, and 100-year floodplain.
  - (d) Property, right-of-way, and easement boundaries.
  - (e) Drainage basin/sub-basin boundaries with area, design point, and flow/release rate labels.
  - (f) Proposed outfall points and conveyance facilities to major drainageway with design point and flow/release rate labels.
  - (g) Existing and proposed structure boundaries.
  - (h) Existing and proposed stormwater conveyance facilities with size, slope, and material designation (storm sewers, culverts, open channels, inlets, and discharge points).
  - (i) Existing and proposed stormwater detention and water quality facilities with drainage area, surface area, side slope/wall, and component labels.

## 7.04 Final Drainage Report and Stormwater Plan

### (A) General

- (1) The Director may require the preparation of a Final Drainage Report and Stormwater Plan by the Engineer. The report and plan will be used to assess the impacts and public improvements needs of any proposed project or development site.
- (2) The Director reviews Final Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.
- (3) Measured or calculated parameters provided with the Final Drainage Report and Stormwater Plan shall be consistent with Subsection 7.02(A)(3) of these Standards.

### (B) Final Drainage Report

The Final Drainage Report shall describe the to-be-constructed drainage conditions for the site. The Final Drainage Report shall include, at a minimum, all required narratives of the Preliminary Drainage Report, as set forth in Subsection 7.03(B) of these Standards, and the items listed in this

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subsection, except for those items not applicable to the proposed development site. The Final Drainage Report shall include visual representations and/or refer to the Final Stormwater Plan (Subsection 7.04(C) of these Standards) or construction drawings (Subsection 7.04(D) of these Standards) with the corresponding content.

The Final Drainage Report shall include a cover page, following the format set forth in Subsection 7.03(B) of these Standards and a certification page with the following statement prepared by a Professional Engineer licensed in the State of Colorado:

I hereby certify that this Final Drainage Report and Final Stormwater Plan for [Site Name] was prepared by me, or under my direct supervision, in accordance with sound engineering practice and all applicable state, federal and local regulations, including the provisions of the City of Boulder Design and Construction Standards.

Registered Professional Engineer

(Affix Seal)

State of Colorado No. \_\_\_\_\_

The Final Drainage Report shall include the following information:

- (1) **Site Description:** Updated narratives for all items listed in Subsection 7.03(B)(2) of these Standards.
- (2) **Drainage Basin Description:** Updated narratives for all items listed in Subsection 7.03(B)(3) of these Standards.
- (3) **Drainage Design Criteria:** Updated narratives for all items listed in Subsection 7.03(B)(4) of these Standards.
- (4) **Stream, Wetland, and Waterbody Impacts**
  - (a) Description of floodplain impacts.
  - (b) Required modification studies.
  - (c) Applicable permits obtained.
- (5) **Stormwater Conveyance Design**
  - (a) Description of proposed conveyance system.
  - (b) Conveyance path to major drainageway and capacity evaluation.
  - (c) Storm sewer, culvert, and inlet design (location, size, tributary area, and peak flows).
  - (d) Open channel design (location, size, tributary area, and peak flows).
  - (e) Outfall design (location, peak flows, and energy dissipation).
  - (f) Street drainage (see Section 7.10 of these Standards).
  - (g) Easement requirements.
  - (h) Maintenance requirements.
- (6) **Detention and Post-Construction Stormwater Quality Design**
  - (a) Description of each proposed facility (identifier, type, drainage area, size, treatment volumes, components, and function).
  - (b) Description of design compliance with detention and post-construction stormwater

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quality requirements with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.15).

- (c) Inlet design (description of pretreatment measures and energy dissipation).
  - (d) Basin and outlet design (storage volumes and release rates, including overflow spillway).
  - (e) Description of vegetation coverage and planting plan.
  - (f) Description of filter media selection and underdrain configuration.
  - (g) Easement requirements.
  - (h) Description of maintenance requirements with reference to Inspection and Maintenance Guide included as an appendix (see Section 7.18 of these Standards).
- (7) **Conclusions:** Updated narratives for all items listed in Subsection 7.03(B)(8) of these Standards.
- (8) **References:** Updated references for all items listed in Subsection 7.03(B)(9) of these Standards.
- (9) **Appendices**
- (a) Completed form(s) documenting post-construction water quality compliance (Section 7.15 of these Standards).
  - (b) Completed form(s) documenting low impact development approaches (Section 7.14 of these Standards).
  - (c) Inspection and Maintenance Guide (Section 7.18 of these Standards).
  - (d) Hydrologic calculations.
  - (e) Hydraulic calculations.
  - (f) Stormwater conveyance calculations.
  - (g) Detention and permanent water quality calculations.
  - (h) Critical reference information copied to create standalone document.

**(C) Final Stormwater Plan**

The Final Stormwater Plan shall detail the to-be-constructed drainage conditions for the site and follow the submittal requirements of the Preliminary Stormwater Plan, as set forth in Subsection 7.03(C) of these Standards.

- (1) **Overall Drainage Plan:** Updated plan depicting all items listed in Subsection 7.03(C)(1) of these Standards.
- (2) **Detailed Drainage Plan(s):** Updated plan(s) depicting all items listed in Subsection 7.03(C)(2) of these Standards.

**(D) Stormwater Construction Plans and Drawings**

Construction Plans and Drawings shall be submitted for review in conjunction with the Final Drainage Report. Preparation of Construction Plans and Drawings shall be consistent with Section

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1.03 of these Standards. The following elements pertaining to site stormwater design shall, at a minimum, be included in the Construction Plans and Drawings.

(1) **Stormwater Conveyance Construction Drawings**

- (a) Plan drawing(s) depicting all proposed storm sewer and open channel conveyances following the requirements of Subsection 1.03(E)(2) of these Standards.
- (b) Profile drawing(s) depicting all proposed storm sewer and open channel conveyances following the requirements of Subsection 1.03(E)(3) of these Standards.

(2) **Detention and Post-Construction Stormwater Quality Construction Drawings**

- (a) Plan drawing(s) depicting each proposed detention and post-construction stormwater quality facility following the requirements of Subsection 1.3(E)(2) of these Standards and, at a minimum, the following components, if proposed:
  - (i) Inlet and outlet structure locations and energy dissipation measures, including emergency spillways,
  - (ii) Proposed contours for treatment surface area and side slopes/walls,
  - (iii) Facility components (e.g. pretreatment, micropool, underdrain, etc.), and,
  - (iv) Vegetative cover.
- (b) Profile and/or cross-sectional drawing(s) depicting each proposed detention and post-construction stormwater quality facility following the requirements of Subsection 1.3(E)(3) of these Standards and, at a minimum, the following components, if proposed:
  - (i) Inlet and outlet structure inverts,
  - (ii) Treatment area and side slope/wall surface elevations,
  - (iii) Filter media components and depths, and
  - (iv) Facility component elevations (e.g. pretreatment, micropool, underdrain, etc.).
- (c) Detail drawing/s depicting each unique detention and post-construction stormwater quality facility component following the requirements of Subsection 1.3(E)(4) of these Standards and, at a minimum for the following components, if proposed:
  - (i) Pretreatment,
  - (ii) Outlet structure,
  - (iii) Underdrain, and
  - (iv) Other unique components.



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## 7.05 Hydrology

### (A) General

The methodologies and design standards for determining rainfall and runoff conditions for any development project are based on the standards prescribed in the USDCM, with local revisions as prescribed in these Standards.

### (B) Storm Frequency

**Table 7-1, “Design Storm Frequencies,” indicates initial and major design storm frequencies to be used in the stormwater design or any project or development: Table 7-1: Design Storm Frequencies**

Land Use	Initial Storm	Major Storm
Single Family Residential	2 Year	100 Year
All Other Uses	5 Year	100 Year
Detention Ponding Design	10 Year	100 Year

### (C) Rainfall

The rainfall intensities to be used in computing runoff shall be determined using the USDCM, Volume 1 and the Boulder station of the NOAA Atlas 14 Point Precipitation Frequency Estimates.

### (D) Runoff

- (1) **CUHP Method:** For basins larger than 160 acres, the Colorado Urban Hydrograph Procedure (CUHP) method shall be applied in conformance with the USDCM using local rainfall conditions.
- (2) **Rational Method:** For all basins smaller than 160 acres, the rational method, as described in the USDCM, shall be used to calculate runoff for both the initial and major storms.
- (3) **Runoff Coefficient:** The runoff coefficient to be used with the rational method may be determined based on either zoning/land use classifications or types of surface classifications prescribed in the USDCM. A composite runoff coefficient may be calculated using land areas impacted by specific classifications.
- (4) **Intensity:** The rainfall intensity used in the rational method shall be calculated per the USDCM using the NOAA Atlas 14 rainfall depth-duration-frequency data.

## 7.06 Materials and Installation

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

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**7.07 Open Drainageways****(A) General**

- (1) **Designated Major Drainageways:** The following list identifies designated major drainageways in the City for primary stormwater conveyance:

<b>Designated Major Drainageways</b>		
Bear Canyon Creek	Four Mile Canyon Creek	South Boulder Creek
Bluebell Canyon Creek	Goose Creek	Sunshine Canyon Creek
Boulder Creek	Gregory Canyon Creek	Two Mile Canyon Creek
Boulder Slough	King's Gulch	Viele Channel
Elmer's Two Mile Creek	Skunk Canyon Creek	Wonderland Creek
Dry Creek Ditch No. 2		

- (2) **Design Approach:** Design of public improvements for local drainageways shall ensure opportunities to provide for open conveyance corridors that may serve multiple functions, including without limitation, stormwater drainage and flood conveyance, wetlands and water quality enhancement, environmental protection and preservation, open space and wildlife areas, and recreational activities and trail corridors. Stormwater improvements impacting local drainageways shall be designed and constructed to respect, restore and enhance these functions in order to maintain a natural ecology, environment and aesthetic value of such drainageways.

**(B) Drainageway Types**

- (1) **Definition:** Drainageways in the City are defined as natural or artificial channels as follows:
- (a) Natural channels include naturally developed creeks, streams and thalwegs, which have been geologically created through the erosion process over time. Boulder Creek is considered a natural channel.
  - (b) Artificial channels include those that are designed, constructed, or developed by human effort. Artificial channels may be unlined or lined (where non-erosive conditions for unlined design cannot be met). Artificial channels also include irrigation ditches, roadside ditches, and drainage swales.
- (2) **Natural Drainageways**
- (a) The hydraulic properties of natural drainageways vary along each stream reach and are to be maintained in a naturally occurring and environmental form. Natural drainageways typically have mild slopes, are reasonably stable, and are not in a state of serious degradation or aggradation.
  - (b) Where unstable conditions are created through the introduction of urbanized stormwater runoff, which alters the nature of flow peaks and volumes and may cause erosion, mitigation measures may be proposed in the natural drainageway to maintain a stabilized and naturally occurring condition. A detailed analysis will be required for all development proposals affecting natural drainageways in order to identify the impacts of changes in flow characteristics, erosion and sedimentation, wetland losses and water quality conditions.

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- (c) Analyses of natural drainageways shall be provided for each project or development application affecting the drainageway. When performed, the Engineer is to prepare cross sections of the drainageway, define water surface profile for the existing and proposed minor and major storm events, investigate the bed and bank material to determine erosion and sediment transport tendencies, identify impacts on the naturally occurring conditions and ecology and study the bank slope and stream bed stability. An analysis shall include engineering calculations to ensure that supercritical flow conditions do not result from proposed project or development activities. Natural channel improvements that would cause supercritical flow conditions shall not be permitted.

(3) **Unlined Artificial Drainageways**

- (a) Unlined artificial drainageways provide improved channel bottoms that are covered with wetlands, grass, or other vegetation, and may be used where naturally occurring drainageways are not present or as proposed under an adopted stormwater master plan. Designs for unlined drainageways shall comply with these Standards and the USDCM.
- (b) Unlined artificial drainageways are to provide conditions for slower flow velocities, reduced flow energy, increased flow retardance, and increased channel storage. The wetlands, grass, or other vegetation along stream beds and banks are intended to stabilize the channel, consolidate the soil mass of the bed, mitigate erosion, and control soil particles transport along the drainageway. Design of these improvements shall also consider opportunities for accommodating multiple functions along the drainageway, providing for a natural ecology, environment and aesthetic value.
- (c) Structural measures such as rock linings used for revetments, drop structures, scour aprons, or trickle channels may be approved as a means of controlling erosion for unlined artificial drainageways.

(4) **Lined Artificial Channels**

- (a) Where conditions for natural or unlined artificial drainageways are not available, including situations where limited right-of-way, supercritical velocities, or extremely erosive conditions exist, lined artificial channels may be constructed, subject to conformance with adopted stormwater master plans and the review, discretion, and approval of the City. Designs for lined artificial channels shall comply with these Standards and the USDCM. Lined artificial channels typically include rock-lined, grouted rip-rap, and concrete-lined stream beds and banks.
- (b) Rock-lined (rip-rapped) or grouted rip-rap channels are generally discouraged but are much preferred to concrete lined channels. A rock-lined or grouted rip-rap channel may typically be steeper and narrower, due to the higher friction factors of rock, and may include steeper banks or side slopes. The lining shall be capable of withstanding all hydraulic and hydrodynamic forces which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining, and erode unlined areas, especially for the supercritical flow conditions. If project constraints suggest the use of a rock-lined or grouted rip-rap channels, the Engineer shall present the justification and design concept to the City for consideration.
- (c) Concrete-lined channels are least desirable and may only be approved under severely restrictive circumstances. The concrete lining shall withstand all hydraulic and hydrodynamic forces which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining, and erode unlined areas, especially for the supercritical flow conditions. If project constraints suggest the use of a concrete lined channel, the

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Engineer shall present the justification and design concept, including a discussion of non-concrete-lined alternatives and why they are not feasible, to the City for consideration.

- (5) **Roadside Ditches and Drainage Swales:** Roadside ditches and drainage swales are open drainage systems that are not part of the major drainageway system and are used to convey minor and major stormwater runoff in projects and developments and along rural-type streets. The design of these drainage swales is similar to the design of unlined artificial drainageways on a reduced scale.

### (C) Drainageway Flow Computation

Uniform flow and critical flow computations for drainageways shall be performed in accordance with the USDCM.

### (D) Drainageway Design Standards

The design standards for drainageways involve a wide range of options intended to create safe, environmental, multipurpose, and aesthetic improvements. The following planning, evaluation, and design standards shall be applied:

- (1) **Natural Drainageways**
- (a) The drainageway and overbank areas necessary to pass 100-year storm runoff are to be reserved for stormwater purposes.
  - (b) Water surface profiles shall be defined to identify floodplain conditions.
  - (c) Flood fringe filling along naturally defined drainageways, which reduces drainageway flood storage capacity and increases downstream runoff peaks, is to be avoided unless approved as part of an adopted City stormwater master plan.
  - (d) Roughness factors (n), which are representative of unmaintained channel conditions, shall be used for the analysis of water surface profiles and to determine velocity limitations
  - (e) The Director may allow the placement of erosion control structures, such as drop structures, check dams, revetments, and scour aprons, where they may be necessary to maintain stabilized drainageway conditions, subject to the design requirement that the drainageway conditions remain as near natural as possible.
  - (f) Design parameters applicable to artificial drainageways, including without limitation, freeboard height, bed and bank slopes, and curvature, may not necessarily apply to natural drainageways. Significant site planning advantages may be realized by maintaining the natural drainageway, without structured improvements, by allowing drainageway overtopping onto reserved flooding areas designated as open space and wetlands and maintaining irregular waterway features that naturally control flow conditions, improve water quality, preserve stream ecology and enhance community and aesthetic values.
- (2) **Unlined Artificial Drainageways:** Where not specified in these Standards, the design of unlined artificial drainageways shall conform with the USDCM.
- (a) **Longitudinal Channel Slopes:** Channel slopes are dictated by velocity and Froude number requirements. Where natural slopes exceed design slopes, drop structures shall be provided to maintain design velocities and Froude numbers. Normally, grass lined channels will have slopes of 0.2 percent to 0.6 percent.

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- (b) Side Slopes: Maximum side slopes shall be no steeper than 4:1, unless specific drainageway conditions warrant steeper side slopes as determined by the Director.
  - (c) Depth: Maximum depth of flow, outside of any low flow or trickle channel, shall be 5 feet. Critical depth shall be determined for both the major and initial storms in order to ensure that supercritical flows do not occur.
  - (d) Bottom Width: Bottom width shall be consistent with the maximum depth and velocity standards, and shall accommodate low flows and the development of wetland and water quality enhancement systems.
  - (e) Horizontal Curvature: The center line curvature shall have a design radius twice the top width for design flow conditions, but not less than 50 feet.
  - (f) Roughness Coefficient: Manning's "n," as adjusted by channel bottom conditions outlined in the USDCM, shall be applied.
  - (g) Cross Sections: Drainageway cross-sections may be almost any type suitable to the location and to the environmental conditions, subject to conformance with these Standards. Cross sections simulating naturally occurring drainageway corridors are strongly recommended.
  - (h) Channel Bottom: The channel bottom is to be designed to convey low flows and enhance water quality in conformance with environmental concerns and regulations. Acceptable channel bottoms, subject to City approval for specific site applications, may include without limitation wetlands or natural vegetation and low flow channels conveying a minimum 3 percent of the design storm flow.
  - (i) Easement/Right-of-Way: The minimum drainageway easement/right of way width shall include the bank to bank dimension of the drainageway section, including the normal flow depth and freeboard areas, and adequate maintenance access.
  - (j) Maintenance Access: Maintenance access shall be provided along the entire length of all major drainageways and shall connect with a public street to allow access by medium and large scale construction and maintenance equipment. An access road shall be at least 12 feet wide and designed to adequately support the loads of expected maintenance equipment. The maintenance road may be shared as a greenway trail, subject to approval by the City.
  - (k) Water Surface Profiles: Water surface profiles shall be determined for all drainageway designs using standard backwater methods, taking into consideration losses due to velocity changes produced by changing channel sections, drops, waterway openings, or obstructions. The water surface and energy gradient profiles shall be shown on the construction plans.
- (3) **Lined Artificial Channels:** Where allowed by the City, lined artificial channels shall be designed in accordance with these Standards and the USDCM, including the following:
- (a) Easement/Right-of-Way: The minimum drainageway easement/right of way width shall include the bank to bank dimension of the drainageway section, including the normal flow depth and freeboard areas, and adequate maintenance access.
  - (b) Maintenance Access: Maintenance access shall be provided along the entire length of all major drainageways and shall connect with a public street to allow access by medium and large scale construction and maintenance equipment. An access road shall be at least 12 feet wide and designed to adequately support the loads of expected maintenance equipment. The maintenance road may be shared as a greenway trail, subject to approval by the City.

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- (c) **Water Surface Profiles:** Water surface profiles shall be determined for all drainageway designs using standard backwater methods, taking into consideration losses due to velocity changes produced by changing channel sections, drops, waterway openings, or obstructions. The water surface and energy gradient profiles shall be shown on the construction plans.
- (4) **Roadside Ditches and Drainage Swales:** The design of roadside ditches and drainage swales is similar to the standards for unlined channels with modifications for application to minor storm drainage. The standards are as follows:
  - (a) **Capacity:** Roadside ditches and drainage swales shall have a minimum capacity for the 10-year design storm.
  - (b) **Flow Velocity:** The maximum velocity for the design storm runoff peak is not to exceed 5 feet per second. The Froude number shall be less than 0.8.
  - (c) **Longitudinal Slope:** The slope shall be limited by flow velocity of the design storm. Swale widening or check drops may be required to control velocities.
  - (d) **Freeboard:** Freeboard above the design flow depth shall be at least 6 inches.
  - (e) **Curvature:** The minimum radius of curvature shall be 25 feet.
  - (f) **Roughness Coefficient:** Manning's "n," as adjusted by channel bottom conditions outlined in the USDCM, shall be applied.
  - (g) **Depth:** A drainage swale shall be at least 1 foot deep. A maximum depth for drainage swales shall not exceed 5 feet and shall be dictated by the design flow and cross-sectional standards.
  - (h) **Side Slopes:** Side slopes shall be no greater than 3:1; however, 4:1 side slopes or flatter are recommended for landscaped areas and to enhance water quality.
  - (i) **Driveway Culverts:** Along roadside ditches, driveway culverts shall be sized to pass the design storm flow without overtopping the driveway, having a minimum culvert diameter size of 18 inches in height with at least 6 inches of cover. Flared end sections or headwalls with appropriate erosion protection shall be provided. Given the depth constraints along roadside ditches, more than one culvert may be required to pass the design flow. Maintenance of all driveway culverts shall be the responsibility of the property owner served by the driveway.
  - (j) **Discharge Points:** Roadside ditches and open drainage swales shall discharge directly to the receiving water and shall not discharge to a piped storm sewer system for conveyance to the receiving water body. If discharge to a piped storm sewer system is necessary, a sediment sump and debris grate shall be provided immediately upstream of the discharge point to the storm sewer system. The grate shall be hinged to allow for maintenance access.
  - (k) **Major Drainage Capacity**
    - (i) The major drainage (100-year storm) capacity of roadside ditches is restricted by the maximum flow depth allowed at the street crown or by the ground surface at the edge of the street right-of-way.
    - (ii) The major drainage capacity of drainage swales is restricted to the maximum flow that can be passed without inundation to and damage of downstream properties.

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**(E) Hydraulic Structures**

- (1) **Where Required:** Hydraulic structures are used in open stormwater systems to control the flow of the runoff. The energy associated with flowing water has the potential to create damage to the drainage system, especially in the form of erosion. Hydraulic structures are intended to control the energy of stormwater flow and minimize the damage potential of stormwater runoff. Typical hydraulic structures may include without limitation the following:
  - (a) Channel drop and check structures,
  - (b) Rip rap and rock linings,
  - (c) Energy dissipaters and stilling basins,
  - (d) Channel rundowns,
  - (e) Bridges and culverts, and
  - (f) Irrigation ditch crossings.
- (2) **Design Standards:** The standards to be used in the design of hydraulic structures shall be in accordance with these Standards and the USDCM.

**7.08 Storm Sewers****(A) System Design**

- (1) **Where Required:** Storm sewers shall be required when the other parts of the minor stormwater system, primarily streets, curbs, gutters, and roadside ditches, no longer have the capacity for additional runoff in the initial storm event.
- (2) **Gravity Flow Conditions:** Storm sewers shall be designed for gravity (open) flow conditions, using a “Manning’s” roughness coefficient from Table 7-2, “Manning’s “n” for Storm Sewers.”

**Table 7-2: Manning’s “n” for Storm Sewers**

Sewer Type	Manning’s “n”
Concrete	0.015
Plastic	0.013
Corrugated Metal	0.013

- (3) **Flow Depth:** Storm sewers are to be designed to carry peak flows at full pipe depth.
- (4) **Pressure Flow Prohibited:** Pressurized surcharged or depressed (inverted siphon) stormwater mains are prohibited in the City’s stormwater system.
- (5) **Continuous Drainage System:** All stormwater drainage facilities shall be a component of a connected and continuous drainage system that does not end in a sump condition and does not discharge to irrigation ditches.

**(B) Location**

All storm sewer mains shall be installed in public rights-of-way or easements, in conformance with Section 4.04, “Utilities Easements,” of these Standards.

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**(C) Depth**

The cover for all storm sewer mains shall be at least 18 inches deep, measured from the top of pipe to the final surface grade, and shall be capable of withstanding AASHTO HS-20 highway traffic loadings.

**(D) Size**

Storm sewer mains shall be at least 18 inches in diameter, and storm sewer laterals shall be at least 15 inches in diameter.

**(E) Slope**

- (1) **Minimum and Maximum:** Minimum allowable slope shall provide flow velocities of at least 2-feet per second and maximum allowable slope shall provide flow velocities no greater than 10 feet per second during peak flow conditions.
- (2) **Constant Slope:** All storm sewer mains shall be laid at a constant slope between manholes.

**(F) Alignment**

- (1) **Straight Alignment:** All storm sewer mains shall be laid in a straight alignment between manholes.
- (2) **Curvilinear Mains Prohibited:** Curvilinear storm sewer mains shall not be allowed.

**(G) Separations and Crossings**

All collection main separations and crossings of other City utilities shall be designed in compliance with Section 4.06, "Separation of Utilities," of these Standards.

**(H) Taps**

All taps approved onto an existing storm sewer main shall be made by the City of Boulder Utilities Division and shall be paid for by the applicant. A manhole shall be provided at all taps 6 inches in diameter or larger. Where taps are made to inlet boxes a manhole is not required.

**(I) Ground Water Barriers**

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

**(J) Extensions**

Where required as part of any adopted City master plan or to satisfy stormwater design requirements as part of any proposed project or development, storm sewer mains shall be extended downstream to the major drainageway, and upstream to the far edge of the property being served, to ensure perpetuation of the stormwater collection system.



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**(K) Manholes**

- (1) **Location:** Manholes shall be provided at each storm sewer main connection with another storm sewer main or lateral line, at all changes in grade, slope, alignment and pipe size, at all tap connections 6 inches in diameter or larger, or every 400 feet at a minimum.
- (2) **Size**
  - (a) Table 7-3, “Required Manhole Sizes,” indicates required manhole sizes.

**Table 7-3: Required Manhole Sizes**

Sewer Main Diameter	Manhole Diameter
12 - 18 Inches	4 Feet
21 - 42 Inches	5 Feet
48 - 54 Inches	6 Feet
60 Inches and Larger	Special Detail

- (b) **Special Provisions:** Larger manhole diameters or a junction structure may be required when sewer alignments are not straight through or more than one sewer line passes through a manhole.
- (3) **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, minimum 12 feet in width, and shall be capable of supporting maintenance vehicles weighing up to 14 tons.
- (4) **Covers**
  - (a) Manholes that are not located within a public street, alley or driveway section shall be installed with a hinged, gasketed, and locking frame and cover assembly. The assembly shall be an “East Jordan Iron Works” ERGO or ERGO XL assembly.
  - (b) Manholes located within the 100-year floodplain, or in a location where runoff may accumulate and pond, shall be installed with a hinged, gasketed, and locking frame and cover assembly. The assembly shall be an “East Jordan Iron Works” ERGO or ERGO XL assembly.

**(L) Hydraulic Design**

- (1) **Rational Method:** The rational method, as described in the USDCM, shall be used for the sizing of storm sewer systems.
- (2) **Hydraulic and Energy Grade Line, and Design Losses:** Storm sewers shall be designed to convey the initial storm flow peaks without surcharging the sewer, and the final energy grade line shall be at or below the proposed ground surface. To ensure that this objective is achieved, the hydraulic and energy grade line shall be calculated by accounting for pipe friction losses and pipe form losses as provided in the USDCM.

**7.09 Inlets****(A) Specifications**

- (1) **Design:** Except as modified in these Standards, storm sewer inlet design shall conform with the standards in the USDCM.

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- (2) **Required:** Storm inlets shall be provided at:
- (a) Areas where street capacity (e.g., allowable design flow spread) would be exceeded without them,
  - (b) At sumps or areas prone to ponding,
  - (c) At median breaks (e.g., where traffic turns across the median),
  - (d) Upstream of speed mitigation and pedestrian structures that would otherwise cause a damming of stormwater runoff,
  - (e) Where nuisance flows would otherwise cross a driving lane, and
  - (f) Where curb and gutter ends.
- (3) **Inlet Classification:** Inlets are classified as a sump or continuous grade condition. Sump inlets are inlets located in a low spot or submerged condition. Continuous grade inlets are inlets located along a continuous grade curb and gutter section where bypass flows may occur, and not in a low point.
- (4) **Standard Inlets:** Table 7-4, “Standard Inlets,” indicates the standard inlets permitted for use in the City.

**Table 7-4: Standard Inlets**

Inlet Type	Drainage Condition	Permitted Use	Percentage of Theoretical Capacity Allowed
Curb Opening Inlet - Type “R”	Continuous Grade or Sump	All Curb and Gutter Street Types	80% (5 Foot Length) 85% (10 Foot Length) 90% (15 Foot Length)
Combination (Curb Opening/Grated) Inlet	Continuous Grade or Sump	All Curb and Gutter Street Types	66%
Grated Area Inlet	Sump	Parking Lots, Alleys	60%

- (5) **Reduction Factors:** In order to account for inlet capacity reductions caused by debris plugging, pavement overlaying, parked vehicles, and other blockage factors, inlet design shall be based on the “percentage of theoretical capacity allowed” as outlined in Table 7-4, “Standard Inlets,” in these Standards.
- (6) **Inlet Spacing**
- (a) Spacing of storm inlets is dependent upon traffic requirements, contributing land use, street slope and distance to the nearest outfall system. The recommended sizing and spacing of the inlets is based upon the interception rate of 70 percent to 80 percent, which has been found to be more efficient than spacing using 100 percent interception rate.
  - (b) Using recommended inlet spacing, only the most downstream inlet is designed to intercept 100 percent of the flow. In addition to recommended interception rates, considerable improvements in overall inlet system efficiency can be achieved if the inlets are located in the sumps created by street intersections.
- (7) **Inlet Grates:** All inlet grates located in a street, alley, parking lot travel lane, bike path, or sidewalk shall utilize a vaned grate on the inlet such as the Denver Type 16 inlet.

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**7.10 Street Drainage****(A) Function of Streets in the Drainage System**

- (1) **Primary Function of Streets:** The primary function of streets is for safe traffic movement; therefore, streets shall be designed and constructed to accommodate runoff and convey it to downstream drainage facilities in order to minimize its interference with traffic. Streets therefore provide an integral part of the stormwater system and are intended to transport local storm runoff within reasonable limits. When the stormwater runoff accumulation in the street exceeds allowable limits, storm sewers or other drainage facilities are required to collect and convey the excess runoff.
- (2) **Continuous Drainage System:** All stormwater drainage facilities for streets shall be a component of a connected and continuous drainage system that does not end in a sump condition and does not discharge to irrigation ditches.

**(B) Street Classification and Allowable Runoff Encroachment**

- (1) **Street Classification:** City streets are classified according to the average daily traffic carried and travel routes they provide. Higher category streets, such as arterials and collectors, are required to provide a greater level of access and through travel for emergency purposes during major storm events than lower category streets.
- (2) **Allowable Runoff Encroachment:** A stormwater drainage system (storm sewer or open drainageway) shall be provided where the gutter runoff encroachment reaches the limits outlined in Table 7-5, “Allowable Street Drainage Encroachment.”

**Table 7-5: Allowable Street Drainage Encroachment**

Street Classification	Minor Storm Maximum Encroachment	Major Storm Maximum Encroachment
Residential and Local Streets	No curb overtopping. Flow may spread to street crown.	Depth at flowline shall not exceed 18 inches.
Collector Streets	No curb overtopping. A minimum one travel lane width shall remain free of drainage encroachment.	Depth at flowline shall not exceed 18 inches.
Arterial Streets	No curb overtopping. A minimum two travel lanes width shall remain free of drainage encroachment.	Depth at crown shall not exceed 6 inches. Depth at flowline shall not exceed 18 inches.
Freeways	No flow encroachment is allowed.	Refer to CDOT Roadway Design Manual

**NOTE:** Flow encroachment shall not extend beyond property lines.

**(C) Hydraulic Street Capacity**

- (1) **Allowable Capacity - Minor Storm:** The allowable minor storm capacity of each street section is to be calculated using the modified Manning's formula as described in the USDCM.
- (2) **Allowable Capacity - Major Storm:** The allowable street capacity for the major storm shall be calculated using Manning's formula, dividing the street cross section into the pavement area and sidewalk/grass area, and computing individual flow contributions. An “n” value of 0.016 for pavement and 0.035 for the sidewalk/grass area shall be used.

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**(D) Cross Street Flow**

The standards outlined in Table 7-6, “Allowable Cross Street Flow,” of these Standards shall be used for allowable cross-street flow, where flow passes from one side of the street to the other. The allowable cross-street flow shall be determined using the methods prescribed in the USDCM.

**Table 7-6: Allowable Cross Street Flow**

Street Classification	Minor Storm Runoff	Major Storm Runoff
Residential and Local Street	Maximum Depth of 6 Inches in Cross Pan	Maximum Depth of 18 Inches Above Flowline
Collector Street	Where Allowed, Maximum Depth of 6 Inches in Cross Pan	Maximum Depth of 18 Inches Above Flowline
Arterial	Not Allowed	Maximum Depth of 6 Inches Over Street Crown

**7.11 Culverts****(A) System Design**

- (1) **Required:** Culverts shall be provided for the conveyance of stormwater runoff under a roadway, railroad, driveway, or other crossings of an open drainage system (such as a drainageway or roadside swale). The size, shape, and type of culvert crossings shall be based on the projected runoff volumes, as well as existing topographic conditions. All culvert designs are subject to approval by the Director.
- (2) **Culvert Types:** Typical culvert types include circular, elliptical, or arch pipe sections, and reinforced concrete box culverts.

**(B) Hydraulic Design**

All culverts shall be designed in accordance with the USDCM. All culvert designs are to include an analysis to determine whether inlet or outlet control conditions govern for both major and minor storm runoff conditions.

**(C) Structural Design**

The structural design of culverts shall conform to accepted structural engineering practices, the Colorado Department of Transportation design standards and standard specifications, any methods and criteria recommended by the manufacturer for a specific culvert type, and for conditions found at the construction site. As a minimum, all culverts shall be designed to withstand an AASHTO HS-20 traffic loading.

**(D) Specifications**

- (1) **Size**
  - (a) Culvert design size shall be based upon the following:
    - (i) Runoff volumes for the appropriate design storm.
    - (ii) Required capacity based on roadway classification and allowable street overtopping, as prescribed in Section 7.10, “Street Drainage,” of these Standards

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- (b) Culverts shall be at least 18 inches in diameter or height.

(2) **Inlet and Outlet Sections**

- (a) All culverts shall be designed with headwalls and wingwalls, or flared end sections at the inlet and outlet. Flared end sections are allowed only on pipe culverts with diameters of 42 inches (or equivalent) or less.
- (b) Erosion protection such as rip-rap, boulder energy dissipators, or adequate vegetation, shall be provided at the inlet or outlet where required to mitigate potential scouring or erosive flow conditions. The Engineer shall propose the erosion protection to be used, subject to approval by the Director.

(3) **Slope and Velocity**

- (a) Culvert slopes shall be designed so that neither silting nor excessive velocities resulting in scour can occur. The minimum design velocity for minor storm conditions shall be 2 feet per second, to provide for self-cleansing of the culvert.
- (b) The maximum culvert velocity is dictated by the channel conditions at the outlet, and the amount of erosion protection or energy dissipation that can be provided to prevent scour or damage.

(4) **Allowable Headwater**

- (a) The maximum headwater / diameter (HW/D) ratio for the 100-year design flows shall be 1.5, and 1.0 for the 10-year design flow. These HW/D ratios are to be applied to culverts at street crossings and should not be applied to outlets from detention ponds or private driveways.
- (b) Ponding above the top of a culvert is not permitted if such ponding could potentially cause property or roadway damage, culvert clogging, saturation of critical embankments, detrimental debris deposition, erosion, or inundation of existing or future utilities, structures, or buildings.

(5) **Trash Racks**

- (a) The installation of a trash rack over a culvert entrance shall be provided as required by the Director where there exists the potential for debris clogging of the culvert or where there is a safety hazard concern for the possibility of people (especially children) being carried into the culvert.
- (b) Trash racks shall be designed to maintain adequate culvert hydraulics, considering the potential for debris buildup and blockage which may render the culvert ineffective. Careful design considerations are to be applied, including without limitation application of the following standards:
  - (i) **Materials:** All trash racks shall be constructed with smooth steep pipe, having an outside diameter of at least 1 ¼ inches. Trash rack ends and bracing shall be constructed with steel angle sections. All trash rack components shall have a corrosion protective finish.
  - (ii) **Design:** Trash racks shall be designed without cross-braces, to minimize debris clogging, and be able to withstand the full hydraulic load of a completely plugged trichroic based on the highest anticipated depth of ponding. The trash rack shall be hinged and removable for maintenance purposes.
  - (iii) **Bar Spacing:** Bar spacing shall provide a maximum clear opening of 6

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inches. The longitudinal slope of the trash rack shall be no steeper than 3:1, horizontal to vertical. The entire trash rack shall have a clear opening at least three times the culvert opening area.

- (c) **Hydraulics:** Use the following equation to compute hydraulic losses through trash racks:

$$H_T = 0.11 * (TV/D)^2 * (\sin A)$$

Where:  $H_T$  = Head Loss through the Trichroic (feet)

T = Thickness of Trichroic Bar (inches)

V = Velocity normal to Trichroic (fps)

D = Center-to-Center Spacing of Bars (inches)

A = Angle of Inclination of Trichroic with Horizontal

The velocity normal to the trichroic shall be computed considering the rack to be 50 percent plugged.

## 7.12 Detention

### (A) System Design

- (1) **Intent:** Detention ponding facilities are intended to store increased runoff from developed property and release this runoff at the historic rate that existed prior to development or redevelopment. By providing detention ponding, increased runoff impacts on downstream facilities may be controlled and minimized to reduce potential damages and the need for greatly expanded stormwater conveyance facilities.
- (2) **Requirements:** Detention ponding for stormwater shall be provided for all new development or redevelopment where the runoff coefficient for the site increased unless one of the following conditions are met:
  - (a) The project site is a single-family lot or a single-family lot split into two single-family lots that is not part of a larger development.
  - (b) Runoff for the project site for the initial and major storm events from the entire tributary basin can be conveyed directly to the major drainage system without adverse impact on upstream, surrounding, or downstream properties and facilities and stormwater detention to meet water quality mitigation measures is not required.
- (3) **Maintenance:** The property owner shall be responsible for maintaining stormwater detention facilities.
- (4) **Easement:** All stormwater detention facilities shall be located in a public easement. The easement shall grant to the City at a no charge a permanent right to inspect, maintain, and reconstruct the stormwater detention facilities. The easement shall be granted on a form provided by the Director. No owner of land or other applicant shall obtain a Final Drainage Plan, unless the owner first grants to the City the easement for all stormwater detention facilities. The City shall have no obligation to the property owner to inspect, maintain, or reconstruct the stormwater facilities.

### (B) Design Frequency, Hydraulic Design, and Storage Requirements

- (1) **Design Storms:** Detention ponds shall be designed in accordance with USDCM, Volume 2, Chapter 12.

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- (2) **Storage Volume:** The storage volume of runoff to be detained on-site shall be sized to contain 110 percent of the difference between the historic runoff and the initial and major storm runoff, as defined in Table 7-1, projected for the ultimate developed conditions of the entire parcel and tributary basin to be developed or redeveloped.
- (3) **Undetained Site Releases:** On project sites where runoff from portions of the site cannot be detained due to topography or site conditions, free release of runoff may be approved with compensating detention storage design subject to the following conditions:
  - (a) Total maximum runoff from the entire parcel and tributary basin to be developed or redeveloped shall not exceed the historic runoff,
  - (b) Release rates from the detention ponds shall be reduced by the developed runoff rate from the undetained drainage area,
  - (c) The undetained drainage area may not exceed five percent of the entire parcel and tributary basin to be developed or redeveloped, and
  - (d) The release rate from the undetained area may not exceed 25 percent of the historic release rate from the entire parcel and tributary basin to be developed or redeveloped.

**(C) Detention Pond Design**

Except where inconsistent with the requirements in this Subsection 7.12(C), detention pond design shall follow all applicable criteria established in the USDCM, Volume 2 and Volume 3.

- (1) **Surface Ponding Required:** All detention ponds shall be provided as open, surface grade improvements. Underground, enclosed, or roof top detention ponds shall not be permitted unless unusual site conditions and adequate detention performance and maintenance conditions are approved by the Director.
- (2) **Location:** Detention ponds shall be located in open, pervious landscaped areas to enhance site drainage and soil percolation, and to improve water quality.
- (3) **Side Slopes:** Side slopes for detention ponds shall be designed to provide for ease of maintenance and access. Landscaped side slopes are not to exceed 4:1, and vertical or steep walls used as side slopes are to be constructed of durable natural materials, such as rock or timber, with heights no greater than 30 inches to reduce safety hazards.
- (4) **Pond Bottoms:** Pond bottoms are to be pervious and sloped to prevent the collection of standing water, unless a permanent pond or wetland bottom is provided for water quality enhancements. The use of combined water quality and detention facilities shall follow criteria specification provided in the USDCM, Volume 3, Chapter 12 and applicable water quality treatment approach criteria as specified in Section 7.17 of these Standards. Hard-lined trickle channels are not to be constructed in detention ponds unless approved by the Director to address specific drainage problems or safety and environmental hazards.
- (5) **Overflow Release Feature:** All detention ponds shall include an overflow release feature to spill during storm events larger than the major design storm or when release outlets fail. This feature shall be designed to release overflows in a direction and manner that will not adversely affect properties downstream of the detention pond.

**7.13 Construction Stormwater Management****(A) Intent**

This section implements requirements of Section 11-5-6, “Stormwater Quality Management for Land

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Development,” B.R.C. 1981, for construction activities and sets standards for stormwater management plans (SWMP) and erosion control plans, their implementation, and the inspection and maintenance of control measures for erosion and sediment control.

**(B) Stormwater Management Plan Requirements**

A SWMP shall include a narrative and erosion control plans that identify the construction activities and their associated potential pollutant sources and address the selection, installation, implementation, and maintenance of control measures for erosion and sediment control that reduce the potential for the pollutant sources to enter the stormwater utility system or waters of the State. Control measures for erosion and sediment control shall prevent pollution and degradation of waters of the State. The SWMP shall include and be prepared, updated, and implemented consistent with the following requirements:

- (1) **General Standards:** Control measures for erosion and sediment control shall be constructed and maintained in accordance with the SWMP, the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE, and the USDCM, Volume 3.
- (2) **Preparation Standards:** The SWMP shall be prepared in accordance with the requirements of the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE and USDCM, Volume 3. The SWMP shall be prepared in accordance with methods, procedures, and practices that are based on scientific facts, reflect best industry practices and standards, are appropriate for the conditions and pollutant source, and provide appropriate solutions to meet the SWMP requirements of this section, including practice based and numeric effluent limits. The SWMP shall include the following elements:
  - (a) Protection for adjacent properties (including public right-of-way) from erosion and/or sediment deposition.
  - (b) Protection for public streets from the deposit of sediment from runoff or vehicles tracking mud.
  - (c) Stabilization for all disturbed areas as defined in the USDCM and CDPS requirements.
  - (d) Protection for all storm sewer inlets from the entry of sediment-laden water.
  - (e) Protection from encroachment by construction equipment, vehicles, and foot traffic into stormwater infiltration measures to eliminate the possibility of soil compaction and vegetation damage.
  - (f) Long-term stability of cut and fill slopes and the successful establishment of permanent vegetative cover on exposed soil.
  - (g) Selection, installation, implementation, and maintenance of control measures for erosion and sediment control.
- (3) **Control Measures for Erosion and Sediment Control and Potential Pollutant Sources:** All control measures for erosion and sediment control shall meet the following requirements:
  - (a) Control measures for erosion and sediment control shall be installed and made operational prior to the start of construction activity. The control measures for erosion and sediment control shall prevent potential pollutants from leaving the



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construction site during each phase of construction and shall be continued through final stabilization. Structural control measures for erosion and sediment control shall be maintained in operational condition through final stabilization.

- (b) Control measures for erosion and sediment control shall be selected, designed, installed, implemented, and maintained to prevent potential pollutants such as, but not limited to, sediment, construction site waste, trash, discarded building materials, concrete truck washout, chemicals, sanitary waste, and contaminated soils in discharges to the stormwater utility system from leaving the construction site.
- (c) The SWMP shall address pollutant sources associated with the following activities (if part of the construction activity), and control measures for erosion and sediment control shall be implemented if the source is determined to be present on the site:
  - (i) Land disturbance and soil storage,
  - (ii) Vehicle tracking,
  - (iii) Loading and unloading operations,
  - (iv) Outdoor storage of construction site materials, building materials, fertilizers, and chemicals,
  - (v) Bulk material storage,
  - (vi) Vehicle and equipment maintenance and fueling,
  - (vii) Significant dust or particulate-generating processes,
  - (viii) Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, and/or oils,
  - (ix) Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment,
  - (x) Dedicated asphalt and concrete batch plants,
  - (xi) Other areas or operations where spills can occur, and
  - (xii) Other non-stormwater discharges including construction dewatering not covered under the CDPS General Permit for Construction Dewatering Discharges and wash water that may contribute pollutants to the stormwater utility system.
- (d) The SWMP shall include control measures for erosion and sediment control detail drawings for both installation and maintenance. Controls measures should be consistent with USDCM, Volume 3 or Colorado Department of Transportation M & S (Miscellaneous and Signage) Standard Plans.
- (4) **Protection of Control Measures for Post-Construction Water Quality:** Requirements for the design and construction of control measures for post-construction water quality are provided in Sections 7.14 through 7.18 of these Standards. The SWMP shall provide provisions to protect the water quality functions of these control measures for post-construction water quality (SCMs) during construction as listed below:
  - (a) Any area consisting of native, un-compacted soil where a SCM will be installed shall be protected from vegetation removal and encroachment by heavy equipment, vehicles, and foot traffic prior to grading and construction. If the area, prior to grading and construction, consists of previously compacted or fill soil, protection

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from encroachment shall be provided after the soil has been amended or otherwise rehabilitated into an un-compacted condition to promote infiltration of stormwater. Methods and controls for protection of these areas shall be indicated in the SWMP.

- (b) The use of the SCM area for construction or maintenance materials stockpiles or for storage of construction equipment, wastes, or pollutants is prohibited after construction of the SCM has commenced.
- (5) **Erosion Control Plan:** The SWMP shall include an Erosion Control Plan. Erosion Control Plan drawings shall locate and identify all structural and non-structural control measures for erosion and sediment control for the proposed construction activities. The Erosion Control Plan shall be prepared in accordance with the requirements of the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE and include the elements listed in form(s) provided by the Director. Erosion Control Plans shall include, at a minimum, three site maps illustrating the initial, interim, and final phases of construction and their associated control measures for erosion and sediment control.

The following Standard Notes shall also be included on Erosion Control Plan(s):

- (a) **Temporary Erosion Controls:** All temporary erosion control measures for erosion and sediment control shall be installed before any construction activities take place.
- (b) **Sediment Controls:** Control measures for erosion and sediment control shall be implemented to prevent the release of sediment from construction sites. Vehicle tracking of sediment shall not be allowed to enter the stormwater utility system or waters of the State. Sediment shall not be tracked onto public streets and, if so, shall be immediately removed.
- (c) **Water Quality Impacts:** Stormwater discharges from construction activities shall not cause or threaten to cause pollution, contamination, or degradation of waters of the State.
- (d) **Waste Controls.** Solid waste, industrial waste, yard waste, and any other pollutants or waste on any construction site shall be controlled using control measures. Waste and/or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waste that may blow, wash, or otherwise be released from the site is prohibited. Sanitary waste facilities shall be provided and maintained by the owner or contractor.
- (e) **Concrete Waste:** Ready-mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying it, shall be contained with appropriate control measures and ultimately removed for proper disposal. Release of these materials is prohibited.
- (f) **Chemical Storage:** Bulk storage structures for petroleum products and other chemicals shall have adequate protection so as to contain all spills and prevent any spilled material from entering the stormwater utility system or waters of the State.
- (g) **Surface Cover Timing:** Cover shall be applied within 14 days to inactive soil stockpiles and shall be maintained for stockpiles that are proposed to remain in place longer than 30 calendar days.
- (h) **Project Phasing:** All earth disturbances shall be designed, constructed, and completed to limit the exposed area of any disturbed land to the shortest possible period of time.

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- (i) Dust Controls: Techniques shall be used to prevent dust, sediment, or debris from blowing off the site.
- (j) Maintenance: Any damage or required maintenance to temporary and permanent controls measures shall be repaired or replaced as soon as possible, immediately in most cases.
- (k) Removal: All control measures for erosion and sediment control shall be removed and disposed within 30 days after final site stabilization is achieved or after the temporary measures are no longer needed, whichever occurs first.
- (l) Responsibility: The erosion control permittee shall be responsible for continued compliance with the requirements of Section 7.13 of the City's Design and Construction Standards during construction activity on the site.

**(C) Inspection and Maintenance Requirements**

The erosion control permittee shall be responsible for implementation of the SWMP or, if no SWMP is required, the Erosion Control Plan during construction, including inspection and maintenance of the control measures for erosion and sediment control in the approved SWMP and/or Erosion Control Plan. Prior to commencement of work, the erosion control permittee shall ensure that all general contractors, subcontractors, and utility agencies obtain a copy of and comply with the SWMP and/or Erosion Control Plan. The erosion control permittee shall amend the SWMP and/or Erosion Control Plan when site conditions change. The erosion control permittee shall keep the SWMP and/or Erosion Control Plan on site and shall implement and update the SWMP and/or Erosion Control Plan throughout construction and final stabilization of the site in accordance with the following requirements:

- (1) If no SWMP is required, the erosion control permittee shall update the Erosion Control Plan to show currently implemented control measures for erosion and sediment control and installation dates.
- (2) If a SWMP is required:
  - (a) An initial site inspection by the Director is required prior to commencing construction.
  - (b) The erosion control permittee shall amend the SWMP whenever there is a change in design, construction, operation, or maintenance that affects the potential for discharge of pollutants to the stormwater utility system or receiving waters, or if the SWMP proves to be ineffective in controlling pollutants in stormwater discharges associated with construction activities.
  - (c) The erosion control permittee shall inspect all control measures for erosion and sediment control per the frequency outlined in the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE for the site. Inspections of control measures for erosion and sediment control shall be conducted by an individual who has successfully completed formal training in erosion and sediment control by an organization acceptable to the Director. The erosion control permittee shall provide a certification of successful completion of such training to the Director upon request.
  - (d) The erosion control permittee shall maintain records of inspection on site with the SWMP. Inspection records shall be available at the site at all times. The erosion control permittee shall make the inspection records immediately available to the Director upon request.

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## 7.14 Land Development Planning Using LID Techniques

### (A) Intent

All new development and redevelopment shall reduce pollutant impacts of the development site on receiving waters and reduce or control stormwater volumes by mimicking natural hydraulic conditions using LID techniques. LID techniques seek to minimize impervious areas and protect and create well-draining vegetated areas that promote infiltration and natural hydrologic processes thereby reducing stormwater runoff and pollutant quantities.

### (B) Requirements for All Developments

- (1) LID techniques shall be implemented for all new development and redevelopment consistent with the standards in this section.
- (2) Compliance with the requirement to implement LID techniques, including the investigation and analysis of LID techniques and an explanation of the implementation choices made, shall be documented in the Preliminary and Final Drainage Reports when such reports are required. Otherwise, compliance shall be demonstrated in building permit construction documents, on form(s) as provided by the Director, submitted as part of the building permit application.

### (C) LID Techniques

LID techniques shall be chosen and applied following the principles summarized in this subsection. Additional guidance on employing LID techniques is provided in USDCM, Volume 3, Chapter 1. The following LID techniques shall be investigated and implemented to the maximum extent practicable:

- (1) **Conserve Existing Amenities:** Planning efforts shall account for and, where practicable, preserve or restore existing site features that naturally retain stormwater on site, including vegetated areas, high infiltrating soils, and natural surface drainage patterns, such as meadows and trees.
- (2) **Minimize Impacts:** Planning efforts shall account for and minimize, where practicable, land disturbance, impervious surface addition, and soil compaction. This may include removing unnecessary impervious areas, minimizing driveway and sidewalk widths, and sequencing construction to minimize compacted areas.
- (3) **Minimize Directly Connected Impervious Areas (MDCIA):** Planning efforts shall account for and minimize impervious areas, such as rooftops and pavement, that directly drain to the stormwater utility system or a local stream without prior stormwater control. This may include using or integrating receiving pervious areas into the site landscape, such as vegetated swales and buffers. Where practicable, site drainage patterns shall be designed to promote sheet flow to vegetated area and roof downspouts shall be disconnected from direct discharge to the storm sewer. Receiving pervious areas shall be designed to slow runoff and promote infiltration.

## 7.15 Post-Construction Stormwater Quality Requirements

### (A) Intent

All new development and redevelopment shall reduce the pollutant impacts of the development site

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on receiving waters. All applicable development sites shall implement post-construction stormwater quality management practices.

**(B) Applicable Development Sites**

- (1) **Applicable Development Site:** Applicable development sites are required to implement control measures for post-construction stormwater quality in accordance with the requirements of Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981, and this section, unless the Director has waived the applicable development site requirements pursuant to Subsection 7.15(B)(2) of these Standards.
- (2) **Waiver:** The Director may waive the requirements for applicable development sites in this section if the applicant demonstrates that the requirement of paragraph (a) of this Subsection 7.15(B)(2) is met and that none of the circumstances described in Subsection 7.15(B)(2)(b)(i) through (vi) exist:
  - (a) One or more of the following criteria is met:
    - (i) **Pavement Management Sites:** The project proposes the rehabilitation, maintenance, and reconstruction of roadway pavement, which includes roadway resurfacing, mill and overlay, white topping, black topping, curb and gutter replacement, concrete panel replacement, and pothole repair. The purpose of the project must be to provide additional years of service life and optimize service and safety. The project must be limited to the repair and replacement of pavement in a manner that does not result in an increased impervious area, and the infrastructure must not substantially change. The types of projects that meet these criteria include day-to-day maintenance activities, rehabilitation, and reconstruction of pavement. “Roadways” include roads and bridges that are improved, designed, or ordinarily used for vehicular travel and contiguous areas improved, designed, or ordinarily used for pedestrian or bicycle traffic, drainage for the roadway, and/or parking along the roadway. Areas primarily used for parking or access to parking are not roadways, and do not meet these criteria;
    - (ii) **Roadway Redevelopment:** The project is the redevelopment of existing roadway and the project (1) adds less than one acre of paved area per mile of roadway to an existing roadway or (2) does not add more than 8.25 feet of paved width at any location to the existing roadway;
    - (iii) **Existing Roadway Areas:** The project is the redevelopment of existing roadway where the project does not increase the width of the original roadway to two times or more on average. Under this criterion, the applicable development site requirements may not be waived for the entire roadway project but only for the area of the existing roadway. The area of the added new roadway shall be considered an applicable development site;
    - (iv) **Aboveground and Underground Utilities:** The project is the installation or maintenance of underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity. The types of projects that meet these criteria include, but are not limited to, activities to install, replace, or maintain utilities under roadways or other paved areas that return the surface to the same condition;

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- (v) Large Lot Single Family Residential Projects: The project involves single-family residential lots greater than or equal to 2.5 acres in size per dwelling, with a total lot impervious area of less than 10 percent, and that are not part of a common plan of development,
  - (vi) Land Disturbance Only Projects: The project involves land disturbance to undeveloped land (land with no structures, such as buildings, and no pavement), and the land will remain undeveloped during and after the disturbance;
  - (vii) Stream Stabilization Projects: The project is a stream stabilization project; or
  - (viii) Sidewalk, Bicycle and Multi-Use Paths: The project adds, modifies, or maintains public sidewalk, bicycle path or multi-use path. Bike lanes that are a part of a roadway do not meet this criterion.
- (b) The Director may not waive the requirements for applicable development sites of this section if any of the following circumstances are present:
- (i) Brownfield: The proposed project is located on a site that is considered a brownfield or is otherwise known or believed to have pollutants in the soil or on the ground that, if discharged from the property in stormwater or groundwater, may cause harm to the general public or the environment;
  - (ii) TMDL: The proposed site will, after development, discharge stormwater to a waterbody that is included on the most recent State of Colorado Department of Public Health and Environment §303(d) List of Water-Quality-Limited Segments Requiring TMDLs or for which a Total Maximum Daily Load (TMDL) is in place;
  - (iii) Wetlands: The proposed site will, after development, discharge stormwater to a delineated wetland or wetland buffer area as defined in Chapter 9-3, “Overlay Districts,” B.R.C. 1981;
  - (iv) History: A history of flooding or drainage problems is known to exist in, or downstream of, the drainage basin where the site is located, whether documented or undocumented;
  - (v) Master Plan: A City-approved stormwater master plan indicates a need for more stringent regulation of stormwater in the watershed where the proposed project is located in order to avoid, or alleviate, any flood, drainage, or pollution problems; or
  - (vi) Exacerbate Problems: There is reason to believe that construction of the proposed project may further exacerbate existing flood or drainage problems.
- (c) Evidence supporting the waiver pursuant to the criteria of this section shall be provided on forms provided by the Director. The Director may require additional documentation to support the waiver request.
- (d) In granting a waiver, the Director may impose specific conditions on the approval of the waiver necessary to ensure that the criteria in this section are, and will remain, satisfied.

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**(C) Requirements**

Applicable development sites are subject to the following requirements:

- (1) **Stormwater Quality Design Standard Compliance:** Each drainage basin or collection of drainage basins (treatment area) associated with an applicable development site shall meet one of the following Stormwater Quality Design Standards:
  - (a) **Runoff Reduction Standard:** Control measures for post-construction stormwater quality (SCMs) are selected, designed, and constructed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 60% of what the calculated Water Quality Capture Volume (WQCV) would be if all impervious area for the applicable development site discharged without infiltration.  
  
None of the treatment area may be excluded when using the Runoff Reduction Standard.
  - (b) **Water Quality Capture Volume Standard:** SCMs are selected, designed, and constructed to provide treatment and/or infiltration of the runoff from the entire treatment area for the 80<sup>th</sup> percentile, 0.6-inch storm event. Evaluation of minimum drain time shall be based on the pollutant removal mechanism and functionality of the SCM(s) implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the SCM (e.g., wetland vegetation).  
  
Up to 20 percent, not to exceed one acre, of the treatment area may be excluded when using the WQCV Standard if the Engineer demonstrates that it is not practicable to capture runoff or implement a separate SCM before runoff drains to an offsite discharge point.
  - (c) **Pollutant Removal Standard:** SCMs are selected, designed, and constructed to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 milligrams per liter (mg/L) or less from the entire treatment area for the 80<sup>th</sup> percentile, 0.6-inch storm event.  
  
Up to 20 percent, not to exceed one acre, of the treatment area may be excluded when using the Pollutant Removal Standard if it is demonstrated that it is not practicable to capture runoff or implement a separate SCM before runoff drains to an offsite discharge point.
  - (d) **Constrained Redevelopment Site Standard:** Applicable development sites having an existing impervious area greater than 35 percent and a proposed impervious area greater than 75 percent that can demonstrate the above design standards cannot be practicably met shall meet one of the following standards:
    - (i) **Constrained Runoff Reduction Standard:** SCMs are selected, designed, and constructed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 30 percent of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration.
    - (ii) **Constrained WQCV Standard:** SCMs are selected, designed, and constructed to provide treatment and/or infiltration of the runoff from at least 50 percent of the treatment area, including at least 50 percent of the impervious area, for the 80<sup>th</sup> percentile, 0.6-inch storm event. Evaluation of minimum drain time shall be based on the pollutant removal mechanism

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and functionality of the SCM(s) implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the SCM (e.g., wetland vegetation).

- (iii) **Constrained Pollutant Removal Standard:** SCMs are selected, designed, and constructed to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less for at least 50 percent of the treatment area, including at least 50 percent of the impervious area, for the 80<sup>th</sup> percentile, 0.6-inch storm event.
- (2) **Required Treatment Approach:** The selection of a required treatment approach shall be determined considering site constraints and infiltration feasibility following the procedure established in Section 7.16 of these Standards.
- (3) **Compliance Documentation Required:** The selected treatment approach and the rationale for such approach selection shall be documented on form(s) as provided by the Director. The form(s) and any supporting data, maps, charts, or calculations shall be provided as part of the Preliminary and Final Drainage Reports.
- (4) **Pretreatment Required:** Pretreatment devices shall be provided for all SCMs to reduce the inflow of trash, debris, and coarse sediment into the SCM. Allowed forms of pretreatment are grass buffers, grass swales, forebays, and inlet sumps. The Director may approve other pretreatment controls if the Director finds the proposed design adequately reduces the inflow of trash, debris and coarse sediment into the SCM.
- (5) **Irrigation Plan Required:** Provisions shall be made to provide water to vegetated SCMs after vegetation installation and in accordance with the Final Drainage Report and as needed to maintain the health of the vegetation. The owner of the SCMs shall be responsible to replace vegetation that is damaged, dead, or otherwise shows signs of poor health to ensure the proper operation of the control measure. The use of native plants in SCMs and other vegetated areas is strongly encouraged as such plants are best suited for local seasonal and climatic conditions.
- (6) **Easement:** All SCMs shall be located in a public easement. The easement shall grant to the City at a no charge a permanent right to inspect, maintain, and reconstruct the SCMs. The easement shall be granted on a form provided by the Director. No owner of land or other applicant shall obtain a Final Drainage Plan, unless the owner first grants to the City the easement for all SCMs.

## 7.16 Post-Construction Stormwater Quality Treatment Approach

### (A) Selection and Design of SCMs

The Engineer for an applicable development site shall apply the SCMs that best address pollutants of concerns and can be implemented on the development site. Infiltration of rainfall and stormwater using volume reduction/green infrastructure SCMs is the preferred treatment approach because it most closely mimics the natural hydrology of undeveloped land and reduces the volume of stormwater that is discharged into the stormwater utility system and to local streams. Therefore, non-structural LID techniques, Receiving Pervious Areas (RPAs), and infiltration-based SCMs shall be used to the degree practicable whenever it is determined that infiltration is feasible. In contrast, the removal of pollutants using underground SCMs is the least desirable treatment approach due to concerns about the practicality and effectiveness of long-term SCM maintenance and the ability of these designs to address pollutants of concern. As a result, the pollutant removal design standard is only allowed when all other treatment approaches have been demonstrated to not

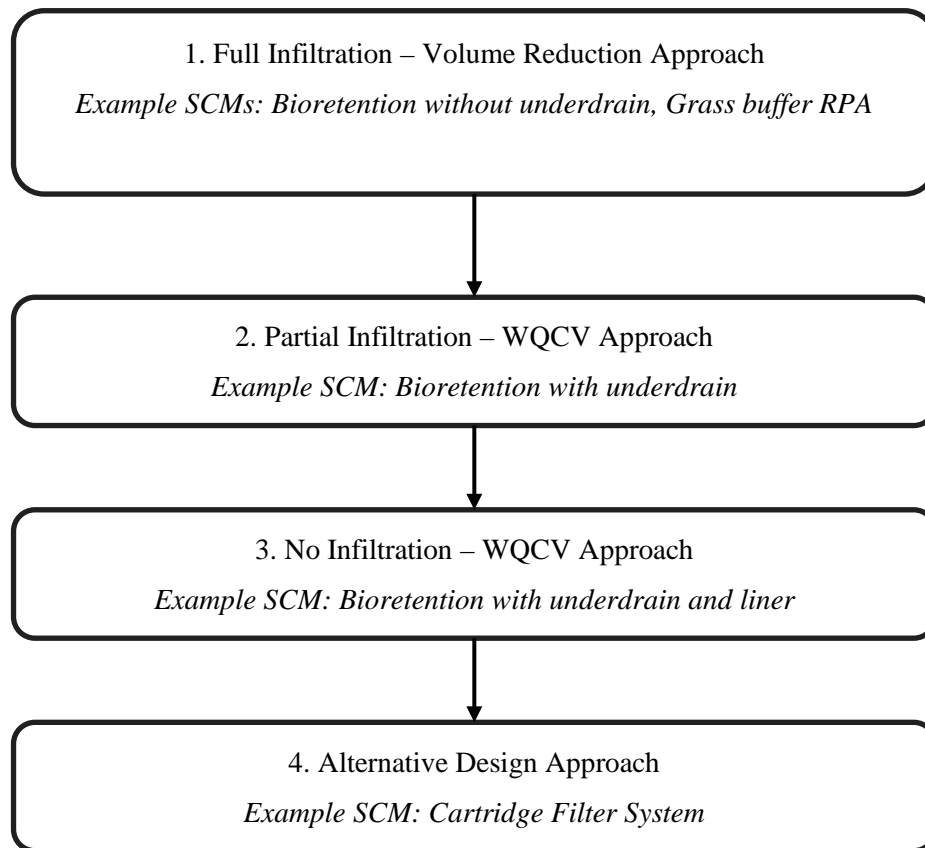


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be feasible.

This subsection summarizes the required procedure and supporting criteria for the selection and design of SCMs on applicable development sites, which are established in the following subsections of this section:

- (1) **Preliminary Infiltration Feasibility Screening:** Site conditions shall be documented prior to SCM design to support selection of an appropriate water quality treatment approach.
- (2) **Treatment Approach Selection:** Selection of an appropriate SCM shall be based on the feasibility of onsite infiltration. The required treatment approach is selected based on the hierarchy provided in Figure 7-1. The purpose of this hierarchy is to promote the use of infiltration using green infrastructure as the preferred approach to permanent stormwater quality management.



**Figure 7-1: Water Quality Treatment Approach Hierarchy**

- (3) **Treatment Approach Design Criteria:** Upon selection of a treatment approach, the required design standard and criteria described in Subsection 7.16(D) of these Standards shall be followed to design and document SCM performance.
- (4) **Soil and Infiltration Test Requirements:** The necessity of soil and infiltration testing is dependent on the treatment approach and SCM type. Subsection 7.16.(E) of these Standards explains soil and infiltration testing required to satisfy the Treatment Approach Design Criteria.

## **(B) Preliminary Infiltration Feasibility Screening**

The Engineer shall investigate the site conditions to determine the treatment approach and the

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Stormwater Quality Design Standards that will be applied to each treatment area. The preliminary infiltration feasibility screening shall be conducted as soon as possible in the design process. The preliminary infiltration feasibility screening does not require field infiltration testing, soil borings, and other detailed tests; however, if the full infiltration treatment approach is indicated to be feasible through this screening process, additional field testing may be required as described in Subsection 7.16(E) of these Standards. The preliminary infiltration feasibility screening shall meet the following requirements:

- (1) Preliminary infiltration feasibility screening shall be conducted for each treatment area associated with the applicable development site prior to development of the Preliminary Drainage Report.
- (2) The Engineer shall create hydrologic soil group (HSG) maps for each treatment area. Soil gradation assessments or field infiltration testing may be used to confirm HSG mapping or determine infiltration parameters for fill materials.
- (3) The Engineer shall assess the following limitations to infiltration for each treatment area. If one of the following factors is determined to limit infiltration feasibility, documentation shall be provided with Preliminary and Final Drainage Reports:
  - (a) Insufficient hydrologic storage capacity of the underlying soil attributable to shallow bedrock, hardpan layer, seasonal high-water table, or similar subsurface conditions. Underlying soil conditions are not a limitation for consideration of Unconnected Impervious Areas (UIA) to RPA.
  - (b) The potential for groundwater contamination resulting from known or suspected soil contamination or from a proposed land use that is incompatible with the use of infiltration practices (e.g., a concrete batch plant or materials storage and loading site) or similar conditions.
  - (c) Close proximity of SCM locations to drinking water wells or groundwater protection areas.
  - (d) Limited or no suitable area for infiltration attributable to regulatory requirements for the proposed applicable development site, including building set-back or build-to requirements; location or area requirements for rights-of-way, parking, and driveways; floodplain regulations; or other state or local regulatory conditions.
  - (e) Limited suitable area for infiltration attributable to the location of existing structures, pavement, utilities, or similar features that will remain; contractive or expansive soils in close proximity to buildings; or the location or extent of steep slopes, springs, seeps, wetlands, trees, or other natural features that will not or cannot be altered as a result of land development.
  - (f) Close proximity to historical or archeological sites that could be damaged or otherwise negatively impacted by infiltration.
  - (g) Flooding conditions that can be exacerbated by, or limit the function of, an infiltration-based SCM, including a history of frequent flooding at proposed SCM locations or a history of wet or flooded foundations, crawl spaces, or basements on or in close proximity to the applicable development site or its proposed SCM locations, and where these conditions will not be corrected by the proposed project.
- (4) Infiltration feasibility screening results shall be documented in the Preliminary and Final Drainage Reports.

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**(C) Treatment Approach Selection**

The treatment approach is the methodology that will be used to design a SCM, or collection of SCMs, to meet the required Stormwater Quality Design Standard. Four treatment approaches are described in Table 7-7, “Treatment Approach Selection Criteria,” and correspond with criteria requirements presented in Subsection 7.16(D) of these Standards. A single SCM design approach shall be initially selected for each treatment area of the applicable development site using the results of the preliminary infiltration feasibility screening and the guidelines presented in Table 7-7, “Treatment Approach Selection Criteria.” The selection of the treatment approach shall begin at the top of the table (with full infiltration) and proceed to the next level down if either the infiltration capacity or infiltration constraints criteria cannot be met. This process continues until both sets of criteria are met for the treatment area. One treatment approach shall be selected for each applicable treatment area.

The Full Infiltration – Volume Reduction approach has two categories depending on the type of SCM being evaluated in the drainage basin:

- (1) **UIA to RPA:** This category is grass swales and grass buffers designed to infiltrate stormwater runoff via disconnection of impervious areas. Infiltration capacity for this category is dependent on identifying UIA:RPA pairs and confirming topsoil suitability.
- (2) **Infiltration SCM:** This category is bioretention, sand filter, permeable pavement or other volume-based SCMs designed to retain runoff from the treatment area. Infiltration capacity for this category is dependent on confirming the infiltration rate of the underlying in-situ soil.

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Table 7-7: Treatment Approach Selection Criteria

Treatment Approach	Design Standard Subsection 7.15(E)(1)	Preliminary Infiltration Feasibility Screening Subsection 7.16(B)	
		Infiltration Capacity	Infiltration Constraints
<b>1. Full Infiltration - Volume Reduction</b> <b>A. UIA to RPA</b> <b>B. Infiltration SCM</b> Subsection 7.16(D)(1)	Runoff Reduction	<b>A. UIA to RPA</b> UIA:RPA pairs have been identified and meet run-on ratio guidelines of USDCM, Volume 3, T-0 Volume Reduction. <b>B. Infiltration SCM</b> HSG A or B OR Field tests indicates infiltration rate is greater than one inch per hour.	Underlying soil, groundwater, and geological conditions have sufficient hydrologic capacity to infiltrate 60% of the WQCV. AND No other limitations to full infiltration are present in the treatment area.
<b>2. Partial Infiltration - WQCV</b> Subsection 7.16(D)(2)	WQCV	HSG C or D OR Field tests indicates infiltration rate is less than one inch per hour.	Underlying soil, groundwater, and geological conditions have sufficient hydrologic capacity to support infiltration of a portion of the WQCV. AND No other limitations to partial infiltration are present in the treatment area.
<b>3. No Infiltration - WQCV</b> Subsection 7.16(D)(3)	WQCV	N/A	Underlying soil, groundwater, and geological conditions prevent infiltration and require a lined system.
<b>4. Alternative Design</b> Subsection 7.16(D)(4)	Pollutant Removal OR Constrained Redevelopment Site	N/A	Physical site constraints or risk factors prevent the use of Treatment Approaches 1, 2, and 3 AND Alternative approach must be approved by the Director.

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**(D) Treatment Approach Design Criteria**

The Engineer shall design the SCMs of the selected treatment approach consistent with the requirements of this subsection. Specific types of SCMs are not prescribed for the individual approaches. Any applicable SCM may be used, provided it meets the treatment approach requirements stated herein. In addition to these requirements, SCM designs shall follow the guidance provided in USDCM, Volume 3.

For any of the treatment approaches, a treatment train using a series of SCMs may be used to meet the Stormwater Quality Design Standard for a given treatment area. The series of SCMs must adhere to the requirements of the treatment approach selected for the treatment area and must ultimately, as a group of SCMs, meet the Stormwater Quality Design Standard associated with the treatment approach.

- (1) **Full Infiltration – Volume Reduction Approach:** Full Infiltration is the preferred treatment approach and is required where feasible. Full infiltration designs retain stormwater onsite through the use of RPAs or infiltration SCMs that do not have underdrains. Plugged or capped underdrains may be specified. The following criteria are applicable to full infiltration SCM designs:
  - (a) **Runoff Reduction Design Standard:** Treatment areas using the Full Infiltration – Volume Reduction Approach shall meet, at a minimum, the requirements of the Runoff Reduction Design Standard of Subsection 7.15(C)(1)(a) of these Standards.
  - (b) **Required Sizing Criteria:** Preliminary and Final Drainage Reports must document sizing criteria and achieved volume reduction for each SCM following methods specified in USDCM, Volume 3. SCMs must be sized for the full tributary area.
    - (i) UIA to RPAs must comply with run-on ratio, topsoil suitability, and other related criteria as specified in USDCM, Volume 3, T-0 Volume Reduction.
    - (ii) Full infiltration SCMs with a storage component must comply with surface (filter) area, geometry, and drain time requirements as specified in the USDCM, Volume 3 for the appropriate SCM type.
  - (c) **Field Infiltration Tests:** Field infiltration tests are mandatory for full infiltration SCM designs following the standards in Subsection 7.16(E) of these Standards. Field infiltration test results must be documented in the Preliminary and Final Drainage Reports.
  - (d) **Minimum Field Infiltration Rate:** Full infiltration SCMs require a field infiltration rate measurement equal to one inch per hour or greater. If field infiltration rates are measured to be less than one inch per hour, a partial infiltration/WQCV approach shall be used consistent with the standards in Subsection 7.16(D)(2) of these Standards.
  - (e) **Required Design Factor of Safety:** Full infiltration SCMs shall utilize a minimum factor of safety of 2 when using the field-measured infiltration rate in drawdown time calculations.
- (2) **Partial Infiltration – WQCV Approach:** This category of SCMs retains stormwater

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on site to the extent practical by using underdrains or rate-controlled outlet structures. RPAs may be used as part of a treatment train to partial infiltration SCMs. The following criteria are applicable to partial infiltration designs:

- (a) **WQCV Design Standard:** Treatment areas using the Partial Infiltration – WQCV Approach shall meet, at a minimum, the requirements of the WQCV Design Standard in Subsection 7.15(C)(1)(b) of these Standards.
- (b) **Required Sizing Criteria;** Preliminary and Final Drainage Reports must document sizing criteria and achieved runoff volume capture for each SCM following the methods specified in the USDCM, Volume 3. SCMs must be sized for the full tributary area.
  - (i) **UIA to RPAs** must comply with run-on ratio, topsoil suitability, and other related criteria as specified in USDCM, Volume 3, T-0 Volume Reduction.
  - (ii) **Partial infiltration SCMs** must comply with surface (filter) area, geometry, and drain time requirements as specified in USDCM, Volume 3 for the appropriate SCM type. The use of underdrains or rate-controlled outlet structures are required components of partial infiltration designs.
- (c) **Field Infiltration Tests:** The following field infiltration test requirements are applicable to Partial Infiltration – WQCV designs:
  - (i) **For UIA-to-RPAs**, topsoil suitability must be shown with a soil graduation test as specified in Subsection 7.16(E) of these Standards.
  - (ii) **For partial infiltration SCMs** with underdrain or rate-controlled outlet, a field infiltration test is not required except when expressly requested by the Director due to a unique design configuration.
- (3) **No Infiltration – WQCV Approach:** No infiltration SCMs are lined systems required by the necessity to prevent infiltration due to underlying soil conditions, high groundwater table, or an otherwise immitigable risk as identified during the preliminary Infiltration feasibility screening. The following criteria apply to no infiltration designs:
  - (a) **WQCV Design Standard:** Treatment areas using the No Infiltration – WQCV Approach shall meet, at a minimum, the requirements of the WQCV Design Standard in Subsection 7.15(C)(1)(b) of these Standards.
  - (b) **Required Sizing Criteria:** Preliminary and Final Drainage Reports must document sizing criteria and achieved runoff volume capture for each SCM following methods specified in USDCM, Volume 3. SCMs must be sized for the full tributary area. No infiltration SCMs must adhere to and document compliance with surface (filter) area, geometry, and drain time requirements as specified in USDCM, Volume 3 for the appropriate SCM type.
  - (c) **Field Infiltration Tests:** Field infiltration tests are not required for no infiltration SCMs. Proof of a watertight liner may be requested at the time of installation by the Director based on necessity for risk mitigation.
- (4) **Alternative Design Approach:** The Director may approve an alternative design approach only if the Engineer demonstrates in the Preliminary Drainage Report or a letter to the Director that none of the above three treatment approaches are feasible. The Preliminary Drainage Report or letter shall explain the alternative design approach. The

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following criteria are applicable to alternative designs:

- (a) Pollutant Removal or Constrained Redevelopment Site Standard. Alternative designs shall meet one of the following:
  - (i) Pollutant Removal Standard in Subsection 7.15(C)(1)(c) of these Standards,
  - (ii) Constrained Runoff Reduction Standard in Subsection 7.15(C)(1)(d)(i) of these Standards,
  - (iii) Constrained WQCV Standard in Subsection 7.15(C)(1)(d)(ii) of these Standards, or
  - (iv) Constrained Pollutant Removal Standard in Subsection 7.15(C)(1)(d)(iii) of these Standards.
- (b) Required Sizing Criteria: Preliminary and Final Drainage Reports must document sizing criteria and applicable performance metrics for each SCM following methods specified in USDCM, Volume 3.
  - (i) For pollutant Removal or Constrained Pollutant Removal Standard designs, the Engineer shall submit TSS reduction metrics applicable to the proposed design. The use and reference of third-party testing data is required when proposing the use of a proprietary device.
  - (ii) Constrained Runoff Reduction Standard designs shall adhere to sizing criteria specified in Subsection 7.16(D)(1) of these Standards.
  - (iii) Constrained WQCV Standard designs shall adhere to sizing criteria specified in Subsection 7.16(D)(2) of these Standards.
- (c) Field Infiltration Tests: The following field infiltration test requirements apply to alternative design approaches:
  - (i) Field infiltration tests are not required when using the pollutant removal or constrained site pollutant removal standard.
  - (ii) Constrained Runoff Reduction Standard designs shall adhere to field infiltration requirements specified in Subsection 7.16(D)(1) of these Standards.
  - (iii) Constrained WQCV Standard designs shall adhere to field infiltration requirements specified in Subsection 7.16(D)(2) of these Standards.

## (E) Soil and Infiltration Test Requirements

Requirements for field infiltration testing depend on treatment approach and SCM type as detailed in Subsection 7.16(D) of these Standards. Field infiltration tests are required for all full infiltration SCMs with a storage component. For all UIA to RPA areas, the Engineer must show topsoil suitability with a soil gradation test. When preliminary infiltration feasibility screenings indicate C or D soils, field infiltration testing is optional to explore feasibility of a full infiltration design. Documentation of field infiltration test results must be submitted in Preliminary and Final Drainage Reports.

- (1) **UIA to RPA Soil Test Requirement:** For all UIA to RPA areas, regardless of HSG, onsite topsoil sampling and testing must be conducted to confirm infiltration capacity.

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Determination of HSG classification based on soil texture analysis shall follow specifications provided in USDCM, Volume 3, T-0 Volume Reduction. At least one soil gradation test shall be conducted for each proposed RPA. Proposed topsoil and soil amendment additions shall follow criteria specified in Chapter 10 of these Standards.

- (a) **Post-Construction Soil Tests:** Depending on site conditions, the Director may require soil tests to confirm infiltration capacity and adequacy of soil chemistry to support vegetation growth for RPAs after construction is complete. When required, soil test results shall be provided with the submission of as-built drawings.
- (2) **Full Infiltration SCM Field Test Requirements:** The following criteria apply to all full infiltration SCMs with a storage component using the Full Infiltration – Volume Reduction Approach of Subsection 7.16(D)(1) of these Standards:
  - (a) **Soil Borings:** Soil borings aid in interpretation of infiltration test results by providing information on groundwater conditions and soil stratification. Therefore, each infiltration test shall be accompanied by a soil boring test to a depth of 10 feet below the lowest planned infiltration elevation (the bottom of the infiltrating SCM). Soil borings performed for a civil site geotechnical analysis that are located within close proximity (less than 50 feet) to the footprint of the SCM may be used. An interpretation of soil boring test results with respect to infiltration shall be provided for each test. This description shall include an assessment of the anticipated seasonal high-water table based on date of soil boring with respect to rainfall patterns, and the presence of hydric soils, redoximorphic features, or other indicator of water table variation.
  - (b) **Allowed Test Methods:** Field infiltration tests shall utilize a double-ring infiltrometer or modified Philip Dunne infiltrometer following the specifications of ASTM D3385 or ASTM 8152, respectively. Alternative infiltration test methods may only be used with approval by the Director. The use of correlation methods based on soil texture applies only to RPA designs using the T-0 factsheet of USDCM, Volume 3. The use of regional soil maps is prohibited for infiltration design or verification purposes.
  - (c) **Number of Tests Required:** At least three infiltration tests shall be conducted for every SCM using the test spacing criteria established below. The Director may require additional tests for large SCMs, greater than 10,000 square feet, or when unique soil or geological conditions are known or suspected at the site.
    - (i) Generally, one infiltration test shall be conducted for every 3,000 to 10,000 square feet of area, depending upon the size of the SCM. Tests shall be spaced appropriately to provide sufficient infiltration rate information across the length and width of the SCM.
    - (ii) For small SCMs, at least one test shall be located within the SCM's footprint. The additional tests can be performed outside the footprint but must be located within 20 feet of the perimeter of the SCM and in soil formations that are representative of the conditions within the footprint of the SCM.
    - (iii) For SCMs that have an area greater than 10,000 square feet, one infiltration test shall be conducted for every additional 10,000 square feet



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of surface area up to a maximum of five infiltration tests.

- (d) **Test Elevation:** The elevation of infiltration tests shall be at or below the bottom (lowest planned infiltration elevation) of the SCM. SCMs that are designed for full infiltration shall not be placed on fill material without prior infiltration tests to confirm full infiltration design feasibility.
- (e) **Post-Construction Field Infiltration Tests:** The Director may require field infiltration tests to confirm infiltration rates after construction is complete if soil compaction or clogging is known or suspected during construction. When required field infiltration test information shall be provided with the submission of as-built drawings.
- (f) **Drainage Report Requirements:** The Preliminary and Final Drainage Report shall include the following information for each infiltration test performed.
  - (i) Test location and elevation;
  - (ii) Test method used;
  - (iii) Location of soil boring(s) used to aid test interpretation; and
  - (iv) Soil boring results and how they were used.

## 7.17 Post-Construction Stormwater Approval Requirements

### (A) General

- (1) Applicable development sites shall receive post-construction approval of the stormwater utility system by the Director prior to the issuance of a Certificate of Occupancy pursuant to a building permit or a Certificate of Completion for a use established pursuant to a development agreement under Chapter 9-2, “Review Processes,” B.R.C. 1981. The Director will base approval on the system’s conformance with the approved Final Drainage Report, the requirements of this section, and its readiness for post-construction operation.
- (2) Post-construction approval of the stormwater utility system shall be granted if the following criteria are met:
  - (a) The stormwater as-built drawing provided for the applicable development site demonstrates conformance of the constructed stormwater utility system with the approved Final Drainage Report and readiness for full post-construction operation, and
  - (b) The site’s stormwater utility system and all associated SCMs are determined, based on visual inspection by the Director, to be clean; free of sediment, debris, and other obstructions; undamaged; and ready for full post-construction operation.

If these criteria are not met, the Director may require the preparation, submittal, and approval of a revised Final Drainage Report and/or corrective actions at the applicable development site before granting post-construction approval. Corrective actions may include cleaning or repair of the stormwater utility system, SCMs, or detention ponds, including, but not limited to, the removal of sediment, debris, or other obstructions; the removal of construction-related

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wastes or stockpiles; the installation of permanent slope stabilization or energy dissipation measures; the removal, replacement, or installation of vegetation; and soil amendment or soil media replacement in infiltration-based SCMs.

- (3) Post-construction approval of the stormwater utility system by the Director indicates that the system was constructed in conformance with City requirements, is currently operating as expected, and stormwater as-built drawings have been approved. Approval also means that the system must comply with the requirements for post-construction inspection and maintenance established in Section 7.18 of these Standards and Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981.
- (4) In no way does post-construction approval imply City ownership, maintenance, operation, or any other liability for any accepted, privately-owned, stormwater utility system, SCM, or detention pond.

**(B) Stormwater As-Built Drawings**

The preparation of stormwater as-built drawings is required for all applicable development sites to document the as-constructed condition of SCMs. The as-built drawings shall indicate where the as-constructed condition differs from the final approved technical drawings following the provisions of Subsection 1.3(G) of these Standards. An engineering certification of elevations shall be included as an attachment to the stormwater as-built drawings.

The figures and drawings depicting the items listed below shall be included with the as-built requirements in Chapter 1 of these Standards to provide a reference for the information provided in the Final Drainage Report. Specific as-built drawings pertaining exclusively to the conditions of the SCM are required and shall depict both plan and profile views as described below:

- (1) **Plan Drawing/s:** Illustrate and label in plan view the components of the SCM, including inlet and outlet locations, embankments, treatment surface area, utility easements, vegetated cover, and other critical drainage elements. Indicate where the as-constructed conditions differ from the final approved technical drawings.
- (2) **Profile Drawing/s:** Illustrate and label in profile view the elevations of SCM components, including filter media depth, bottom elevation, embankment slopes, inlet/outlet inverts, and other critical drainage components. Indicate where the as-constructed conditions differ from the final approved technical drawings.

**(C) Post-Construction Acceptance Inspection Required**

- (1) Each SCM must pass a post-construction inspection by the Director to confirm SCMs, including RPAs, are clean, have established vegetation, and are fully operational in keeping with their approved design. After these conditions are met, the SCM is considered fully functional and subject to Section 7.18 of these Standards.
- (2) The post-construction acceptance inspection shall occur after submittal of the complete as-built drawings to the Director. No application for inspection is required, as submittal of the stormwater as-built drawings will signify the project’s readiness for inspection. An inspection will not be performed in the event of submittal of incomplete drawings. Confirmation of information on the stormwater as-built drawings will also be included in the inspection.

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**(D) Vegetation Warranty Required**

The Director may require a financial guarantee for vegetation installed within SCMs consistent with the requirements of Subsection 11-5-6, “Stormwater Quality Management for Land Development,” B.R.C. 1981. The financial guarantee may be held for up to three years and will be released after an inspection confirms the vegetation within each SCM is in good health.

**7.18 Post-Construction Stormwater Quality Inspection and Maintenance Requirements****(A) Applicability**

The owner of SCMs of an applicable development site shall protect, inspect, maintain, repair, and reconstruct SCMs and associated drainage infrastructure on the property to ensure full, functional operation in accordance with the requirements in this section and pursuant to Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981.

**(B) Inspection and Maintenance Requirements for SCMs**

- (1) **Inspection and Maintenance Required:** The owner of SCMs shall inspect and maintain the SCMs as is necessary to ensure their full, functional operation at all times.
- (2) **Inspection Frequency:** The owner of SCMs shall be responsible to inspect the SCMs as often as necessary to assess the need for maintenance. The optimum inspection frequency for SCMs varies depending on a number of factors including, but not limited to, the type of SCM, whether the SCM is vegetated, and activities that have occurred in the area draining to the SCM. SCMs shall be visually inspected:
  - (a) After storms and snow melt to assess whether stormwater in the SCM is draining as expected, and
  - (b) During property landscape maintenance activities to look for build-up or blockages of trash, debris, or sediment; check for damage; and determine current maintenance needs.

Documentation of these inspections is not required. However, the owner of SCMs shall document a detailed visual inspection of their SCM(s) in accordance with the frequencies defined in Table 7-8, “Required Inspection Frequency by SCM Type.” The documented inspection shall be performed between May and August, when vegetation is not dormant and snow does not cover the SCM.

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**Table 7-8: Required Inspection Frequency by SCM Type**

SCM Type	Documented Inspection Frequency
Bioretention (Rain Garden) Constructed Wetland Channel Constructed Wetland Pond Extended Detention Pond Grass Buffer Grass Swale Permeable Pavement Receiving Pervious Area (RPA) Retention Pond Sand Filter Other SCM Designs	Annually
Underground SCMs	Every 3 months

- (3) **Inspection Documentation:** Inspections shall be documented using form(s) provided by the Director and located in the Inspection and Maintenance Guide for the SCMs in an appendix to the Final Drainage Report. Inspection documentation shall be kept by the owner of SCMs or their delegated representative for five years and shall be made available by the owner of SCMs or their delegated representative to the Director immediately upon request.
- (4) **Performed Maintenance:** Routine maintenance shall be performed to ensure that SCMs are functioning as designed. Corrective action shall be performed immediately when an inspection indicates the need for maintenance. Routine maintenance varies by SCM type but generally requires the regular removal of trash and debris (e.g., dead leaves, sticks, tree limbs) from inflow, outflow, and water storage areas; removal of sediment at inflows; repair of eroded areas; and general vegetation maintenance (if vegetation is part of the SCM).
- (5) **Transitional Regulations:** For any permanent stormwater quality facilities approved under the City of Boulder Design and Construction Standards in effect prior to the effective date of Ordinance 8324, the property owner shall be responsible for maintaining the stormwater quality facilities. The stormwater quality facilities shall be maintained as recommended in the USDCM and such that the design of the properties of the facility are preserved.

**(C) Inspection and Maintenance Guide**

An Inspection and Maintenance Guide shall be submitted as an appendix to the Preliminary and

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Final Drainage Report. This guide shall be provided by the Engineer to the owner of SCMs upon completion of construction and signifies transfer of maintenance responsibilities from the erosion control permittee to the owner of the SCMs. The Inspection and Maintenance Guide shall provide inspection and maintenance guidelines specific to the SCM type and shall follow the format provided by the Director.

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**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

**CHAPTER 9**  
**UTILITIES STANDARDS**

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**9.01 General****(A) Intent**

The Utilities Standards are intended to complement the design standards specified in Chapter 4, “General Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” Chapter 7, “Storm Water Design,” and Chapter 11, “Technical Drawings,” of these Standards, and provide minimum standards for the construction of public utilities improvements in public rights-of-way and public easements.

**(B) Scope**

These Standards apply to all city-operated public utility improvements within the City of Boulder service area. This chapter describes the construction of public utilities and other work within the public right-of-way and public easements including, but not limited to, work activities involved, materials used, installation methods, and required testing. The utilities construction requirements of this chapter are in addition to those set forth in Chapter 4, “General Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” Chapter 7, “Storm Water Design,” and Chapter 11, “Technical Drawings,” of these Standards and the B.R.C. 1981.

**(C) Reference Standards**

Where not specified in these Standards or the B.R.C. 1981, in order 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 utilities and may refer to one or more of the references listed in the References Section of these Standards.

**(D) City Approval Required**

All work associated with the construction of public utilities within or upon any City of Boulder public right-of-way or public easement is subject to City of Boulder approval or permit issuance as set forth in Chapter 8-5, “Work in the Public Right Of Way and Public Easements,” B.R.C. 1981.

**9.02 Excavation and Trenching****(A) General**

(1) **Scope:** This section describes excavation and trenching, which includes the following:

- (a) Necessary clearing, grubbing, and preparation of the site;
- (b) Removal and disposal of debris;
- (c) Excavation and trenching as required;
- (d) The handling, storage, transportation, and disposal of all excavated material;
- (e) Necessary sheeting, shoring, and protection work;
- (f) Preparation of subgrades;
- (g) Pumping and dewatering as necessary or required;

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- (h) Protection of adjacent property
  - (i) Backfilling;
  - (j) Pipe embedment;
  - (k) Placement of fills;
  - (l) Surfacing and grading; and
  - (m) Other relevant work.
- (2) **Quality Assurance:** All tests required for the preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of the contractor. Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material. The contractor shall pay for all in-place field density tests, Proctor moisture-density tests, and relative density tests on the materials as required.

**(B) Materials**

- (1) **General:** All bedding and backfill material shall be free of frozen material, organic material, and debris.
- (2) **Pipe Bedding:** Bedding materials shall conform to the following requirements:
  - (a) **Bedding Materials:** Bedding materials shall not contain cinders or other material that may cause pipe corrosion.
  - (b) **Concrete Arch Encasement:** A concrete arch encasement is not required unless improper trenching or unexpected trench conditions require its use, as determined by the Director.
  - (c) **Granular Bedding Material:** Granular bedding material shall consist of well graded sand or squeegee meeting a fine aggregate standard shown in Table 9-1, "Granular Bedding Material." Instead of a material meeting the requirements in Table 9-1, the Director may approve 3/8-inch chips conforming to the grading and composition requirements of Course Aggregate No. 8 in Table 703-1, "Concrete Aggregate Gradation Table," of the CDOT Standard Specifications for Road and Bridge Construction, 2017, due to lack of availability of the materials meeting Table 9-1 requirements.

**Table 9-1: Granular Bedding Material**

Sieve Size	Percent Passing by Weight
3/8-inch	100%
No. 4	60-100%
No. 8	0-45%
No. 16	0-30%
No. 50	0-6%
No. 200	0-2%

- (d) **Compaction:** All granular bedding material shall be compacted by vibrating or

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slicing with a shovel and placed in layers no more than 6 inches thick.

- (3) **Stabilization Material:** Stabilization material shall be placed on suitably prepared subgrades and compacted by vibration. Stabilization material shall be crushed rock or gravel; free from dust, clay, or trash; and graded 1 ½ inch to No. 4 as defined in ASTM C33, and shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254.
- (4) **Trench Backfill:** Trench backfill is material placed above the pipe bedding and shall meet specifications for Class 1 structural backfill material of Subsection 703.08 “Structural Backfill Material,” of the CDOT Standard Specifications for Road and Bridge Construction (2017), or shall be flowable fill as specified in Subsection 9.02(B)(6) of these Standards..
- (5) **Groundwater Barrier Material:** Groundwater barrier material shall be flowable fill or meet AASHTO soil classification SC or CL, free from stones, organic material or debris.
- (6) **Flowable Fill:** Flowable fill, meeting the standards outlined in Table 9-2, “Flowable Fill Requirements,” shall be used for trench backfill or for groundwater barriers.

**Table 9-2: Flowable Fill Requirements**

Ingredients	Lbs./C.Y.	Kg/m <sup>3</sup>
Cement	50	30
Coarse Aggregate (AASHTO No. 57 or 67)	1,700	1,009
Fine Aggregate (AASHTO M 6)	1,845	1,095
Water (39 gallons) (147L)	325 (or as needed)	193 (or as needed)

- (a) Enough water shall be used so that the flowable fill flows into place properly without excessive segregation. Approximately 39 gallons of water per cubic yard (193 liters per cubic meter) of flowable fill is normally needed. Additional water shall not be added to the mixture at the project site.
- (b) The contractor may use aggregate that does not meet the specifications in Table 9-2, “Flowable Fill Requirements,” if the cement is increased to 100 pounds per cubic yard (60 kilograms per cubic meter) and the aggregate conforms to following gradation:

Sieve Size or Designation	Percent Passing
1 inch (25.0 mm)	100%
No. 200	0-10%

- (c) The contractor may make the following substitutions in the flowable fill mix:
  - (i) Thirty pounds per cubic yard (18 kilograms per cubic meter) of cement and 30 pounds per cubic yard (18 kilograms per cubic meter) of fly ash for 50 pounds per cubic yard (30 kilograms per cubic meter) of cement, or
  - (ii) Sixty pounds per cubic yard (36 kilograms per cubic meter) of cement and 60 pounds per cubic yard (36 kilograms per cubic meter) of fly ash for 100 pounds per cubic yard (60 kilograms per cubic meter) of cement.

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- (d) The City reserves the right to review the use of recycled broken glass (glass cullet) as part or all of the aggregate.
  - (e) Compaction of flowable fill shall not be required
  - (f) The maximum layer thickness for flowable fill shall be 3-feet. Additional layers shall not be placed until the flowable fill has lost sufficient moisture to be walked on without indenting more than 2-inches. Any damage resulting from placing flowable fill in layers that are too thick or from not allowing sufficient time between placement of layers shall be repaired at the Contractor's expense.
- (7) **Rock Backfill Material:** Rock backfill material shall be an imported graded material that meets either the 57/67 size requirements of ASTM C33 or the requirements for stabilization material specified in Subsection 9.02(B)(3) of these Standards.

**(C) Execution****(1) Site Preparation**

- (a) All sites to be occupied by permanent construction shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. All waste materials shall be removed from the site and properly disposed.
- (b) In natural areas where excavation will occur all topsoil shall be stripped or, in the absence of topsoil, the top 6 inches of surface material shall be stripped and stored separately from other excavated materials.
- (c) For concrete walks, roadways, parking areas, and road crossings existing pavement shall be cut full depth to a true line before excavation. For Portland Cement pavements, cuts shall be made at existing joints.

- (2) **Classification of Excavated Materials:** Excavated materials shall not be classified. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

- (3) **Unauthorized Excavation:** Undermining or tunneling under walls, footings, slabs on grade, foundations, sidewalks, concrete or bituminous asphalt pavements, or any other surface or subsurface facilities or structures shall not be permitted unless authorized by the Director. If unauthorized tunneling or undermining occurs, the contractor shall pay for all repairs and restorations the Director deems necessary. The repairs and restorations may include removing and replacing part or all of the affected facility or structure.

**(4) Stabilization of Subgrades**

- (a) Subgrades for concrete structures and trench bottoms shall be firm, dense, thoroughly compacted and consolidated, and free from mud and muck.
- (b) Subgrades for concrete structures or trench bottoms that are otherwise solid, but become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel meeting the requirements for stabilization material, described in Subsection 9.02(B)(3) of these Standards and approved by the Director.
- (c) Stabilization material shall be spread and compacted to a depth of not more than 4 inches. However, if the required depth exceeds 4 inches, the subgrade for

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concrete structures or trench bottom shall be re-excavated and all mud and muck removed and replaced with stabilization material, as required by Subsection 9.02(B)(3) of these Standards and approved by the Director.

- (d) This material shall be placed, and compacted, as prescribed in these Standards. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the drawings.
- (5) **Blasting:** Blasting or other use of explosives for excavation will not be permitted.
- (6) **Shoring**
  - (a) All excavations shall be properly shored and braced to meet federal, state and local laws governing safe working conditions. The shoring shall be arranged so that no stress is placed on any portion of the completed work until the general construction thereof has proceeded far enough to provide ample strength.
  - (b) Shoring shall be removed as the work progresses. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling.
  - (c) Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner that will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.
  - (d) The contractor shall pay to repair any damage to pipes or structures resulting from missing, failed or improper shoring, sheeting, or bracing or any negligence on the part of the contractor.
- (7) **Water Control and Dewatering**
  - (a) Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
  - (b) All excavations for concrete structures or trenches that extend down to or below the groundwater table shall be dewatered by lowering and keeping the groundwater level 12 inches or more below the bottom of the excavation.
  - (c) Surface water shall be diverted or otherwise prevented from entering the excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
  - (d) The contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes. All such pipe or conduit shall be left clean and free of sediment.
- (8) **Trench Excavation:** Trenches shall be excavated so that pipes can be laid according to the profiles, grades, elevations, and minimum cover shown on the drawings or specified in these Standards. Trench subgrades shall be clean and free of loose material of any kind.
  - (a) **Excavation in Streets and Other Paved Surfaces:** Excavations in streets with asphalt paving must be confined to the minimum width required to maintain a

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safe trench condition. The contractor shall pay for replacing any pavement damage resulting from their construction work. The Director will determine the limits of the damaged pavement needing replacement.

- (b) **Minimum Cover:** Where pipe grades or elevations are not definitely fixed by the approved plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe as follows:

- (i) Water lines require at least 4.5 feet of cover;
- (ii) Sanitary sewers require at least 3 feet of cover; and
- (iii) Storm sewers require at least 1.5 feet of cover.

- (c) **Trench Widths**

- (i) Trench widths shall be as shown below where the maximum trench width is measured at the top of the pipe barrel:

Pipe Diameter Inches	Maximum Trench Inches	Pipe Diameter Inches	Maximum Trench Inches
4	24	24	48
6	26	27	52
8	28	30	56
10	30	33	60
12	34	36	68
14	36	39	72
15	37	42	76
16	38	48	82
18	40	54	90
20	42	72	110
21	44		

- (ii) If the stated maximum trench widths are exceeded, and if the Director determines that the combined dead- and live-loads will exceed the design loadings on the pipe, the Director may require the contractor to either cradle the pipe in concrete or use a pipe of a stronger class. Remedial measures shall be entirely at the contractor's expense.
- (iii) As illustrated on Drawing No. 4.03 in Chapter 11, "Technical Drawings," of these Standards, the pipe trench shall be excavated to a depth below the bottom of the pipe, backfilled with the specified granular bedding material, and compacted to the requirements of these Standards.

- (d) **Trench Walls**

- (i) The contractor may slope or bench trench sidewalls in areas where an increased trench width will not interfere with surface features or other utilities. Such sloping or benching shall terminate at least 1 foot above the top of the pipe barrel; from that point down, the trench wall shall be vertical.

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- (ii) The trenching operation, including the spoil bank and the sloping of trench sidewalls, shall be confined to the width of any permanent and temporary rights-of-way or easements.
  - (iii) A sufficient clear area shall be maintained away from the top edge of the excavation to avoid overloading that may cause slides or caving of the trench walls. The excavated material shall be kept trimmed to avoid inconveniencing the public and adjoining property owners. Unless otherwise authorized by the Director, all public thoroughfares and crossroads shall be kept open to traffic. When required by the Director, the contractor shall, at their own expense, provide open-cut bridging at street crossings, sidewalks, and other necessary points to prevent serious travel interruptions and to provide access to fire hydrants and public and private premises.
- (e) **Trench Preparation**
  - (i) The trench shall be excavated only so far in advance of pipe laying as permitted by the Director. Trench preparation shall also conform to the details shown on the drawings in Chapter 11, “Technical Drawings,” of these Standards.
  - (ii) Bell holes in the trench bottom shall be provided at each joint to permit the jointing to be made properly and to prevent the pipe from bearing on the pipe bells.
  - (iii) After excavation, the trench bottom shall be uniformly graded and hand-shaped so that the pipe barrel (exclusive of the joint) will have uniform and continuous bearing on thoroughly compacted pipe bedding material throughout the length of the pipe.
  - (iv) The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade and without exceeding the permissible joint deflection. If raising the pipe subgrade is necessary, and approved by the Director, compacted bedding material may be used at the contractor’s expense.
- (f) **Excavation Material:** Excess excavated material shall be removed from the construction site and disposed of by the contractor.
- (g) **Rock Excavation:** In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material. During its placement, the bedding material shall be shaped to provide support along the full length of pipe.
- (9) **Installation of Pipe Bedding**
  - (a) Pipe bedding material shall consist of the material as specified in Subsection 9.02(B)(2) of these Standards. Bedding material shall be placed to provide the grade and elevation specified on the approved plans.
  - (b) After bedding material has been placed and approved, and after the pipe has been installed and approved, the additional granular bedding material shall be installed to an elevation 12 inches above the top of the pipe.
- (10) **Installation of Trench Backfill**

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- (a) Backfilling during freezing weather shall not be performed, except by permission of the Director. No backfill shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill.
  - (b) Unless accurate results cannot be obtained, the compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture- Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.
  - (c) When required by the Director, the contractor shall excavate backfilled trenches for purposes of performing compaction tests at locations and depths determined by the Director. The contractor shall be responsible for reinstalling and recompacting the test excavations.
  - (d) All backfill above the bedding material shall be carefully placed and compacted. Except for the backfill requirements as set forth under Section 8-5-12, “Standards for Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981, approved backfill material shall be placed in loose lifts, not exceeding 8 inches thick, and shall be compacted by equipment and means approved by the Director. If the contractor wishes to use equipment and means other than what was approved for the project by the Director, the contractor shall submit, in writing, a request for approval of the proposed equipment and means to the Director for review and approval. Any approval by the Director, of an alternate method of compaction shall not relieve the contractor from providing a finished product that meets or exceeds all the intents and requirements of the approved plans and these Standards.
  - (e) All backfill shall be compacted to 95 percent of maximum laboratory dry density or 70 percent relative density. The material shall be within 2 percent of optimum moisture content.
  - (f) A loose layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.
- (11) **Structural Excavation and Backfill**
- (a) All structural excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
  - (b) The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for earthfills and embankments. Backfill materials shall be placed in loose lifts, not to exceed 8 inches in thickness, and shall be compacted to at least 95 percent of maximum dry density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.
  - (c) No backfill shall be deposited or compacted in water.
  - (d) Particular care shall be taken to compact structure backfill that will be beneath



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pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

(12) **Restoration**

- (a) **Streets and Roadways:** Any pavements disturbed during construction shall be repaired in accordance with the requirements as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981. All dirt and debris, including dust shall be removed from streets and paved surfaces within 3 days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.
- (b) **Fencing and Culverts:** Restore all existing structures to conditions equal to or exceeding existing structures.
- (c) **Landscape**
  - (i) After other outside work has been finished, and backfilling and embankments completed and settled, all areas that are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas that have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.
  - (ii) Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.
  - (iii) Final grading and surfacing shall be smooth, even, and free from clods and stones larger than 1 inch in greatest dimension, weeds, brush, and other debris.
  - (iv) The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.
  - (v) The Director will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.

- (13) **Cleanup:** The contractor shall maintain a clean site at all times. Prior to final inspection and acceptance, the contractor shall remove all rubbish and excess materials and leave the area in a neat, satisfactory condition.

- (14) **Maintenance of Backfill:** All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained for a period of 2 years following the date of final acceptance of all work. When the contractor discovers or is notified by the City that any backfill is not in compliance with City standards, the

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contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the contractor to the satisfaction of the City. In addition, the contractor shall be responsible for the cost of all claims for damages due to settlement of backfilled areas.

### 9.03 Ductile Iron Pipe (DIP)

#### (A) General

- (1) **Scope:** This section describes the furnishing and installation of ductile iron pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4 inches to 30 inches.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

#### (B) Materials

- (1) **Ductile Iron Pipe**
  - (a) Unless revised on the approved drawings, the ductile-iron pipe shall conform to ANSI A21.51, AWWA C151, Class 52 thickness. The interior of each length of pipe shall have a cement-mortar lining, conforming to the requirements set forth in ANSI A21.4, AWWA C104, of standard thickness. The exterior of the pipe shall be coated with standard coating approximately 1 mil thick.
  - (b) Unless otherwise specified, the pipe joint shall be the "push-on" type, made in accordance with ANSI A21.11, AWWA C111, and the gaskets shall be standard for buried water service and as provided by the pipe manufacturer.
- (2) **Polyethylene Wrap**
  - (a) All ductile iron pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices - Ductile Iron Pipe and Fittings.
  - (b) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.
  - (c) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.
  - (d) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
  - (e) Tube Size or Sheet Width: Table 9-3, "Tube Size and Sheet Width for Pipe Diameter," shows the tube size or sheet width for each pipe diameter.

**Table 9-3: Tube Size and Sheet Width for Pipe Diameter**

Nominal Pipe Diameter (Inches)	Flat Tube (Inches)	Minimum Sheet Width (Inches)
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4"	16"	32"
6"	20"	40"
8"	24"	48"
10"	27"	54"
12"	30"	60"
14"	34"	68"
16"	37"	74"
18"	41"	82"
20"	45"	90"
24"	54"	108"

**(C) Thrust Restraint**

Where designated by the Engineer with expertise in thrust restraint systems, or where existing conditions do not permit the use of concrete thrust blocks, individual joint restraint systems shall be provided as follows:

- (1) **Alternative A:** Full length tie rods between joints. “Star” systems fabricated from “Cor-Ten” steel or an equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings.
- (2) **Alternative B:** Pacific States Lock Mechanical Joint with Tyton Joint Core, or equivalent fittings with ductile iron joint restraint features conforming to ANSI Standard A21.10. Push-on joints for such fittings shall be in accordance with AWWA Standard A121.11. Assembly of the joint portion of the product shall be in accordance with AWWA C600-77
- (3) **Alternative C**
  - (a) Follower gland type systems may be used for 12-inch diameter pipe and smaller. Pipe clamps shall be fabricated from “Cor-Ten” steel or an equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings. The follower gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to AWWA C111 and C153.
  - (b) The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as tee head bolts, shall be used to ensure proper actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain. The device shall have a working pressure of at least 200-psi with a minimum safety factor of 2:1.
  - (c) Follower gland joint restraint devices shall be of the type listed below:
    - (i) “EBAA Iron, Inc.,” Megalug 1100 Series (4 -12 inches)
    - (ii) “Uniflange,” 1400 Series (4 -12 inches)

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**(D) Connections to the Existing System**

- (1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.
- (2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved drawings.
- (3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the affected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.
- (4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the contractor shall advise such customer in writing 24 hours in advance of when the supply will be disconnected and reestablished.

**(E) Execution**

- (1) **Installation of Ductile Iron Pipe:** Except as specified herein or unless specifically authorized by the Director, all installation of pipe shall conform to the recommendations contained in “Installation Guide for Ductile Iron Pipe,” published by the Ductile Iron Pipe Research Association. The contractor shall assure that a copy is available at the job site.
  - (a) **Pipe Laying**
    - (i) Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Director. Pipe shall be laid on the bedding with support over the full length of the pipe barrel.
    - (ii) Table 9-4, “Ductile Iron Pipe Deflection,” shows the maximum allowable pipe joint deflections.
    - (iii) The information in the columns referring to the deflection and the approximate radii shall be adjusted for pipe lengths different than 18-foot lengths. Shorter pipe lengths will be required if a shorter radius is called for on the approved construction plans. Double hubs may be used to lay pipelines on curved alignment.

**Table 9-4: Ductile-Iron Pipe Deflection**

Approximate Radius of Curve Produced by:			
Size of Pipe (Inches)	Bend in One Joint (%)	Deflection in One 18-Foot Length (Inches)	Succession of 18-Foot Joints (Feet)
4 - 12	4	15	250
14 - 24	2	7.5	510

- (iv) Vertical deflections shall not exceed any of the above values.

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- (v) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.
- (vi) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. The pipe end shall be beveled and free of sharp edges that could damage the gasket during installation.
- (b) **Mechanical Joints:** Mechanical joints shall be installed per the manufacturer's specifications and guidelines.
- (c) **Push-On Joints:** For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. The proper gasket supplied with the pipe shall be placed in the bell in compliance with the manufacturer's specifications and guidelines so it will spring into its proper place inside the pipe bell. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position.
- (d) **Installation of Polyethylene Wrap**
  - (i) All pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices -Ductile Iron Pipe and Fittings.
  - (ii) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.
  - (iii) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.
  - (iv) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
- (2) **Installation of Thrust Restraint**
  - (a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.
  - (b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on

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each side of the pipe. The tie rod nut should first be hand tightened with a 12-inch wrench (approximately 50 to 100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.

- (c) Follower gland type joint restraint systems shall be assembled according to manufacturer's instructions.
- (3) **Testing:** Testing of ductile iron pipe shall be as specified in Section 9.13, "Testing of Water Pipes," of these Standards.
- (4) **Backfilling and Restoring Surface Conditions:** Surface conditions shall be backfilled and restored as specified in Section 9.02, "Excavation and Trenching," of these Standards.
- (5) **Disinfecting Potable Pipelines:** Ductile iron pipe shall be disinfected as specified Section 9.12, "Disinfecting Waterlines," of these Standards.

## 9.04 Polyvinyl Chloride (PVC) Pressure Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) pressure pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4 to 12 inches.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) PVC Pressure Pipe

- (a) All PVC pipe shall meet the requirements of AWWA C-900-16, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (4 – 12 inches) and shall be Pressure Class 305 psi (DR 14), or shall meet the requirements of AWWA C-905-08, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (14 – 48 inches) and shall be Pressure Class 235 psi (DR 18).
- (b) All pipe shall be suitable for use as a pressure conduit. Provisions must be made for expansion and contraction at each joint with a rubber ring. The bell shall consist of an integral wall section with a solid cross-section rubber ring which meets the requirements of AWWA C-900-07.
- (c) Laying length of pipe shall be 20 feet for all sizes of pipe.
- (d) Each length of pipe shall bear the date manufactured, type, grade, length, manufacturer's name, and NSF seal of approval.
- (e) Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint.
- (f) Solvent cement joints are prohibited.
- (g) The manufacturer shall furnish a certified statement that all specified tests and inspections have been made and the results thereof comply with the AWWA

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standards specified in this Subsection 9.04(B). A copy of the certification shall be sent to the City upon request.

(2) **Polyethylene Encasement**

- (a) All pipeline fittings and appurtenances shall be encased in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105.
- (b) The finished polyethylene film shall have a minimum nominal thickness of 0.008-inch (8 mil), and the minus tolerance on thickness shall not exceed 10 percent of the nominal thickness. The film shall have at least 1200-psi tensile strength of with an elongation of 300 percent minimum. The dielectric strength shall be at least 800 volts per mil thick.

- (3) **Tracer Cable:** Tracer wire shall be Type THHN, AWG size #12, UL listed with a single copper conductor, PVC insulation, and nylon jacket. Test stations at fire hydrants shall be CP Test Services, Glenn Series Glenn-4 with locking lid, 3½ x 4 inches, or approved equal.

(C) **Thrust Restraint**

- (1) **Required:** All fittings and joints shall be restraint from movement due to hydraulic forces with concrete thrust blocks as shown in Chapter 11, “Technical Drawings,” of these Standards except where existing conditions or other practical difficulties do not permit the use of concrete thrust blocks. Where the applicant demonstrates to the satisfaction of the Director that existing conditions or other practical difficulties do not permit the use of concrete thrust blocks, individual restraint systems shall be provided meeting one of the following:
  - (a) **Alternative A - Full Length Threaded Tie Rods:** Threaded rods shall be Type 316L stainless steel coated with an anti-galling compound. Connecting T-bolts and nuts shall be Type 316L stainless steel coated with an anti-galling compound or corrosion resistant fluorocarbon coating such as “NSS Industries” Cor-Blue or “Star Pipe Products” Core Blue. The number and diameter of tie rods shall be as shown on the approved plans.
  - (b) **Alternative B - Follower Gland Type Mechanical Joint Restraint Systems:** Follower gland type mechanical joint restraint systems may be used only for 16-inch diameter and smaller pipe. Restraint rings shall be manufactured of ductile iron conforming to ASTM A536, Grade 65-45-12 with a factory applied fusion epoxy coating. The mechanical joint follower gland shall be incorporated into the restraint. Connecting T-bolts and nuts shall be as required in Alternative A.
  - (c) **Alternative C - Bolt-Through Positive Restraint Mechanisms:** A bolt-through positive restraint mechanism may be used only for connecting 12-inch diameter and smaller mechanical joint valves and fittings. It shall not be used for pipe attachment or fire hydrant connections. Adaptor body shall be made of ductile iron, conforming to ASTM A536 80-55-06 with styrene butadiene rubber gaskets conforming to AWWA C111. Connecting T-bolts and nuts shall be as required in Alternative A.
- (2) **Bell-And-Spigot Joints:** Restraint devices for PVC pipe bell-and-spigot joints may be used, if approved by the Director, for sizes 4 to 16 inches. Devices shall be of ductile iron conforming to ASTM A536. Connecting T-bolts and rods as required in Alternative A.

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- (3) **Mechanical Joint Restraint Required:** Mechanical joint restraint devices are required for the following installations:
- (a) Fire hydrants;
  - (b) Fire line connections;
  - (c) Three inch and larger domestic line connections;
  - (d) Reducers;
  - (e) Vertical and horizontal offsets (all angles);
  - (f) Bends, line valves, and fittings;
  - (g) Bulkheads and plugs;
  - (h) Bored casing carrier pipe; and
  - (i) When the bearing capacity of the soil is not sufficient to provide adequate restraint, as determined by the Director.
- (4) **Mechanical Joint Restraint Design Requirements:** The mechanical restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability; or a series of machined serrations designed to grip the entire pipe surface; or a system that is integral to the gasket. For twist-off nut-type designs, the nuts shall be sized the same as T- bolts and be used to insure proper actuating of restraining devices. When the nut head is sheared off, a standard hex nut shall remain. All devices shall have a working pressure of at least 200 psi with a minimum safety factor of 2:1.
- (5) **Follower Gland Type Joint Restraints:** Follower gland type joint restraint devices shall be of the type listed below:
- (a) “EBAA Iron”
    - (i) Megalug 2000 Series for PVC (4 to 16 inches)
    - (ii) Megalug 1600 Series for PVC (4 to 12 inches) Pipe Bell Joints
    - (iii) Megalug 2800 Series for PVC (14 inches and larger)
  - (b) “Star Pipe Products”
    - (i) Domestic PVC Stargrip Series 4000 (4 to 12 inches)
    - (ii) Domestic 1100C Bell Restrainers Series 1100 for PVC Pipe Bell Joints
  - (c) “U.S. Pipe”: MJ FIELD LOK Gasket with MJ FIELD LOK Gland, Series for PVC (4 to 12 inches)
  - (d) “Romac Industries”: PVC RomaGrip Series, fusion bonded polyester coating is required if using C909 PVC
- (6) **Bolt-Through Mechanical Joint Restraints:** Bolt-through mechanical joint restraint devices shall be of the type listed below:
- (a) “Infact Corporation”: Foster Adaptor (4 to 12 inches) with fusion bonded epoxy coating. Standard foster adaptor accessory pak is required for restraining C153 compact fittings and valves



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**(D) Connections to the Existing System**

- (1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.
- (2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved construction plans.
- (3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the effected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.
- (4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the owner-developer-contractor shall advise such customer in writing 24 hours in advance of when the supply will be disconnected and when the supply will again be available.

**(E) Execution**

- (1) **Installation of PVC Pressure Pipe:** Unless specifically authorized by the Director, all pipe shall be installed as follows:
  - (a) Pipe Laying
    - (i) Pipe shall be laid with bell ends facing in the direction of laying. No deflection in the joints shall be allowed. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or to plumb valve operators, the pipe itself may be uniformly curved as shown in Table 9-5, "Pipe Laying."

**Table 9-5: Pipe Laying**

Approximate Pipe Size (Inches)	Offset in 20-Foot Length (Inches)	Radius of Curve (Feet)
4"	15"	120'
6"	15"	160'
8"	15"	250'
10"	15"	300'
12"	15"	400'

- (ii) Pipe deflection for curvature shall not be permitted at temperatures less than 32° F ambient temperature.
- (iii) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.
- (iv) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a

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clearly visible position mark at the correct distance from the end of the field cut pipe.

- (v) Tracer wire shall be attached to the pipe as shown in Chapter 11, “Technical Drawings,” of these Standards.
- (b) **Mechanical Joints:** Mechanical joints shall be installed per the manufacturer’s specifications and guidelines.
- (c) **Push-On Joints:** For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. A thin film of the pipe manufacturer’s joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position. Position the completed joint so that the joint mark on the pipe end is in line with the end of the bell.

(2) **Installation of Thrust Restraint**

- (a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.
- (b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on each side of the pipe. The tie rod nut should first be hand tightened with a 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.
- (c) Follower gland type joint restraint systems shall be assembled according to manufacturer’s instructions.

(3) **Installation of Tracer Cable:** Tracer wire shall be spirally wrapped around the pipe exterior, 2 wraps minimum per 20-feet of pipe, as it is installed in the trench or taped to the top of the pipe. Splices due to breaks in wire continuity shall be made by stripping insulation coating from each wire with wire stripper pliers. Wires shall be joined with a solderless connector, 3M Direct Bury Splice Kit or equivalent in suitability, strength, effectiveness, and durability as approved by the Director. The join shall be made in accordance with manufacturer instructions. The solderless connector shall be covered with Emmerson Electric Seal-A-Conn II putty or approved equal.

The wire shall form a continuous electrical circuit between any 2 contact points on the new pipeline, including branch lines and fire hydrant laterals. Wire shall be stubbed out to the point where the new pipe connects to the existing main unless otherwise directed by the Director. Where the wire terminates at a point where there is not an installed wire, the ends of the wire shall be stripped bare a minimum of 18-inches and grounded into the

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native soil material. Special care should be taken to avoid contact from the tracer wire to steel gas service lines.

- (4) **Testing:** Testing of PVC pressure pipe shall be as specified in Section 9.13, “Testing of Water Pipes,” of these Standards.
- (5) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, “Excavation and Trenching,” of these Standards.
- (6) **Disinfecting Potable Pipelines:** PVC pressure pipe shall be disinfected as specified Section 9.12, “Disinfecting Waterlines,” of these Standards.

## 9.05 Water Services

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of water services and fire lines in the pipe diameter size range of 3/4 to 2 inches. For water services and fire lines greater than 2 inches in diameter refer to Section 9.03, “Ductile Iron Pipe,” Section 9.04, “Polyvinyl Chloride (PVC) Pressure Pipe,” Section 9.06, “Gate Valves,” and Section 9.08, “Tapping Sleeves and Valves,” of these Standards.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **Pipe:** Pipe shall be Type K copper, soft drawn, in accordance with ASTM B88.
- (2) **Curb Stops:** All curb stops shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). Curb stop valves shall be ball type with a maximum working pressure of 300 psi and shall have compression fittings.
- (3) **Corporation Stops**
  - (a) All corporation stops and threaded brass fittings shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). All corporation stops shall be tested at the factory and shall meet the following minimum physical requirements:
    - (i) Tensile strength 30,000 PSI minimum.
    - (ii) Yield Strength 14,000 PSI minimum.
    - (iii) Elongation in 2 inches 20 percent minimum.
  - (b) Corporation stops shall be ball valve type designed for a maximum working pressure of 300 psi. The inlet side shall have AWWA taper thread (CC thread) and the outlet side shall have a compression fitting.
  - (c) Corporation stops shall be the following type or a corporation stop approved by the Director as equivalent in design and composition to the following types:
    - (i) Ford – FB1000-3-NLG.

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- (ii) Mcdonald – 74701BQ No lead brass.
- (iii) Mueller – B25008N.

(4) **Water Meters**

- (a) General: All water meter installations shall be in accordance with the following standards and the drawings in Chapter 11, “Technical Drawings,” of these Standards for all water services:
  - (i) All meters shall be “Badger” meters.
  - (ii) No connections shall be made in the meter pit other than those related to the meter and bypass. Sprinkler system or backflow preventer connections shall be made no closer than 5 feet from the meter pit or vault on the downstream side of the meter.
  - (iii) The City will own and maintain the service line and fittings up to and including the meter.
  - (iv) Residential 3/4-inch meters with transponders shall be provided and installed by the City upon the contractor’s request for a final meter inspection. All other meters and associated transponders shall be purchased by the contractor and then provided to the City for testing prior to installation.
  - (v) The contractor shall contact the City’s Meter Shop prior to purchasing meters and transponders to verify the type of meter that will be required. The contractor shall also contact the City’s Meter Shop to make an appointment for delivery of the meter(s) to the City for testing. The location of installation and manufacturer’s information shall accompany the meter when delivered by the contractor to the City. The meter will be tested and a schedule set for picking up the meter within two working days by the contractor.
- (b) 3/4-Inch and 1-Inch Meter Installations: 3/4-inch and 1-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, “Technical Drawings,” of these Standards:
  - (i) The meter shall be installed within right-of-way or a public easement.
  - (ii) No meter shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces.
  - (iii) In attached sidewalk areas, the meter shall be located a minimum of 18 inches from the back of the sidewalk to the edge of the meter lid.
  - (iv) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back edge of the curb.

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- (v) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.
  - (vi) The dome or meter lid shall be level and 2 inches above the approved final grade.
  - (vii) The copper setter shall be a minimum of 15 inches and a maximum of 17 inches below the meter pit lid.
  - (viii) Meter pits shall be constructed of modified hi-density polyethylene. The size shall be as specified in the detail drawing in the appendix of this Chapter. Grade adjustment shall be made at the top of the pit using concrete rings. The trench floor under the concrete rings shall be compacted earth. The concrete pit shall not bear on the service pipe.
  - (ix) Lids shall be a 12-inch cast iron lid and bonnet and shall have a 2-inch diameter hole in the center to accommodate the transponder.
  - (x) Final inspections of the meter pit will be made at the time the meter is set. The permit applicant is responsible for any required adjustments to the copper setter or meter lid at that time.
- (c) 1-1/2-Inch and 2-Inch Meter Installations: 1-1/2 -inch and 2-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, “Technical Drawings,” of these Standards:
- (i) The meter model shall be Badger E112 SS 1 ½ Model 120 or Badger E2 SS 2 Model 170.
  - (ii) 1-1/2-inch and 2-inch meters shall be installed in a manhole.
  - (iii) A meter manhole shall be installed within the right-of-way or a public utility easement.
  - (iv) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.
  - (v) In attached sidewalk areas, the meter manhole shall be located a minimum of 3 feet behind the sidewalk and in no case shall the manhole be located more than 25 feet from the back edge of curb.
  - (vi) Where no sidewalk exists, the meter manhole shall be located a maximum of 6 feet behind the back of curb.
  - (vii) In detached sidewalk areas, the meter manhole shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.

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- (viii) Meter manhole lids shall be a maximum of 2 inches above the approved final grade.
  - (ix) A curb stop is required on the service line behind the back of curb and outside of the manhole.
  - (x) Meter manholes shall use a 24-inch aluminum ring and cover, and the outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch thick concrete collar shall be placed around the manhole ring.
  - (xi) The manhole cover shall have a 2-inch diameter recessed hole in the center of the cover for the transponder, and the cover shall have the lettering “Water Meter” cast into the lid.
- (d) 3-Inch and Larger Meter Installations: 3-inch and larger meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, “Technical Drawings,” of these Standards:
- (i) 3-inch and larger meters shall be installed in a vault.
  - (ii) The entry hole through the roof of the vault shall be aligned perpendicular to the service line and adjacent to the water meter.
  - (iii) Vaults shall be sealed at all joints and made watertight.
  - (iv) Meter vault lids shall be a maximum of 2 inches above the approved final grade.
  - (v) In attached sidewalk areas, the meter vault shall be located a minimum of 5 feet behind sidewalk or back of curb and no more than 25 feet from the back of curb.
  - (vi) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back of curb.
  - (vii) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.
  - (viii) A curb stop is required on the service line behind the back of curb and outside of the vault.
  - (ix) The meter vault shall be installed within the right-of-way or a public utility easement.
  - (x) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.

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- (xi) Meter vaults shall use a 24-inch aluminum cover and shall have the lettering “Water Meter” cast into the lid.
  - (xii) A 24-inch x 36-inch aluminum cover adaptor and ring shall be used to enlarge the access opening, and the adaptor shall have a 2-inch diameter hole for the transponder. The outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch thick concrete collar shall be placed around the manhole ring.
  - (xiii) PVC pressure pipe shall be used on the service line outside the vault except where the PVC pipe stubs through the vault walls. Ductile iron pipe shall be used inside the vault.
  - (xiv) For all 3-inch and 4-inch meter settings, 4-inch service pipe will be required on the City side of the meter. A reducer will be required before the meter and on the bypass for 3-inch settings. Insulators shall be provided between connections of dissimilar metals. Meter installations larger than 4 inches shall require submittal of drawings for approval by the Director.
  - (xv) A minimum of distance 5 times the pipe diameter of straight, unobstructed pipe is required upstream of the meter.
  - (xvi) Final inspections of the meter vault will be made at the time the meter is set.
- (5) **Service Saddles:** Corporation stops require the installation of a bronze or brass bodied service saddle with 304L stainless steel double straps and studs, equivalent in design and composition to “Mueller” BR 2 S series or “McDonald” 3855 series for cast iron or PVC. All saddles require an AWWA tapered thread (CC) outlet. No direct taps to PVC pipe are allowed.
  - (6) **Insulators (Ferrous Pipes only):** Insulators shall be installed at the inlet end of the corporation stop and shall be Ford Service Insulators or an approved equivalent for service lines.

**(C) Execution**

- (1) **General**
  - (a) Size as shown, lay to grades and lines in accordance with pipe manufacturer’s specifications. Thoroughly clean pipe interiors of foreign matter before placing into trench. Replace with new pipe any laid section of pipe found damaged or defective. All pipe fittings, valves, and appurtenances shall be installed according to manufacturer’s instructions. Corporation stops shall be installed with the appropriate tapping machine in the presence of the Director after the waterline has been pressure tested.
  - (b) All bedding, pipe zone backfill, compaction, polyethylene sheathing and other details of the water pipeline construction shall be returned to original condition after service connections are completed.
  - (c) Service connections to all ferrous mains shall be electrically insulated by means of a City approved insulating fitting.
- (2) **Pipe Cutting:** Cutting shall be done neatly by methods that will not damage pipe.

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- (3) **Testing:** Testing of water service pipe shall be as specified in Section 9.13, “Testing of Water Pipes,” of these Standards.
- (4) **Backfilling and Restoring Surface Conditions:** Backfilling and Restoring surface conditions shall be as specified in Section 9.02, “Excavation and Trenching,” of these Standards.
- (5) **Disinfecting Potable Pipelines:** Water service pipe shall be disinfected as specified Section 9.12, “Disinfecting Waterlines,” of these Standards.

## 9.06 Gate Valves

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of gate valves and appurtenances for potable water service in the pipe diameter size range of 4 to 12 inches.
- (2) **Quality Assurance**
  - (a) Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) All valves shall be tested in accordance with AWWA C500 or C509. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

- (1) **Gate Valves**
  - (a) Gate valves are required for 4-inch through 12-inch valve sizes. The Director may approve a different valve type where practical installation of a gate valve is not feasible.
  - (b) Gate valves shall be iron body, resilient-seated gate valves with non-rising bronze stems with design, construction, and pressure ratings conforming to AWWA Specifications C-509-01, Resilient Seated Gate Valves, or C515-01, Reduced Wall Resilient Seated Gate Valves, and with modifications specified herein.
  - (c) Stem seals shall be triple "O" ring seals designed so that the seals above the stem collar can be replaced with the valve under pressure and in full open position.
  - (d) Gate valves shall be one of the following types:
    - (i) American Flow Control, Series 2500 (C515 only).
    - (ii) Mueller, Series 2360 (C509 only).
    - (iii) American AVK.
    - (iv) Series 45 CLOW Valves, Models 2639 and 2640.
  - (e) With the exception of tapping valves and valves in vaults, gate valves shall have mechanical joint ends.
  - (f) All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings



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for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.

- (g) The resilient seat gate valve stem shall have external break-off capabilities for over-torqueing and positive stop to prevent over compression.
- (h) All external bolts, nuts, and washers used in conjunction with valves shall be stainless steel, and tee-bolts shall be "Cor-blu".
- (i) Valves shall be delivered complete with bolts, glands, and rubber gaskets in conformance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

(2) **Valve Boxes**

- (a) All buried valves shall be provided with valve boxes. Valve boxes shall be of cast iron, 3 piece screw type, suitable for the depth of cover required by the drawings. Valve boxes shall be 5 ½ inches in diameter, shall have a minimum thickness at any point of 1/16 inch, and shall be provided with suitable cast iron bases and stay-put covers. Covers shall have cast thereon "water" on the top. They shall be Tyler 6860 series or approved equal.
- (b) The valve box shall have at least 6 inches adjustment above and below specified depth of cover over pipe.
- (c) All parts of valve boxes, bases, and covers shall be coated by dipping in bituminous varnish.
- (d) Valves and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

- (4) **Special Wrenches and Keys:** All tools needed to operate valve and to open valve box lid. At least one of each type as required for each style and size of box and lid shall be furnished by the contractor. Provide 1 key for each valve. Key lengths shall be as approved by the Director.

**(C) Execution**

- (1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.
- (2) **Installation:** Install valves as indicated in Chapter 11, "Technical Drawings," of these Standards, and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation.
- (3) **Valve Boxes:** Install a valve box over the gate valve with the base section centered over the operating nut and resting on well-compacted backfill. The top section shall be so set as to allow equal movement above and below finished grade, with the final elevation to be 1/4 inch below finished grade in roadways and 1 to 2 inches above grade outside of

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roadways. The top of base section shall be placed approximately on line with the operating nut at the top of the valve stem, and the entire assembly shall be plumb.

- (4) **Tests:** Gate valve tests shall be with and part of the general tests on the companion water lines.
- (5) **Disinfection:** Gate valve disinfection shall be done with and as a part of the disinfection to the companion water lines.

## 9.07 Butterfly Valves

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of butterfly valves and appurtenances for potable water service in the pipe diameter size range of 12 inches to 24 inches.
- (2) **Quality Assurance:** Manufacturer's installation recommendations and certificates of compliance shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
- (3) **Testing:** All valves shall be tested in accordance with Section 3.8 of AWWA C504. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

#### (1) Butterfly Valves

- (a) Butterfly valves shall be rubber-seated conforming to the AWWA C504 and designed for buried service. The valves shall be designed to operate as open or closed with a design velocity of 8 feet per second. The valves shall have a cast-iron body with mechanical joint ends conforming to ANSI 21.11, AWWA C111 and shall be rated for a design working pressure of 150 psi. Butterfly valves shall be one of the following types: Mueller, Lineseal III and XPII (sizes up to 48 inches), Pratt, Triton XR-70 (sizes 24 inches to 72 inches), or K-Flo 500 Series (sizes up to 20 inches); unless a butterfly valve equivalent in design and composition to these types has been approved by the Director.
- (b) Discs shall be cast or ductile iron with stainless steel, type 304, either stub or one piece shafts. Discs shall be secured to shafts by means of solid, smooth sided, stainless steel or monel pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of bolts, setscrews, knurled or fluted dowel pins, expansion pins, roll pins spring pins, or other devices in lieu of the pins specified herein will not be acceptable.
- (c) Shaft bearings shall be the bushing type of nylon or Teflon. Thrust bearings that are directly exposed to line liquid and that consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable. Shaft seals may be rubber ring or chevron packing.
- (d) Seats shall be rubber vulcanized to the body and designed to provide bubble tight shutoff with mating surface of Type 304 or 316 stainless steel or monel mounted

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on the discs. Valve seat configurations that rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

- (e) The valve operator shall be the traveling-nut type designed for previous stated conditions, in an enclosed body, sealed to prevent the entrance of groundwater up to the depth of 5 feet above the valve. The operator shall have travel limiting devices to prevent over closing or opening damage to the valve. Valves shall open counterclockwise with the use of a valve key on a 2-inch square operating nut. The housing of traveling-nut type actuators shall be fitted with a removable cover that shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve.

**(C) Execution**

- (1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.
- (2) **Installation:** Install valves with the shaft horizontal according to the manufacturer's recommended installation procedures. Operate all valves from full open to full close before installation. Check all seats, seat rings, shaft sleeves, disc connections, etc. prior to installation.
- (3) **Valve Boxes:** Install valve boxes over the valve operator with the base section centered over the operator nut and resting on well-compacted backfill. The top section shall be set to allow equal movement above and below finished grade, with final elevations to be 1/4 inch below finished grade in roadways and 1 inch to 2 inches above grade outside of roadways. The top of base sections shall be placed approximately on line with the operator nut at the top of the valve stem, and the entire assembly shall be plumb.
- (4) **Tests:** Butterfly valve tests shall be done with and as a part of the general tests on the companion water lines.
- (5) **Disinfection:** Butterfly valve disinfection shall be done with and as a part of the general disinfection to the companion water line.

**9.08 Tapping Sleeves and Valves****(A) General**

- (1) **Scope:** This section describes the furnishing and installation of tapping sleeves and valves for potable water service in the pipe diameter size range of 4 inches to 12 inches.
- (2) **Quality Assurance**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) The manufacturer of tapping sleeves and valves shall be experienced in their design and construction, shall be regularly engaged in their manufacture, and shall have produced tapping sleeves and valves of the sizes specified herein that have given successful service for a period of at least 5 years.

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**(B) Materials****(1) General**

- (a) All tapping sleeves shall be constructed of stainless steel that meets or exceeds the requirements of ASTM A240 Type 304 UNS designated S30400. Tapping sleeves shall be “Romac Industries” SST, “Mueller” H-304L, “Ford” FTSS, “JCM” 432, or a tapping sleeve of equivalent design, material, and rating approved by the Director.
- (b) Extension stems, valve boxes, and special wrenches and keys shall be as specified in Section 9.06(B), “Materials,” of these Standards.
- (2) **Flanges:** Flanges shall be fabricated from steel plate, and all dimensions shall conform to AWWA Standard C207, Class D. Flanges shall be machined to a flat rate with finish of 250 micro inches or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207. In addition, the machined face shall also be recessed for tapping valves in accordance with the MSS Standard SP-60.
- (3) **Gaskets:** Gaskets shall be compounded from new materials, and the shape and cross-section of the gasket shall provide adequate seal for the design pressure. Gaskets shall be shop glued to the groove provided in the body section.
- (4) **Fasteners:** Bolts and hex nuts shall be stainless steel or an approved equivalent for corrosion control.
- (5) **Testing Outlet:** A 3/4 inch NPT by welded coupling shall be attached to the outlet nozzle of each tapping sleeve assembly, complete with a 3/4 inch square head pipe plug.
- (6) **Tapping Valves:** With the exception of the valve ends and other modifications necessary for tapping service, tapping valves shall be as specified in Section 9.06(B), “Materials,” of these Standards. Each tapping valve shall be provided with a flanged inlet end designed, faced and drilled for attachment to the outlet flange of the tapping sleeve; an outlet end provided with a tapping flange for attachment of a standard drilling machine; and a mechanical joint bell end for connection of the branch main. The size of the waterway shall include the appropriate clearance for the diameter of the tapping machine cutter recommended by the valve manufacturer. Tapping valves shall be Mueller “No. H-667” or equal.
- (7) **Painting:** All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.

**(C) Execution**

- (1) **Tapping Valves:** Install tapping valves in the lines as indicated on the drawings, and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation. Valves shall be securely bolted to the tapping sleeve in accordance with

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the manufacturer's instructions using the fasteners specified in Subsection 9.08(B)(4) of these Standards.

- (2) **Tests:** Valve tests shall be done with and as a part of the general tests on the companion waterlines.
- (3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterline.

## 9.09 Fire Hydrants

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of fire hydrants for potable water service.
- (2) **Quality Assurance**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) All valves shall be tested in accordance with Section 5.1 of AWWA C502. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

Fire hydrants shall be "Mueller" Super Centurion 250 A-423 or "CLOW" Medallion 395" (the "CLOW" Medallion shall be a higher-pressure rating with chain tagged "heavy duty"), with mechanical joint bottom connection and meet the following requirements:

- (1) **Inlet Pipe:** 6-inch, mechanical joint inlet shoe and accessories.
- (2) **Trench Depth:** 4-1/2 feet cover (Note: standard shipping depth is 5.0').
- (3) **Operating Nut:** 1-1/2-inch Pentagon National Standard Threads.
- (4) **Open:** Left (CCW).
- (5) **Connection:** Two 2-1/2-inch hose nozzles and one 5-1/4-inch pumper nozzle.
- (6) **Threads:** National Standard Hose Threads.
- (7) **Pressure:** 150 psi working pressure, 300 psi pressure.
- (8) **Break-Off Flange:** Hydrants shall be provided with traffic break-off flange.
- (9) **Mechanical Joint Bolts and Nuts:** The mechanical joint bolts and nuts shall be anti-galling coated stainless steel, "NSS" Cor-Blue, or an equivalent in design, material, and specifications.
- (10) **Shoe Nuts and Bolts:** Shoe nuts and bolts shall be corrosion resistant stainless steel, Grade 304.
- (11) **Color:** Color shall be Rustoleum No. 831 "restful green" or KWAL "hydrant green" except for bonnet, weather caps and nozzle caps, which must be Rustoleum No. 2766 "reflectorized white."
- (12) **Spares:** A set of spare break-off parts shall be furnished.

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**(C) Execution**

- (1) **Hydrants:** Where applicable, hydrants shall be installed with pumper outlet facing the adjacent roadway or parking area. Set hydrants at such elevations that the connecting pipe shall drain to the main with a grade of not less than 1 percent, and upon a concrete foundation not less than 6 inches thick and 18 inches square. The centerline of nozzles shall be at least 18 inches above finished grade. Firmly block the back of the hydrant opposite the pipe connection with a concrete thrust block braced against the vertical face of the trench to prevent the hydrant from blowing off the line.
- (2) **Drainage Aggregate and Backfill:** Place not less than 1/3 cubic-yard of approved clean gravel or crushed rock around the base of each hydrant and 12 inches over the top of the supply pipe to insure drainage. A layer of 30-pound asphalt-saturated felt paper or heavy vinyl sheet shall be placed over gravel to keep backfill material from sifting into gravel. Thoroughly compact the backfill around hydrants, to the grade line, in an approved manner.
- (3) **Operations Check:** Clean hydrant interiors of all foreign matter before installation. Stuffing boxes shall be tightened and the hydrant inspected in opened and closed positions to see that all parts are in working condition.
- (4) **General:** Hydrants shall be tagged “out-of-service” until the water system is operational. It is the responsibility of the contractor to notify Boulder Police Communications regarding the location of the tagged hydrants.

**9.10 Combination Air Valve****(A) General**

- (1) **Scope:** This section describes the furnishing and installation of combination air valves for potable water service.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

**(B) Materials**

- (1) **Manholes:** Refer to Section 9.16, “Manholes and Inlets,” of these Standards.
- (2) **Combination Air Valve:** The valve shall be a 2-inch combination air release vacuum valve, “Vent-O-Mat” Series 050 RB X 25 2 1, or approved equivalent in design, material, and specifications. The combination air valve shall be provided with a 2-inch diameter hand wheel operated gate valve.
- (3) **Hose Gate Valve:** A 3/4-inch hose gate valve is to be installed in the air release valve manhole. The valve shall have a bronze body, threaded end, solid wedge, union bonnet, inside screw rising stem gate valve. These valves shall be “Powell” 375 HS. Each hose gate valve shall be equipped with a brass cap and chain.
- (4) **Ball Valve:** Ball valves shall be of bronze or brass construction with two-piece end entry body, bronze or brass ball, Teflon or Viton stem seal, reinforced Teflon seats and thrust washer, a removable operating lever, and threaded ends. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be drip-tight in both directions. Valves shall

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be “Conbraco Industries” Apollo 70-100 Series, “Powell” Fig 4210T, or “Stockham” S-216.

- (5) **Corporation Stop:** A corporation stop shall be as referenced in Subsection 9.05(B)(3), of these Standards.
- (6) **Insulators:** Insulators shall be as referenced in Subsection 9.05(B)(6), of these Standards.

**(C) Execution**

- (1) **Installation:** Install valve, manhole, and appurtenances as indicated on Drawing No. 5.22, in Chapter 11, “Technical Drawings,” of these Standards, and in accordance with applicable provisions of the related sections.
- (2) **Tests:** Valve tests shall done be with and as a part of the general tests on the companion waterlines.
- (3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterlines.

**9.11 Pipeline Fittings****(A) General**

- (1) **Scope:** This section describes the furnishing and installation of pipeline fittings for potable water service.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

**(B) Materials**

- (1) **Gray or Ductile Iron:** Fittings shall be made from gray iron or ductile iron and manufactured in accordance with AWWA C110-08, Ductile Iron and Gray Iron Fittings, or AWWA C153-06, Ductile Iron Compact Fittings.
- (2) **Rubber Gasket Joints:** Fittings shall be furnished with rubber gasket joints in accordance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- (3) **Design:** Fittings shall be rated for a design working pressure of 350 psi pressure rating and shall conform to the dimensions and weights shown in the tables of the AWWA standards referenced in this Section 9.11(B) of these Standards.
- (4) **Certification:** The manufacturer shall prepare a certified statement that the inspection and all specified tests have been performed and the results thereof comply with the requirements of the applicable AWWA standard(s) specified in Section 9.11(B) of these Standards. The contractor shall cause a copy of the certification to be sent to the City upon request.
- (5) **Ductile Iron Flanged Fittings:** Ductile iron flanged fittings shall be manufactured in accordance with the following:
  - (a) Integrally cast flange fittings: AWWA C110-08, Ductile Iron and Gray Iron

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## Fittings.

- (b) Threated flange fittings: AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
- (c) Ductile iron flanged fittings shall be rated for 250 psi working pressure and shall be installed with special gaskets that achieve 350 psi working pressure.
- (6) **4 Through 6 Inch Fittings:** 4 through 16-inch diameter fittings shall be furnished with a fusion bonded epoxy inside and out, with a standard thickness as defined in AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings. The Director may waive the requirement for fusion bonded epoxy on fittings if the Director finds that specific fittings are not available.
- (7) **Bolts and Nuts:** Fittings shall be furnished with tee-head mechanical joint bolts and hexagon nuts, fabricated from corrosion resistant high strength, low alloy steel such as "Cor-Ten" or "Blue Bolts."
- (8) **Connection fitting:** Mechanical joint anchoring fittings (swivel) shall also be used. Infact Corporation's "Foster Adaptor" may also be used to connect between mechanical joint fittings, valves and hydrant connections.

## 9.12 Disinfecting Waterlines

### (A) Scope

This section describes the disinfecting of all portions of the potable water system, including buried piping, valves, hydrants, and any portion of the existing connecting system that might have become contaminated during construction activities, and also any temporary water service piping used during construction.

### (B) Materials

- (1) **Chlorinating Material:** The chlorinating material shall either be a hypochlorite solution, tablets or granules.
- (2) **Tablet Attachment:** The hypochlorite tablets shall be fastened to the top of the pipe using Permatex No. 1.

### (C) Execution

- (1) **Disinfection**
  - (a) Care shall be taken to prevent contaminating materials from entering the water mains during construction or repair. Such materials that may accidentally enter the main shall be removed by flushing. This flushing shall be done prior to disinfection unless the tablet method of disinfection is used. If, in the opinion of the Director, the contaminated material that has entered cannot be removed by flushing, the interior of the pipe shall be cleaned by mechanical means and then swabbed with a 1 percent hypochlorite solution.
  - (b) Upon completion of the water pipelines, all new pipe, valves, hydrants, etc. shall be thoroughly flushed and disinfected, using a continuous-feed method of



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hypochlorite and water mixture or hypochlorite tablets or granules in accordance with AWWA Standard C-651, latest revision.

- (c) The chlorinating material shall be introduced into the water lines and distribution systems in a manner approved by the Director. After a contact period of not less than 24 hours, the treated water in the lines shall contain not less than 10 mg per liter chlorine using the continuous-feed method or 25 mg per l chlorine using the tablet or granular method throughout the length of the line. The system shall be flushed after successful completion of disinfection with clean water until the residual chlorine content is no more than 1.0 mg per liter. All valves in lines being disinfected, except those being used as bulkheads, shall be opened and closed several times during the contact period. During flushing and disinfection the contractor shall make sure that none of the disinfection solution enters any existing water main.
- (d) Flushing shall be done with a flushing velocity of at least 2 ½ feet per second. The contractor shall provide all fittings required to flush the line. Flushing will be accomplished in such a manner that no erosion will occur and there will be no damage to street, fish, animals, plants or other property.
- (2) **Bacteriological Examination:** After the system has been thoroughly flushed and before the new water line is connected to the distribution system, samples shall be taken from representative points in the system, at intervals of 1200 feet, in sterile bottles treated with sodium thiosulfate. Labeled samples shall be submitted to the City Drinking Water Program staff, or designated certified laboratory, for bacteriological examination. Submitted samples shall meet all City and State bacteriological standards, showing the absence of both coliform and heterotrophic bacterial growths. If the initial disinfection fails to produce satisfactory bacteriological results, the new main shall be reflushed and resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous feed or slug method until satisfactory results are obtained.
- (3) **Disposal of Solution:** Following testing, the solution and flushing water shall be disposed of by the contractor into the nearest sanitary sewer line. The solution and flushing water shall not be dumped into any lakes, streams, waterways, irrigation ditches or stormwater drainage systems. If wasted water cannot be safely discharged into a sanitary sewer system, and then a reducing agent shall be applied to the wasted water to thoroughly neutralize the chlorine residual remaining in the water.

## 9.13 Testing of Water Pipes

### (A) General

This section describes the testing of all water pipe including water mains, fire lines and services.

### (B) Materials

The contractor shall provide all necessary test equipment including test pumps, pipe, connectors, meters, gauges, instruments, and other equipment required. Pressure gauges used shall be graduated in increments no more than 5 psi and shall have a range of approximately twice the test pressure. Gauges meters and other instruments shall be calibrated prior to testing.

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**(C) Execution****(1) Notification and Witness**

- (a) The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.
- (b) The pipe may be subjected to hydrostatic pressure and inspected and tested for leakage at any convenient time after the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director. Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least 2 days have elapsed after the concrete was installed.

**(2) Pressure Test**

- (a) All new pipe shall be pressure tested prior to connection to the existing system. All pipe shall be tested at a pressure of 150 psi at the lowest point in each section or 1½ times the working pressure, whichever is greater.
- (b) Prior to testing, all equipment that would be damaged by the test pressure shall be removed. This equipment shall be replaced in the system after testing is complete. All pipe and appurtenances shall be backfilled except for joints unless otherwise permitted by the Director.
- (c) The contractor shall slowly fill the pipe with water prior to testing and remove all air from the piping system. Each valved section, unless otherwise directed by the Director, shall be tested prior to connection to the existing system. The duration of each pressure test shall be at least 2 continuous hours. Test time will be accrued only while full test pressure is on the system. All water used in testing the pipelines shall be provided by the contractor from a potable water source.
- (d) The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Director. The contractor shall furnish all necessary labor, equipment, and connection corporation stops to the pipeline to perform the test.
- (e) No testing shall be permitted against valves or fittings that are part of the existing system unless specifically approved by the Director. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the test. Any cracked or defective pipe, fittings, valves, or hydrants discovered during the pressure test shall be removed and replaced by the contractor with sound material. The test shall be repeated until the test is satisfactory to the Director.

**(3) Leakage Test**

- (a) A leakage test shall be conducted after the pressure test has been completed, unless the pressure test indicates that there are no leaks. The contractor shall furnish the pump, pipe, connections, meters and all other necessary apparatus, and shall furnish all necessary assistance to conduct the test. The duration of each leakage test shall be two hours, and, during the test, the main shall be subjected to a hydrostatic pressure specified.
- (b) No pipeline installation will be accepted until the leakage is less than the amount computed by the following formula:

$$L = \frac{SD(P)^{0.5}}{133,200}$$

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Where: L = Allowable Leakage (Gallons Per Hour)  
 S = Tested Length of Pipe (Feet)  
 D = Nominal Diameter of Pipe (Inches)  
 P = Average Test Pressure During the Test (psi)

- (c) The contractor shall, at their own expense, locate and repair the points of leakage until the leakage is within the specified allowance.

## 9.14 Polyvinyl Chloride (PVC) Non-pressure Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) non-pressure pipe and appurtenances for storm sewer mains, sanitary sewer mains and sewer services in the pipe diameter size range of 4inches to 15inches.
- (2) **Quality Assurance: Manufacturer's** certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **PVC Non-pressure Pipe**
  - (a) PVC non-pressure pipe shall be type PSM polyvinyl chloride (PVC) having a cell classification of 12454 or 12454 or 13364 (with a minimum tensile modules of 500,000 psi) as defined in ASTM D1784. All PVC pipe and fittings shall meet or exceed all of the material requirements of ASTM D3034 and thickness requirements of SDR 35.
  - (b) Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Gaskets shall conform to ASTM F477. Pipe shall be supplied in laying lengths of 19-1/2 to 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe and all fittings shall have marked on the exterior the following:
    - (i) Manufacturer's Name or Trademark;
    - (ii) Nominal Pipe Size;
    - (iii) PVC Cell Classification (e.g. 12454-B);
    - (iv) Legend - Type PSM SDR-35 Sewer Pipe; and
    - (v) ASTM - D3034.
  - (c) All fittings and plugs to be used with the PVC pipe shall be those manufactured by the manufacturer of the pipe. Each special fitting shall be a completely manufactured unit with either bells or spigots on each connection that are an exact duplication of the bells and spigots on the pipeline. Fittings with any other type of connections will not be accepted.
- (2) **Plugs:** Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation.

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(3) **Couplings**

- (a) Couplings shall be used only where shown on the approved drawings or where approved in writing by the Director. The contractor shall provide a description of an exact location of any couplings used.
- (b) Flexible couplings shall consist of a rubber gasket or boot with a stainless steel shield and tightening bands. Couplings shall be ASTM C1173 Type B couplings and shall be “Fernco Strong Back” or an approved equivalent.

(4) **Grout**

- (a) Grout shall conform to the specifications defined in Section 9.16(B)(5). The contractor may substitute a two-component, 100 percent solids epoxy resin for the specified grout.
- (b) Grout used for sealing service connections shall be a 2-component, waterproof epoxy grout specifically manufactured for this application. The grout shall adhere to any of the dissimilar materials.

- (5) **Sealants:** Sealants used on manholes or pipe connections shall be equal to SIKAFLEX-1a, a one component polyurethane base, elastomeric sealant. When required due to moisture or immersion, provide SIKAFLEX 429 or an equivalent primer for application onto the substrate according to manufacturer’s recommendation.

**(C) Execution**(1) **General**

- (a) Each pipe length and fitting interior, interior surface of bells, and exterior surface of spigots shall be cleaned of all foreign material before placement in the trench and shall be kept clean at all times thereafter. Each item shall also be examined for cracks and other defects before installation.
- (b) Pipe shall be cut, only whenever necessary, to conform to location of manholes or connections. All cuts shall be straight, true, and at right angles to the axis of the pipe. The cutting process shall leave a smooth end without damaging the pipe. All burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed. All tools used in cutting pipe will be subject to the Director’s approval.
- (c) Pipe laying shall proceed with the spigot ends of pipe pointing in the direction of the flow, unless otherwise approved by the Director. Each pipe length shall be laid true to line and grade in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets to the flow line. Pipe shall be laid in a dewatered trench and shall not be used for draining water from the trench. Do not lay pipe when trenches or weather conditions are unsuitable for such work.
- (d) Whenever the pipe is left unattended or pipe laying is not in progress, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent debris and animals from entering the pipe. All temporary plugs will be subject to approval by the Director.
- (e) The contractor shall install the materials in accordance with the manufacturer’s recommendations. If there is a conflict between the methods prescribed in the

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approved plans and the manufacturer's instructions, the contractor shall obtain resolution from the Director, before proceeding with the work.

(2) **Pipe Installation**

- (a) Pipe Laying: No deflection in the joints shall be allowed. All pipe shall be fully supported along the full length of pipe barrel without support by the bell mounding.
- (b) Pipe Joints
  - (i) The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
  - (ii) Bevel the end of cut pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

(3) **Connection of Pipe to Concrete Manhole Base**

- (a) The pipe shall be encased in the concrete poured for the manhole base as detailed in Drawing No. 6.01, "Standard Sewer Manhole," in Chapter 11, "Technical Drawings," in these Standards. Special provisions shall be made for water tightness of the connection.
- (b) The exterior circumference of the pipe where encased in concrete for water tightness shall be uniformly roughened or scarified by sanding with coarse sandpaper or emery cloth for at least 6 inches encased length.
- (c) Additionally, gasket as specified elsewhere shall be stretched onto the pipe to form a weep ring where encased in concrete. Any alteration to the above specified methods for pipe connection to concrete shall be submitted to the Director for approval.

(4) **Grouting**

- (a) Any opening between the manhole wall and pipe made during construction shall be closed and sealed with watertight grout. The opening shall be of sufficient size to accommodate the pipe, "O" rings, and grout. The grout shall extend no less than the full width of the manhole barrel.
- (b) Channels that have been cut into concrete bases shall be smoothed to the specified contour with grout. The grout shall extend no less than the full width of the manhole barrel.

- (5) **Temporary Plugs:** Where required on construction plans and at the end of each sewer service stub out, the pipe shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation without permanently sealing the joint.

- (6) **Sewer Services:** The general location of the sewer service lines is detailed in Drawing No. 6.06, "Sewer Service Line," in Chapter 11, "Technical Drawings," in these Standards. Actual locations of the service lines shall be determined by the approved

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construction plans and in the field by the Director. The contractor shall notify the Director prior to constructing each sewer main so that the Director may have adequate time to determine the final location of each service tee or wye fitting to be installed in the sewer main. Failure of the contractor to properly notify the Director as noted above may result in the contractor's removal of any portion of the sewer main that is necessary to install the fittings in their proper location as determined by the Director.

- (a) The contractor will be allowed to tap and install a service saddle to new sewer mains only at those locations approved by the Director. Connections onto sewer mains shall be made only by boring or drilling with equipment designed for this purpose. Connections shall not be made by impact equipment. The contractor shall request, in writing, Director approval of methods and equipment proposed to be used for performing connections.
- (b) The contractor shall remove from the sewer main all debris created by making connections before the service line is connected.
- (c) Service line saddle connections shall be attached to the sewer main with an epoxy-bonding agent. Where the sewer main has been lined, the original sewer main shall be removed and the saddle shall be attached directly to the liner. The bonding agent shall be applied to a clean, dry surface. The connection shall remain dry until the bonding material has set, depending upon environmental conditions. Backfill around the connection shall not be attempted until the material has hardened and been accepted by the Director.
- (d) At the end of all sewer services, the contractor shall provide plugs and furnish and set two marker posts. One marker post shall be buried at least 3 feet and shall extend at least 2 feet above the ground surface and shall have a piece of green flagging at the top or be painted green. The second marker shall extend from the end of the service to 18 inches below the existing surface. The marker posts shall be wood 2 x 4, 4 x 4 or #4 rebar.
- (7) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.
- (8) **Testing:** Testing of PVC non-pressure pipe shall be as specified in Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

## 9.15 Reinforced Concrete Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of reinforced concrete pipe and appurtenances for culverts and storm drains in the pipe diameter size range of 12 inches to 144 inches. Reinforced concrete pipe shall not be used for sanitary sewer mains.
- (2) **Quality Assurance:**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) The pipe will be tested by the manufacturer based on the three-edge bearing test for both the 0.01 inch crack and the ultimate strength as set forth in ASTM C-497. The pipe shall be tested at the manufacturer's plant. Not more than 1

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percent of the number of pipe lengths, but no fewer than two pipes, for each size of pipe, will be tested. The contractor shall provide copies of the test results to the Director for approval. The Director may select pieces to be tested.

**(B) Materials****(1) Reinforced Concrete Pipe**

- (a) The reinforced concrete pipe shall comply with the requirements of ASTM C76. The pipe shall be Class III unless noted otherwise on the approved construction plans. The cement for the pipe shall conform to the requirements set forth in ASTM 150 and shall be type II and shall have a minimum compressive strength of 4,000 psi. All wall thicknesses shall be those established in “Wall B” in table 3, of said C76 specification, and the reinforcement shall be shown in the same “Wall B.” Each section, or “stick”, of pipe shall be 7 feet-6 inches or greater in length.
- (b) No elliptical reinforcement will be permitted except for any elliptical reinforced concrete pipe designated on the construction plans.
- (c) Lifting holes will not be permitted in any of the pipe. The following shall be clearly marked on the exterior surface of the pipe:
  - (i) ASTM Specification;
  - (ii) Date of manufacture;
  - (iii) Class and size; and
  - (iv) Name or trademark of manufacturer.
- (d) The joint design shall be tongue and groove, or bell and spigot. Joints for the circular reinforced concrete pipe shall be all rubber gasket conforming to ASTM C-443, latest revision. The gasket shall be attached to the spigot of the pipe and shall make the joint flexible and watertight. The contractor may use butyl mastic joint sealant in rope or trowel applied form in lieu of rubber gaskets for circular pipe if approved in writing by the Director. For all non-circular pipe and culverts, butyl mastic joint sealant may be used. The contractor shall submit test results and material specifications on the sealant to the Director before the Director gives written approval of its use. This sealant shall be made specifically for permanently sealing joints in tongue and groove concrete sewer pipe, must adhere tightly to the pipe surface, and form a tight flexible joint. The gaskets or sealants shall be installed as directed by the manufacturer of the pipe.
- (e) Flared end sections, bends and tees shall comply with the requirements of ASTM C76 and shall be the same class and shall have the same joint design as the pipe described above.
- (f) Visual inspections of all materials shall be made at the job site, and pipe will be rejected on account of any deficiencies covered by ASTM Specification Designation C76 or on account of the following:
  - (i) Porous spots, inside or outside, having a greater area than 10 square inches and a depth of more than 1/4 inch;
  - (ii) Patched or repair of porous spots or other defects that are not approved by the Director; or

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- (iii) Exposure of reinforcement that indicates the reinforcement has been replaced.

**(C) Execution****(1) Laying Pipe**

- (a) All materials shall be carefully lowered into the trench piece-by-piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage. Under no circumstances shall materials be dropped or dumped into the trench. All pipe shall be inspected for defects prior to installation. Any defective, damaged or unsound pipe shall be rejected.
- (b) All foreign matter or dirt shall be removed from the inside of the pipe and fittings before the pipe is lowered into its position in the trench. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew is unable to place the pipe into the trench without getting foreign matter or dirt into it, the Director may require that, before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size be placed over each end and left there until the connection is to be made to the adjacent pipes.
- (c) An approved snug-fitting stopper or plug shall be installed in each pipe immediately after it is laid and prior to any further excavating, or backfilling. All openings along the line of the main shall be securely closed as directed and, in the suspension of work at any time, stoppers shall be placed to prevent dirt or other substances from entering the main. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.
- (d) Pipes shall be laid to a true line and at uniform rates of grade between manholes as shown on the approved construction plans. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying. The grade shall be accurately established for each joint by laser beam, or other means approved in writing by the Director. The laser beam shall be checked with a level each time it is moved and each day before construction proceeds, and thereafter as required to assure that it is set at the correct alignment. If any errors of grade are observed, pipe laying shall stop until the grade is corrected.
- (e) Pipe laying shall proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work. The contractor shall make all connections of pipe to the manholes that have previously been constructed. When connecting to existing sewers, the contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.
- (f) Bedding shall be placed under and on both sides of the pipe as each length of sewer pipe is installed.

**(2) Joining Pipe**

- (a) Use a method of joining pipe sections that ensures that ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate enough to overcome the gasket pressure involved.
- (b) Just prior to joining the pipes, the ends of the pipe shall be thoroughly cleaned to remove all foreign substances that may have adhered to the pipe surface. All



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dust and dirt shall be removed with a clean rag. A lubricating solution that is not injurious to the gasket or concrete, such as flax soap or water glass, shall be liberally applied to the gasket groove and to the entire surface of the bell ring. Following this operation, a thin film of lubricant shall be applied to the gasket that shall then be snapped into place in the groove, after which a small diameter smooth steel rod shall be inserted between the gasket and groove and run completely around the gasket to equalize the gasket tension.

- (c) In the event that any foreign matter becomes imbedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant shall be applied.
- (d) The pipe being jointed shall be carefully moved into position, be line and grade checked, and as the spigot end is started into the bell of the section previously laid, the gasket position shall be checked to ensure uniform entry into the bell at all points.

(3) **Testing and Flushing Pipe**

- (a) Prior to acceptance of each section of storm sewer line, the contractor shall jet clean all sewers up through 18 inches in diameter. Larger storm sewers shall be cleaned by other appropriate methods approved by the Director. All dirt and debris shall be prevented from entering the existing storm sewer system by means of watertight plugs or other suitable methods.
- (b) If the Director finds it necessary to clean the mains immediately after construction by rodding, jetting, or both, the Director shall assess the contractor for the cleaning at a set per foot charge with a minimum dollar amount.
- (c) The Director will televise all mains as part of public inspection, and will bill the contractor for the televising at a set per foot charge with a minimum dollar amount. Any defects found during the televising shall be repaired by the contractor, in a manner approved by the Director.
- (d) Any visible infiltration, that the Director finds to be the result of poor installation of the specified materials, shall be repaired by the contractor in a manner approved by the Director before the work will be accepted.
- (e) Before acceptance of the work, the Director will survey the manhole invert and surface elevations. Any inverts or surface elevations not meeting the approved design in the construction plans shall not be approved and shall be redone to the satisfaction of the Director.
- (f) Upon completion of construction, the Director will carefully inspect all sewers and appurtenances. Any unsatisfactory work shall be removed and replaced by the contractor in a proper manner. The invert of sewer and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. Manhole rings and covers must be raised to finished grade before final acceptance of the sewer.
- (g) For sanitary sewers, testing shall be as specified in Section 9.17, “Testing of Gravity Sewer Pipelines and Manholes,” of these Standards.

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**9.16 Manholes and Inlets****(A) General**

- (1) **Scope:** This section describes the furnishing and installation of precast concrete manholes, storm sewer inlets and appurtenances.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

**(B) Materials****(1) General**

- (a) Manholes shall be constructed of precast concrete riser sections, in accordance with Drawing No. 6.01, "Standard Sewer Manhole," in Chapter 11, "Technical Drawings," of these Standards. The concrete sections shall conform to ASTM C478. The top section required for change of diameter shall be concentric cone or flat slab. Invert channel shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. The minimum internal diameter of the manhole barrel shall be in Table 9-6, "Required Manhole Diameters," for all manhole installations:

**Table 9-6: Required Manhole Diameters**

Pipe Size (Diameter)	Inner Manhole Section Diameter
18 Inches (and Smaller)	4 Feet
21 - 36 Inches	5 Feet
42 - 48 Inches	6 Feet
54 Inches (and Larger)	Special Detail

- (b) The minimum internal diameter of the manhole barrel may also be determined by the number and size of pipes junctioning at a manhole. In such cases, the Director may modify the minimum internal diameter of the manhole barrel as required.
- (c) To bring the manhole cover to the correct elevation, the adjustment section of each manhole shall be constructed of brick that is sound and true in shape and size and shall be Grade S-W from clay or shale. Precast concrete grade adjustment rings may be substituted for the brick. These rings shall be not less than 6 inches wide and furnished in heights to allow for 1-inch adjustment. Total adjustment height, with grade rings or bricks, shall not exceed 12 inches.
- (2) **Joints:** Precast manhole and inlet joints shall be made watertight with RUB'R-NEK, Kent Seal No. 2, or LO-MOD GEL material, or approved equivalent. The diameter of gasket shall be as recommended by the manufacturer.
- (3) **Frame and Cover:** Manhole frames and covers shall be of heavy duty traffic lids, Colorado Springs pattern, round base, 22-1/8 inch opening lids 1 inch thick, non-locking type with frame and cover weighing approximately 327 pounds. The cover and frame seat shall be machine finished to prevent any rocking of the cover in its associated frame.

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The cover shall have the word “SEWER” for sanitary sewer manholes, or “STORM SEWER” for storm sewer manholes clearly cast on the surface. Covers for other utility manholes shall also be marked with the appropriate utility designation. Frames and covers shall be CASTINGS, INC. MH 310 COVER B, or approved equivalent.

- (4) **Manhole Steps:** Manhole steps shall be built into and thoroughly anchored to the manhole walls at time of fabrication and shall be positioned as shown on the approved construction plans, and in accordance with the technical drawings in Chapter 11, “Technical Drawings,” of these Standards. The steps shall be made of polypropylene coated reinforcing steel.
- (5) **Grout:** Grout shall be “non-shrink” type with aluminum filings; grout with iron filings is not acceptable. Grout shall be “Five Star Grout,” “Embeco Grout” or equivalent.
- (6) **Concrete:** Concrete for cast-in-place manhole bases shall have a 28-day compressive strength of not less than 3,000 psi. The maximum water content shall be 0.5 pounds of water per pound of cement. Entrained and entrapped air shall be between 4 and 9 percent. All reinforcement shall be standard deformed reinforcement conforming to the requirements set forth in ASTM, A615, Grade 60.
- (7) **Inlets:** Inlets shall be constructed of reinforced concrete and shall conform to the dimensions and specifications as set forth for Type “R” Curb Inlets in Chapter 11, “Technical Drawings,” of these Standards, and CDOT’s M & S Standards. Inlet steps shall be built into and thoroughly anchored to the walls at the time of inlet construction. These steps shall conform to the requirements for manhole steps and shall be positioned as shown on the technical drawings.

**(C) Execution****(1) Construction of Manholes**

- (a) Concrete bases shall be poured on undisturbed ground. Pipe sections shall be flush on the inside of the structural wall (except as noted below) and project outside sufficiently for proper connection to the next pipe section. All pipelines into a manhole shall have a joint located no more than 12 inches from the exterior wall. Where incoming pipes enter a storm drain manhole at an elevation 3 feet or greater above the base, the incoming pipe shall project 2 inches inside the manhole. All annular spaces around the pipe opening shall be grouted.
- (b) For all precast manhole bases, the ground surface below precast concrete bases shall be excavated 6 inches below the elevation of the bottom of the base and backfilled with bedding material, meeting the requirements of Subsection 9.02(B) of these Standards. The bedding material shall be carefully leveled and smoothed as to give uniform support to the precast base over its entire area.
- (c) The invert channels of manholes shall be constructed in accordance with the Drawing No. 6.03, “Manhole Invert,” in Chapter 11, “Technical Drawings,” of these Standards. They shall be smooth and semicircular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Where differences of 24 inches or less in invert elevations are called for, sloped flow channels shall be formed so the water does not undergo a vertical drop. A drop manhole shall be installed where the specified distance in the manhole inverts exceeds 24 inches. The inlet channels may be formed directly in the concrete of the manhole base. The floor of the manhole

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outside of the channel shall be smooth and shall slope towards the channel not less than 1 inch per foot nor more than 2 inches per foot. The manhole covers shall be set with a final elevation of 1/4 inch below the finished grade in roadways and 1 to 2 inches above grade outside of roadways. When a manhole is located in the pavement area, it shall not be constructed to final grade until the pavement has been completed, unless directed otherwise by the Director.

- (d) Install joint material per manufacturer's instructions so that no voids are present. Grout all joints inside and outside after manhole assembly is completed.
  - (e) Gaskets for connecting PVC pipe to manhole sections shall be specifically manufactured for that purpose. The gasket shall provide for at least five bearing points on the pipe surface. The interior circumference of the gasket shall be approximately 5 percent less than the exterior circumference of the pipe. The gasket shall be as manufactured by Hamilton Kent Mfg. Co. of Kent, Ohio, or approved equivalent. All annular spaces around pipe openings must be grouted.
  - (f) Stubs shall be provided at manholes when indicated on the construction plans. Such stubs shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation.
- (2) **Adjusting Manhole Tops:** When grade adjustment of an existing structure is specified, remove frames and covers and reconstruct as required. Reset cleaned frames at the indicated elevation. Prior to final acceptance, clean structures of accumulations of silt, debris, or foreign matter.
  - (3) **Testing Manholes:** Refer to Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

## 9.17 Testing of Gravity Sewer Pipelines and Manholes

### (A) General

This section describes the testing of gravity sewer pipelines and manholes including sanitary sewers and storm drains.

### (B) Materials

The contractor shall provide all equipment and material specifically designed for the testing specified in this section.

### (C) Execution

- (1) **Notification and Witness:** The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.
- (2) **When to Test:** The pipe shall be tested for leakage after the pipe has been installed and the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director.
- (3) **Testing Procedures**

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- (a) **General:** All sanitary sewer mains and appurtenances shall be cleaned, tested, and PACP TV inspected after backfill operations have been completed. The contractor shall furnish all labor, materials, tools, and equipment necessary to clean the pipe and appurtenances, perform the tests and all work incidental thereto. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the contractor
  - (b) **Alignment and Grade:** Gravity sewer pipelines will be checked by the Director to determine whether any displacement of the pipe has occurred after the trench has been bedded. The maximum vertical deflection allowed for PVC pipe is five percent. The City may require the contractor to perform deflection tests of the pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the City. To ensure accurate testing, the line shall be thoroughly cleaned prior to testing.
- (4) **Air Tests**
- (a) Air testing of sanitary sewer pipes shall be done on all sections of pipe between manholes. The pipe shall be cleaned and may be wetted before air testing. The section of pipeline being tested shall be plugged at each manhole with pneumatic balls.
  - (b) Low-pressure air shall be introduced into the plugged line until an internal pressure of 4 psig greater than the average backpressure of any ground water pressure that may submerge the pipe would cause. At least 2 minutes shall pass to allow air temperature to stabilize before the test time is started.
  - (c) No pipeline installation will be accepted if the pressure drops 0.5 psig or more during the time and for the length of pipe shown in Table 9-7, “Specifications for Air Testing of Sanitary Sewer Pipes,” of these Standards:
  - (d) If the pipeline installation fails the air test, repairs shall be made and the pipe shall be retested until it passes the air test.
- (5) **Deflection**
- (a) All PVC non-pressure pipes shall be tested for vertical deflection after placement and compaction of backfill. The maximum deflection allowed is 5 percent.
  - (b) Method of testing shall be by calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the Director. Any and all pipe with vertical deflection greater than the allowable shall be excavated, and removed from the pipeline, replaced, backfilled and compacted as specified, and retested at the contractor’s expense.

**Table 9-7: Specifications for Air Testing of Sanitary Sewer Pipes**

Pipe Diameter (Inches)	Minimum Test Time for Pipe Lengths up to Lengths in Column 3 (min:sec)	Maximum Pipe Length for Minimum Time Testing in Column 2 (Feet)	Minimum Test Time for Pipe Lengths Greater than Column 3 (Seconds)
4	1:53	597	0.190 x Pipe Length (Feet)
	2:50	398	0.427 x Pipe Length (Feet)
8	3:47	298	0.760 x Pipe Length (Feet)

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10	4:43	239	1.187 x Pipe Length (Feet)
12	5:40	199	1.709 x Pipe Length (Feet)
15	7:05	159	2.671 x Pipe Length (Feet)

**(6) Television**

- (a) Following completion of sewer line work, the contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer. TV inspections shall be performed by a PACP certified inspector. Prior to performing the TV inspection, the sewer improvements must be complete, accessible, and cleaned using pressurized water sufficient to allow for a detailed inspection. The City will not accept inspections for lines that have not been cleaned.
- (b) Following TV inspections and any necessary repairs that the contractor may have identified, the City will review the inspection data. If the condition of the pipe is determined to be free of structural defects, deflections, debris, defects in pipe material, and other installation errors, the work will be eligible for acceptance.

**(D) Sanitary Sewer Manholes****(1) General**

- (a) During the construction of the manholes, the contractor shall, in accordance with good construction practice, insure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the sections. The Director shall check each manhole to determine whether the manhole fulfills the requirements of the construction plans and these Standards.
- (b) The Director shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies that might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, any repairs deemed necessary by the Director shall be made by the contractor.
- (c) Exfiltration tests as specified above shall be performed on all sanitary sewer manholes.

**(2) Vacuum Testing:** When required by the Director, sanitary sewer manholes shall be vacuum tested with the following procedure:

- (a) Each manhole shall be tested immediately after assembly and prior to backfilling.
- (b) All lift holes shall be plugged with an approved non-shrink grout.
- (c) No grout will be placed in the horizontal joints before testing.
- (d) All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole.
- (e) The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation.
- (f) A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for one 48 inch diameter manhole, 75 seconds for 60 inches, and 90 seconds for 72 inches.

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- (g) If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

## 9.18 Corrugated Metal Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of corrugated metal pipe and appurtenances for drainage culverts in the pipe diameter size range of 12 to 54 inches.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) Corrugated Metal Pipe

- (a) Pipe shall be fabricated from zinc-coated (galvanized) iron or steel sheets conforming to AASHTO M-218 except as modified herein. The diameter or span by rise dimensions indicated on the drawings shall mean the nominal inside dimensions of the conduit. The widths of the laps and depths or corrugations shall be as specified in AASHTO M-36. The pipe shall have the following minimum gauge (specified thickness) for the sizes shown in Table 9-8, "Corrugated Base Metal Specifications," of these Standards:

**Table 9-8: Corrugated Base Metal Specifications**

Diameter (Inches)	Gauge Number	Specified Galvanized Thickness (Inches)	Specified Galvanized Thickness (Inches)
21 and Smaller	16	0.064	0.0598
24	14	0.079	0.0747
30 - 54	12	0.109	0.1046

- (2) **Dimpled Coupling Bands:** The dimpled coupling bands shall be the same thickness as that used for the pipe and shall be at least 12 inches wide. The dimples shall conform substantially to the shape and depth of pipe corrugations and shall be in circumferential rows. Each row shall contain dimples so spaced as to effectively engage all corrugations of the pipe ends. All bands shall have at least two zinc coated bolts per connection, conforming to ASTM A 307, grade A, electroplated in accordance with ASTM A 164, Type RS, not less than ½ inch in diameter. The bands shall have end connection angles, conforming to ASTM A 36, zinc-coated in accordance to ASTM A 153, not less than 2 inches by 2 inches by 3/16 inch by 11 inches, adequately fastened to the band.
- (3) **Fittings (Including Flared End Sections) and Specials:** Fittings and specials shall be of the same material, coating, and wall thickness, including the same structural qualities, as the adjoining pipe. Steel flared end sections shall be furnished complete with field-bolted toe plates.

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- (4) **Repair of Damaged Spelter Coatings:** Units such as tees, angles or bends on which the spelter coating has been burned by flame cutting and gas or arc welding, or otherwise damaged in fabrication or shipping, shall be wire-brushed and painted with two coats of Haltz-Rust HR-54-53 or equal conforming to Federal Specification and Standards, TT-P-641, or as otherwise approved by the Director. Culverts, pipes, fittings, specials, etc., on which the spelter coating has been bruised or broken either in the shop or in shipping, or that shows defective workmanship, will be rejected.

**(C) Execution**

Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the “Handbook of Steel Drainage and Highway Construction Projects,” published by the American Iron and Steel Institute.

**(1) Bedding**

- (a) All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.
- (b) The bedding material shall be placed evenly on both sides of the pipe to a point 12 inches above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.

- (2) **Backfilling:** After the pipe has been properly installed and bedded, the remaining trench excavation shall be restored as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981. Pipe installed outside of public rights-of-way where no pavement is impacted may be backfilled in the following manner. The backfill shall be placed in 8 inch loose lifts and compacted to 90 percent Standard Proctor density (AASHTO T-180) with mechanical hand tampers, for the first 2 feet. At least 4 feet of cover over the top of pipe shall be provided before the use of wheel-mounted mechanical tampers (free drop hammer), hydraulic tampers, (Hydraulic ram hammers) or other heavy tamping equipment will be permitted. Puddling or jetting will not be allowed.

- (3) **Removal of Trench Protection:** Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point 1 foot above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for “flexible conduits” and create excessive lateral soils pressures and pipe deflections.



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- (4) **Protection of Conduit During Construction:** Maximum supporting strength in flexible conduits does not develop until the fill consolidates. Therefore, excessive concentrated loads or heavy equipment on top of or along side of the pipe shall be avoided.

## 9.19 Cured-in-Place Pipe (CIPP)

### (A) General

- (1) **Scope:** This section describes the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is inserted into the original non-pressure conduit.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **Resin-Impregnated Tube**
- (a) The tube shall meet the requirements of ASTM F1216 and shall have a uniform thickness that, when compressed at installation pressures, will equal the specified nominal tube thickness, with a -5 percent manufacturing tolerance. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during insertion. The minimum length shall be that deemed necessary by the contractor to effectively span the distance between respective access points unless otherwise specified. The contractor shall verify the lengths and diameters in the field before fabricating the tube. Individual insertion runs can be made over one or more manhole sections as determined in the field by the contractor. The maximum allowed insertion run is 1,200 feet. Intermediate manholes will be reopened as directed by the Director.
  - (b) The outside layer of the tube (before insertion) shall be translucent plastic coated with a flexible material that clearly allows inspection of the resin impregnation (wet-out) procedure. The translucent plastic coating on the tube will allow visual proof that the resin has wet-out the entire tube and that there are no dry areas. A vacuum shall be used to ensure the resin fills all dry areas. The plastic coating shall not be subject to delamination after curing of the CIPP.
  - (c) The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials will be allowed in the tube that is subject to delamination of the cured CIPP.
- (2) **Resin:** The resin system shall meet the requirements of ASTM F1216.
- (3) **Structural Requirements**
- (a) The CIPP wall thickness will be measured in accordance with the applicable sections of ASTM Test Method D2122. Sufficient readings, at least eight, will be made to ensure that the minimum thickness has been determined. A cylindrical anvil tubing micrometer accurate to +0.02mm (+0.001 in) will be used. The minimum wall thickness at any cross section shall meet or exceed those shown on the proposal forms and the approved plans, with the allowable

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minus five (-5) percent tolerance. The wall thickness tests will be performed by a Certified Independent Laboratory, approved by the Director. All costs, for testing, shall be borne by the contractor.

- (b) The layers of the CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly of the probe or knife blade moves freely between the layers, nor shall separation of any layers occur during testing performed under the requirements of this specification.
- (c) The cured pipe material (CIPP) shall conform to the minimum structural standards, as follows:
 

(i)	Flexural Stress (ASTM D-790)	4,500 psi
(ii)	Modulus of Elasticity (ASTM D-790)	250,000 psi
- (d) The liner shall be designed assuming a fully deteriorated host pipe.

**(C) Execution****(1) Cleaning**

- (a) The contractor shall be required to remove all internal debris from the line by use of water jet equipment prior to inserting the CIPP tube. The cleaning operation shall remove any and all debris so that each joint of pipe can be thoroughly inspected and successfully reconstructed.
- (b) All sludge, dirt, sand, rocks, grease and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole to another will not be permitted.
- (c) All such debris resulting from the cleaning operations shall be removed from the site and disposed of in the proper manner. The contractor shall bear all costs associated with testing of debris and proper dumping. Dumping of the debris shall be in accordance with all local, state, and federal regulations.
- (d) All debris shall be removed from the downstream manhole and the site no less often than at the end of each workday. The contractor shall leave no debris unattended at the site. Under no circumstances will the contractor be allowed to accumulate debris beyond the stated time. In the event the contractor has not removed the debris generated by the cleaning operation, the contractor will not be allowed to proceed with the work until the debris is properly removed.
- (e) During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might occur by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public or private property being served by the section of sewer line being cleaned. The contractor shall bear all costs associated with any flooding or damage to basements or structures.

- (2) **Bypassing Flows:** The contractor shall provide for flows around the section(s) of pipe designated for rehabilitation. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and

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service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.

- (3) **Inspection of Pipelines:** Inspections of pipelines shall be performed by trained personnel experienced in locating breaks, obstacles and service connections by closed circuit television. The inspection of pipelines is also to determine active service connections and the addresses that they serve. The interior of the pipe shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the CIPP into the pipeline and it shall be noted so these conditions can be corrected. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining.
- (4) **Line Obstructions:** It shall be the responsibility of the contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of the CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional cleaning equipment, then the contractor shall repair the excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Director prior to the commencement of the work.
- (5) **CIPP Installation**
  - (a) CIPP installation shall be in accordance with ASTM F1216, Section 7, with the additional following requirements. The resin shall be cured by circulating hot water within the tube. After curing, the finished pipe (CIPP) shall be continuous and tight fitting.
  - (b) The contractor, and the Director, shall designate a location where the tube will be impregnated with resin prior to installation, in order that an inspection can be made to determine proper materials and procedures. A resin and catalyst system compatible with the requirements of this method shall be used.
  - (c) The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply. Another such gauge shall be placed at the remote manhole to determine the temperature at that location during the cure. If air pressure and steam are used with styrene based resins, the compressed atmosphere shall be monitored with a safety gas detector to ensure that it does not reach the explosive limit.
  - (d) The finished CIPP shall be continuous over the entire length of an insertion run between two manholes and be free, as commercially practicable, from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. It shall also meet the leakage/pressure test requirements specified below (water tightness).
  - (e) Before the insertion process begins, the minimum pressure required to hold the tube tight against the existing conduit and the maximum allowable pressure so as not to damage the tube shall be provided by the tube manufacturer, and it will be the contractor's responsibility to obtain and submit this information to the Director. Once the insertion has started, the pressure shall be maintained between the minimum and maximum pressures until the operation has been completed. If air pressure is used for inversion, the equipment shall be fitted with a pressure gauge accurate to 0.01 psi. Should the pressure deviate from within the range of minimum and maximum pressures, the installed tube will be rejected and the contractor will remove and dispose of the tube, at their expense.

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- (f) Before the curing process begins, the pressure required to hold the flexible tube tight against the host pipe shall be provided by the tube manufacturer and submitted to the Director prior to any inversion process. Once the cure has started and dimpling for laterals is completed, the required pressure shall be maintained until the cure is complete. Should the pressure deviate more than 1 psi (2.3 feet of water) from the required pressure during the critical curing period, the tube will be rejected and the contractor will be responsible for its removal and disposal and replacement with new CIPP at, at their expense. A complete log of the pressures shall be maintained on site and shall be offered to the Director after each inversion.
- (6) **Sealing at Manholes:** A hydrophilic end seal shall be installed at the upstream and downstream manholes prior to installation of the CIPP liner. The end seals shall be LMK Insignia End Seals or equivalent.
- (7) **Service Connections**
  - (a) After the curing of the CIPP is completed, the contractor shall restore the existing active service connections and branch connections. The connections shall be reopened without excavation, and in the case of non-man entry pipes, from the interior of the pipeline utilizing a remotely controlled cutting device, monitored by a closed circuit television camera, that re-establishes them to not less than 95 percent capacity, while conforming to the shape of the existing opening. All reinstated openings shall be smoothed by brushing with a wire brush.
  - (b) The contractor shall verify the possession of at least two complete cutting devices in good working order before each insertion.
  - (c) If excavations for the purpose of re-opening connections are required, the contractor will be responsible for all costs and liability associated with such excavation and restoration work.
  - (d) No service connection shall remain out of service for more than 24 hours at a time unless the contractor has provided temporary facilities or other appropriate accommodations for the affected service.
- (8) **Testing:** CIPP samples shall be prepared and tested in accordance with ASTM F1216, Section 8.1, using both methods 8.1.1 and 8.1.2 if so required by the Director. The test will be performed by a Certified Independent Laboratory, approved by the City. Tests results shall be submitted to the Director. Costs of the tests are considered to be incidental to the project.
- (9) **Visual Inspection:** Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.4. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining.

## 9.20 Pipe Bursting Non-Pressure Pipe

### (A) General

- (1) **Scope:** This section describes the reconstruction of pipelines and conduits by which a bursting unit splits the existing pipe while simultaneously installing a new polyethylene pipe of the same size or larger where the old pipe existed.

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- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

**(B) Materials**

- (1) **Polyethylene Plastic Pipe:** The pipe shall be high density polyethylene pipe and meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR). Sizes of the insertions to be used shall be such to renew the pipe to its original or greater flow capacity. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
- (2) **Dimension Ratios:** The polyethylene pipe shall meet or exceed the thickness requirement of SDR 17.

**(C) Execution**

- (1) **Bypassing Flows:** The contractor shall provide for flow around the section(s) of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.
- (2) **Inspection:** Inspection of work shall be in accordance with Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.
- (3) **Equipment:** The pipe bursting tool shall be designed and manufactured to force its way through existing pipe material by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall be pneumatic and shall generate sufficient force to burst and compact the existing pipeline. The bursting tool shall be selected in accordance with the manufacturer's recommendations to meet the project specific requirements for the type and size of pipe being burst and upsized if specified. The pipe bursting tool shall be pulled through the sewer by a winch located at the receiver pit. The bursting unit shall pull the polyethylene pipe with it as it moves forward.

**9.21 Telecommunication or Cable System Standards**

The installation and construction of telecommunication or cable systems shall comply with the requirements as set forth in Chapter 11-6, "Boulder Cable Code," B.R.C. 1981, and these Standards.

**(A) General**

- (1) **Applicable National Standards:** All telecommunications and cable system construction shall conform to the requirements of the following standards:
  - (a) American National Standards Institute, Inc. (ANSI), Electronic Industries Association (EIA), and Telecommunications Institute of America (TIA) Standards: EIA/TIA Standards Proposal No. 2840-A, Proposed Revision of EIA/TIA-568 (if approved to be published as EIA/TIA-568-A), EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces,

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and TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

- (b) National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.
  - (c) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).
  - (d) Federal Communications Commission.
  - (e) Colorado Public Utilities Commission.
  - (f) Williams-Steiger Occupational Safety and Health Act (OSHA).
- (2) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, “General Requirements,” of these Standards, showing the specific underground and/or aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director’s office for review and approval.
- (3) **Protection of Systems:** All systems shall be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

**(B) Underground Facilities****(1) Cable Protection**

- (a) All buried telecommunications cable, shall be installed in conduit, PVC Schedule 40 or equivalent. Cable placement by means of direct plow-in will not be allowed within the City’s rights-of-way.
- (b) Major conduit duct banks (more than 4 conduits) and those comprising a portion of the City’s telecommunications conduit backbone infrastructure shall be encased in concrete with a minimum strength of 2000 psi. When encased in concrete, conduit may be PVC Type EB, DB or equivalent. The concrete encasement shall have a minimum thickness of 4 inches around the entire conduit or duct bank.
- (c) Multiple duct systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.
- (d) Conduit placed by directional bore method will be allowed subject to approval by the Director.

(2) **Depth of Cover:** The minimum depth of cover over the conduit shall be 30 inches.

**(3) Trench Specifications - Roadway and Other Paved Surfaces**

- (a) All trenches shall be open cut unless otherwise permitted by the City.
- (b) Trenches shall have a minimum width of 10 inches.
- (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement and Sidewalks,” B.R.C. 1981.

**(4) Trench Specifications - Landscaped Areas**

- (a) All trenches shall be open cut unless otherwise permitted by the City.
- (b) Trenches shall have a minimum width of 10 inches.

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- (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
- (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees shrubs or other landscaping or if construction is within 5 feet of a tree.
- (5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.
- (6) **Joint Use Trench Requirements**
  - (a) Joint trenching operations require advanced planning and coordination with the utilities involved.
  - (b) Vertical and horizontal separations between telecommunications or cable systems and other facilities shall be maintained as required by NESC Section 32, Underground Conduit Systems. Conduit systems for telecommunications and cable systems shall be separated from conduit systems for power supply systems by:
    - (i) 3 inches of concrete,
    - (ii) 4 inches of masonry, or
    - (iii) 12 inches of well-tamped earth.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.
- (8) **Manholes**
  - (a) All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane, road shoulders, sidewalk, multi-use path, or bike lane.
  - (b) Manholes or handholes shall be placed at maximum 1,200 feet intervals. In no case shall conduit bend radius exceed 180 degrees between manholes. Manholes shall be installed at each street intersection at a minimum. Manholes shall be rectangular: 6 feet wide by 7 feet long by 4 feet deep; or circular 4 feet diameter with a nominal depth of 4 feet minimum.
  - (c) Manholes or handholes shall be installed flush or ¼” below the surrounding grade.

**(C) Aboveground Facilities**

- (1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.
- (2) **Obstruction to Traffic Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.
- (3) **Clearances:** All aboveground telecommunications facility construction shall conform with the minimum clearances as specified in Section 23 of the NESC.

Exhibit A

- (a) Cables shall maintain the following minimum clearances between any adjacent or crossing power cables under all conditions of cable loading:
  - (i) Horizontal clearances shall be at least 5 feet from power cables at a potential of up to 129 kV, and at least 5 feet plus 0.4 inches per kV over 129 kV from power cables exceeding a potential of 129 kV.
  - (ii) Vertical clearances shall be at least 4 feet from power cables at a potential of up to 750 V, at least 6 feet from power cables at a potential of 750 V to 22 kV, at least 6 feet plus 0.4 inches per kV over 22 kV from power cables at a potential between 22 kV and 470 kV. Vertical clearances shall comply with NESC Rule 233C3 for minimum clearance from cables at a potential greater than 470 kV.
- (b) Cables, poles, and stubs shall maintain the following minimum clearances from power conductors, power poles and other objects:
  - (i) Poles shall have a minimum clearance of 4 feet from fire hydrants, signal pedestals, and call boxes.
  - (ii) Cables shall have a minimum horizontal clearance from power poles in no wind conditions.
  - (iii) Poles and stubs shall have a minimum horizontal clearance of 5 feet in no wind condition from power wires up to 50 kV.
- (c) Poles shall have a minimum separation of at least 2 feet from the street side of the curb to the nearest part of the pole and shall be located a sufficient distance from the street side of the curb to avoid contact with ordinary vehicles using the road.
- (d) Poles shall have at least 12 feet horizontal clearance from the nearest rail to the nearest part of the pole.
- (e) Cables shall have at least 2 feet vertical clearance from Police and Fire Alarm facilities.
- (f) Cables shall have at least 3 feet clearance in all directions from signs, chimneys, tanks, and other installations.
- (g) Cables shall maintain the following minimum vertical clearances as measured from the lowest point of the cable when crossing the following objects:
  - (i) Roads, Streets, and all areas subject to truck traffic: 18 feet.
  - (ii) Alleys, Driveways, and Parking Lots: 18 feet.
  - (iii) Railroad tracks: 28 feet.
  - (iv) Roofs, not accessible: 4 feet.
  - (v) Spaces and Ways, accessible to pedestrians only: 12 feet.
  - (vi) Roofs, accessible to vehicular traffic, but not trucks: 12 feet.
- (h) Cables shall maintain a minimum vertical clearances of 16 feet as measured from the lowest point of the cable when running alongside but not overhanging roads, streets, or alleys.



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- (i) A minimum vertical clearance of 40 inches shall be maintained between telecommunications cables and power cables at the attachment points on joint use poles.

## 9.22 Electric Power Facility Standards

The following standards shall apply to all electric power related facilities constructed within the City's public rights-of-way or easements.

### (A) General

- (1) **Undergrounding Required:** All electric power facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.
- (2) **National Standards:** All electric power facility construction shall conform to the requirements of the following standards:
  - (a) 1993 National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.
  - (b) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).
  - (c) Colorado Public Utilities Commission.
  - (d) Williams-Steiger Occupational Safety and Health Act (OSHA).
- (3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific underground and/or aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director for review and approval.
- (4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

### (B) Underground Facilities

- (1) **Underground Cable Protection**
  - (a) All primary circuits (greater than 600 volts) located under concrete road surfaces, where circuit density is high, and in all arterial roads shall be installed in conduit, 4 inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.
  - (b) All secondary circuits (600 volts or less) supplying services larger than 800 amperes shall be installed in conduit, 2-inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.
  - (c) Multiple duct bank systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.
- (2) **Depth of Cover**

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- (a) The minimum depth of cover over primary circuits (greater than 600 volts) shall be 42 inches.
  - (b) The minimum depth of cover over secondary circuits shall be 30 inches (600 volts or less).
  - (c) The minimum depth of cover over circuits for street lighting and signals shall be 18 inches.
- (3) **Trench Specifications - Roadways and Other Paved Surfaces**
  - (a) All trenches shall be open cut unless otherwise permitted by the Director.
  - (b) Trenches shall have a minimum width of 10 inches.
  - (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement and Sidewalks,” B.R.C. 1981.
- (4) **Trench Specifications - Landscaped Areas**
  - (a) All trenches shall be open cut unless otherwise permitted by the Director.
  - (b) Trenches shall have a minimum width of 10 inches.
  - (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
  - (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.
- (5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.
- (6) **Joint Use Trench Requirements**
  - (a) Joint trenching operations require advanced planning and coordination with the utilities involved.
  - (b) Vertical and horizontal separations between electric power facilities and other facilities shall be maintained as required by the NESC section 32 Underground Conduit Systems.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit or cable in the trench.
- (8) **Manholes:** All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane including road shoulders, sidewalks, multi-use paths, or bike lanes.

**(C) Aboveground Facilities**

- (1) **General**
  - (a) All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.

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- (b) All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.
- (2) **Clearances:** The minimum overhead transverse clearance shall conform to National Electrical Safety Code Standards, but shall not be less than 18 feet measured from the highest point of the road prism to the bottom of the cable.

## 9.23 Gas Distribution Facility Standards

The following standards shall apply to all gas distribution related facilities constructed within the City's public rights-of-way or easements.

### (A) General

- (1) **Undergrounding Required:** All gas distribution facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.
- (2) **National Standards:** All gas distribution facility construction shall conform to the requirements of the following standards:
  - (a) Minimum Federal Safety Standards for Natural Gas Pipelines in the Code of Federal regulations 49 Part 192.
  - (b) Colorado Public Utilities Commission.
  - (c) Williams-Steiger Occupational Safety and Health Act (OSHA).
- (3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific gas distribution line and appurtenances locations and specifications, shall be submitted to the Director for review and approval.
- (4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

### (B) Underground Facilities

- (1) **Materials**
  - (a) Steel or plastic material shall be used for the gas distribution pipe.
  - (b) All plastic pipe must be installed below ground level.
- (2) **Depth of Cover**
  - (a) Depth of cover shall be measured from the final grade to the top of the pipe.
  - (b) Minimum depth of cover for shall be 36 inches for transmission lines and 30 inches for distribution lines.
  - (c) Minimum depth of cover for service lines shall be 24 inches.
  - (d) Transmission and distribution lines installed under streams and ditches must have minimum cover of 48 inches.
- (3) **Trench Specifications - Roadways and Other Paved Surfaces**
  - (a) All trenches shall be open cut unless otherwise permitted by the Director.

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- (b) Trenches shall have a minimum width of 10 inches.
- (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement and Sidewalks,” B.R.C. 1981.
- (4) **Trench Specifications - Landscaped Areas**
  - (a) All trenches shall be open cut unless otherwise permitted by the Director.
  - (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
  - (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
  - (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.
- (5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.
- (6) **Joint Use Trench Requirements**
  - (a) Joint trenching operations require advanced planning and coordination with the utilities involved.
  - (b) Vertical and horizontal separations between gas distribution facilities and other facilities shall be 6 inches minimum.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.
- (8) **Components**
  - (a) Transmission line valves shall be installed in boxes or be otherwise readily accessible.
  - (b) Transmission line pressure relief and pressure limiting devices shall be installed in underground vaults, unless aboveground installation is permitted by the Director.
  - (c) All service lines shall be equipped with shutoff valves.
  - (d) An electrically conductive tracer wire shall be installed with all plastic and non-conductive pipes.
- (9) **Casing Pipe:** Gas pipe shall be installed in casings under all highways. Casing pipe shall be steel pipe with a wall thickness of 1/4 inch minimum extending at least 5 feet beyond the limits of any highway improvements.
- (10) **Corrosion Protection**
  - (a) All pipes susceptible to corrosion shall be cathodically protected and have a protective coating.
  - (b) All corrosion susceptible pipes must also be electrically isolated from other metallic structures.

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**(C) Testing Requirements**

All newly constructed pipes shall be tested prior to placing the line in service. No pipe shall be placed in service, or returned to service, with leaks or without adequate corrosion protection.

- (1) **Pressure Testing:** All pipes shall be pressure tested for leakage as described in CFR 49 part 192. In order to establish the maximum allowable operating pressure (MAOP), pipes shall be tested at 1-1/2 times the MAOP.
- (2) **Corrosion Control Testing:** Corrosion control devices shall be tested whenever the pipe is exposed for maintenance or repair. Additionally, all corrosion control devices must be tested at least once each calendar year.
- (3) **Records Retention:** Records of the testing shall be maintained for the life of the pipe.

**(D) Aboveground Facilities**

- (1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.
- (2) **Traffic Obstruction Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.

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**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

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# CHAPTER 11

## TECHNICAL DRAWINGS

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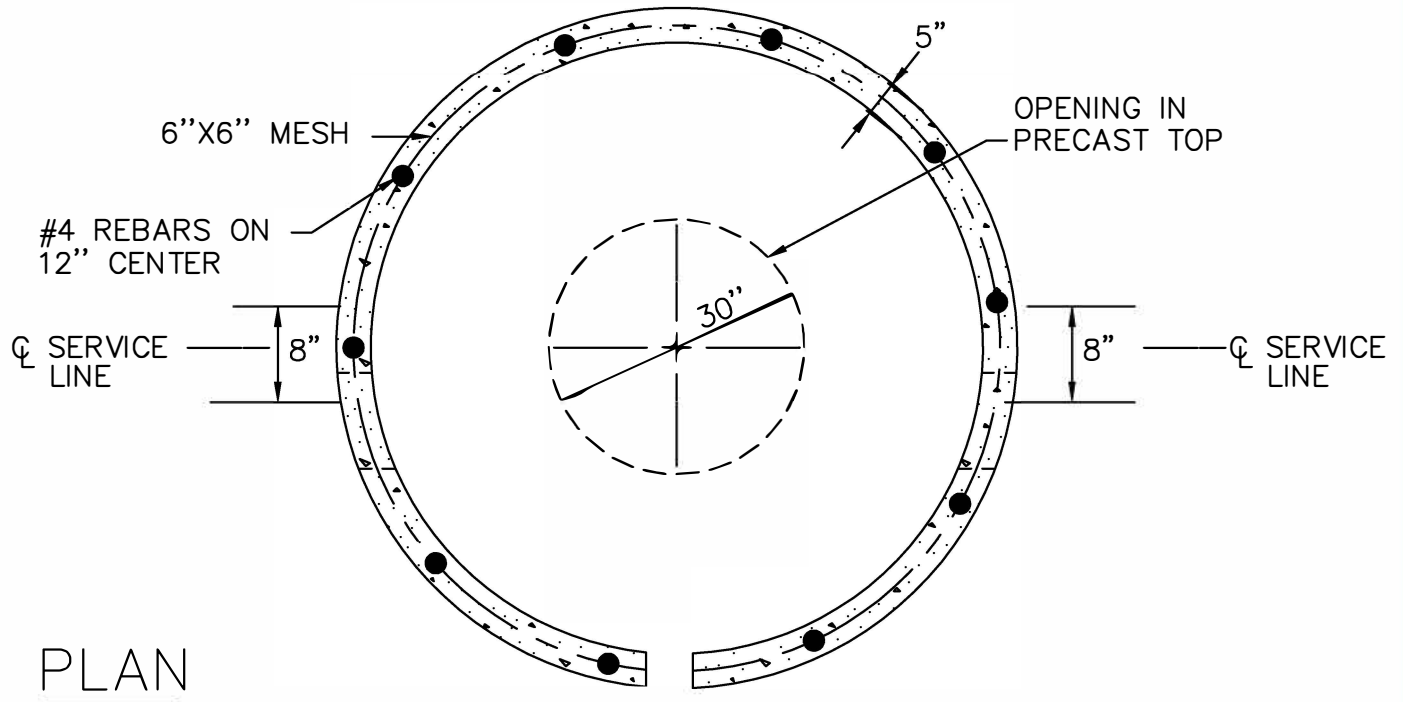
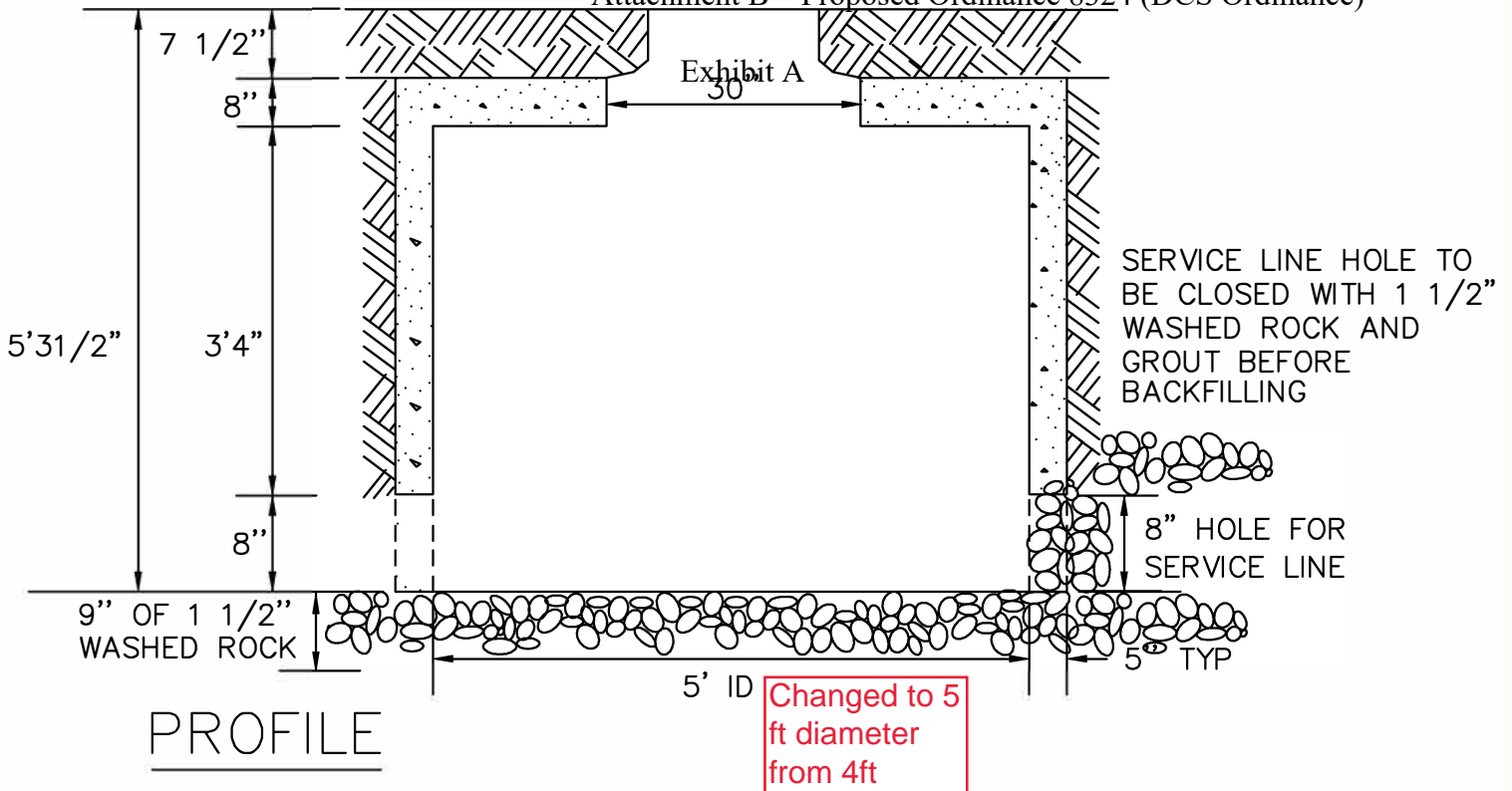
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NOTE: PRECAST CONCRETE STRUCTURES SHALL MEET ASTM C-478.

DRAWN BY: JSH

CHECKED BY: RJH

APPROVED BY:  
DIRECTOR OF PUBLIC WORKS

Item 3E - Stormwater and DCS Updates

CITY OF BOULDER, COLORADO  
STANDARD METER PIT  
1 1/2" - 2" SERVICE

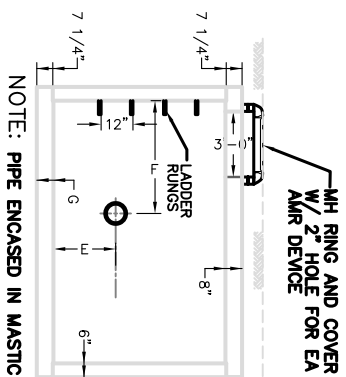
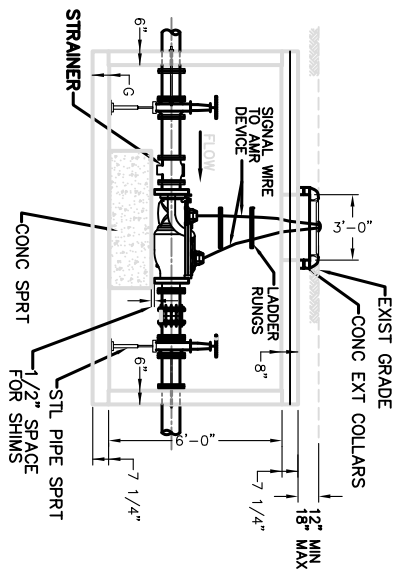
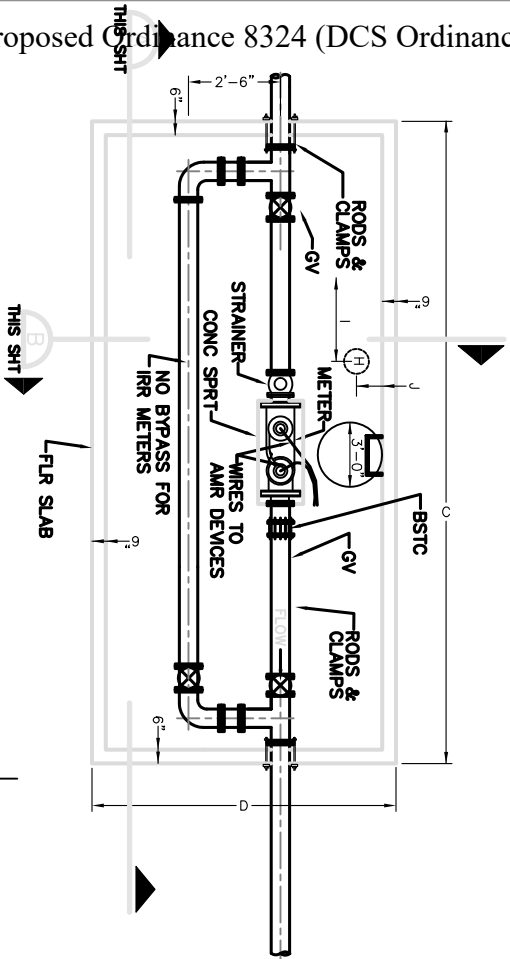
ISSUED: JULY 2, 1998

REVISED: OCT. 17, 2000

DRAWING NO.

5.17B

# Attachment B – Proposed Ordinance 8324 (DCS Ordinance)



NOTES:  
Exhibit A

THE ROOF SLAB MAY BE CAST IN SECTIONS FOR FUTURE ACCESS THE INDIVIDUAL SECTION WEIGHT MUST NOT EXCEED 7,500 POUNDS ACCORDING TO MS-26.

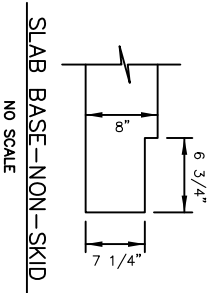
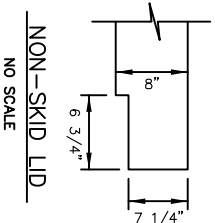
THE DISTANCE BETWEEN RUNGS, CLEATS AND STEPS SHALL NOT EXCEED 12 INCHES AND SHALL BE UNIFORM THROUGHOUT THE LENGTH OF THE LADDER.

3. EACH METER REGISTER REQUIRES AN ELECTRONIC DIGITAL ENCODER OR MECHANICALLY ENCODED REGISTER WITH AMR DEVICES EXCEPT FOR MASTER METER DISTRIBUTORS. THE CITY OF BOULDER WILL DETERMINE TYPE OF AMR DEVICES AND LOCATION PRIOR TO VAULT INSTALLATION.

4. ALL VALVES MUST BE NON RISING STEM RIGHT HAND OPEN VALVES.

5. STRAINER TO BE USED ONLY ON TURBINE METERS.

6. ALL VALVES MUST HAVE STEEL PIPE SUPPORTS.



METER SIZE	PIPE SIZE Ø	PRECAST VAULT DIMENSIONS						SUMP			
		C	D	E	F	G	H	I	J		
3"	3"	9'-6"	8'-0"	2'-0"	2'-6"	6"	12"	2'-2"	1'-6"		
4"	4"	10'-6"	8'-0"	2'-6"	2'-6"	6"	12"	2'-2"	1'-6"		

NOTE:  
VAULTS ARE PRECAST TO DIMENSION IN CHART

DRAWN BY: CSM  
CHECKED BY: RJH

APPROVED BY:  
DIRECTOR OF PUBLIC WORKS

CITY OF BOULDER, COLORADO  
LARGE METER IN  
PRECAST VAULT  
3" OR LARGER

ISSUED: JULY 2, 1998  
REVISED: SEPT 29, 2010

DRAWING NO.  
5.18A

## Exhibit A

1. THE ROOF SLAB MAY BE CAST IN SECTIONS FOR FUTURE ACCESS. THE INDIVIDUAL SECTION WEIGHT MUST NOT EXCEED 7,500 POUNDS ACCORDING TO MS-26.

2. THE DISTANCE BETWEEN RUNGS, CLEATS AND STEPS SHALL NOT EXCEED 12 INCHES AND SHALL BE UNIFORM THROUGHOUT THE LENGTH OF THE LADDER.

3. EACH METER REGISTER REQUIRES AN ELECTRONIC DIGITAL ENCODER OR MECHANICALLY ENCODED REGISTER WITH AMR DEVICES EXCEPT FOR MASTER METER DISTRIBUTORS. THE CITY OF BOULDER WILL DETERMINE TYPE OF AMR DEVICES AND LOCATION PRIOR TO VAULT INSTALLATION.

4. ALL VALVES MUST BE NON RISING STEM RIGHT HAND OPEN VALVES.

5. ALL PIPING MUST HAVE STEEL PIPE SUPPORTS.



NOTE:  
VAULTS ARE PRECAST TO DIMENSION IN CHART

CITY OF BOULDER, COLORADO  
LARGE METER IN  
PRECAST VAULT  
6" OR LARGER

DRAWING NO.  
5.18B

## Exhibit A

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

---

## GLOSSARY

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### SECTION 1: ABBREVIATIONS

Wherever the following abbreviations are used in these Design and Construction Standards (Standards), or in association with these Standards, the intent and meaning shall be as follows:

<b>AAN</b>	American Association of Nursery-men	<b>ASME</b>	Architects American Society of Mechanical Engineers
<b>AAR</b>	Association of American Railroads	<b>ASTM</b>	American Society for Testing and Materials
<b>AASHTO</b>	American Association of State Highway and Transportation Officials	<b>ATSSA</b>	American Traffic Safety Services Association
<b>ABC</b>	Aggregate Base Course	<b>AWG</b>	American Wire Gauge
<b>AC</b>	Asphaltic Cement	<b>AWPA</b>	American Wood Preservers Association
<b>ACI</b>	American Concrete Institute	<b>AWS</b>	American Welding Society
<b>ADT</b>	Average Daily Trips	<b>AWWA</b>	American Water Works Association
<b>AGCA</b>	Associated General Contractors of America		
<b>AI</b>	Asphalt Institute	<b>BFD</b>	Boulder Fire Department
<b>AIA</b>	American Institute of Architects	<b>BMP</b>	Best Management Practices
<b>AISC</b>	American Institute of Steel Construction	<b>BRC</b>	Boulder Revised Code, 1981
<b>AISI</b>	American Iron and Steel Institute	<b>CCA</b>	Colorado Contractors Association
<b>AITC</b>	American Institute of Timber Construction	<b>CDOT</b>	Colorado Department of Transportation
<b>ANSI</b>	American National Standards Institute, Inc.	<b>CDPHE</b>	Colorado Department of Public Health and Environment
<b>APWA</b>	American Public Works Association	<b>CDPS</b>	Colorado Discharge Permit System
<b>ARA</b>	American Railway Association	<b>CFR</b>	Code of Federal Regulations
<b>AREA</b>	American Railway Engineering Association	<b>CFS</b>	Cubic Feet per Second
<b>ARTBA</b>	American Road and Transportation Builders Association	<b>CLOMA</b>	Conditional Letter of Map Amendment
<b>ASCE</b>	American Society of Civil Engineers	<b>CLOMR</b>	Conditional Letter of Map Revision
<b>ASLA</b>	American Society of Landscape Architects	<b>CMP</b>	Corrugated Metal Pipe

## Exhibit A

<b>CP</b>	Colorado Procedure	<b>IMSA</b>	International Municipal Signal Association
<b>CPUC</b>	Colorado Public Utilities Commission	<b>IPCEA</b>	Insulated Power Cable Engineers Association
<b>CRS</b>	Colorado Revised Statutes, 1973, as amended	<b>ISO</b>	Insurance Service Office
<b>CRSI</b>	Concrete Reinforcing Steel Institute	<b>ITE</b>	Institute of Transportation Engineers
<b>CUHP</b>	Colorado Urban Hydrograph Procedure	<b>LID</b>	Low-Impact Development
		<b>LLD PE</b>	Linear low-density polyethylene
		<b>LOMA</b>	Letter of Map Amendment
		<b>LOMR</b>	Letter of Map Revision
		<b>LOS</b>	Level of Service
<b>DHV</b>	Design Hour Volume		
<b>DIP</b>	Ductile Iron Pipe		
<b>DRCOG</b>	Denver Regional Council of Governments		
<b>DWG</b>	Drawing		
<b>EDLA</b>	Equivalent Daily Load Applications	<b>MDCIA</b>	Minimizing Directly-Connected Impervious Areas
<b>EIA</b>	Electronic Industries Association	<b>MIL</b>	Military Specifications
<b>EPA</b>	Environmental Protection Agency	<b>MPH</b>	Miles Per Hour
		<b>MUP</b>	Master Utility Plan
		<b>MUTCD</b>	Manual on Uniform Traffic Control Devices
<b>FEMA</b>	Federal Emergency Management Agency		
<b>FHWA</b>	Federal Highway Administration		
<b>FL</b>	Flowline	<b>NCAR</b>	National Center for Atmospheric Research
<b>FPS</b>	Feet Per Second	<b>NEC</b>	National Electrical Code
<b>FSS</b>	Federal Specifications and Standards	<b>NEMA</b>	National Electrical Manufacturers Association
<b>GIDM</b>	Gallons Per Inch Diameter Per Mile	<b>NESC</b>	National Electrical Safety Code
<b>GPAD</b>	Gallons Per Acre Per Day	<b>NFPA</b>	National Fire Protection Association
<b>GPCD</b>	Gallons Per Capita Per Day	<b>NIST</b>	National Institute of Standards and Technology
<b>GPM</b>	Gallons Per Minute	<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>HCM</b>	Highway Capacity Manual	<b>NPK</b>	Nitrogen-Phosphorus-Potassium
<b>HBP</b>	Hot Bituminous Pavement	<b>NSF</b>	National Sanitation Foundation
<b>HGL</b>	Hydraulic Grade Line		
<b>HSG</b>	Hydrologic Soil Group		
<b>ICBO</b>	International Conference of Building Officials	<b>OSHA</b>	Occupational Safety and Health Administration
<b>IFC</b>	International Fire Code		
<b>IPC</b>	International Plumbing Code		
<b>IEEE</b>	Institute of Electrical and Electronics Engineers	<b>PC</b>	Point of Curve
<b>IES</b>	Illuminating Engineering Society	<b>PCC</b>	Portland Cement Concrete or

## Exhibit A

<b>PLS</b>	Point of Compound Curve Pure Live Seed	<b>VPC</b>	Vertical Point of Curve
<b>PMR</b>	Physical Map Revision	<b>VPI</b>	Vertical Point of Intersection
<b>POTW</b>	Publicly Owned Treatment Works	<b>VPT</b>	Vertical Point of Tangent
<b>PRC</b>	Point of Reverse Curve	<b>WQCV</b>	Water Quality Capture Volume
<b>PRV</b>	Pressure Reducing Valve		
<b>PT</b>	Point of Tangent		
<b>PVC</b>	Polyvinyl Chloride		
<b>RCP</b>	Reinforced Concrete Pipe		
<b>ROW</b>	Right of Way		
<b>RPA</b>	Receiving Previous Area		
<b>SAE</b>	Society of Automotive Engineers		
<b>SCM</b>	Stormwater Control Measure or Control Measure for Post-Construction Stormwater Quality		
<b>SDR</b>	Standard Dimensional Ratio		
<b>SEO</b>	State Engineer's Office		
<b>SHAC</b>	State Highway Access Code		
<b>SWMP</b>	Stormwater Management Plan		
<b>TC</b>	Top of Curb		
<b>TIA</b>	Telecommunications Institute of America		
<b>TMDL</b>	Total Maximum Daily Load		
<b>TMP</b>	Transportation Master Plan, City of Boulder		
<b>UBC</b>	Uniform Building Code		
<b>UDFCD</b>	Urban Drainage and Flood Control District		
<b>UIA</b>	Unconnected Impervious Area		
<b>UL</b>	Underwriters Laboratories, Inc.		
<b>UMC</b>	Uniform Mechanical Code		
<b>USDCM</b>	Urban Storm Drainage Criteria Manual		
<b>USGS</b>	United States Geological Survey		

Exhibit A

**SECTION 2: DEFINITIONS**

Words and phrases contained in these Standards shall be read in context and construed according to the rules of grammar and common usage. Words and phrases that have acquired a technical or particular meaning, whether by definition, adoption herein, or otherwise, are intended to be construed accordingly.

Wherever the phrases "**as directed**", "**as required**", "**as permitted**", or phrases of like meaning are used, it shall be understood that the direction, requirements or permission of the Director of Public Works (Director) is intended. Similarly, use of the words "**approved**", "**acceptable**", and "**satisfactory**" shall refer to approval of the Director.

The definitions in this Glossary apply throughout these Standards. The words or phrases presented have the following meaning unless the context clearly indicates otherwise:

**“Alteration”** means a request to use a substitute or alternative material, method, or process which will perform the same function as that provided in a particular standard.

**“Approach”** means the portion of an intersection leg which is used by traffic approaching the intersection.

**"Approved plan"** means the engineering design and construction drawings for public improvements, prepared by an engineer, which has been granted final approval by the Director of Public Works in accordance with these standards.

**"As-built"** means an engineering drawing of record, prepared under the direction of a licensed Colorado registered professional engineer, reflecting the actual construction of public improvements in the service area, including, but not limited to, final grading, alignments, dimensioning, elevations, locations and materials sizing and type.

**“Average Daily Trips (ADT)”** means the volume of traffic passing through a given point during a given time period, divided by the number of days in that time period.

**"Backflow"** means the reversal of the direction of flow of water or mixtures of water and other liquid, gases, or other substances into the distribution pipes of a potable water supply from any source or sources caused by backpressure and/or back-siphonage.

**"Backflow prevention assembly"** means any approved assembly, method, or type of construction designed to prevent backflow or back-siphonage into a public water supply by isolating the owner's water system from the public water system. In addition, see Section I. of these rules.

**“Caliper”** means a diameter measurement of a tree's trunk, and is measured around the trunk of the tree, six inches above tree base grade for one to four inch caliper trees and 12 inches above tree base grade for five to eight inch caliper trees. Trees measuring between four and five inch caliper shall be rounded off to the nearest inch.

**“Capacity”** means the maximum number of vehicles that have a reasonable expectation of passing over a given roadway or section of roadway in one direction during a given time period.



Exhibit A

**“Certified Backflow Prevention Device Tester”** means any person who has passed a State of Colorado approved or sponsored certification examination, and who is listed as a certified backflow prevention device tester with the Colorado Department of Public Health and Environment.

**"City"** means the City of Boulder, a Colorado home rule city in Boulder County, Colorado.

**"City water system"** means the source and distribution facilities of the water system to the point of delivery to the owner water system. The source includes all components of the facilities utilized in the production, treatment, storage, and delivery of water to the distribution system. The distribution system includes the network of conduits used for the delivery of water from the source to the owner water system.

**"Contractor"** means a person, firm, partnership, subcontractor or corporation, licensed by the City that is responsible for the construction of approved public improvements associated with a specific project, or projects, within the City of Boulder service area. This term also includes the contractor’s superintendent and on-site manager.

**"Colorado Cross Connection Control Manual"** means a manual published by the Colorado Department of Public Health and the Environment addressing cross connection control practices, Fourth Edition - Revised.

**"Cross connection"** means any physical arrangement whereby the city’s water supply system is connected, directly or indirectly, with any other water supply system, sewer, drain, conduit, pool, storage reservoir, plumbing fixture, or other device which contains, or may contain, contaminated water, sewage, or other waste or liquid of unknown or unsafe quality which may be capable of imparting contamination to the public water supply as a result of backflow. Bypass arrangements, jumper connections, removable sections, swivel or changeover assemblies, and other temporary or permanent assemblies through which, or because of which, backflow could occur are considered to be cross connections.

**“Delay”** means the stopped time per approach vehicle, in seconds per vehicle.

**“Design Hour Volume”** means the hourly traffic volume used for street design and capacity analysis, usually one (1) or more peak hours during a 24 hour period.

**“Design Speed”** means five (5) to 10 miles per hour above the proposed or desired speed limit of the facility under design.

**“Design Vehicle”** means that all public and private streets must be designed to accommodate an SU-30 vehicle. The definition of this vehicle type is found in AASHTO’s Geometric Highway Design Standards.

**"Developer"** means the person, owner, firm, or corporation responsible for the development and completion of all public improvements associated with a proposed project in accordance with these standards.

**“Diameter”** means the diameter size measurement of a tree's trunk, and is measured around the trunk at 4.5 feet above the tree base grade for trees greater than eight (8) inch caliper.

Exhibit A

**“Director” or “Director of Public Works”** means the authorized City employee, or his/her designee, responsible for the enforcement of these standards and approval of the design and construction of public improvements within the City of Boulder service area, and the overall management and direction of the Public Works Department.

**“Dripline”** means the outermost edge of a tree's canopy, projected on the ground.

**"Engineer"** means the Colorado registered professional engineer responsible for the design of all public improvements submitted to the City for a proposed project in accordance with these standards, including all plans, calculations, specifications, and coordination of field surveys.

**"Construction plan"** means the engineering design and construction drawings for public improvements, prepared by an Engineer which has been submitted for final approval by the Director of Public Works in accordance with these standards.

**“Hourly Volume”** means the number of vehicles that pass over a given section of a lane or roadway during one hour.

**"Inspector"** means the Director of Public Works, or his/her designee, responsible for the inspection of public improvements construction.

**“Level of Service (LOS)”** refers to the definitions of LOS provided in the Highway Capacity Manual, “Definitions and Concepts.”

**"May"** means is authorized to, or a permissive condition which indicates a choice between two (2) or more alternatives.

**“Modification”** means a request to change or modify a standard or the parameters of a standard because the particular application may not require the degree of rigor which the standard requires.

**“Peak Hour”** means the concept referring to the hour of a day when the highest volume of traffic occurs on a transportation facility.

**“Planting Strip”** means the landscape area within a street median, the landscape planting strip between the curb and detached sidewalk, or the landscape area between the back edge of a public sidewalk (attached or detached) and the right-of-way/property line.

**"Public improvements"** means any public facility, system or infrastructure in the City of Boulder service area including, but not limited to: earthwork or landscaping, streets, sidewalks, bike paths, trails, parking and traffic control devices; water supply, treatment, storage and distribution systems; wastewater collection and treatment systems; and stormwater and flood control collection and conveyance systems in public easements or right-of-way.

**“Public Sign”** means any sign that is posted by a governmental entity within the right-of-way for the purpose of directing traffic or parking.

Exhibit A

**"Record Set"** means the engineering design and construction drawings for public improvements, sealed and signed by an engineer, approved by the Director of Public Works in accordance with these standards, and maintained on file in public records as the final approved construction document.

**"Root Protection Zone"** means the ground area surrounding the entire tree that extends from trunk to dripline, or a minimum of fifteen feet for column-shaped trees, whichever is greater.

**"Shall"** means a mandatory duty to conform to the specified standard. Where certain requirements in these standards are described with the "shall" stipulation, it is mandatory that these requirements be met or exceeded.

**"Should"** means an advisory condition. Where "should" is used, it is considered to be recommended or advisory, but not mandatory.

**"Sidewalk, Attached"** means a sidewalk and curb that are attached as one (1) continuous element.

**"Sidewalk, Detached"** means a sidewalk that is separated from the curb by a landscape planting strip.

**"Sight Distance"** means the length of roadway ahead visible to the driver. The minimum sight distance available must be long enough to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

**"Speed Change Lane"** means a separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase (acceleration lane) or decrease (deceleration lane) its speed to a rate at which it can more safely merge or diverge with through traffic. Includes tapered areas.

**"Standards"** means the "Design and Construction Standards" manual for the City of Boulder.

**"Storage Lane"** means additional length added to a deceleration lane, to store the maximum number of vehicles likely to accumulate during a critical period without interfering with the through lanes.

**"Street Tree"** means any tree in the public right-of-way.

**"Streetscape"** means landscaping design for any streetside area, generally including but not limited to planting strips and medians.

**"Transportation Demand Management"** means any action or set of actions aimed at reducing the impact of traffic by influencing people's travel behavior.

**"Trips"** means a vehicle moving from an origin point to a destination point. Trips are one-way.

**"Waiver"** means a request to delete or omit the application of a particular standard.

**"Work"** means any activity involved in the performance of constructing, installing, repairing or maintaining public improvements.

Exhibit A

**CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS**

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## REFERENCES

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Where not specified in these Standards or the Boulder Revised Code (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 improvements and may refer to one or more of the following references:

### **GENERAL REFERENCES**

Code of Federal Regulations (CFR)

Colorado Revised Statutes (CRS)

### **TRANSPORTATION REFERENCES**

Institute of Transportation Engineers (ITE) *Guidelines for Major Urban Street Design*

ITE *Trip Generation Manual*

*Manual on Uniform Traffic Control Devices* (MUTCD)

### **STREETSCAPE AND TREE PROTECTION REFERENCES**

*American Standard for Nursery Stock*, American Association of Nurserymen.

*Guide for Plant Appraisal*, International Society of Arboriculture.

*Species Ratings and Appraisal Factors Guide*, Rocky Mountain Chapter, I.S.A.

*Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance* (ANSI. A300), American National Standard Institute.

*Streetscape Standards* for the Boulder Valley Regional Center.

*Himelick's Tree and Shrub Transplanting Manual*, International Society of Arboriculture.

*Valuation of Landscape Trees, Shrubs, and Other Plants*, International Society of Arboriculture.

### **UTILITIES REFERENCES**

*Manual of Water Supply Practices*, American Water Works Association (AWWA)

Insurance Services Office (ISO)

Exhibit A

Denver, Colorado, Board of Water Commissioners, Engineering Standards

*Colorado Cross Connection Control Manual*

American Society of Civil Engineers (ASCE) *Manuals and Reports on Engineering Practice - Gravity Sanitary Sewer Design and Construction*

Colorado Department of Health *Design Criteria for Wastewater Treatment Works*

*International Plumbing Code (IPC)*

*International Fire Code (IFC)*

CDOT Standard Specifications for Road and Bridge Construction. 2017

*Installation Guide for Ductile-Iron Pipe*, Ductile Iron Pipe Research Association

*Handbook of Steel Drainage and Highway Construction Projects*, American Iron and Steel Institute

**STORM WATER REFERENCES**

Urban Drainage and Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3.*

US Army Corps of Engineers *Users and Programmers Manuals for HEC-1 (Flood Hydrograph Package), HEC-2 (Water Surface Profiles), and HEC-RAS.*

*State of Colorado Department of Public Health and Environment §303(d) List of Water-Quality-Limited Segments Requiring TMDLs or for which a Total Maximum Daily Load (TMDL)* (Note: with this list, adopted in 5 CCR 1002-93, the State of Colorado implements the requirements of §303(d) of the federal Clean Water Act.)

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

# CHAPTER 1

## GENERAL REQUIREMENTS

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## 1.01 General

### (A) Intent

The Design and Construction Standards (“Standards”) are intended to protect the public health, safety, and welfare in the provision and maintenance of public improvements within the City of Boulder “City”). These Standards apply to the comprehensive design and construction of adequate and functional public improvements associated with developing, redeveloping and subdividing lands and providing necessary right-of-way, transportation, and utility services.

### (B) Scope

The City will review, approve, and monitor the design and construction of all public improvements within the public right-of-way or public easements to ensure compliance with these Standards. The City has the sole authority for approving, accepting, or denying the design and construction of any public improvement.

### (C) Minimum Standards

- (1) These Standards prescribe minimum requirements that shall be met or exceeded when designing and constructing all public improvements. Whenever the requirements of these Standards are found to be inconsistent with any other adopted standards, regulations, or codes, the more restrictive standards, regulations, or codes shall control. Reference to any code, regulation, standard, criterion, or manual of any technical society, organization, or association, or to any law or regulation of any governmental authority, whether such reference be specific or by implication, shall mean the most recently adopted or current law, code, regulation, standard, criterion, or manual in effect at the time of City approval of any project.
- (2) The design of all public improvements shall be prepared by or under the direct supervision of a professional Engineer duly registered and licensed in the State of Colorado. The construction of all public improvements shall be performed in a professional and workmanlike manner by a contractor licensed by the City as set forth in Chapters 4-6, “Contractor in the Public Right of Way License,” and 8-5, “Work in the Public Right-of-Way and Public Easements,” Boulder Revised Code, 1981 (~~B.R.C.~~). The City assumes no responsibility for supervising or directing construction activities performed by a licensed contractor.
- (3) All materials and equipment used for public improvements shall be of new and good quality. Recycled materials and equipment may be used if they meet the quality standards and conditions equivalent to new materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the instructions of the applicable supplier or manufacturer, except as otherwise prescribed.

### (D) Terminology

Terms, words, and abbreviations used in these Standards are defined in the Glossary (Appendix

B).

## 1.02 Description and Use of These Standards

### (A) Using these Standards

- (1) These Standards are to be used when designing and constructing all public improvements and infrastructure within the City. For the purposes of this document, public improvements and infrastructure include without limitation: streets, sidewalks, trails, curb and gutter, curb cuts, streetscaping, water mains, fire hydrants, water services and meters, wastewater mains and services, manholes, storm-water mains, inlets, drainage swales and channels, and other improvements intended for public purposes or for the benefit of the community located within dedicated public rights-of-way and public easements.
- (2) These Standards also provide design and construction requirements to be used when developing private lands that create an impact on public rights-of-way and public easements. The required private improvements associated with property development include without limitation: traffic mitigation, site access and driveway design, storm-water site drainage and detention ponding improvements, and stormwater quality and erosion control measures.

### (B) Restrictions

The descriptions in this Chapter provide the reader with a general guide to using these Standards. Nothing in this Chapter is intended to be a substitute for the requirements, criteria, and procedures contained in these Standards.

### (C) Public Improvements Design

- (1) These Standards prescribe minimum requirements and specifications for designing adequate and functional public improvements. However, the design of public improvements also depends on the land use zoning and comprehensive planning requirements for the City, as well as the specific site geography of the land to be improved or developed.
- (2) The City review for approval of submitted design plans for public improvements occurs as part of the development review process that distributes design applications to staff in multiple departments, divisions, and agencies. The Department of Public Works development review staff has the primary responsibility for the review and approval of construction plans for public improvements. An applicant for construction approval would be well advised to consult with the Department of Public Work's development review staff prior to submitting designs for public improvements.

### (D) Construction Approvals

- (1) An applicant seeking approval to construct public improvements in the City will need to develop engineering designs and construction plans that comply with the design and construction standards provided in this manual. In addition to complying with these Standards, an applicant will need to file the necessary applications and meet the requirements of the City's land use regulations, permit standards, and fee assessments as prescribed in the Boulder Revised Code (B.R.C.), 1981.



- (2) An applicant seeking construction approval will need to consult local master plans and the location of existing public infrastructure to develop specific project designs.
- (3) In order to develop project designs that comply with these Standards, an applicant for construction approval will need to enlist the services of a professional civil Engineer and professional land surveyor to meet the requirements for certifying acceptable designs for public improvements. An applicant may consult local directories for listings of professional engineering and surveying service providers.

**(E) Public Improvements Construction**

- (1) **Right-of-Way Permit:** The construction of public improvements in the City public rights-of-way and public easements requires a right-of-way permit, as set forth in Chapter 8-5, “Work in the Public Right-of-Way and Public Easements,” B.R.C., 1981. An applicant for construction approval will need to enlist the services of a contractor licensed with the City, as set forth in Chapter 4-6, “Contractor in the Public Way License,” B.R.C. 1981, in order to obtain a permit to construct public improvements.
- (2) **Variances**
  - (a) When practical difficulties are involved in meeting the provisions of these Standards, the Director of Public Works (“Director”) may alter, modify, or waive the strict application of these Standards to allow for the reasonable use of land or accommodate special circumstances peculiar to such land as set forth in Section 1.04, “Alternate Materials and Methods of Construction,” and Section 1.05, “Alterations, Modifications, and Waivers,” of these Standards.
  - (b) Alterations, modifications, or waivers are intended only for the special purposes described, and are not to be routinely considered or approved. Where it is necessary to vary from these Standards, an applicant for construction approval must clearly demonstrate that the provisions of these Standards cannot be met and the alteration, modification, or waiver will create the minimum variance necessary to accomplish the intended purpose.

**(F) Standards**

- (1) **Transportation:** The transportation standards prescribed in Chapter 2, “Transportation Design,” and Chapter 8, “Transportation Standards,” provide for the study, design, and construction of site accesses, streets, sidewalks, bicycle facilities, and trails. A traffic impact study may be required as part of construction approvals to demonstrate adequate design and mitigation for traffic impacts associated with new streets and driveways.
- (2) **Streetscapes:** The streetscape standards prescribed in Chapter 3, “Streetscape Design and Tree Protection,” and Chapter 10, “Streetscaping Standards,” provide for the selection, design, placement, and protection of trees and landscaping along public streets throughout the community. The City places high value on and strongly encourages the use of streetscapes as a means to calm automobile traffic, address environmental concerns for clean air and water quality, and enhance neighborhood qualities. General criteria are also included related to subsurface work impacting transportation infrastructure.
- (3) **Water and Wastewater Utilities:** The utility standards prescribed in Chapter 4, “General

Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” and Chapter 9, “Utilities Standards,” provide for the study, design, and construction of water and wastewater service facilities. These Standards detail required forecasting for sizing water distribution and wastewater collection mains, specific construction requirements for ensuring public health standards, and requirements for installing domestic water and sewer service lines.

- (4) **Storm-Water:** The storm-water standards prescribed in Chapter 7, “Stormw-Water Design,” and Chapter 9, “Utilities Standards,” provide for the study, design, and construction of storm-water drainage, stormwater quality and flood control improvements. Detention ponding, storm sewer and drainageway systems, stormwater quality, and erosion control measures may be required as part of construction approval to mitigate the impacts of increased runoff resulting from land development and to comply with the city’s Phase II Municipal Separate Stormwater System Permit.
- (5) **Technical Drawings:** The standards for construction detail drawings prescribed in Chapter 11, “Technical Drawings,” provide design requirements for specific construction features associated with the general construction of public improvements and infrastructure. These drawings are intended to supplement the design and approval of construction plans and ensure consistency in project construction to promote long-term dependability and maintenance of public improvements and infrastructure.

### 1.03 Submittal Requirements for Construction Approval

#### (A) Documentation

- (1) An applicant for construction approval shall submit required engineering reports, rights-of-way and easement dedications, ancillary permits and agreements, and construction plans in compliance with these Standards. Construction approvals are subject to the Director’s review, approval, and acceptance.
- (2) Prior to approving construction plans, the Director may require an applicant to submit the following documentation:
  - (a) Engineering reports
  - (b) Rights-of-way and easement dedications
  - (c) Permits and agreements
  - (d) Financial guarantees
- (3) Prior to issuing a right-of-way permit or building permit, the Director may require an applicant to submit the following documentation:
  - (a) Documents listed in Section 1.03, Paragraph (A)(1), above
  - (b) Construction plans
  - (c) City land use approvals
  - (d) Financial guarantees
  - (e) Documents required by Section 8-5-4, “Permit Application,” B.R.C., 1981.
- (4) Prior to the final acceptance of public improvements, the Director may require an

applicant to submit the following documentation:

- (a) Documents listed in Section 1.03, Paragraphs (A)(1) and (A)(2), above
- (b) As-built drawings
- (c) Testing results
- (d) Inspection approvals
- (e) Financial guarantees and warranties

**(B) Engineering Reports**

- (1) Engineering reports required for construction approval shall be prepared as follows:
  - (a) In compliance with these Standards.
  - (b) Under the direct supervision of the Engineer certified as an expert in areas covered in the report, and it shall be signed, sealed, and dated by the Engineer.
  - (c) Containing adequate information to evaluate submitted findings and designs, including calculations, details, and references.
- (2) Engineering reports required for construction approval may include the following:
  - (a) Geotechnical Soils Report, which provides geotechnical conditions and design requirements based on soils investigation and testing and geologic site conditions in compliance with standard engineering practices for soil mechanics and groundwater analysis.
  - (b) Pavement Design Report, which provides geotechnical soils conditions and adequate pavement design requirements and structural cross-sections for roadway, sidewalks, trails, and parking lot construction. Pavement design shall be in accordance with CDOT standards.
  - (c) ~~Storm Water~~Drainage Report and Stormwater Plan, which addresses storm-water conditions, impacts, and design requirements in compliance with Section 7.04, “Final ~~Storm Water Report and Plan~~Drainage Report and Stormwater Plan.”
  - (d) Utility Report, which addresses water and wastewater utilities service impacts, demands, and design requirements in compliance with Sections 5.02, “Utility Report,” and 6.02, “Utility Report.”
  - (e) Traffic Study, which identifies traffic impacts from proposed developments or roadway modifications and proposes transportation design requirements and mitigation measures in compliance with Section 2.02, “Traffic Study.”
- (3) The Engineer shall be responsible for correcting any error or omission in the engineering report. City approval of the report in no way relieves the Engineer of any responsibility for errors or omissions in the report.
- (4) An applicant for construction approval shall submit at least three copies of any required engineering report to the Director for review and approval. If acceptable, a City approval stamp signed and dated by the Director will be placed on each copy of the report. The City will retain one copy as a record set, one copy as a field copy for construction

inspection, and one copy will be returned to the ~~Engineer~~applicant.

- (5) Engineering report approval expires 1 year following the date of approval, unless construction of improvements under the report has been initiated.

**(C) Rights-of-Way and Easement Dedications, Permits, and Agreements**

- (1) Rights-of-way and easements required for construction approval shall be described by a licensed professional land surveyor registered in the State of Colorado and dedicated as follows:
  - (a) In compliance with these Standards; and
  - (b) By subdivision platting or by a separate legal instrument that describes a specific legal description of the dedication.
- (2) Agreements required for construction approval shall be executed and may include without limitation:
  - (a) Development agreement
  - (b) Public improvements agreement
  - (c) Public improvements extensions agreement
  - (d) Subdivision agreement
  - (e) Utility oversizing reimbursement agreement
- (3) Permits required for construction approval shall be of approved and issued status and may include without limitation:
  - (a) City of Boulder floodplain development permit
  - (b) City of Boulder right-of-way construction permit
  - (c) City of Boulder revocable right-of-way permit
  - (d) City of Boulder wetland permit
  - ~~(e)~~ City of Boulder erosion control permit
  - ~~(f)~~ Colorado Department of Transportation access permit
  - ~~(g)~~ Colorado Department of Transportation utility permit
  - ~~(h)~~ Railroad right-of-way encroachment permit
  - ~~(i)~~ State of Colorado Public Health and Environment Department 401 permit
  - ~~(j)~~ State of Colorado ~~storm water discharge permit~~general permit for stormwater discharges associated with construction activities
  - ~~(k)~~ United States Corps of Engineers 404 permit

**(D) Construction Plans**

- (1) **Preparation Standards:** Construction plans required for construction approval shall be prepared as follows:
  - (a) In compliance with these Standards;

- (b) Under the direct supervision of the Engineer certified as an expert in areas covered in the report, and it shall be signed, sealed, and dated by the Engineer; and
  - (c) With adequate information and detail to evaluate submitted designs and ensure accurate and functional construction of public improvements.
- (2) **Drafting Standards:** All construction plans shall meet the following minimum drafting standards to ensure legibility and consistency; to facilitate review, construction, and public inspection; and to provide a clear public record.
- (a) Drawings shall be submitted in both hard copy and electronic, computer-aided design and drafting (CADD) formats to allow information to be transferred to the City's geographic information system and facilitate clear microfilming or digital scanning.
  - (b) Electronic drawing format, or electronic CADD files, shall be in ".DXF" or "AutoCad.DWG" format on ~~CD-ROM or 3 1/2 inch disks~~ computer media specified by the Director of Public Works. Construction plan drawings are to be layered in electronic CADD format by improvement type in a manner acceptable to the Director of Public Works. Separate layers shall be provided for individual improvement categories including without limitation base mapping, transportation, landscaping, water, wastewater, and storm-water.
  - (c) Hard-copy drawing format shall measure ~~22-24~~ inches by ~~34-36~~ inches ~~on 3-mil reproducible sepia or black line mylar~~, and be clean, clear, and free from objectionable background.
  - (d) Symbols and line types shall comply with Technical Drawing 1.01 in Chapter 11, "Drafting Standards," and shall graphically distinguish between existing and proposed items.
  - (e) All drawings are to be numbered in consecutive order.
  - (f) Abbreviations reflected on the construction plans are to correspond to those presented in the Glossary.
  - (g) No hand-drawn or adhesively attached information, such as Kroy lettering, adhesive backed reproductive film, or tape, may be placed on construction plans.
- (3) **Cover Sheet:** Construction plans required for obtaining construction approval shall include a cover sheet with the following elements:
- (a) Project name, with legal description of the project parcel;
  - (b) Vicinity map, on a scale reflecting the location of the project and all streets within 1 mile of the project;
  - (c) Key map, on drawing sets of three sheets or more, of a scale reflecting the entire project, separate drawing numbers, and street names;
  - (d) Index of drawings presenting the title of each drawing and drawing number; and
  - (e) The following standard construction notes:
    - (i) "All work shall be performed in accordance with the "Design and

Construction Standards” of the City of Boulder, and shall be completed to the satisfaction of the Director of Public Works. In the event that a design element does not reflect City standards, the matter must be immediately brought to the attention of the Engineer and the Director of Public Works.

The Engineer shall be responsible for recommending a solution or alternative solutions to the City for review and approval.”

- (ii) “The approval of a Construction Plan does not relieve the Contractor of the responsibility of constructing workable public improvements. All revisions and/or corrections required will be solely the Contractor's responsibility, and at their expense.”
- (iii) “These Plans have been checked by the City of Boulder only for conformance with the “Design and Construction Standards,” compliance with development agreement conditions, and for general conceptual approval of public improvements as shown. The City’s review does not verify or ensure the accuracy of existing or proposed dimensions, lines, coordinates, or grades shown, including all existing utilities shown or not shown.”
- (iv) “Utility locations shown reflect available record data. The Contractor shall take precautionary measures to protect all utility lines shown and other utility lines otherwise located. The Contractor shall contact the “Utility Notification Center of Colorado” at 1-800-922-1987 or 811 for utility locates 24 hours prior to beginning construction.”
- (v) “Before work begins, the Contractor shall obtain a permit to work in the right-of-way from the City and must notify the City Right-of-Way Inspection staff at least 24 hours in advance of commencing construction activities.”
- (vi) “The Contractor shall obtain and maintain a complete and approved set of Construction Plans. These drawings, and any required permits, shall be available at the project site at all times and shall be made available to City staff upon request. If construction plans are not readily available at the project site, the Director of Public Works may issue a stop work order and halt all construction activities pending compliance by the Contractor.”
- (vii) “The Contractor agrees to comply with the provisions of the Traffic Control Plan and the current edition of the “Manual on Uniform Traffic Control Devices,” “Temporary Traffic Control” section, for construction signage and traffic control.”
- (viii) “All surplus materials, tools, and temporary structures, furnished by the Contractor, shall be removed from the project site by the Contractor. All debris and rubbish caused by the operations of the Contractor shall be removed, and the area occupied during construction activities shall be restored to its original condition, within 48 hours of project completion, unless otherwise directed by the Director of Public Works.”
- (ix) “The Contractor shall provide tree and landscape protection as set forth in Chapter 6-6, “Protection of Trees and Plants,” Boulder Revised Code (B.R.C.) 1981 and the City of Boulder Design and Construction

Standards (DCS). All landscaping shall be provided and maintained in compliance with the approved Landscaping Plan, B.R.C. and DCS.”

- (x) “The Contractor is required to provide and maintain erosion and sediment control measures in accordance with the Urban Drainage and Flood Control District “Urban Storm Drainage Criteria Manual Volume 3”, the M-Standard Plans of the Colorado Department of Transportation, and the approved ~~erosion control~~ stormwater management plan. The Director of Public Works may require the contractor to provide additional erosion control measures due to unforeseen erosion problems or if the plans do not function as intended.”
  - (xi) "The City of Boulder requires that sidewalks constructed have a cross slope of less than 2%. Sidewalks shall be designed and constructed with cross slopes sufficiently less than 2% to ensure that they do not exceed the 2% maximum."
- (4) **Plan Sheets:** Construction plans required for construction approval may include without limitation the following plan sheets:
- (a) ~~Storm Water Quality and Erosion Control~~ Stormwater Management Plan, prepared in compliance with Subsection 7.04(E)13, “~~Storm Water Quality and Erosion Control~~ Construction Stormwater Management.”
  - (b) Utility Plan, prepared in compliance with Section 4.03, “Utility Plan.”
  - (c) ~~Final Storm-Water Plan~~, prepared in compliance with Section 7.04, “~~Final Storm Water Report and Plan~~ Drainage Report and Stormwater Plan.”
  - (d) Traffic Control Plan, when construction plans have an impact on existing transportation facilities, such as utility or access construction within existing public streets, sidewalks, or trails. The plan is to be prepared in compliance with Section 8.04, “Temporary Traffic Control Plan,” of these Standards, the current edition of the “Manual on Uniform Traffic Control Devices,” “Temporary Traffic Control” section and as set forth in Section 8-5-10, “Temporary Traffic Control,” B.R.C., 1981. Plans shall include adequate provision for the detour of vehicular, bicycle, and pedestrian traffic.
  - (e) Transportation Striping and Signage Plan, when construction plans include transportation traffic control measures, such as stop signs, centerline striping, and trail signage. The plan is to be prepared in compliance with the current edition of the “Manual on Uniform Traffic Control Devices,” and should include the following standard construction notes:
    - (i) Contact the City of Boulder Sign Shop (303-413-7122) for location of all signs prior to installation and for sign layout/details prior to ordering.
    - (ii) All sign sheeting to be Class XI (DG3 material) with 3M 1150 overlay film.
    - (iii) All signs shall be 0.100 gauge aluminum.
    - (iv) All sign posts to be 12 gauge 2 inch unistrut.
    - (v) All sign bases to be 12 gauge 2-1/4 inch unistrut.

- (vi) Sign post lengths will vary, but 7 foot minimum clearance from bottom of sign to ground level is required.
- (vii) All sign mount hardware to be Gator Lock System.
- (f) Construction Phasing Plan, when projects are planned to be constructed in phases. The plan is to illustrate the entire project site and delineate and label each separate phase,
- (g) Landscaping Plan, when construction plans include streetscaping improvements or landscaping that has an impact on public rights-of-way or public easements. The plan is to be prepared in compliance with Subsection 3.02, "Landscaping Plan."
- (5) **Survey Information:** Construction plans shall refer horizontally to the Colorado State Plane Coordinate System NAD83, and are to include at least two horizontal and two vertical control points presenting appropriate *x*, *y*, and *z* coordinates. Electronic base map and survey control monument information is available from the City and should be used as a basis for construction plan drawings.
  - (a) Horizontal control monuments reflected on drawing sheets and survey lines are to correspond to City-recognized horizontal control points. Horizontal locations for design features are to be presented in terms of survey line stationing and offset or *x*, *y* coordinates.
  - (b) Vertical elevation control points reflected on drawing sheets are to be tied to City-recognized benchmarks with reference to the City's vertical control network. Vertical elevations for design features are to be presented as a *z* coordinate.

**(E) Plan and Profile Drawings**

- (1) **Required Elements:** Plan and profile drawings are required as part of the construction plan to ensure accurate and functional construction by the contractor when the construction is for public improvements. Plan and profile drawings are to be prepared on standard engineering plan and profile grid sheets and shall contain the following elements:
  - (a) Drawing border at least one-half inch from all edges of the drawing;
  - (b) Title block located inside the border in the lower portion of the sheet that includes the following information:
    - (i) Project name, location, and sheet title;
    - (ii) Name, address, and telecommunication numbers of the engineering consultant preparing the drawing, and the name of the supervising professional Engineer;
    - (iii) Date designed, drawn, surveyed, and checked;
    - (iv) Date prepared, and dates of all revisions;
    - (v) Drawing number and total number of drawings; and
    - (vi) Name of electronic file;
  - (c) North orientation arrow and scale;
  - (d) Certification space: a 2-inch by 2-inch space near the title block reserved for the



- seal and signature of the Engineer;
- (e) Approval space: a 3-inch by 3-inch space in the lower-right corner of each drawing sheet reserved for the City's approval stamp;
  - (f) Revisions information space: space for noting all revisions, separate from the original plan preparation date, that includes revision numbers, a brief description of what was revised, and the date of the revision;
  - (g) Survey information;
  - (h) Property boundaries, lot lines, public rights-of-way, and public easements, which are to be clearly labeled by type and dimension. Dedications previously recorded are to be referenced by applicable film and reception numbers;
  - (i) Subdivision block, and lot numbering; and
  - (j) Street names.
- (2) **Plan Drawing:** The "plan view" is to be located on the upper half of the drawing sheet and drawn to a scale of 1 inch equals 20 feet. This view contains the following information:
- (a) Existing and proposed public improvements and structures, including without limitation all grading, transportation, landscaping, City-operated and non-City-operated public utilities (including telephone, gas, electric, cable television, fiber optics), irrigation ditches, and other significant features.
  - (b) Match lines connecting information between drawings.
  - (c) Utility information required in Section 4.03, "Utility Plan," and the following:
    - (i) Pipe type, size, class and joint restraint.
    - (ii) Separation distance between existing and proposed water and wastewater mains and services, with horizontal and vertical location of sewer crossings requiring special construction.
    - (iii) Angles at alignment changes.
    - (iv) Horizontal and vertical locations and sizing of water service lines and meters with ties to property lines.
    - (v) Horizontal and vertical locations, sizing, and types of valves, fittings, control devices, and fire hydrants.
    - (vi) Horizontal and vertical locations and sizing of manholes, cleanouts, and service lines for sanitary sewers.
    - (vii) Horizontal locations of soil borings.
    - (viii) Horizontal locations of structures.
  - (d) Storm-water information required in Section 7.04, "~~Final Storm Water Report and Plan~~Drainage Report and Stormwater Plan," and the following:
    - (i) Existing and proposed contours of at least 2-foot intervals.

- (ii) Existing and proposed storm drainage facilities and details, including storm sewers, inlets, manholes, culverts, swales, detention ponds and drainageways.
  - (iii) Horizontal and vertical locations and sizing of manholes and inlets for storm drainage.
  - (iv) Horizontal and vertical location of existing and proposed drainage outfall points.
- (e) Survey, transportation, and surface improvements information including without limitation:
  - (i) Survey lines and stations based on center line or flowline stationing, and equated to flowline at bubbles, cul-de-sacs, horizontal curves, and other departures from normal street cross sections.
  - (ii) Stations and elevations of flowlines at all existing and proposed curb returns, such as horizontal points of curvature (PC's), points of tangency (PT's), and points of compound curvature (PCC's); at the high or low point on all vertical curves; at inlets (including invert); and at intervals of no more than 50 feet along the streets.
  - (iii) Existing and proposed curb return radii.
  - (iv) Handicap access ramps.
  - (v) Complete horizontal curve data: radius ( $R$ ), delta ( $D$ ), arc length ( $L$ ), and tangent length ( $T$ ).
  - (vi) All crown lines, where they depart from the normal cross sections (transitions to existing roadways), with appropriate transition starting elevation.
  - (vii) Centerline stations at all intersecting streets.
  - (viii) Stations of drainage facilities, including inlets, manholes, and storm-water outfalls, and directional drainage flow arrows.
  - (ix) Full width of right-of-way, intersecting roadways, street cross sections, sidewalks and trails, existing curb cuts, and other relevant features along all roadways abutting the project.
  - (x) Traffic control devices, including striping, markings, signage, and signals.
- (3) **Profile Drawing:** The "profile view" is to be located directly below the plan view along a matching survey line and stationing and is to be drawn at a horizontal scale of 1 inch equals 20 feet and a vertical scale of 1 inch equals 5 feet. This view shall contain the following information:
  - (a) Original and proposed ground elevations.
  - (b) Stationing sequence, left to right.
  - (c) Elevations labeled on both left and right sides of the drawing sheet.
  - (d) Match lines.
  - (e) Elevations based on center line, flow line, or invert of pipe. (Top of pipe is

acceptable only for existing utilities.)

- (f) Stations and elevations of existing and proposed grade breaks.
- (g) Crossings of existing and proposed utilities.
- (h) Elevations of manhole inverts and rims, and service line inverts.
- (i) Elevations of inlets, top of curb, flowline, inverts, and connection locations.
- (j) Slopes or grades of wastewater and storm-water sewers.
- (k) Existing and proposed finished grades over utilities.
- (l) Street profiles, including:
  - (i) Stations and elevations of existing and proposed horizontal PC, PT, PCC, PRC.
  - (ii) Vertical curves with VPI, VPC, VPT, high point or low point (not middle ordinate) stations and elevations.
  - (iii) Center line stations of all intersecting streets.
  - (iv) Grades for all profiles.
  - (v) Curb flowlines at 25-foot minimum intervals, and at all vertical sags or crests.
  - (vi) Curb return profiles to ensure positive drainage at ramp locations.
- (4) **Detail Drawings:** Detail drawings are required for construction details not provided in Chapter 11, "Technical Drawings." Detail drawings illustrate construction details for critical design features such as concrete paving sections, mechanical pipeline connections, and detention ponding release structures. Detail drawings are to include dimensioning, materials, specifications, and specific construction notes appropriate to each construction detail.
- (5) **Cross-Sectional Drawings:** These drawings are required with all construction plans that include varying or transitional features, such as street sections, fill slopes, and drainage channels. Cross-Sectional drawings reflect dimensions, elevations, stationing, and any other detailed information necessary to ensure accurate construction.

**(F) Submittal and Approval of Construction Plans and Drawings**

- (1) **Submittal:** An applicant for construction approval shall submit at least three drawing sets of any required construction plans to the Director for review and approval, including:
  - (a) Original ~~mylar, mylar-sepia, black-lined or blue-lined~~ drawing set prepared by the Engineer to be stamped and approved by the City and returned to the Engineer
  - (b) 2 Sets of black-lined ~~or blue-lined~~ prints drawing set signed, sealed, and dated on each drawing sheet by the Engineer to be maintained on file with the City as the record set of the construction plan approval documents and for use by the City right-of-way inspector.
- (2) **Approval:** The Director will review construction plans for compliance with these

Standards. If acceptable, a City approval stamp signed and dated by the Director will be placed on each drawing sheet of the construction plans.

- (3) **Effective Period:** Construction plan approval expires 1 year following the date of approval, unless construction has been initiated. An applicant for construction approval may resubmit the construction plan for reapproval, subject to review for compliance with standards in effect at the time of resubmittal.
- (4) **Errors and Omissions:** The Engineer shall be responsible for correcting any error or omission in the construction plans or drawings. City approval of the construction plans in no way relieves the Engineer of any responsibility for errors or omissions in the plans.

#### (G) As-Built Drawings

- (1) **Requirements:** As-built drawings reflect the actual in-place construction of public improvements.
  - (a) The applicant shall submit as-built drawings for final construction approval within 60 days from the date construction was completed and prior to City acceptance of any public improvements.
  - (b) The applicant shall ensure that every sheet of the approved construction plans reflects the as-built drawings conditions.
- (2) **Preparation:** As-built drawings shall be prepared by the Engineer responsible for the original construction plan approved by the City. Drawings shall be prepared as follows:
  - (a) In compliance with the requirements in Sections 1.03(D), "Construction Plans," and 1.03(E), "Plan and Profile Drawings."
  - (b) In compliance with the requirements in Section 7.17(B), "Stormwater As-Built Drawings."
  - (~~c~~b) Based on completed field inspections, accurate measurements, survey data, and testing results, materials, and equipment records.
  - (~~d~~e) To reflect any variations from the approved construction plans in the public improvements actually constructed.
- (3) **Transfer of Responsibility:** If the Engineer responsible for the original construction plan is replaced prior to preparing as-built drawings, the replacement Engineer shall agree in writing to accept the responsibility for the design certified by the original Engineer under the approved construction plan prior to City acceptance of the constructed public improvements.

#### (H) Submittal and Approval of As-Built Drawings

- (1) **Submittal:** An applicant for construction approval shall submit at least two drawing sets of any required as-built drawings to the Director of Public Works for review and approval. ~~As-built drawing sets shall contain the following:~~
  - (a) ~~A complete 3 mil mylar drawing set of the as-built construction plan drawing set reflecting the as-built conditions.~~
  - (b) ~~A complete black-lined or blue-lined prints drawing set of the as-built drawing set reflecting the as-built conditions and signed, sealed, and dated on each~~

drawing sheet by the Engineer.

(2) **Approval:**

- (a) The Director will review the as-built drawings for compliance with these Standards. If acceptable, a City approval stamp, signed and dated by the Director, will be placed on each drawing sheet of the as-built drawings.
    - (i) ~~The mylar drawing set will replace the construction approval drawing set and will be maintained on file with the City's Mapping and Records Office as the approved as-built drawings set, from which copies may be reproduced.~~
    - (ii) ~~The black or blue lined print drawing set, signed, sealed, and dated by the Engineer, will be maintained on file with the City as the record document of the as-built drawing set that has been approved by the City.~~
  - (b) The Director will not approve any construction, place in service, release financial guarantees, or issue utility connections for any public improvements for which acceptable as-built drawings have not been submitted.
- (3) **Variations and Discrepancies:** If any substantial variations or discrepancies, particularly with respect to location, design slopes, grades, dimensions, capacities and clearances, are discovered between the approved construction plans and the public improvements actually constructed, the Engineer shall propose and recommend a solution or alternative solutions to the City for review and approval. If no proposed alternative will satisfy the requirements of these Standards, the contractor shall reconstruct the deficient public improvements to comply with the approved construction plans.
- (4) **Errors and Omissions:** The Engineer shall be responsible for the correction of any error or omission in the as-built drawings. City acceptance of the as-built drawings in no way relieves the Engineer of any responsibility for errors or omissions in the drawings.

## 1.04 Alternative Materials and Methods of Construction

(A) **Use**

The provisions of these Standards are not intended to prevent the use of any materials or methods of construction, design, or compliance not specifically prescribed in these Standards, provided that the alternative materials or methods of construction, design, or compliance have been approved and their use authorized by the Director.

(B) **Approval**

The Director may approve an alternate material or method of construction, design, or compliance, provided the proposed design is satisfactory and complies with the provisions of these Standards and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in these Standards in suitability, strength, effectiveness, durability, safety, and sanitation.

**(C) Proof of Claims**

The Director will require that sufficient evidence be submitted to substantiate any claims that may be made regarding an alternate material or method of construction, design, or compliance. The details of any action granting approval of an alternate material or method will be recorded and entered in the files of the City.

**1.05 Alterations, Modifications, and Waivers****(A) Practical Difficulties**

When practical difficulties are involved in executing the provisions of these Standards, the Director may alter, modify, or waive the strict application of these Standards, according to the process described herein.

**(B) Criteria**

No alteration, modification, or waiver of the strict application of any provision of these Standards shall be granted unless the applicant clearly demonstrates and the Director finds that the following conditions exist:

- (1) The strict application of the provisions of these Standards would deprive an individual of the reasonable use of land or structure, and
- (2) Special circumstances peculiar to such land or development justify the requested alteration, modification, or waiver, and
- (3) Any alteration, modification, or waiver would result in a solution consistent with the goals of the underlying zoning district, a Boulder Valley Comprehensive Plan goal, a specific neighborhood plan, or an adopted design guideline, and
- (4) Any alteration, modification, or waiver represents the minimum variance from these Standards that will accomplish the intended purpose, and
- (5) Any alteration or modification will at least equal the suitability, strength, effectiveness, fire resistance, durability, safety, and sanitation performance requirements prescribed in these Standards, and
- (6) Any alteration, modification, or waiver will not harm the adjacent land owners, the neighborhood, or the welfare of the public at large, and
- (7) Any alteration, modification, or waiver will not create an additional maintenance or financial burden for the affected property owners or the City.

**(C) Application Requirements**

- (1) An applicant for an alteration, modification, or waiver to these Standards shall submit a written request to the Director. The request shall state in detail the specific sections and subsections of these Standards requested to be altered, modified, or waived, and the request shall describe in detail why the requested waiver, alteration, or modification meets the criteria in Section 1.05(B), above.
- (2) The Director may require additional documentation to support the request and shall require that sufficient evidence be submitted to substantiate any claims that may be made

regarding alterations, modifications, or waivers to these Standards. Sufficient evidence may include verification by a Colorado registered professional Engineer, possessing relevant expertise in the area.

**(D) Decision**

- (1) The Director will advise the applicant, in writing, of the decision on the requested alteration, modification, or waiver. The Director's decision is a final action that is administrative and may be appealed through the judicial process. In granting any alteration or modification to these Standards, the Director may impose specific conditions necessary to ensure that the criteria described in Section 1.05(B), above, are, and will remain, satisfied.
- (2) The Director of Public Works will consult with the Planning Director when evaluating issues that potentially impact urban design. The details of any decision granting approval of an alteration, modification, or waiver to these Standards will be entered in the form of written findings. A written log of all decisions granting alterations, modifications, or waivers to these Standards will be kept current in the office of the Director of Public Works and will be available for public inspection.

CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS

CHAPTER 4  
GENERAL UTILITIES DESIGN

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## 4.01 General

### (A) Intent

The General Utilities Design Standards are intended to provide for an integrated public utilities system for all public utilities, including water, wastewater, storm drainage, gas, electric and telecommunications systems.

### (B) Utilities Master Plans

All improvements proposed to the City's public utilities system shall conform with the goals, policies, and standards adopted in the Water Distribution Utility Master Plan, Wastewater Collection Utility Master Plan, Storm Water Collection and Major Drainageway Master Plans and Comprehensive Flood and Stormwater 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 utilities improvements and may refer to one or more of the references listed in the References Section of these Standards.

## 4.02 Utility Connection Plan

### (A) Required

The Director of Public Works may require the preparation of a Utility Connection Plan in order to assess the feasibility of providing utility service to any project or development and identify impacts of any development application on the existing and planned public utility systems. A Utility Connection Plan may be prepared in lieu of a Utility Plan for projects or developments that meet all of the standards below:

- (1) City utilities required to serve the site are located directly adjacent to the subject property.
- (2) No extension, enlargement, or improvement of public mains is required to serve the site.
- (3) No change in use is proposed which may alter the utility needs of the site.

### (B) Plan Requirements

The Utility Connection Plan shall include the following project or development information:

- (1) **Title Block:** Include the label "Utility Connection Plan" and name of project or development application, and the original preparation date and dates of any revisions.
- (2) **Site Location Data:** Include vicinity map and north arrow,
- (3) **Drawing Scale:** The drawing scale shall be between 1 inch equals 20 feet and 1 inch equals 100 feet, placed on the minimum number of plan sheets possible.
- (54) **Property and Street Information:** Include the location of existing and proposed lot lines, block and lot numbers, and street names.
- (65) **Construction Note:** Include the statement that "Utilities shall comply with the City of Boulder Design and Construction Standards."

- (76) **Existing and Proposed Utilities:** Include the location, type and size of all existing and proposed utilities mains and service lines. Utilities to be identified include without limitation: water, wastewater, storm drainage, flood control, gas, electric, telecommunications, drainageways, and irrigation ditches within and adjacent to the project or development site. Include and assign identification numbers to all existing and proposed manholes, inlets, fire hydrants, meter settings and pits, and provide “direction of flow” arrows on gravity pipelines.
- (87) **Easements and Rights-of-Way:** Include the location, dimensions, and dedication type of all existing and proposed easements and rights-of-way for all utilities improvements. If available, reference existing easements to appropriate recorded film and reception numbers.
- (98) **Structures and Trees:** Include the location and dimensions of all existing and proposed structures, including without limitation buildings and fences, trees 1½ inch caliper or greater, and major landscape features.
- (109) **Floodplain:** Delineate any 100-year floodplain boundaries that impact the project or development site and identify the floodplain designation, base flood elevations and floodplain mapping source used to determine the floodplain.
- (110) **Storm Water Plan Combination:** The Director may approve a combined “Utility Connection and Storm Water Plan,” reflecting storm water design information, prepared in compliance with the requirements outlined in Chapter 7, “Storm Water Design,” of these Standards.
- (112) Applications for Annexation or Out-of-City Utility Service for a single family residential dwelling may provide the required information on a scaled Improvement Location Certificate or Improvement Survey Plat.

## 4.03 Utility Plan

### (A) Required

The Director may require an applicant to submit a Utility Plan as a condition of any development application in order to adequately assess the availability of utility service and impacts of any development application on the existing and planned public utility systems. The Utility Plan shall provide an overview of the proposed project or development application and identify whether the proposal is:

- (1) Eligible for utility service and has access to available public utility systems.
- (2) Consistent with current Utilities Master Plans, ~~and~~ meets the minimum design standards for system layout, and is compatible with and allows for the perpetuation of the existing utility systems.
- (3) Located within any mapped 100-year floodplain.

### (B) Plan Requirements

The Utility Plan shall include the following project or development information:

- (1) **Title Block:** Include the label “-Utility Plan” and name of project or development application, and the original preparation date and dates of any revisions.
- (2) **Site Location Data:** Include vicinity map, north arrow, relationship of the property to range, township, and section lines.

- (3) **Survey Information:** Include the elevation and location of City-recognized benchmarks with reference to local, USGS and NGVD data.
- (4) **Drawing Scale:** The drawing scale shall be between 1 inch equals 20 feet and 1 inch equals 100 feet, placed on the minimum number of plan sheets possible.
- (5) **Property and Street Information:** Include the location of existing and proposed lot lines, block and lot numbers, and street names.
- (6) **Construction Note:** Include the statement that “Utilities shall comply with the City of Boulder Design and Construction Standards.”
- (7) **Existing and Proposed Utilities:** Include the location, type and size of all existing and proposed utilities mains and service lines. Utilities to be identified include without limitation: water, wastewater, storm drainage, flood control, gas, electric, telecommunications, drainageways, and irrigation ditches within and adjacent to the project or development site. The locations of existing underground utility mains and service lines, and the invert and surface grade elevations of all manholes, inlets and culverts, shall be field verified to the Director’s satisfaction (by “pothole” excavations, if necessary) and accurately delineated and dimensioned. Include and assign identification numbers to all existing and proposed manholes, inlets, fire hydrants, valves, pipe lengths, meter settings and pits, and provide “direction of flow” arrows on gravity pipelines. Proposed invert and surface grade elevations shall be provided for all proposed manholes, inlets and culverts.
- (8) **Site Topography:** Include existing and proposed contour lines showing at least 2-foot contour intervals, and reflecting spot elevations at various locations, “cut and fill” areas, and surface drainage systems.
- (9) **Easements and Rights-of-Way:** Include the location, dimensions, and dedication type of all existing and proposed easements and rights-of-way for all utilities improvements. If available, reference existing easements to appropriate recorded film and reception numbers.
- (10) **Structures and Trees:** Include the location and dimensions of all existing and proposed structures, including without limitation buildings and fences, trees 1½~~2~~ inch caliper or greater, and major landscape features.
- (11) **Maintenance Access:** Include the location and dimensions for existing and proposed “all-weather” maintenance access drives for 14-ton maintenance equipment to reach manholes and inlets not located in existing or proposed streets.
- (12) **Floodplain:** Delineate any 100-year floodplain boundaries that impact the project or development site and identify the floodplain designation, base flood elevations and floodplain mapping source used to determine the floodplain.
- (13) **Storm Water Plan Combination:** The Director may approve a combined “-Utility and Storm Water Plan,” reflecting storm water design information, prepared in compliance with the requirements outlined in Chapter 7, “Storm Water Design,” of these Standards.

## (C) Utility Plan Approvals

- (1) The U~~ti~~lity p~~l~~an shall reflect proposed utility infrastructure and utility service to development applications, and may serve as the basis for approving site review and preliminary subdivision proposals.
- (2) A final version of the U~~ti~~lity p~~l~~an shall be included in all Construction Plans proposing

the construction of utility infrastructure to reflect overall system layout and design configurations.

- (3) The ~~Utility~~ Plan may serve as the Construction Plan under the following conditions:
  - (a) The proposed utility improvements include only private service line (water, wastewater, or storm sewer) or fire line connections to individual properties.
  - (b) The proposed utility improvements include only water main extensions or fire hydrant runs on individual properties.
  - (c) Standard construction notes are included on the Utility Plan, and no other Construction Plans for other public improvements are required.
- (4) The Director may waive the requirement that the Utility Plan be prepared by an Engineer for development applications that include only private utility (water, wastewater and storm drainage) service lines or fire lines to individual properties.

## 4.04 Utilities Easements

### (A) General

- (1) All City-operated public utilities, including without limitation, water, wastewater and storm drainage systems, shall be located within public rights-of-way or public utility easements.
- (2) Public utility easements shall be at least 25 feet wide. Wider easements may be required where the depth of a utility, or number of utilities occupying the easement, requires additional width to satisfy standards for utility separations, trenching excavations, or adequate maintenance access.
- (3) Public utility easements shall provide a minimum parallel separation of 6 feet between the edge of any utility line and the easement boundary.
- (4) Public utility easements are to be placed longitudinally along one side of any property line in a manner that no portion of any easement falls on both sides of a parallel property line.
- ~~(5) Trees proposed to be planted in public utility easements shall be located at least 10 feet away from existing or future utilities.~~
- ~~(6)~~ Structures and landscaping proposed in public utility easements shall comply with the standards as set forth in Chapter 8-5, "Work in the Public Right-of-Way and Public Easements," and Chapter 8-6, "Public Right-of-Way and Easement Encroachments, Revocable Permits, Leases, and Vacations," B.R.C. 1981.
- ~~(6)~~ The Director may allow water service taps from water mains in easements only if free and unobstructed vehicle access is permanently guaranteed for all-weather water meter reading, valve access, and maintenance. Where the Director allowed a service tap from a water main in an easement, the property owners shall ensure all city owned and maintained utilities are accessible and surface features such as valve covers, manholes, and meter pits are visible and not covered by landscape materials, concrete or asphalt. Proposals will be reviewed on a case-by-case basis, and are subject to prior approval by the Director.

### (B) Easements Crossing Single-Family Residential Lots

Public utility easements crossing single-family residential lots may be allowed only for the

following:

- (1) Completing required water system looping in cul-de-sac type applications where water mains would otherwise dead-end, ~~and~~
- ~~(2) for the i~~ (2) Installation of fire hydrants.
- (23) Continuing a wastewater main that would otherwise dead-end in cul-de-sac type applications.
- (34) Conveying storm water drainage and overflows from back-draining cul-de-sac or street sump type applications.

## 4.05 Pipe Strength

All utility pipe shall be of adequate strength to support the trench and AASHTO HS-20 highway loadings.

## 4.06 Separation of Utilities

### (A) Parallel (Horizontal) Separation

Parallel separations between utility mains and services to provide for adequate trench excavations and maintenance operations shall be as follows. All distances are measured from outside of pipe to outside of pipe:

**Table 4-1: Utility Separation Requirements**

	Water	Sewer	Storm	Electric, Telecommunications, and/or Gas
Water		10-ft	5-ft	5-ft
Sewer	10-ft		10-ft	10-ft
Storm	5-ft	10-ft		5-ft
Electric, Telecommunications, and/or Gas	5-ft	10-ft	5-ft	

### (B) Pipe Crossings (Vertical) Separation

- (1) The minimum vertical separation between water and wastewater line crossings, as measured outside of pipe to outside of pipe, shall be 18 inches. The water line shall be constructed above the wastewater line.
- (2) The minimum vertical separation between water and storm drainage line crossings shall be 18 inches, measured from outside of pipe to outside of pipe.
- (3) The minimum vertical separation between wastewater and storm drainage line crossings, as measured outside of pipe to outside of pipe, shall be 6 inches. In addition, including the following applies:
  - (a) If the storm drainage line is constructed below the wastewater line, pressure-class pipe will be required for both utility lines to prevent possible wastewater contamination of storm drainage.

- (b) If the vertical separation between the wastewater and storm drainage line is less than 18 inches, structural support will be required, subject to the Director's approval.
- (4) The minimum vertical separation between City public utilities pipelines or conduits and all gas, electric, and telecommunications utilities shall be 6-12 inches.

### (C) Drainageway and Irrigation Ditch Crossings

Utility crossings of natural and improved drainageways and irrigation ditches listed in Table 4-24, "Local Drainageways and Irrigation Ditches," ~~and~~ shall meet the following conditions:

- (1) **Water Main Crossings:** The water main shall be placed at least 4.5 feet below the invert of the drainageway or irrigation ditch, and shall be placed in a steel sleeve in conformance with the applicable standard drawings in Chapter 11, "Technical Drawings" of these Standards.
- (2) **Wastewater and Storm Drainage Main Crossings:**
  - (a) The wastewater or storm drainage main shall be placed at least 3 feet below the invert of an open drainageway or irrigation ditch or at least 18 inches below the invert of a drainageway or irrigation ditch culvert, and the main shall be placed in a steel sleeve in conformance with the applicable standard drawings in Chapter 11, "Technical Drawings," of these Standards.
  - (b) In open drainageway or irrigation ditch crossings, the Director may allow the wastewater or storm drainage main to be encased in concrete instead of placement in a steel sleeve, and the concrete encasement shall conform with the applicable standard drawings in Chapter 11, "Technical Drawings," of these Standards.
  - (c) When a drop manhole is used to obtain the required vertical separation for a drainageway or irrigation ditch crossing, the drop manhole shall be located at least 20 feet from the end of a steel sleeve.
- ~~(3) **Storm Drainage Main Crossings:** When a storm drainage line is required to cross an irrigation ditch, it shall comply with the conditions prescribed in subsection (C)(2).~~
- ~~(4)~~ **Other Utility Line Crossings**
  - (a) Other utility lines, including without limitation, gas, electric, and telecommunications lines, shall be placed at least 30 inches below the invert of a drainageway or irrigation ditch.
  - (b) Other utility lines shall be placed in a Schedule-40 steel casing, extending horizontally at least 10 feet beyond each side of the drainageway or irrigation ditch, measured from top of bank to top of bank.

**Table 4-2: Local Drainageways and Irrigation Ditches**

Anderson Ditch	Elmer's Two Mile Creek	Skunk Canyon Creek
Bear Canyon Creek	Farmer's Ditch	South Boulder Creek
Bluebell Creek	Fourmile Canyon Creek	Sunshine Creek
Boulder Creek	Goose Creek	Two Mile Canyon Creek
Boulder and Whiterock Ditch	Gregory Creek	Viele Channel
Boulder and Left Hand Ditch	Howard Ditch	Wellman Canal
Dry Creek	King's Gulch	Wonderland Creek

Dry Creek #2	New Anderson Ditch	
Dry Creek #2 Ditch	North Boulder Farmer's Ditch	

### **(D) Separation of Utilities from Trees**

Trees proposed to be planted in public utility easements and rights-of-way shall be located at least 10 feet away from existing and proposed utilities and shall not block vehicle access along the easement. All utility construction near existing trees shall abide by the tree protection requirements specified in Chapter 3, "Streetscape Design," of these Standards.

### **(ED) Special Conditions for the Separation of Utilities**

If the required horizontal or vertical separation of utilities cannot be obtained as required in this section, the Director may apply special conditions to the design of utilities separations, to ensure the safety, protection and integrity of the utility system, as follows:

#### **(1) Parallel Separation**

- (a) If 10 feet of parallel separation between water and wastewater lines cannot be obtained, the wastewater line may be laid closer to the water line, provided the following conditions exist:
  - (i) The wastewater line is constructed of pressure-class pipe, in conformance with these Standards, until the required horizontal separation is obtained, and
  - (ii) The water line is located at least 18 inches above the wastewater line, as measured from the top of the wastewater pipe to bottom of the water pipe.
- (b) If 5 feet of parallel separation between water and storm drainage lines cannot be obtained, the storm drainage line may be laid closer to the water line, provided the storm drainage line is constructed of pressure-class pipe, in conformance with these Standards, until the required horizontal separation is obtained. The storm drainage line does not need to be pressure tested.

#### **(2) Crossings Separation**

- (a) If 18 inches of vertical separation between either water and wastewater line crossings, or water and storm drainage line crossings, cannot be obtained, the wastewater or storm drainage line shall be constructed of pressure-class pipe, in conformance with these Standards, for at least 10 feet beyond each side of the water line crossing. This distance shall be measured along the wastewater or storm drainage line from the center of the water line. The storm drainage line does not need to be pressure tested.
- (b) If the water line cannot be constructed above the wastewater line at water and wastewater line crossings, the wastewater line shall be constructed of pressure-class pipe, in conformance with these Standards, for at least 10 feet beyond each side of the water line crossing. This distance shall be measured along the wastewater line from the center of the water line.
- (c) If either 18 inches of vertical separation between water and wastewater line crossings, and water and storm drainage line crossings, or 6 inches of vertical separation between wastewater and storm drainage line crossings cannot be obtained, special structural support shall be required to prevent settlement and potential pipe damage at the crossing. Structural support design shall be subject to



the Director's approval.

- (3) **Pressure-Class Pipe for Crossings:** When pressure-class pipe is required to satisfy the requirements prescribed in this section, the following will apply:
- (a) Pipe materials and quality shall be suitable for water main construction in accordance with specifications prescribed in these Standards.
  - (b) Individual pipe sections shall be at least 18 feet long and placed at the crossing so that the ends are located 9 feet beyond each side of the water line crossing.
  - (c) The inside diameter of the pressure-class crossing pipe shall be of equal size or nearest diameter larger than the non-pressure-class wastewater or storm drainage pipe inside diameter for the length until the required separation between utilities is obtained. Pressure-class pipe installations shall include watertight transition couplings.
  - (e~~d~~) Both the water and wastewater lines shall be pressure tested.

## 4.07 Undergrounding of Utilities

New, replacement, or relocated electrical utilities and telecommunication and cable television systems shall be installed underground as set forth in Section 9-512-129, "Standards for Lots and Public Improvements," B.R.C. 1981.

## 4.08 Abandonment, Repair and Upgrade of Service Lines and Taps

### (A) General

Inactivity, damage, age of materials, redevelopment, or changes in service requirements for the premises may require repair, removal or abandonment of a utilities service line or stub-in. Repair, removal and abandonment of a utilities service line or stub-in shall comply with the standards of this section.

### (B) Abandonment

An abandoned service line shall be disconnected at the corporation with the main.

### (C) Witnessing

Service line abandonments and repairs shall be witnessed by City inspection staff.

### (D) Tap Upgrade

When an existing service line must be upgraded, the existing main tap shall be upsized and re-used wherever possible.

### (E) Water Services

When a water service line is abandoned or repaired, the following will apply:

- (1) **Services 2 Inches and Smaller:** For a water service line that is a 2-inch line or smaller, the water service connection shall be excavated where the corporation stop is inserted into the water main. The corporation stop shall be closed, the service tubing or piping shall be removed from the corporation stop, and a section of the water service line at least 12 inches long shall be cut off. A plug or cap shall be placed on the corporation stop to

prevent leakage. If the service line has a meter, the meter shall be returned to the City for final testing and reading. The meter pit/vault, if present, shall be removed in its entirety, or, if left in place, shall be cut off at least 18 inches below finished grade and filled with sand or other fill material. If the corporation stop is leaky or corroded, the corporation stop shall be removed and a "Ford" FS1 repair sleeve or an equivalent sleeve, approved by the Director, shall be installed while the main is shut off.

- (2) **Services Larger than 2 Inches:** For a water service line that is larger than 2 inches, the water service connection shall be excavated over the service tee on the water main. The tapping valve shall be closed, a length of service pipe at least 12 inches long shall be removed, and the tapping valve shall be plugged or capped. The valve box shall be removed in its entirety or, if left in place, shall be cut off at least 18 inches below finished grade and filled with granular pipe bedding material (squeegee) as specified in Chapter 9, "Utilities Standards," of these Standards. If the service line has a meter, the meter shall be returned to the City for a final testing and reading. The meter vault, if present, may be removed in its entirety, or abandoned in place by filling it with sand or granular pipe bedding material (squeegee) as specified in Chapter 9, "Utilities Standards," of these Standards. If practicable, the manhole shall be cut off at least 18 inches below grade. In the event a wet tapped valve is leaky or corroded, the valve shall be removed and a "Ford" FS1 repair sleeve or an equivalent sleeve, approved by the Director, shall be installed while the main is shut off. Valves on tees that are leaky or corroded shall be removed and replaced with a blind flange.
- (3) **Copper Lines:** Water service line repairs and connections on copper lines may use flare to flare or grip-tite compression fittings as specified in Chapter 9, "Utilities Standards," of these Standards.

## **(F) Sewer Services**

When a sewer service line is abandoned or repaired, the following will apply:

- (1) **Abandonment:** A sewer service lines shall be abandoned by excavation of the connection with the main, removal of the section of main with the connection tap, and replacement of that section of the main with PVC non-pressure pipe and couplings as specified in Chapter 9, "Utilities Standards," of these Standards. Manhole taps may be plugged at the manhole with the service line left intact.
- (2) **Repair:** Sewer service line repairs that require the coupling of two pipe sections to create a joint shall use couplings for non-pressure pipe as specified in Chapter 9, "Utilities Standards," of these Standards.

**CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS**

**CHAPTER 5  
WATER DESIGN**

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## 5.01 General

### (A) Intent

The Water Design Standards establish minimum design standards for providing and maintaining the public water utility distribution system.

### (B) ~~Treated Water~~ Utility Master Plan

All improvements proposed to the City's public water utility system shall conform with the goals, policies, and standards adopted in the ~~Treated Water~~ Utility 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 water utility improvements and may refer to one or more of the references listed in the References Section of these Standards.

## 5.02 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 water distribution system. The utility report shall be prepared by the Engineer and include a technical report, preliminary plan, and connection and isolation plan as outlined in the following subsections.

### (B) Report

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

- (1) **Water Demands:** Include estimated water demands based on occupancy and building type for the following conditions:
  - (a) ~~Maximum~~ Peak Hour (gallons-per-minute),
  - (b) ~~Maximum~~ Peak Day (gallons-per-minute),
  - (c) ~~Average Day~~ (gallons per minute),
  - (~~c~~d) Insurance Service Office (ISO) Fire Flows (gallons-per-minute), and
  - (~~d~~e) Irrigation (gallons-per-minute).
- (2) **Conformance with ~~Treated Water~~ Utility Master Plan:** Describe how the proposed water utility improvements conform with the adopted ~~Treated Water~~ Utility Master Plan.
- (3) **System Layout:** Describe the proposed distribution system layout, including locations for connections with the existing water utility system.

- (4) **Network Analysis:** Include a distribution network analysis as required by the Director, performed through an EPANet or MWH InfoWater computer simulation ~~or appropriate manual calculation~~, identifying any systems impacts based on proposed demands and providing design solutions to ensure perpetuation of future water utility system growth and maintain system pressures and flow rates.

**NOTE:** Computer simulations of hydraulic analyses are to be performed using electronic input data for the existing water system provided by the City on EPANet software~~software compatible with the “H2ONET” network analysis program~~. Computer analyses are to be submitted in both hard copy and electronic format.

- (5) **Main Sizing:** Indicate the required sizing of proposed distribution mains based on water demands.
- (6) **Design Alternatives:** –Discuss alternative system layouts and methods of providing water service, including an evaluation of each alternative and reasons for selecting the recommended design.
- (7) **Special Conditions:** Identify any special conditions, such as the presence of erosive soils, conflicts with other utilities, unusual installation depths or oversizing requirements, that require special provisions for improvements construction.

## (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 water distribution 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 water utilities, including fire hydrants and valves, 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 water distribution mains, valves, and fire hydrant locations, including construction phasing.

## (D) Connection and Isolation Plan

A connection and isolation plan shall be provided in the utility report to identify proposed connection points with the existing water systems and design conditions for providing required system isolation for maintenance and flushing. The connection and isolation plan is to include the following:

- (1) **Valve Locations:** Identify all valves necessary to isolate a point of connection for the

proposed water system onto the existing system. Existing system valves should be inspected for location and accessibility.

- (2) **Thrust Restraint:** Determine and include design and construction requirements for sufficient thrust restraint for existing water mains and valves at proposed connection points ("stub outs" and terminal extensions) to allow construction while the existing water system remains in service.
- (3) **System Isolation:** Identify water main sections that can be isolated within the proposed and existing water systems that provide for emergency maintenance and identify discharge points for system flushing.

## 5.03 Water Main Extensions

### (A) ~~Treated-Water~~ Utility Master Plan

Where major water distribution mains, 12 inches or larger in diameter, are proposed to be constructed in the ~~Treated-Water~~ Utility Master Plan, an applicant for construction approval shall provide for the construction of the main as part of any development proposal, when the major distribution 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 distribution service for the proposed development.

### (B) Main Extension Agreements

- (1) When construction of a major distribution main is required, and the diameter of the major distribution 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 11-1-42, "Agreement to Extend Water Mains," and 11-1-43, "Reimbursement of Costs for Water Main Extension," B.R.C. 1981.
- (2) When construction of an offsite major or local water distribution main is required to extend water 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 11-1-42, "Agreement to Extend Water Mains," and 11-1-43, "Reimbursement of Costs for Water Main Extension," B.R.C. 1981.

## 5.04 Design Flow

### (A) Water Distribution Mains

- (1) The water distribution system (mains and looping) shall be designed to provide a minimum residual pressure of 20 pounds per square inch (psi), at ground surface, under ~~maximum~~ peak day demand flow, plus the required ISO fire flow.
- (2) The water distribution system shall be designed to provide a minimum of 40 psi under ~~maximum~~ peak hour demand flow, without fire flow.

- (3) The water distribution system shall be designed so that water main flow velocities do not exceed 4 feet per second under peak hour demand without fire flow and 8 feet per second under peak day demand with fire flow.
- (43) Pressure and flow capacity data for both existing and future conditions for the City's major water distribution system is to be obtained from the Utilities Division for use in the design and analysis of proposed improvements.
- (54) Table 5-1 indicates water demand forecasting for peak day conditions.

**Table 5-1: Peak Day Water Demands**

Development Type	Peak Day Demand
Residential	
Low Density	180 gpcd
Medium Density	150 gpcd
High Density	75 gpcd
Commercial	10,000 gpad
Industrial	12,000 gpad

- (65) Table 5-2 indicates water demand peaking factors for forecasting demands.

**Table 5-2: Water Demand Peaking Peak Hour Factors for Forecasting Demands**

Development Type	Maximum Hour	Maximum/Day
Residential		
Low Density	5.1	5.1
Medium Density	5.0	2.5
High-Density	5.0	2.0
Commercial	2.5	2.5
Industrial	1.5	1.5

- (76) Water design flows that reduce the water system pressures below the acceptable levels or increase water system flow velocities above the acceptable levels specified in this section or elsewhere in these Standards are considered detrimental to the overall system. In these situations, the Director will deny project approval, or require the developer to provide additional water system improvements, both onsite and offsite, to ensure no reduction in levels of service.

## **(B) Water Services**

Design flows for water services shall be determined in conformance with the most current ~~Uniform Plumbing Code (UPC)~~ International Plumbing Code, as adopted by the City of Boulder.

## **5.05 Materials and Installation**

Construction of water-related public improvements shall be in compliance with these Standards. All pipe shall be of adequate strength to support the 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.

## 5.06 Corrosion Protection

Corrosion protection will be required for all water system improvements where corrosive soil conditions are encountered. The Engineer shall perform a soils resistivity survey to evaluate the corrosion potential of soils in proposed projects or developments, and recommend any necessary corrosion protection measures, such as alternative pipe type or cathodic protection. The Director will review the soils resistivity survey and Engineer's recommendations and the service history for water system corrosion in the area and determine the pipe type or protection to be used prior to construction plan approval.

## 5.07 Transmission Mains

### (A) Specifications

- (1) **Size:** All water mains 14~~6~~ inches or larger in diameter shall be classified as “transmission mains.”
- (2) **Location:** All transmission mains shall be installed in public rights-of-way or easements, as prescribed in Section 4.03~~4~~, “Utilities Easements,” of these Standards.
- (3) **Depth:** All transmission mains shall have no less than 4.5 feet and no more than 10 feet of cover, measured from the top of pipe to the final surface grade.
- (4) **Separations and Crossings:** All transmission main separations and crossings of other City utilities shall be designed in compliance with Section 4.05~~6~~, “Separation of Utilities,” of these Standards.

### (B) Taps

- (1) **Minimum Tap Size:** No main extension or fire hydrant taps smaller than 6 inches in diameter shall be installed in any transmission main.
- (2) **Service Line Taps Prohibited:** Service line taps shall not be installed in any transmission main.
- (3) **Pressure Taps:** Unless approved by the Director, all taps installed onto a transmission main shall be made under “wet tap” conditions, using a tapping tee and valve, to allow the transmission main to remain in service.

### (C) Valves

- (1) **Separation:** Valve separation along transmission mains shall be no greater than 1,200 feet, measured along the alignment of the transmission main.
- (2) **Valve Locations:** Valves shall be installed at the following locations:
  - (a) At all connections with transmission mains. Where a distribution main connects with a transmission main, a valve shall be installed on the distribution main at the transmission main.
  - (b) Where necessary to ensure that no more than three valves must be closed to isolate any section of a transmission main. Two valves shall be installed at all tee-type

connections, and three valves shall be installed at all cross-type connections.

- (c) Where possible, valves shall be aligned with extensions of property lines or right-of-way lines. Valves shall not be placed in locations that may be subject to routine parking or storage and shall not be placed within public sidewalks, multi-use paths, or on-street bike lanes.

## (D) Relief Valves

- (1) **Air and Vacuum Release Valves:** Air and vacuum release valves shall be installed in transmission mains at all high points where an elevation differential of 20 feet exists along the main.
- (2) **Pressure Blow-Off Assemblies:** Pressure blow-off assemblies shall be installed in transmission mains at all low points where an elevation differential of 20 feet exists along the main.

## (E) Ground Water Barriers

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

## 5.08 Distribution Mains

### (A) Specifications

- (1) **Size:** Distribution mains shall be at least 8 inches in diameter.
- (2) **Locations**
  - (a) All water mains shall be installed in public rights-of-way or easements, as prescribed under Section 4.0~~4~~<sup>3</sup>, “Utilities Easements,” of these Standards.
  - (b) All platted lots, whether existing or proposed as part of a subdivision, shall front on a distribution main.
- (3) **Depth:** All distribution mains shall have no less than 4.5 feet and no more than 10 feet of cover, measured from the top of pipe to the final surface grade. Where final grades have not been established, mains shall be installed deep enough to ensure acceptable cover below the future grade based on the best available information. Under no condition shall a main be installed with less than 4.5 feet of cover.
- (4) **Separations and Crossings:** All distribution main separations and crossings of other City utilities shall be designed in compliance with Section 4.0~~5~~<sup>6</sup>, “Separation of Utilities,” of these Standards.

## (B) Taps

- (1) **Pressure Taps:** All taps approved onto a distribution main shall be installed under “wet tap” conditions, using a tapping tee and valve, which allows the distribution main to remain in service at all times.
- (2) **Tap Installation:** All taps approved onto an existing distribution main will be made by the City of Boulder Utilities Division and shall be paid for by the applicant.

## (C) Valves

- (1) **Where Required:** Valves shall be installed as necessary on distribution mains to ensure that:
  - (a) No more than 600 feet of water main will be located between isolation valve zones (i.e., sections of main that may be taken out of service for maintenance activities).
  - (b) No more than two fire hydrants will be located between isolation valve zones.
  - (c) No more than three valves will require closure to isolate any section of a distribution main. Two valves shall be installed at all tee-type connections, and three valves shall be installed at all cross-type connections.
  - (d) Valves are to be aligned with extensions of property lines or right-of-way lines where possible. Valves shall not be placed within public sidewalks, multi-use paths, or on-street bike lanes.
- (2) **Emergency Access:** Valves shall be located to provide maximum accessibility for emergency access. Valves shall not be placed in locations that may be subject to routine parking or storage operations.

## (D) Looping and Terminal Mains

- (1) **Looping Required:** All distribution mains shall be looped into the existing and proposed water distribution system to ensure at least two feed sources and to maintain system strength, except as allowed under Section 5.08(E) below.
- (2) **Maximum Terminal Length:** Where allowed, terminal (dead-end) distribution mains shall not be more than 600 feet long, measured along the entire centerline length of the terminal main from the connection main to the terminus.
- (3) **Fire Hydrant on Terminal Mains:** All terminal mains shall have a fire hydrant at the terminus and no more than two fire hydrants in total. Fire hydrant installations shall be offset from the terminus to ensure that the hydrant can be removed for maintenance while the terminal main remains in service.
- (4) **Service Taps:** Service taps along terminal mains shall not be located closer than 3 feet to the terminus nor located between the fire hydrant connection and the terminus.

## (E) Extensions

- (1) **Standards:** Water distribution main extensions are subject to the requirements in Section 11-1-41, “Extensions of Water Mains,” B.R.C. 1981, and these Standards.
- (2) **System Perpetuation:** Water 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 water distribution system, may dictate that water 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.

## (F) Future Connections

- (1) **Isolation Valve Required:** When future main extensions are provided for by “stub out” or terminal connections, the stub out or terminal main extension shall be valved so that only one valve must be closed when the future main is extended. The valve shall be restrained to the existing distribution main to allow closure of the stub out or terminal main section without creating a pressure separation of the valve from the in-service distribution main.
- (2) **Valve Restraint:** Valve restraint may be ensured by the use of a direct swivel connector or adapter, or by providing a pipeline extension that can restrain the valve through frictional resistance. All future connections designed at perpendicular angles to the existing distribution main shall include a valve on the extension that is directly attached to the existing main. Where valve restraint through frictional resistance of extended pipe line sections is proposed, the Engineer shall determine the necessary pipe length required to provide adequate frictional resistance, subject to review and approval by the Director.
- (3) **Testing:** When future connections are made, the entire main beyond the stub out or terminal main extension shall be flushed, chlorinated, and pressure tested.
- (4) **Service Taps Prohibited:** No service taps shall be allowed on a stub out or on a terminal main beyond the isolation valve.

## (G) Ground Water Barriers

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

## 5.09 Water Services

### (A) General

- (1) **Standards:** Water services are water system extensions that are tapped onto the distribution system to provide water to consumers. Water services are subject to the requirements of these Standards and Section 11-1-20, “Taps or Connections to Water

Mains,” and Section 11-1-21, “Water Service Lines,” B.R.C., 1981.

- (2) **Water Meters:** Water services shall include the installation of a meter and shall be subject to the requirements of these Standards and the conditions of Sections 11-1-34, “Meter and Appurtenances to be Purchased by User,” Section 11-1-35, “Meter Size Requirements,” and Section 11-1-36, “Location and Installation of Meters; Maintenance of Access to Meters,” 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 water service connection to a distribution main without crossing adjacent lots.
- (4) **Service Alignment:** When the water service is located in the public right-of-way or easement, the service shall be installed perpendicular to the distribution main, up to and including the meter and pit. Where this is not possible, the water service alignment shall be subject to the determination of the Director.
- (5) **Pressure Boosters Prohibited:** No pressure booster of any kind is allowed on any water service.

## (B) Domestic Services

- (1) **Separate Services to Structures:** Each principal structure shall be served by a separate water service line and meter connected to the distribution main. Where more than one principal structure is proposed on a single lot, an additional water service line and meter will be required for each additional principal structure.
- (2) **Accessory Buildings or Structures:** An accessory building or structure, (as defined under Subsection 9-16-31(4c), “General Definitions,” B.R.C. 1981, may draw limited service from a principal building or structure without a separate water service, subject to the following:
  - (a) If the accessory structure contains no toilet and no bathtub or shower fixtures, the accessory structure is limited to the following plumbing fixtures:~~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 fixture), and
    - (v) Interceptor (one fixture).
  - (b) If the accessory structure is proposed to have a sink and toilet, the accessory structure shall not contain any additional sinks or toilets nor a bathtub or shower fixture, shall not be used as a separate dwelling unit, may not be located on a property that can be subdivided into separate lots, and shall be limited to the following additional plumbing fixtures:
    - (i) Sink (one fixture),
    - (ii) Toilet (one fixture),
    - (iii) Floor drain (one fixture), and

- (iv) Interceptor (one 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) An approved detached accessory dwelling unit, as defined under Subsection 9-16-13(c), "General Definitions," B.R.C. 1981, is not subject to this section's plumbing fixture limitations.
- ~~(e)~~(d) The Director of Public Works may permit water hookups and meters separate from a principal detached dwelling unit only upon finding that topography or other physical circumstances make utility connections to the principal structure impractical.
- (3) **Services Crossing Lots:** Domestic water services 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 water service line only, or by the water and wastewater service lines only if the water and wastewater service lines are installed in compliance the UPC, as adopted by the City.
  - (c) The Director determines that a water main extension is not necessary to perpetuate the system, or that future development of abutting properties cannot benefit from a main extension.
  - (d) The water 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 UPC, as adopted by the City.

## (C) Irrigation Services

- (1) **Separate Service:** With the exception of single-family residential properties, all irrigation services shall have a separate service line and meter.
- (2) **Property to be Served:** Irrigation service lines shall serve no more than one individual property, unless approved by the Director under the provisions of a homeowners association. Where irrigation services serve more than one individual property, the plant investment fee (PIF) and associated credit shall apply to the individual property where the water meter is located and the service originates.
- (3) **Building Connection Prohibited:** Irrigation service shall not connect with any building or structure or with any other consumptive-use water service.
- (4) **Reduced Pressure Assembly Required:** All irrigation systems with a separate, metered service line shall have a reduced pressure principle assembly installed in compliance with all applicable City regulations and standards.

## 5.10 Fire Protection

### (A) Fire Hydrants

- (1) **Standards:** All fire hydrants shall be installed in compliance with these Standards.
- (2) **Easements:** All fire hydrants shall be installed within public rights-of-way or easements as prescribed in Section 4.034, "Utilities Easements." Easements shall be a minimum of 25 feet in width and extend at least 10 feet beyond the hydrant assembly.
- (3) **Placement:** The placement of fire hydrants shall comply with the International Uniform Fire Code, as adopted with local amendments under Chapter 10-8, "Fire Prevention Code," B.R.C. 1981, and the following requirements:
  - (a) Fire hydrants shall be placed at the entrance or intersection for each street, with a hydrant place on each side of any divided roadway.
  - (b) In a single-family residential area, there shall be no more than 500 feet of fire access distance between hydrants. No dwelling unit shall be over 250 feet of fire access distance from the nearest hydrant.
  - (c) In all other areas, there shall be no more that 350 feet of fire access distance between hydrants. No exterior portion of any building shall be over 175 feet of fire access distance from the nearest hydrant.

**NOTE:** Fire access distance means the distance between two hydrants, or the distance from a hydrant to any external portion of any building, measured along public or private (but accessible to fire equipment) roadways or fire lanes, as would be traveled by motorized firefighting equipment.
- (4) **Alignment with Property Lines:** Hydrants shall be aligned with an extension of the property line when located midblock.
- (5) **Horizontal Clearances:** Hydrants shall be placed no farther than 5 feet behind the curb, outside of any fenced area, and have a 10-foot radius of clearance to adjacent obstacles (fences, walls, shrubs, trees, etc.).
- (6) **Vertical Clearances:** Hydrants shall have the lowest water outlet not less than 18 inches or more than 30 inches above the final ground elevation.
- (7) **Colors:** The hydrants' color shall be Rustoleum No. 831 "restful green" or "KWAL" hydrant green except for bonnet, weather caps, and nozzle caps, which must be Rustoleum No. 2766 "reflectORIZED white" unless otherwise specified by the Director of Public Works. Designated hydrant colors shall be "Restful Green Bonnet" for barrels and "Reflective White" for caps.

### (B) Fire Sprinkler Lines

- (1) **Dedicated Line:** A fire sprinkler line for any structure or building, other than a single-family or duplex residential structure, which is either required to be installed by the Boulder Fire Department or installed voluntarily by the applicant, shall be a separate dedicated fire sprinkler line tapped at the water distribution main. The minimum tap and valve diameter size for a dedicated fire sprinkler line shall be 4 inches. The property owner may choose to reduce the line diameter, as needed, beyond the City-maintained valve in the property owner-maintained portion of the fire sprinkler line. The City shall not

be responsible for maintenance beyond the first valve on the line.

- (2) **Maintenance Responsibility:** The property owner shall be responsible for maintaining all dedicated fire sprinkler lines beyond the ~~water-valve-tap~~ at the main distribution line. It is the property owners' responsibility to ensure all City owned and maintained valves are visible and not covered by landscape materials, concrete or asphalt.
- (3) **Service Taps Prohibited:** No taps will be approved onto a fire sprinkler line for any purpose other than the fire sprinkler system. Combination fire sprinkler/service lines for domestic or irrigation services will not be approved, except as allowed in Subsection (B)(4), below.
- (4) **Combination Line:** A single-family or duplex residential structure may have a combination fire sprinkler/domestic service line from the City's water distribution main to the water meter, if the following conditions are met:
  - (a) The combination line shall be sized to convey maximum domestic service and fire sprinkler protection service flows. ~~The maximum~~ combination line size ~~is~~ shall be 2 1/2 inches in diameter; otherwise, the combination line shall be separated into a dedicated fire sprinkler line and separate domestic service line, each tapped at the distribution main.
  - (b) The combination line shall separate at the water meter pit into a domestic service line (with meter) and a dedicated fire sprinkler line (without meter, but with oriseal shutoff).
  - (c) Beyond the water meter pit, both the domestic and fire sprinkler water service lines may be placed in the same trench. However, they may not be tied back together in any manner, and they may not have any type of cross-connection either inside or outside the structure.
  - (d) The property owner is responsible for maintaining the domestic service and the fire sprinkler lines beyond the water meter pit.

**NOTE:** Section 5.11, "Cross-Connection Regulations," of these Standards, identifies the requirements for cross-connection control and backflow prevention as they apply to fire sprinkler systems.

## 5.11 Cross-Connection Regulations

### (A) Purpose

The purpose of these standards is to protect the ~~e~~City water system from contamination or pollution by backflow due to cross connections from owner water systems, and to a continuing program of cross connection control to prevent the contamination or pollution of the Ccity water system. For the purpose of this section, "Contamination" means any impairment of the quality of the potable water by pollution from sewage, industrial fluids or waste liquids, compounds or other materials to a degree which may create a hazard to the public health through poisoning or through the spread of disease.

### (B) Additional Regulations

- (1) Sections 11-1-3, "Rules and Regulations," and 11-1-25, "Duty to Maintain Backflow Prevention Assembly and Prevent Cross-Connection," B.R.C. 1981.



- (2) The Colorado Cross Connection Control Manual

### **(C) General Requirements**

- (1) If a backflow prevention assembly is required by the Ceity, the Director of Public Works may give notice in writing to the owner to install an approved backflow prevention assembly at each service connection to the premises. The owner shall install an approved assembly at each service connection to the premises at the owner's own expense.
- (2) No provision of this section exempts the owner from the cross-connection control provisions for internal water distribution systems as contained in the International Uniform Plumbing Codes and other plumbing standards adopted by the B.R.C. 1981, or state or federal regulations regarding cross-connections.
- (3) No person shall operate an industrial fluids system, auxiliary water supply, or an owner water system that allows for the occurrence of a cross connection to the water utility.
- (4) There shall be no unprotected branches from the service line ahead of any meter or backflow prevention assembly located at the point of delivery to the owner's water system.
- (5) No person owning, managing, installing or repairing any water system shall fail to comply with any of these rules.

### **(D) Installation Required**

- (1) ~~A~~ backflow prevention assembly approved by the Director of Public Works shall be installed immediately inside the structure being served, after the meter on private property, and before the first branch line leading off the service line wherever any of the following conditions exist:
  - (a) If a property has an auxiliary water supply which is not or may not be of safe bacteriological or chemical quality and which is not acceptable as an additional source by the Director of Public Works, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line appropriate to the degree of hazard.
  - (b) If a non-residential property that contains any liquid processes or fluids system or any other unapproved water system, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line appropriate to the degree of hazard.
  - (c) In all premises that contain internal cross connections that cannot be permanently corrected and controlled, or that contain intricate plumbing and piping arrangements, or where entry to all portions of the premises is not readily accessible for inspection purposes making it impracticable or impossible to ascertain whether or not dangerous cross connections exist, the water utility shall be protected against backflow from the premises by installing a backflow prevention assembly in the service line.
- (2) Installation shall be as approved by FCC and URC, USC list including vertical and horizontal assembly orientation.
- (3) Backflow prevention assemblies shall be installed in an accessible location to facilitate inspection, testing and maintenance without removal of the device. An adequate drainage area for the assembly must be provided for in the event that water is released. Installation clearance requirements shall meet requirements of the Colorado Cross-Connection Control

Manual and allow removal of all parts from the assembly. Pit and vault installations are prohibited.

### (E) Duty to Inspect, Test and Repair

The owner shall have certified inspections and operational tests made on the backflow prevention assembly upon installation and at least once per year thereafter. The Director of Public Works may require certified inspections at more frequent intervals. These inspections and tests shall be made at the expense of the owner. A backflow prevention assembly shall be repaired or replaced at the expense of the owner whenever an assembly is found to be defective.

### (F) Specifications

(1) After written notification by the Director of Public Works, any property with a backflow incident shall be responsible for installation, inspection and testing, or repair of a backflow prevention assembly within 10-days. Backflow prevention devices shall be air-gap ("AG") or reduced pressure principle assembly ("RP") except for Solar heating systems with make-up water which shall be "RP" devices.

(2) After written notification by the Director of Public Works, the owners and operators of the following types of existing facilities shall be responsible for installation, inspection and testing, or repair of a backflow prevention assembly within 30-days of such written notice. Backflow prevention devices shall be air-gap ("AG"), or reduced pressure principle assembly ("RP") unless otherwise noted.

- |   |   |   |
|---|---|---|
| • Automotive service station or repair shop               | • Laboratory - clinical and chemical  | • Sewage treatment plant                              |
| • Auxiliary water supply                                  | • Laundry or dry cleaning service   | • School with laboratory                              |
| • Commercial service line greater than four-inch diameter | • Manufacturing and industrial facility (to be determined on an individual basis) | • Shell business development space                    |
| • Carwash   | • Medical office  | • Solar heating system with make-up water ("RP Only") |
| • Food processing and Packing plant                       | • Morgue and mortuary   | • Swimming pool                                       |
| • Greenhouse  | • Multi-storied buildings (4 stories or more)                                     | • Veterinary office or clinic                         |
| • Hospital, inpatient and outpatient care                 | • Photographic studio and laboratory  | • Water treatment plant                               |
| • Hotel or lodging facility                               |   |   |
| • Kennel - boarding only                                  |   |   |

(3) Prior to ~~F~~final ~~i~~nspection of any new structure or alteration requiring a building permit, the owners and operators of the following types of facilities shall be responsible for installation, inspection, testing, or repair of a backflow prevention assembly. Backflow prevention devices shall be air-gap ("AG"), or reduced pressure principle assembly ("RP") unless otherwise noted. Double Check Valve Assembly ("DC") devices shall only be permitted where specifically approved below.

- |  |                          |                                   |
|--|--------------------------|-----------------------------------|
| • Any establishment with a backflow incident | • or repair shop         | line greater than 4-inch diameter |
| • Automotive Service station                 | • Auxiliary water supply |                                   |
|  | • Commercial service     | • Carwash                         |

- |  |   |  |
|--|---|--|
| • Fire line -- no chemicals added (AG, RP, or DC)  | • Laundry and cleaning service  | • Sewage treatment plant                                     |
| • Fire line -- chemicals added                     | • Manufacturing and industrial facility (to be determined on an individual basis) | • School with laboratory                                     |
| • Food processing and packing plant                | • Medical office  | • Shell business development space                           |
| • Greenhouse                                       | • Morgue and mortuary   | • Solar heating system with make-up water system ("RP" Only) |
| • Hospital, outpatient care and long-term facility | • Multi-storied building (4 stories or more)                                      | • Swimming pool  |
| • Hotel and lodging                                | • Photographic studio and lab   | • Veterinary office  |
| • Kennel - boarding only                           |   | • Water treatment plant                                      |
| • Laboratory -- clinical and chemical              |   |  |

- (4) Any building or facility not listed in the foregoing table may be required by the Director of Public Works to install a backflow prevention assembly. The compliance period and assembly required shall be determined by the Director of Public Works based on the degree of hazard.
- (5) The compliance periods listed above may be modified by the Director of Public Works for good cause shown, and after submittal and approval by the Director of Public Works of a compliance plan.
- (6) Compliance plans shall be enforceable against subsequent owners of non-residential property. If no approved compliance plan exists, then the property must be in compliance with this rule prior to any sale of the property.

## **(G) Records and Reports**

A certified tester shall record the results of all inspections, tests and maintenance on a form prescribed by the Director. This report shall be submitted to the Director and the owner within ten days following the completion of the inspection, test, or maintenance of the assembly. The certified tester shall also attach a card to the backflow prevention assembly following each inspection, test, or maintenance activity to document and date the activities performed. Records of all inspections, test, or maintenance activities, including materials and parts changed, shall be kept by the certified inspector and the owner.

## **(H) Backflow Prevention Assemblies**

- (1) The term "approved backflow prevention assembly" or "approved assembly" means any of the following:
- (a) an assembly that is in conformance with the laboratory and field performance specifications of the Foundation for Cross Connection Control and Hydraulic Research (FCC and HR) of the University of Southern California; or
  - (b) an assembly which has been approved, inspected and installed to the satisfaction of the Director of Public Works.
- (2) All backflow prevention assemblies shall have a unique serial number attached to the assembly by the manufacturer.
- (3) Backflow prevention assemblies currently installed which are not approved shall be replaced with an approved assembly within 30 days of written notice by the eCity. If the assembly fails an annual operational test or inspection, it shall be repaired or replaced with an approved

assembly within 30 days of written notice by the ~~e~~City.

**(l)        Certified Tester Criteria**

- (1) Testing of backflow prevention assemblies on fire sprinkler systems shall require the certified Cross Connection Control and Backflow Prevention Device Tester to also be a certified Fire Sprinkler System Installer, or be supervised by a certified Fire Sprinkler System Installer registered with the City of Boulder Fire Department.
- (2) Certified Cross Connection Control and Backflow Prevention Device Testers shall also be required to provide the following information in order to be listed on the Backflow Prevention Program's list of certified testers in the area. Such information shall be sent or faxed directly from the laboratory to the Backflow Prevention Program office at 5605 N. 63rd St., Boulder, Colorado 80301-; FAX: 303-530-1137.
  - (a) Copy of a current Cross Connection Control and Backflow Device Tester certificate.
  - (b) Test kit calibration certificate from an authorized manufacturers calibration/ repair laboratory or an ISO 9002 certified calibration/repair laboratory for instrument repairs or measurements. Documented calibration must be National Institute of Standards and Technology (NIST) traceable and meet the current ASME/ANSI B40.01 standards. The certified calibration report shall include the following:
    - (i)        Indicate minimally the descending reading at 10, 7, 5, 2, 1 and 0 PSID with a minimum required tolerance range of  $\pm 0.1$  PSID~~;~~
    - (ii)        ~~d~~Data as found (data prior to any adjustment of the test kit)~~;~~ and
    - (iii)        ~~a~~After calibration data or returned information documented (data after adjustment, if required-)~~;~~
  - (c) Provide a certificate signed by a qualified agent of an insurance company that meets minimum limits required by Section 4-1-8(a) and (b), B.R.C. 1981.

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

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**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 Utility 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~~Utility 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 ~~wastewater~~wastewater 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~~Utility Master Plan:** Describe how the proposed wastewater utility improvements conform with the adopted Wastewater ~~Collection System~~Utility 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<sub>5</sub> (total and soluble fraction, carbonaceous and nitrogenous demand),
  - (h) COD (total and soluble),
  - (i) TSS,
  - (j) Nitrogen (TNK, NO<sub>3</sub>, NO<sub>4</sub>, NH<sub>4</sub>, organic), and
  - (k) Inorganics (salts, metals)<sub>2</sub>

## (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 Wasterwater~~ Utility Master Plan

Where major wastewater collection mains, 12 inches or larger in diameter, are proposed to be constructed in the ~~Wastewater Collection System~~ Utility 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 flow and minimum flow factors for forecasting discharges. These flow factors are; used with the preceding average day load estimates as defined in Section 6.04 A(10) of these Standards to determine minimum required wastewater main capacity:

**Table 6-2: Factors for Forecasting Wastewater Discharges**

<b>Collection Main Diameter</b>	<b>Minimum <u>Flow</u> Factor</b>	<b><del>Peaking</del> <u>Peak Flow</u> Factor</b>
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, building areas, pumped discharge flow rates, existing wastewater flow rates, existing or anticipated industrial discharges, ~~and average day~~, peak flow, minimum flow, ~~day~~, and infiltration/inflow flow rates.

## **(B) Wastewater Services**

Design flows for wastewater services shall be determined in conformance with the most current International 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 “Manning’s” 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 no more than 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 4.024 of these ~~criteria~~ Standards.
- (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"	0.332400	8.2997.5
10"	0.247332	6.1645.5
12"	0.193247	4.8334.5
15"	0.144193	3.5903.5
18"	0.113144	2.8152.5
21"	0.092113	2.2922.0
24"	0.077092	1.9181.8

- (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 4.056, “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~~ 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 wastewater distribution-collection 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 400 feet:
  - (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-six (86)~~ 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 11-3-164, "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 shall not be placed in detention basins, drainage ditches, or should not be located in areas subject to localized flooding ponding. Placement of manholes ~~in from floodplains, surface runoff, or ponding~~ should be avoided if possible.

## (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. The access drive shall be free of obstructions and landscaping.

## (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 hinged, gasketed, and locking frame and cover assembly. The assembly shall be an "East Jordan Iron Works" ERGO or ERGO XL assembly~~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 storm water, 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.
- (8) **Maintenance Access:** Wastewater services shall be provided with a two-way cleanout outside and adjacent to the building being served; and where there is a change in alignment of the service. Cleanouts shall be constructed as follows:
  - (a) No cleanouts shall be installed within the public right-of-way.
  - (b) Cleanouts shall be constructed of the same diameter pipe as the wastewater service.
  - (c) Cleanouts shall not be located in detention ponds, ditches, swales, or other areas

of stormwater runoff or ponding.

(d) Cleanouts shall be fitted with a threaded watertight cap that prevents the inflow of stormwater or irrigation water.

(e) The cleanout shall allow maintenance access for cleaning and inspection in both the upstream and downstream direction.

## **(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 any of the following conditions exist:
  - (a) The service size is ~~eight~~six 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.~~If the accessory structure contains no toilet and no bathtub or shower fixtures, the accessory structure is limited to the following plumbing fixtures:
    - (i) Sink (one fixture),
    - (ii) Clothes washer connection (one set),



- (iii) Hose bib or sill cock (one fixture),
- (iv) Floor drain (one-~~(4)~~ fixture), and
- (v) Interceptor (one-~~(4)~~ fixture).
- (b) If the accessory structure is proposed to have a sink and toilet, the accessory structure shall not contain any additional sinks or toilets nor a bathtub or shower fixture, shall not be used as a separate dwelling unit, may not be located on a property that can be subdivided into separate lots, and shall be limited to the following additional plumbing fixtures:
  - (i) Sink (one fixture),
  - (ii) Toilet (one fixture),
  - (iii) Floor drain (one fixture), and
  - (iv) Interceptor (one fixture).
- (c) An approved detached accessory dwelling unit, as defined under Subsection 9-16-1(c), "General Definitions," B.R.C. 1981, is not subject to this section's plumbing fixture limitations.
- (d) 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.
- ~~(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.

CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS

# CHAPTER 7

## ~~STORM WATER~~STORMWATER DESIGN

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## 7.01 General

### (A) Intent

The ~~Storm Water~~Stormwater Design Standards are intended to provide for a comprehensive and integrated ~~storm water~~stormwater utility system to convey and manage ~~storm water~~stormwaters in order to mitigate safety hazards and minimize property losses and disruption due to heavy storm runoff and flooding, maintain travel on public streets during storm events, enhance water quality of storm runoff by mitigating erosion, sediment and pollutant transport, control and manage increased runoff due to local development, establish effective long-term management of natural drainageways, and provide for ongoing and emergency maintenance of public ~~storm water~~stormwater systems. These standards are intended to prevent pollution and degradation of state waters.

The City is an operator of a Phase II Municipal Separate Storm Sewer System (MS4) and is required by the State of Colorado to hold a permit to discharge stormwater from its municipal separate storm sewer system to the waters of the State. The Stormwater Design Standards establish standards implementing the requirements of the MS4 Permit and Chapter 11-5, "Stormwater and Flood Management Utility," B.R.C. 1981.

### (B) Comprehensive Flood and Stormwater~~Storm Water~~ and Greenways Master Plans

All improvements proposed to the City's ~~storm water~~stormwater system shall conform with the goals, policies, and standards outlined in adopted ~~Storm Water Collection, Major Drainageway, Comprehensive Flood and Stormwater~~ and Greenways ~~Program~~ Master Plans.

### (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 ~~storm water~~stormwater improvements and may refer to one or more of the references listed in the References Section of these Standards.

### (D) Floodplains

Where improvements are proposed within a designated 100-year floodplain, as defined on the current FEMA Flood Insurance Rate Map (FIRM) or floodplain mapping adopted by the City, an applicant for construction approval shall satisfy and comply with all applicable regulations and requirements as set forth in Chapter 9-~~39~~, ~~"Floodplain Regulation Overlay Districts,"~~ B.R.C. 1981.

### (E) Storm Water~~Stormwater~~ Quality and Erosion Control

The ~~UDFCD's Urban Storm Drainage Criteria Manual~~USDCM, Volume 3, "Best Management Practices," "Colorado Department of Transportation M-Standards, and/or City of Boulder, "Wetlands Protection Program Best Management Practices" manual shall be applied to address ~~storm water~~stormwater quality management and erosion control for all proposed projects and developments. An applicant for construction or development approval shall also satisfy and comply with all applicable regulations and requirements as set forth in Chapter 11-5, "Stormwater

and Flood Management Utility,” B.R.C. 1981. All ~~storm water~~stormwater reports and plans shall include necessary analyses, mitigation measures, and improvements needed to meet these ~~storm water~~stormwater quality and erosion control standards.

## **(F) Wetlands Protection**

Where improvements are proposed within a delineated wetland or wetland buffer area, as defined under the City’s wetland protection ordinance, an applicant for construction approval shall satisfy and comply with all applicable regulations and requirements as set forth in Section~~Chapter~~ 9-423-9, “Stream, Wetlands, and Water Body Protection,” B.R.C. 1981, including any necessary identification, analyses, avoidance and mitigation measures, and improvements needed to address wetlands protection requirements.

## **(G) Streets**

~~Streets are an integral part of the local storm water drainage system and may transport local storm runoff as specified in these Standards. However, the primary purpose of streets is for transportation, and storm water conveyance shall not be the major function of a street. The primary function of streets is for safe traffic movement; therefore, streets shall be designed and constructed to accommodate runoff and convey it to downstream drainage facilities in order to minimize its interference with traffic. When the stormwater runoff accumulation in the street exceeds allowable limits, storm sewers or other drainage facilities are required to collect and convey the excess runoff.~~

## **(H) Irrigation Ditches and Laterals**

Where a project or development is proposed adjacent to or impacts an existing irrigation ditch, an applicant for construction approval shall meet the following standards:

- (1) No storm runoff shall be conveyed into an irrigation ditch or lateral without written approval and permission from the affected irrigation ditch company or lateral owner.
- (2) An adequate right-of-way or drainage easement for maintaining the affected irrigation ditch shall be dedicated to the City.
- (3) The irrigation ditch or lateral shall not be relocated, modified, or altered without written approval and permission from the affected irrigation ditch company or lateral owner.
- (4) The irrigation ditch or lateral shall not be used for the following purposes:
  - (a) Basin boundaries to eliminate the contribution of the upper basin area in the evaluation of runoff conditions. Irrigation ditches shall not be assumed to intercept ~~storm water~~stormwater runoff.
  - (b) Outfall points for new development where runoff into irrigation ditches and laterals has increased in flow rate or volume, or where historic runoff conditions have been changed, without written approval and permission from the affected irrigation ditch company or lateral owner.

## **(I) Multiple Functions of Major Drainageways**

Boulder Creek’s numerous tributaries are part of a comprehensive natural open drainageway system. These drainageways provide open corridors and serve multiple functions, including without limitation, ~~storm water~~stormwater drainage and flood conveyance, wetlands and water quality enhancement, environmental protection and preservation, open space and wildlife areas, and recreational activities and trail corridors. ~~Storm water~~Stormwater improvements impacting

these drainageways shall be designed and constructed to respect, restore and enhance these functions in order to maintain the creek corridor ecology, environment and aesthetic value of such drainageways.

## **(J) Definitions**

The words defined in this subsection and used in this Chapter have the meanings established in this section unless the context clearly indicates otherwise:

*Applicable development site* means (1) any new development or redevelopment site resulting in land disturbance of greater than or equal to one acre, including a site that is less than one acre that is part of a larger common plan of development or sale that would disturb or has disturbed one acre or more, or (2) any development site for which a stormwater detention pond is required under these Standards.

*Common plan of development or sale* means a plan or sale where multiple separate and distinct construction activities may be taking place at different times on different schedules in a contiguous area, within 1/4 mile, but remain related through such plan or sale.

*Construction activity* means an activity that disturbs the ground surface and associated activities that include, without limitation clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. Activities from initial ground breaking through final stabilization are construction activities regardless of ownership. Construction activities do not include routine maintenance to maintain the original line and grade, hydraulic capacity, or original purpose of a facility. Activities to conduct repairs that are not part of routine maintenance, activities for replacement, and activities for repaving where underlying or surrounding soil is exposed, cleared, graded, or excavated are all construction activities for the purposes of this chapter.

*Control measure* means an activity, practice, or structural control used to prevent or reduce the discharge of pollutants to waters of the State. The two categories of control measures are:

*Control measure for post-construction stormwater quality*, also referred to as a stormwater control measure (SCM), means a permanent device, practice, or method for removing, reducing, retarding, or preventing targeted stormwater runoff constituents, pollutants, and contaminants from reaching receiving waters.

*Control measures for erosion and sediment control* means a device, practice, or method implemented on a construction site to remove, reduce, retard, or prevent pollutants or pollutant-laden water from discharging off the site. These control measures may be structural (e.g., wattles/sediment control logs, silt fences, earthen dikes, drainage swales, sediment traps, subsurface drains, pipe slope drains, inlet protection, outlet protection, gabions, sediment basins, temporary vegetation, permanent vegetation, mulching, geotextiles, sod stabilization, slope roughening, maintaining existing vegetation, protection of trees, and preservation of mature vegetation) or non-structural (e.g., schedules of activities, prohibitions of practices, pollution prevention and educational practices, and maintenance procedures).

*Detention pond* means a structural control intended to store increased runoff from developed property and release this runoff at the historic rate that existed prior to development or redevelopment.

*LID technique* means low impact development technique.

*Low Impact Development (LID) technique* means a non-structural land development planning and site layout strategy intended to reduce stormwater volume, peak discharge, and pollutant load.

*MS4 Permit* means the Municipal Separate Storm Sewer System Phase II discharge permit issued

by the Colorado Department of Public Health and Environment pursuant to Regulation 61, Colorado Permit Discharge System, 5 CCR 1002-61, and the Colorado Water Quality Control Act, C.R.S. § 25-8-101, *et seq.*, as that permit may be amended in the future.

*New development* means a vegetative or non-vegetative change in the existing land surface, including without limitation construction activities, compaction associated with stabilization of structures, road construction, construction or installation of a building or other structure, and creation of impervious surfaces, and land subdivision for a site that does not meet the definition of redevelopment.

*Receiving Pervious Area (RPA)* means a vegetated pervious area that receives stormwater from an impervious area, thus un-connecting the impervious area from directly discharging stormwater to a local stream, lake, or to the public stormwater utility system.

*Redevelopment* means the creation or addition of impervious area or paved surface on a site that is already substantially developed with 35% or more existing imperviousness, including without limitation expansion of a building footprint, addition or replacement of a structure, structural development, and construction or replacement of paved surface area.

*Stormwater utility system* means the municipal storm sewer system that includes without limitation the conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels, or storm drains) that discharge to state waters and is owned or operated by the City and designed or used for collecting or conveying stormwater, and is not a combined sewer or part of a publicly owned treatment works.

*Stormwater Quality Design Standard* means a performance metric from the MS4 Permit that must be demonstrated to be achieved to document compliance with City of Boulder stormwater requirements for applicable development sites. Stormwater Quality Design Standards are volume reduction, Water Quality Capture Volume (WQCV), pollutant removal, and constrained redevelopment site standards, as defined in Subsection 7.16(D).

*Treatment area* means a single drainage basin or group of drainage basins for which a proposed design completely satisfies a single Stormwater Quality Design Standard.

*Unconnected Impervious Area (UIA)* means an impervious area that discharges to a RPA and, therefore, does not discharge directly to a local stream, lake, or the stormwater utility system.

*Water Quality Capture Volume (WQCV)* means the volume equivalent to the runoff from an 80<sup>th</sup> percentile storm, meaning that 80 percent of the most frequently occurring storms are fully captured and treated and larger events are partially treated.

## **7.02 Conceptual Drainage Report ~~Storm Water Report~~ and Stormwater Plan**

### **(A) Required General**

- (1) If a project is determined to be of sufficient size or complexity, the Director may require the preparation of a Conceptual Drainage Report and Stormwater Plan by the Engineer to assess feasibility of stormwater utility system improvements. The purpose of the Conceptual Drainage Report and Stormwater Plan shall be to demonstrate that required stormwater utility system facilities can be accommodated on the development site and to identify and plan for impacts to neighboring properties and stormwater utility systems.
- (2) The Director reviews Conceptual Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.

(3) Measured or calculated parameters provided in all submitted Conceptual Drainage Reports and Stormwater Plans shall be reported using the English System of Measurement unless Metric System units are the standard expression for the parameter.

(a) Land or surface area shall be reported in square feet (ft<sup>2</sup>, sf, or sq.ft.) for projects having a land disturbance area less than one acre and shall be reported to the nearest tenth of an acre (acre or ac.) for projects having a land disturbance of one acre or greater.

(b) Water volume shall be provided in cubic feet (ft<sup>3</sup> or cu.ft.).

(c) Soil volume shall be provided in cubic yards (yd<sup>3</sup> or cu.yd.).

(d) Water discharge (also stated as flow rate or flow) shall be provided in cubic feet per second (ft<sup>3</sup>/s or cfs).

(e) Infiltration rate shall be reported in inches per hour (in/hr).

~~The Director of Public Works may require the preparation of a Conceptual Storm Water Report and Plan in order to assess the feasibility of any project or development. The purpose of the report shall be to demonstrate that required drainage facilities and/or easements can be accommodated on the project site, to identify any probable impacts to neighboring properties or drainage facilities, and to provide recommendations for mitigation of these impacts. A Conceptual Storm Water Report and Plan shall be used only for projects or developments where proposed improvements and mitigation measures are contained within the limits of the project site. The Conceptual Storm Water Report shall include a technical report as outlined in the following sections. Approval of a Conceptual Storm Water Report and Plan shall not be construed as approval of specific design details.~~

## **(B) — Technical Report**

~~The technical report shall provide a description of the proposed project or development, historic and developed runoff conditions, approximate storm water runoff flow rates and volumes, water quality and erosion control measures, storm water attenuation or detention ponding measures, proposed storm water utility improvements, basic design requirements, and a reference of study data sources, methods and findings, and include the following information:~~

~~(1) — **Background:** Provide a written statement describing the proposed project or development that includes the following information:~~

~~(a) — Site location, including legal description and a discussion of the area characteristics, identifying land development patterns and features, transportation networks and storm water systems (creeks, channels, irrigation ditches, and storm sewers) in the surrounding area.~~

~~(b) — Site description, including the total land area, general topography, and existing ground cover, wetlands, groundwater conditions, and storm water and irrigation ditch systems.~~

~~(2) — **Development Proposal:** Provide a general description of the proposed project or development, including land use, density, site development plans and coverage, and storm water planning concepts.~~

~~(3) — **Existing Storm Water Basins and Drainage Patterns:** Include a description and of the storm water basins and drainage patterns that are impacted by site development, including:~~

~~(a) — Offsite drainage patterns and their effect on site development,~~

- (b) ~~Onsite drainage patterns, existing runoff systems, and infall and outfall points,~~
- (c) ~~Previous drainage studies for the site, drainage basin, or local area that may influence drainage design, and~~
- (d) ~~Existing drainage problems, floodplain impacts, and ground water conditions contributing to site runoff.~~
- (5) ~~**Storm Water Quality and Erosion Control Measures:** Describe mitigation measures and improvements that will be utilized to address Subsection 7.13 of these standards and how and where these improvements will be accommodated within the site development plan.~~
- (6) ~~**Wetlands Impacts:** Identify any delineated wetland or wetland buffer areas as set forth in Chapter 9-12, "Wetlands Protection," B.R.C. 1981, and include a discussion of any necessary analyses, avoidance and mitigation measures, and improvements needed to address wetlands permitting requirements.~~
- (7) ~~**Hydrology:** Provide sufficient hydrological analysis to determine the approximate size and location of storm water conveyance and detention facilities on the site. Calculations should be consistent with the methodologies identified in Section 7.05, "Hydrology," of these Standards.~~
- (8) ~~**Storm Water Detention:** Identify the approximate size and location of any detention facilities required by Section 7.12, "Storm Water Detention," of these Standards.~~
- (9) ~~**Developed Storm Water Conditions:** Describe and define proposed storm runoff conditions following development, estimated by using the proposed land use and development patterns for the subject site based on the initial and major storm events, including a discussion of the following:~~
  - (a) ~~Acceptance and conveyance of offsite runoff through the proposed site development,~~
  - (b) ~~Proposed flow patterns, approximate onsite drainage rates, drainage facilities, detention ponds, water quality measures, and outfall points,~~
  - (c) ~~Proposed on-site storm water systems and facilities, including a discussion of general concepts and alternatives for site drainage improvements, such as the provision, layout, alignment and size of storm sewers, open swales and channels, drainageways, inlets, detention ponds and outlets.~~
- (10) ~~**Conclusions and Recommendations:** Include conclusions and recommendations for proposed drainage facilities to be provided in conjunction with site development, and conformance with the B.R.C. and these Standards. The Conclusions and Recommendations section of the report must include a statement addressing the feasibility of designing and constructing required stormwater improvements without substantial modification of the proposed site development plan.~~
- (11) ~~**Drawings and Figures:** Include a Conceptual Storm Water Plan, as outlined in Section 7.02(C), "Conceptual Storm Water Plan," of these Standards.~~

## **(GB) Conceptual Storm Water Plan~~Drainage Report~~**

The Conceptual Drainage Report shall provide a response for each of the elements listed in the Preliminary Drainage Report narrative requirements, as set forth in Subsection 7.03(B) of these Standards, or if more data is necessary identify the data collection efforts necessary to complete the Preliminary Drainage Report.

A storm water plan shall be included in the storm water report to provide a reference for the proposed improvements and identify systems and issues addressed in the report unless all required information can be clearly identified on the site development plan. The storm water plan shall be prepared on a 24 by 36 inch drawing using an engineering scale ranging from 1 inch equals 20 feet to 1 inch equals 100 feet, including the following:

- (1) — **Property Boundaries:** Reflect legal boundaries for the proposed project or development site, including existing and proposed property and lot lines, existing and proposed rights-of-way and easements (with reception numbers and purposes noted), and boundaries of abutting properties.
- (2) — **Topography:** Illustrate existing topography at minimum 2 foot interval contours, and elevation and location of City recognized benchmarks with reference to local, USGS, and NGVD 29 data (monument information may be obtained from the City's Land Information Services). Illustrate proposed topography using 2 foot interval contours or flow arrows.
- (3) — **Storm Water Basins:** Illustrate existing and proposed storm water basins, inflow and outfall points, and upstream and downstream storm water conveyance systems. Mapping shall extend beyond the property boundaries far enough to identify offsite drainage systems that affect the proposed development. Storm water basins may be delineated on a separate sheet.
- (4) — **Storm Water Drainage Facilities:** Reflect existing and proposed storm water drainage facilities and systems, including storm sewers, inlets, manholes, culverts, swales, detention ponds, water quality systems, roadside swales, crosspans, and drainageways.
- (5) — **Streets:** Reflect existing and proposed streets, indicating curb type and approximate slopes.
- (6) — **Irrigation Ditches:** Reflect existing irrigation ditches and laterals, including ownership information.
- (8) — **Floodplains:** Delineate any 100 year floodplain, conveyance, and high hazard zones limits.
- (9) — **Building Floor Elevations:** Identify minimum finished floor elevations for existing and proposed structures.

### **(C) Conceptual Stormwater Plan**

The Conceptual Stormwater Plan shall address each of the elements listed in the Preliminary Stormwater Plan requirements, sufficient to provide an overall drainage plan, as set forth in Subsection 7.03(C) of these Standards, or if more data is necessary identify the data collection efforts necessary to complete the Preliminary Stormwater Plan.

## **7.03 Preliminary Storm WaterDrainage Report and Stormwater Plan**

### **(A) RequiredGeneral**

- (1) — The Director may require the preparation of a Preliminary Drainage Report and Stormwater Plan by the Engineer. The Preliminary Drainage Report and Stormwater Plan will be used to assess the impacts and public improvement needs of any proposed project or development site. Approval of the Preliminary Drainage Report and Stormwater Plan shall not be construed as approval of specific design details.

- (2) The Director reviews Preliminary Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.
- (3) Measured or calculated parameters provided with the Preliminary Drainage Report and Stormwater Plan shall be consistent with Subsection 7.02(A)(3) of these Standards.

~~The Director of Public Works may require the preparation of a Preliminary Storm Water Report in order to assess the impacts and public improvements needs of any project or development prior to preparation of a Final Storm Water Report and Plan. The Preliminary Storm Water Report shall be prepared by the Engineer and include a technical report and storm water plan as outlined in the following sections. Approval of a Preliminary Storm Water Report and Plan shall not be construed as approval of specific design details.~~

## **(B) Preliminary Drainage ReportTechnical Report**

The Preliminary Drainage Report shall define the proposed development site, describes existing conditions, and proposes needed stormwater facilities to meet the requirements of these Standards. The Preliminary Drainage Report shall include, at a minimum, narratives addressing the items listed in this subsection except for those items not applicable to the proposed development site. The Preliminary Drainage Report shall include visual representations and/or refer to the Preliminary Stormwater Plan sheet with the corresponding content (see Subsection 7.03(C) of these Standards for Preliminary Stormwater Plan requirements). The Preliminary Drainage Report narrative shall include the following information:

~~The technical report shall provide an overview and impacts analysis of the proposed project or development, historic and developed runoff conditions, storm water runoff flow rates and volumes, water quality and erosion control measures, storm water attenuation or detention ponding measures, proposed storm water utility improvements, basic design requirements, and a reference of study data sources, methods and findings, and include the following information:~~

- (1) **Cover Page:** Provide a cover page that includes the site name, site address, submittal and revision dates as applicable, site owner, and preparing Engineer.
- (2) **Site Description**
  - (a) Site Location Description
    - (i) County, city, township, range, section, and ¼ section.
    - (ii) Site vicinity and legal boundaries map.
    - (iii) Adjacent developments and associated land use.
    - (iv) Roadways located within or adjacent to the site.
  - (b) Property Description
    - (i) Site area and proposed area of disturbance in acres.
    - (ii) Existing and proposed site use.
    - (iii) Land surface (vegetation type, topography, slope, buildings, etc.)
    - (iv) Easements within or adjacent to the site.
  - (c) Drainage Description
    - (i) Major and minor drainageways.
    - (ii) Natural drainage features (e.g., streams, lakes, ponds, wetlands, and



buffer areas).

(iii) Irrigation ditches.

(iv) Regulatory floodplain extents.

(v) Known drainage issues.

(vi) Hydrologic soil group map and description.

(vii) Geotechnical and groundwater site investigation results.

(viii) Preliminary Infiltration Feasibility Screening results and map (see Subsection 7.16(A) of these Standards).

### **(3) Drainage Basin Description**

#### **(a) Major Drainage Basin**

(i) General description of major drainage basin characteristics and flow patterns.

(ii) Flow conveyance from site to receiving major drainageway.

(iii) Reference to all applicable planning studies for the major drainageway and, if applicable, describe requirements of these plans for the development site.

(iv) Impact of site development on upstream and downstream properties .

(v) Impact of site development on downstream natural and constructed open channels and piped stormwater utility systems and the measures proposed to reduce or eliminate those impacts.

#### **(b) Site Drainage Basin(s)**

(i) Existing and proposed basin and sub-basin characteristics for the site, including land cover, area, flow patterns, and discharge points for each basin/sub-basin.

(ii) Acceptance and conveyance of off-site stormwater into and through the proposed development site.

(iii) Overview of all existing and proposed conveyance, detention, and water quality facilities, including rationale, for each basin/sub-basin.

### **(4) Drainage Design Criteria**

#### **(a) Regulation Applicability**

(i) Detention requirements (see Section 7.12 of these Standards).

(ii) Construction stormwater management requirements (see Section 7.13 of these Standards).

(iii) Post-construction stormwater quality requirements (see Section 7.15 of these Standards).

(iv) Stream, Wetland, and Waterbody Protection Requirements as set forth in Chapter 9-3, "Overlay Districts," B.R.C. 1981.

(v) Other applicable criteria and permits.

#### **(b) Site Planning and Constraints**

- (i) Description of previous drainage studies or master plans for the site and adjacent areas and influence on proposed stormwater utility system design.
    - (ii) Description of site constraints caused by structures, utilities, etc. and influence on proposed stormwater utility system design.
    - (iii) Description of Low Impact Development (LID) techniques utilized for stormwater management with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.14 of these Standards).
  - (c) Hydrologic and Hydraulic Criteria
    - (i) Design storm(s).
    - (ii) Runoff calculation methods.
    - (iii) Detention storage and discharge calculation method.
    - (iv) Velocity and capacity calculation method(s) for inlets and conveyances.
    - (v) Water surface profile and hydraulic grade line (HGL) calculation methods.
  - (d) Post-Construction Stormwater Quality Criteria
    - (i) Selected treatment approach and design standards (see Section 7.16 of these Standards).
- (5) **Stream, Wetland, and Waterbody Impacts**
  - (a) Description of floodplain impacts.
  - (b) Required modification studies.
- (6) **Stormwater Conveyance Design**
  - (a) Description of proposed conveyance system.
  - (b) Conveyance path to major drainageway and capacity evaluation.
- (7) **Detention and Post-Construction Stormwater Quality Design**
  - (a) Description of each proposed facility (identifier, type, drainage area, size, treatment volumes, components, and function).
  - (b) Description of design compliance with detention and post-construction stormwater quality requirements with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.15 of these Standards).
- (8) **Conclusions**
  - (a) Drainage plan effectiveness.
  - (b) Compliance with requirements.
  - (c) Exclusions and variances.
- (9) **References:** Reference all standards, criteria, guidance documents, master plans, and technical reports used.
- (10) **Appendices**

- (a) Completed form(s) documenting post-construction water quality compliance (Section 7.15 of these Standards).
- (b) Completed form(s) documenting low impact development approaches (Section 7.14 of these Standards).
- (1) ~~**Background:** Provide a discussion of the proposed project or development including the following information:~~
  - (a) ~~Site location, including legal description (county, city, township, range, and section) and a discussion of the area characteristics, identifying land development patterns and features, transportation networks and storm water systems (creeks, channels, irrigation ditches, and storm sewers) in the surrounding area.~~
  - (b) ~~Site description, including the total land area, general topography, and existing ground cover, wetlands, groundwater conditions, and storm water and irrigation ditch systems.~~
- (2) ~~**Development Proposal:** Provide a general description of the proposed project or development, including land use, density, site development plans and coverage, and storm water planning concepts.~~
- (3) ~~**Storm Water Basins and Drainage Patterns:** Include a description of the storm water basins and drainage patterns that are impacted by site development, including:~~
  - (a) ~~The major storm water basin containing the project site and the tributary major drainageway,~~
  - (b) ~~The minor and major storm water basins that are onsite, upstream, and downstream of the site,~~
  - (c) ~~Offsite drainage patterns and their effect on site development,~~
  - (d) ~~Onsite drainage patterns, existing runoff systems, and infall and outfall points,~~
  - (e) ~~Previous drainage studies for the site, drainage basin, or local area that may influence drainage design, and~~
  - (f) ~~Existing drainage problems, floodplain impacts, and ground water conditions contributing to site runoff.~~
- (4) ~~**Conformance with Storm Water Master Plans:** Describe how the proposed storm water system improvements conform with adopted Storm Water Collection, Major Drainageway, and Greenways Program Master Plans.~~
- (5) ~~**Storm Water Quality:** In compliance with Subsection 7.13, of these Standards, include a storm water quality analysis, and describe necessary mitigation measures and improvements that will be incorporated into the Storm Water Quality and Erosion Control Plan as part of the project or development construction plans.~~
- (6) ~~**Wetlands Impacts:** Identify any delineated wetland or wetland buffer areas as set forth in Chapter 9-12, "Wetlands Protection," B.R.C. 1981, and include a discussion of any necessary analyses, avoidance and mitigation measures, and improvements needed to address wetlands permitting requirements.~~
- (7) ~~**Hydrology:** Provide sufficient hydrological analysis to determine the approximate size and location of storm water conveyance and detention facilities. Calculations shall be consistent with the methodologies identified in Section 7.05, "Hydrology," of these~~

~~Standards.~~

- ~~(8) — **Storm Water Detention:** Include a technical analysis of storm water detention proposed for the development in conformance with Section 7.12, “Storm Water Detention,” of these Standards.~~
- ~~(9) — **Developed Storm Water Conditions:** Describe and define proposed storm runoff conditions following development, estimated by using the proposed land use and development patterns for the subject site based on the initial and major storm events, including a discussion of the following:~~
  - ~~(a) — Acceptance and conveyance of offsite runoff through the proposed site development;~~
  - ~~(b) — Proposed onsite drainage rates, flow patterns, drainage facilities, detention ponds, water quality measures, and outfall points;~~
  - ~~(c) — Downstream properties and systems, such as streets, utilities, existing structures, and developments, impacted by the proposed development from the site to the receiving major drainageway, and~~
  - ~~(d) — Proposed storm water systems and facilities design, including a discussion of the following:~~
    - ~~(i) — General concepts and alternatives for site drainage improvements, such as the provision, layout, alignment and size of storm sewers, open swales and channels, inlets, detention ponds and outlets.~~
    - ~~(ii) — Solutions and alternatives for conveying onsite and contributing offsite runoff, mitigating drainage impacts, enhancing water quality, erosion and sedimentation control, and maintenance.~~
- ~~(10) — **Conclusions and Recommendations:** Include conclusions determined by analysis and proposed recommendations for onsite and offsite drainage facilities to be provided in conjunction with site development, and conformance with the B.R.C. and these Standards.~~
- ~~(11) — **Technical Appendices:** Provide all technical support materials in an appendix, including without limitation, engineering equations, assumptions, and calculations used in preparing the report, and hydrologic and hydraulic sources, references, and methods. The hydrologic analysis shall include areas, storm frequencies, runoff coefficients, times of concentration, and all runoff computation. If the CUHP is used, the synthetic unit hydrographs shall also be included.~~
- ~~(12) — **Drawings and Figures:** Include the following drawings and figures in the technical report:~~
  - ~~(a) — General location map, providing a vicinity map identifying the major drainage basin and surrounding development and public infrastructure systems. This map should provide sufficient detail to identify drainage flows entering and leaving the development, and any other development occurring in the vicinity. Typically, this map should be 8 ½ by 11 inches or 11 by 17 inches in size at a scale ranging from 1 inch equals 400 feet to 1 inch equals 2,000 feet.~~
  - ~~(b) — Storm water plan, as outlined in Section 7.03(c), “Storm Water Plan,” of these Standards.~~
  - ~~(c) — General concept drawing details for proposed open drainage systems (such as cross sections for swales and channels), culverts, bridges, detention ponds, outlet structures, and storm water quality and erosion control measures.~~

- (d) ~~Floodplain map, identifying the 100-year floodplain, conveyance, and high hazard zones for sites impacted by adopted floodplains.~~

### (C) Preliminary Stormwater Plan

A storm water plan shall be included in the storm water report to provide a reference for the proposed improvements and identify systems and issues addressed in the report. ~~The storm water plan shall be prepared on a 24 by 36 inch drawing using a scale ranging from 1 inch equals 20 feet to 1 inch equals 100 feet, including the following:~~

The purpose of the Preliminary Stormwater Plan is to provide visual representations of existing and proposed site conditions to support the Preliminary Drainage Report narrative. The Preliminary Stormwater Plan shall be included with the Preliminary Drainage Report, submitted as a single PDF document. All Preliminary Stormwater Plan sheets shall be prepared on 24-inch by 36-inch paper with appropriate scale ranges. The Preliminary Stormwater Plan shall include plan sheets addressing, at a minimum, the following items, except for those items not applicable to the proposed development site:

- (1) ~~**Property Boundaries:** Reflect legal boundaries for the proposed project or development site, including existing and proposed property and lot lines, existing and proposed rights of way and easements (with reception numbers and purposes noted), and boundaries of abutting properties.~~
- (2) ~~**Topography:** Illustrate existing and proposed topography at minimum 2-foot interval contours, and elevation and location of City-recognized benchmarks with reference to local, USGS, and NGVD data (monument information may be obtained from the City Surveyor). The Director may approve the use of flow direction arrows in lieu of proposed contours if no significant changes to site grading are anticipated.~~
- (3) ~~**Storm Water Basins:** Illustrate existing and proposed storm water basins, inflow and outfall points, and upstream and downstream storm water conveyance systems. Mapping shall extend beyond the property boundaries far enough to identify offsite drainage systems that affect the proposed development.~~
- (4) ~~**Storm Water Drainage Facilities:** Reflect existing and proposed storm water drainage facilities and systems, including storm sewers, inlets, manholes, culverts, swales, detention ponds, water quality systems, roadside swales, crosspans, and drainageways.~~
- (5) ~~**Streets:** Reflect existing and proposed streets, indicating curb type and approximate slopes.~~
- (6) ~~**Irrigation Ditches:** Reflect existing irrigation ditches and laterals, including ownership information.~~
- (7) ~~**Site Runoff:** Indicate historic and developed runoff flows and volumes, and release rates for detention ponds.~~
- (8) ~~**Floodplains:** Delineate any 100-year floodplain, conveyance, and high hazard zones limits and based flood elevations.~~
- (9) ~~**Building Floor Elevations:** Identify minimum finished floor elevations for existing and proposed structures.~~
- (10) ~~**Storm Water Routing:** Identify routing and accumulation of storm water runoff flows at various critical points for the initial and major storm runoff.~~

#### (1) Overall Drainage Plan

- (a) Title block, legend, north arrow, and scale.
- (b) Existing topographic contours.
- (c) Property boundary.
- (d) Major drainage basin boundaries with area, design point, and existing flow rate

labels.

- (e) Drainage flow arrows depicting flow patterns to, from, and within the site.
- (f) Existing stormwater detention and water quality facility boundaries.
- (g) Easement boundaries.
- (h) Existing waterways (streams, lakes/ponds, wetlands, and irrigation facilities).
- (i) Land cover (vegetation and impervious surfaces).
- (j) Key map depicting extents of detailed drainage plan sheets.

**(2) Detailed Drainage Plan/s**

- (a) Title block, legend, north arrow, and scale (scale range of 1 inch = 20 feet to 1 inch = 100 feet).
- (b) Existing (screened) and proposed (solid) topographic contours (2 feet max interval).
- (c) Location and elevation of all waterways, regulated buffer areas, and 100-year floodplain.
- (d) Property, right-of-way, and easement boundaries.
- (e) Drainage basin/sub-basin boundaries with area, design point, and flow/release rate labels.
- (f) Proposed outfall points and conveyance facilities to major drainageway with design point and flow/release rate labels.
- (g) Existing and proposed structure boundaries.
- (h) Existing and proposed stormwater conveyance facilities with size, slope, and material designation (storm sewers, culverts, open channels, inlets, and discharge points).
- (i) Existing and proposed stormwater detention and water quality facilities with drainage area, surface area, side slope/wall, and component labels.

## **7.04 Final Storm WaterDrainage Report and Stormwater Plan**

### **(A) RequiredGeneral**

~~The Director of Public Works may require the preparation of a storm water report in order to assess the impacts and public improvements needs of any project or development proposal. The storm water report shall be prepared by the Engineer and include a technical report and storm water plan as outlined in the following sections.~~

- (1) The Director may require the preparation of a Final Drainage Report and Stormwater Plan by the Engineer. The report and plan will be used to assess the impacts and public improvements needs of any proposed project or development site.
- (2) The Director reviews Final Drainage Reports and Stormwater Plans for local-level purposes, including conformance with these Standards pertaining to stormwater utility systems.
- (3) Measured or calculated parameters provided with the Final Drainage Report and Stormwater Plan shall be consistent with Subsection 7.02(A)(3) of these Standards.

**(B) Technical Report**~~**Final Drainage Report**~~

The technical report shall provide an overview and impacts analysis of the proposed project or development, historic and developed runoff conditions, storm water runoff flow rates and volumes, water quality and erosion control measures, storm water attenuation or detention ponding measures, proposed storm water utility improvements, basic design requirements, and a reference of study data sources, methods and findings, and include the following information:

- (1) — **Background:** Provide a discussion of the proposed project or development including the following information:
  - (a) — Site location, including legal description (county, city, township, range, and section) and a discussion of the area characteristics, identifying land development patterns and features, transportation networks and storm water systems (creeks, channels, irrigation ditches, and storm sewers) in the surrounding area.
  - (b) — Site description, including the total land area, general topography, and existing ground cover, wetlands, groundwater conditions, and storm water and irrigation ditch systems.
- (2) — **Development Proposal:** Provide a general description of the proposed project or development, including land use, density, site development plans and coverage, and storm water planning concepts.
- (3) — **Storm Water Basins and Drainage Patterns:** Include a description and discussion of the storm water basins and drainage patterns that are impacted by site development, including:
  - (a) — The major storm water basin containing the project site and the tributary major drainageway,
  - (b) — The minor and major storm water basins that are onsite, upstream, and downstream of the site,
  - (c) — Offsite drainage patterns and their effect on site development,
  - (d) — Onsite drainage patterns, existing runoff systems, and infall and outfall points,
  - (e) — Previous drainage studies for the site, drainage basin, or local area that may influence drainage design, and
  - (f) — Existing drainage problems, floodplain impacts, and ground water conditions contributing to site runoff.
- (4) — **Conformance with Storm Water Master Plans:** Describe how the proposed storm water system improvements conform with adopted Storm Water Collection, Major Drainageway, and Greenways Program Master Plans.
- (5) — **Storm Water Quality and Erosion Control Measures:** In compliance with Subsection 7.13, of these Standards, include a storm water quality and erosion control analysis, and describe necessary mitigation measures and improvements that will be incorporated into the Storm Water Quality and Erosion Control Plan as part of the project or development construction plans. Provide a discussion of how proposed erosion and sedimentation control measures will ensure that downstream properties and drainageways will not be adversely impacted by site development and construction activities.
- (6) — **Wetlands Impacts:** Identify any delineated wetland or wetland buffer areas as set forth in Chapter 9-12, “Wetlands Protection,” B.R.C. 1981, and include a discussion of any necessary analyses, avoidance and mitigation measures, and improvements needed to address wetlands permitting requirements.

- (7) ~~**Hydrology:** Include a technical analysis of the historical and developed runoff conditions for the proposed development in conformance with Section 7.05, "Hydrology," of these Standards.~~
- (8) ~~**Storm Water Detention:** Include a technical analysis of storm water detention proposed for the development in conformance with Section 7.12, "Storm Water Detention," of these Standards.~~
- (9) ~~**Developed Storm Water Conditions:** Describe and define proposed storm runoff conditions following development, estimated by using the proposed land use and development patterns for the subject site based on the initial and major storm events, including a discussion of the following:~~
  - (a) ~~Acceptance and conveyance of offsite runoff through the proposed site development,~~
  - (b) ~~Proposed onsite drainage rates, flow patterns, drainage facilities, detention ponds, water quality measures, and outfall points,~~
  - (c) ~~Downstream properties and systems, such as streets, utilities, existing structures, and developments, impacted by the proposed development from the site to the receiving major drainageway, and~~
  - (d) ~~Proposed storm water systems and facilities design, including a discussion of the following:~~
    - (i) ~~General concepts and alternatives for site drainage improvements, such as the provision, layout, alignment and size of storm sewers, open swales and channels, inlets, detention ponds and outlets.~~
    - (ii) ~~Solutions and alternatives for conveying onsite and contributing offsite runoff, mitigating drainage impacts, enhancing water quality, erosion and sedimentation control, and maintenance.~~
- (10) ~~**Conclusions and Recommendations:** Include conclusions determined by analysis and proposed recommendations for onsite and offsite drainage facilities to be provided in conjunction with site development, and conformance with the B.R.C. and these Standards.~~
- (11) ~~**Final Storm Water Design Features:** Construction plans for any project or development proposal, shall include final storm water design features in the storm water report and storm water plan. The final design information in the report shall provide the technical basis and support for the proposed construction design and all detailed engineering calculations for storm water systems, including without limitation:~~
  - (a) ~~Inlet sizing and design,~~
  - (b) ~~Storm sewer sizing, design and type,~~
  - (c) ~~Open channel (swale and drainageway) design and sizing,~~
  - (d) ~~Storm water routing for storm water conveyance (storm sewers and swales) and detention ponding facilities,~~
  - (e) ~~Curb and gutter conveyance capacities,~~
  - (f) ~~Detention pond outfall structures (orifices, inlets, and weirs),~~
  - (g) ~~Water quality measures, and~~
  - (h) ~~Any unique storm water improvements design details.~~



- (12) ~~**Technical Appendices:** Provide all technical support materials in an appendix, including without limitation, engineering equations, assumptions, and calculations used in preparing the report, and hydrologic and hydraulic sources, references, and methods. The hydrologic analysis shall include areas, storm frequencies, runoff coefficients, times of concentration, and all runoff computation. If the CUHP is used, the synthetic unit hydrographs shall also be included.~~
- (13) ~~**Drawings and Figures:** Include a Storm water plan, as outlined in Section 7.04 (C), "Storm Water Plan," of these Standards.~~

The Final Drainage Report shall describe the to-be-constructed drainage conditions for the site. The Final Drainage Report shall include, at a minimum, all required narratives of the Preliminary Drainage Report, as set forth in Subsection 7.03(B) of these Standards, and the items listed in this subsection, except for those items not applicable to the proposed development site. The Final Drainage Report shall include visual representations and/or refer to the Final Stormwater Plan (Subsection 7.04(C) of these Standards) or construction drawings (Subsection 7.04(D) of these Standards) with the corresponding content.

The Final Drainage Report shall include a cover page, following the format set forth in Subsection 7.03(B) of these Standards and a certification page with the following statement prepared by a Professional Engineer licensed in the State of Colorado:

I hereby certify that this Final Drainage Report and Final Stormwater Plan for [Site Name] was prepared by me, or under my direct supervision, in accordance with sound engineering practice and all applicable state, federal and local regulations, including the provisions of the City of Boulder Design and Construction Standards.

Registered Professional Engineer \_\_\_\_\_ (Affix Seal)

State of Colorado No. \_\_\_\_\_

The Final Drainage Report shall include the following information:

- (1) **Site Description:** Updated narratives for all items listed in Subsection 7.03(B)(2) of these Standards.
- (2) **Drainage Basin Description:** Updated narratives for all items listed in Subsection 7.03(B)(3) of these Standards.
- (3) **Drainage Design Criteria:** Updated narratives for all items listed in Subsection 7.03(B)(4) of these Standards.
- (4) **Stream, Wetland, and Waterbody Impacts**
  - (a) Description of floodplain impacts.
  - (b) Required modification studies.
  - (c) Applicable permits obtained.
- (5) **Stormwater Conveyance Design**
  - (a) Description of proposed conveyance system.
  - (b) Conveyance path to major drainageway and capacity evaluation.
  - (c) Storm sewer, culvert, and inlet design (location, size, tributary area, and peak flows).
  - (d) Open channel design (location, size, tributary area, and peak flows).

(e) Outfall design (location, peak flows, and energy dissipation).

(f) Street drainage (see Section 7.10 of these Standards).

(g) Easement requirements.

(h) Maintenance requirements.

**(6) Detention and Post-Construction Stormwater Quality Design**

(a) Description of each proposed facility (identifier, type, drainage area, size, treatment volumes, components, and function).

(b) Description of design compliance with detention and post-construction stormwater quality requirements with reference to completed form(s) as provided by the Director and included as an appendix (see Section 7.15).

(c) Inlet design (description of pretreatment measures and energy dissipation).

(d) Basin and outlet design (storage volumes and release rates, including overflow spillway).

(e) Description of vegetation coverage and planting plan.

(f) Description of filter media selection and underdrain configuration.

(g) Easement requirements.

(h) Description of maintenance requirements with reference to Inspection and Maintenance Guide included as an appendix (see Section 7.18 of these Standards).

**(7) Conclusions:** Updated narratives for all items listed in Subsection 7.03(B)(8) of these Standards.

**(8) References:** Updated references for all items listed in Subsection 7.03(B)(9) of these Standards.

**(9) Appendices**

(a) Completed form(s) documenting post-construction water quality compliance (Section 7.15 of these Standards).

(b) Completed form(s) documenting low impact development approaches (Section 7.14 of these Standards).

(c) Inspection and Maintenance Guide (Section 7.18 of these Standards).

(d) Hydrologic calculations.

(e) Hydraulic calculations.

(f) Stormwater conveyance calculations.

(g) Detention and permanent water quality calculations.

(h) Critical reference information copied to create standalone document.

**(C) Final Storm-Water Plan**

~~A storm water plan shall be included in the storm water report to provide a reference for the proposed improvements and identify systems and issues addressed in the report. The storm water plan shall be prepared on a 24 by 36 inch drawing using a scale ranging from 1 inch equals 20 feet~~

to 1 inch equals 100 feet, including the following:

- (1) — **Property Boundaries:** Reflect legal boundaries for the proposed project or development site, including existing and proposed property and lot lines, existing and proposed rights-of-way and easements (with reception numbers and purposes noted), and boundaries of abutting properties.
- (2) — **Topography:** Illustrate existing and proposed topography at minimum 2-foot interval contours, and elevation and location of City-recognized benchmarks with reference to local, USGS, and NGVD data (monument information may be obtained from the City Surveyor).
- (3) — **Storm Water Basins:** Illustrate existing and proposed storm water basins, inflow and outfall points, and upstream and downstream storm water conveyance systems. Mapping shall extend beyond the property boundaries far enough to identify offsite drainage systems that affect the proposed development.
- (4) — **Storm Water Drainage Facilities:** Reflect existing and proposed storm water drainage facilities and systems, including storm sewers, inlets, manholes, culverts, swales, detention ponds, water quality systems, roadside swales, crosspans, and drainageways.
- (5) — **Streets:** Reflect existing and proposed streets, indicating curb type and approximate slopes.
- (6) — **Irrigation Ditches:** Reflect existing irrigation ditches and laterals, including ownership information.
- (7) — **Site Runoff:** Indicate historic and developed runoff flows and volumes, and release rates for detention ponds.
- (8) — **Floodplains:** Delineate any 100-year floodplain, conveyance, and high hazard zones limits and based flood elevations.
- (9) — **Building Floor Elevations:** Identify finished floor elevations for existing and proposed structures.
- (10) — **Storm Water Routing:** Identify routing and accumulation of storm water runoff flows at various critical points for the initial and major storm runoff.
- (11) — **Final Storm Water Design Features:** Prior to preparation of construction plans for any project or development proposal, the Engineer shall include final storm water design features in the storm water report and storm water plan. The final design information in the plan shall illustrate details for the proposed construction design, including without limitation:
  - (a) — Inlet sizing and design,
  - (b) — Storm sewer sizing, design and type,
  - (c) — Open channel (swale and drainageway) design and sizing,
  - (d) — Storm water routing for storm water conveyance (storm sewers and swales) and detention ponding facilities,
  - (e) — Curb and gutter conveyance capacities,
  - (f) — Detention pond outfall structures (orifices, inlets, and weirs),
  - (g) — Water quality measures, and
  - (h) — Any unique storm water improvements design details.

The Final Stormwater Plan shall detail the to-be-constructed drainage conditions for the site and follow the submittal requirements of the Preliminary Stormwater Plan, as set forth in Subsection 7.03(C) of these Standards.

- (1) **Overall Drainage Plan:** Updated plan depicting all items listed in Subsection 7.03(C)(1) of these Standards.
- (2) **Detailed Drainage Plan(s):** Updated plan(s) depicting all items listed in Subsection 7.03(C)(2) of these Standards.

#### **(D) Stormwater Construction Plans and Drawings**

Construction Plans and Drawings shall be submitted for review in conjunction with the Final Drainage Report. Preparation of Construction Plans and Drawings shall be consistent with Section 1.03 of these Standards. The following elements pertaining to site stormwater design shall, at a minimum, be included in the Construction Plans and Drawings.

- (1) **Stormwater Conveyance Construction Drawings**
  - (a) Plan drawing(s) depicting all proposed storm sewer and open channel conveyances following the requirements of Subsection 1.03(E)(2) of these Standards.
  - (b) Profile drawing(s) depicting all proposed storm sewer and open channel conveyances following the requirements of Subsection 1.03(E)(3) of these Standards.
- (2) **Detention and Post-Construction Stormwater Quality Construction Drawings**
  - (a) Plan drawing(s) depicting each proposed detention and post-construction stormwater quality facility following the requirements of Subsection 1.3(E)(2) of these Standards and, at a minimum, the following components, if proposed:
    - (i) Inlet and outlet structure locations and energy dissipation measures, including emergency spillways,
    - (ii) Proposed contours for treatment surface area and side slopes/walls,
    - (iii) Facility components (e.g. pretreatment, micropool, underdrain, etc.), and,
    - (iv) Vegetative cover.
  - (b) Profile and/or cross-sectional drawing(s) depicting each proposed detention and post-construction stormwater quality facility following the requirements of Subsection 1.3(E)(3) of these Standards and, at a minimum, the following components, if proposed:
    - (i) Inlet and outlet structure inverts,
    - (ii) Treatment area and side slope/wall surface elevations,
    - (iii) Filter media components and depths, and
    - (iv) Facility component elevations (e.g. pretreatment, micropool, underdrain, etc.).
  - (c) Detail drawing/s depicting each unique detention and post-construction stormwater quality facility component following the requirements of Subsection 1.3(E)(4) of these Standards and, at a minimum for the following components,

if proposed:

- (i) Pretreatment,
- (ii) Outlet structure,
- (iii) Underdrain, and
- (iv) Other unique components.

## 7.05 Hydrology

### (A) General

The methodologies and design standards for determining rainfall and runoff conditions for any development project are based on the standards prescribed in the ~~Urban Drainage and Flood Control District (UDFCD), Urban Storm Drainage Criteria Manual~~ USDCM, with local revisions as prescribed in these Standards.

### (B) Storm Frequency

Table 7-1, “Design Storm Frequencies,” indicates initial and major design storm frequencies to be used in the ~~storm water~~ stormwater design or any project or development:

**Table 7-1: Design Storm Frequencies**

Land Use	Initial Storm	Major Storm
Single Family Residential	2 Year	100 Year
All Other Uses	5 Year	100 Year
Detention Ponding Design	10 Year	100 Year

### (C) Rainfall

The rainfall intensities to be used in computing runoff ~~were based on the UDFCD on-going hydrology research program and shall be obtained from Figure 7-1, “Rainfall Intensity Duration-Frequency Curve for the City of Boulder,” of these Standards~~ shall be determined using the USDCM, Volume 1 and the Boulder station of the NOAA Atlas 14 Point Precipitation Frequency Estimates.

### (D) Runoff

- (1) **CUHP Method:** For basins larger than 160 acres, the Colorado Urban Hydrograph Procedure (CUHP) method shall be applied in conformance with the ~~UDFCD Drainage Criteria Manual~~ USDCM using local rainfall conditions.
- (2) **Rational Method:** For all basins smaller than 160 acres, the ~~Rational Method, as described in the UDFCD Drainage Criteria Manual~~ USDCM, shall be used to calculate runoff for both the initial and major storms. ~~A detailed description and in-depth discussion of the rational method and its components are presented in the UDFCD Drainage Criteria Manual. The formula for the rational method is as follows:~~

$$Q = CIA$$

Where: Q = Flow Rate in Cubic Feet Per Second

C = Runoff Coefficient

~~I~~ ——— = Rainfall Intensity for the Design Storm (inches/hour)

~~A~~ ——— = Drainage Area (acres)

- (3) **Runoff Coefficient:** The runoff coefficient to be used with the ~~Rational-rational Method method~~ may be determined based on either zoning/land use classifications or types of surface classifications prescribed in ~~Table 7-2, "Runoff Coefficients for the Rational Method."~~the USDCM Drainage Criteria Manual. A composite runoff coefficient may be calculated using land areas impacted by specific classifications.

- (4) **Intensity:** The rainfall intensity used in the rational method shall be calculated per the ~~UDFCDUSDCM Drainage Criteria Manual~~ using the NOAA Atlas 14 rainfall depth-duration-frequency data.

- (4) ~~**Time of Concentration ( $t_c$ ):** For urban areas, the time of concentration consists of an inlet time or overland flow time ( $t_i$ ) plus the time of travel ( $t_r$ ) in a storm sewer, paved gutter, roadside drainage ditch, drainage channel, or other drainage facilities. For non-urban areas, the time of concentration consists of an overland flow time ( $t_i$ ) plus the time of travel in a combined form, such as a swale, channel, or drainageway. The travel time ( $t_r$ ) portion of the time of concentration ( $t_c$ ) is estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway.~~

- (a) ~~The time of concentration is calculated as follows:~~

$$t_c = t_i + t_r \text{ (Minutes)}$$

Where  ~~$t_c$  = time of concentration in minutes~~

~~$t_i$  = initial, inlet, or overland flow time in minutes~~

~~$t_r$  = travel time in ditch, channel, gutter, storm sewer, etc. in minutes~~

- (b) ~~Non Urbanized Basins~~

~~The initial or overland flow time ( $t_i$ ) is calculated using the following formula or Figure 7-2, "Overland Time of Flow Curves." The initial time of concentration for non-urbanized basins is not to be less than 10 minutes.~~

$$t_c = \frac{1.8(1.1 - C_s)\sqrt{L}}{\sqrt[3]{S}}$$

Where  ~~$t_i$  = initial or overland flow time in minutes~~

~~$C_s$  = runoff coefficient for 5-year frequency~~

~~L = length of overland flow in feet (500-foot max)~~

~~S = average basin slope in percent~~

~~For basins longer than 500 feet, runoff shall be considered to be in a combined form and travel time ( $t_r$ ) shall be calculated using the hydraulic properties of the swale, ditch or channel, or estimated using Figure 7-3, "Time of Travel." The time of concentration ( $t_c$ ) is the sum of the initial flow time ( $t_i$ ) and the travel time ( $t_r$ ). The minimum ( $t_c$ ) shall be ten minutes for non-urbanized basins.~~

- (c) ~~Urbanized Basins~~

~~The time of concentration ( $t_c$ ) to the first design point after urbanization shall be the lesser value determined from the two equations below.~~

$$t_c = \frac{1.8(1.1 - C_s)\sqrt{L}}{\sqrt[3]{S}}$$

Where  $t_c$  = initial or overland flow time in minutes

$C_s$  = runoff coefficient for 5 year frequency

L = length of overland flow in feet (300 foot max)

S = average basin slope in percent

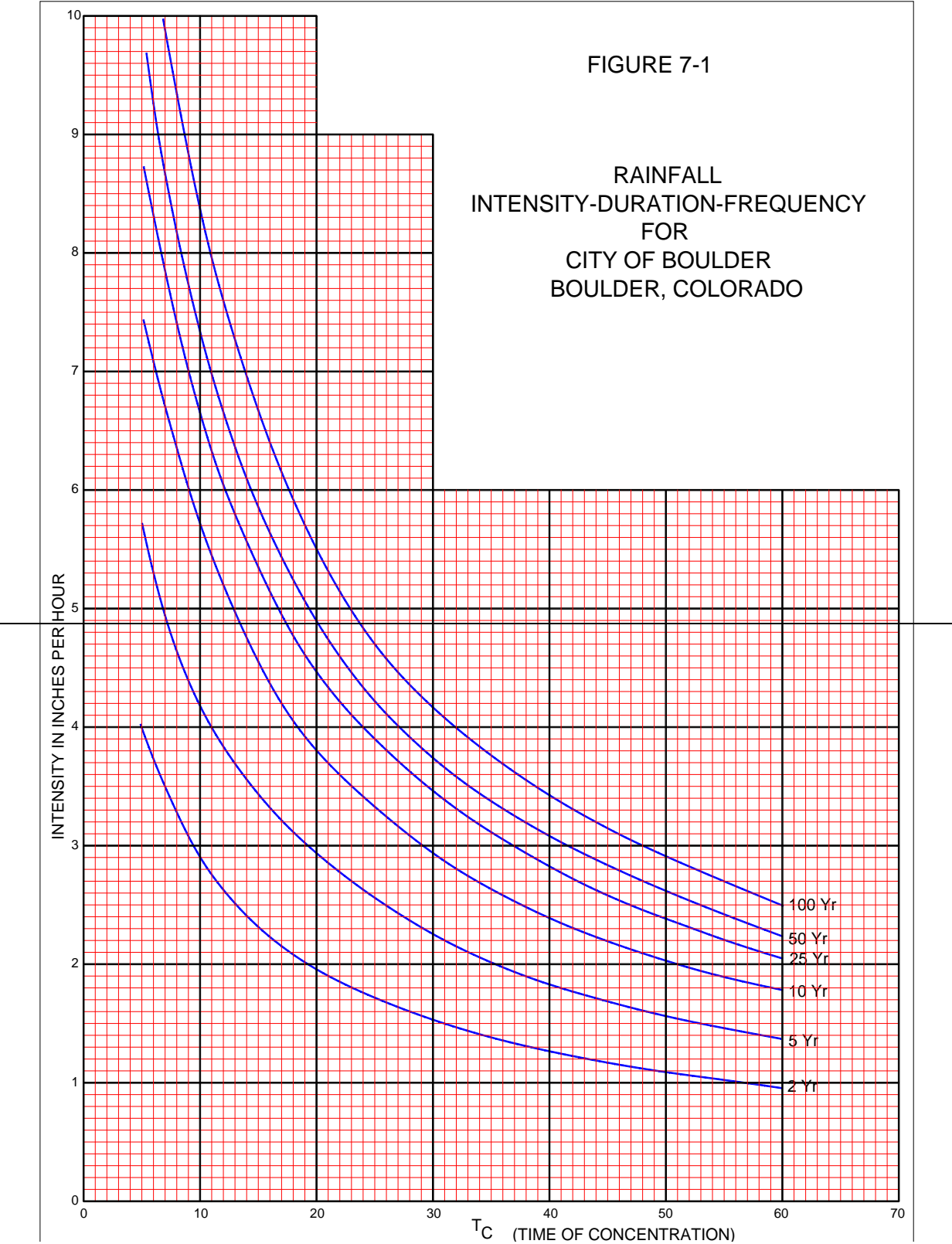
Or

$$t_c = \frac{L}{180} + 10$$

Where  $t_c$  = time of concentration in minutes

L = length of flow to first design point from the most remote point in feet

The travel time ( $t_t$ ) portion of the time of concentration shall be computed using the hydraulic properties of the ditch, channel, curb and gutter, or storm sewer. The minimum time of concentration ( $t_c$ ) for urbanized conditions shall be five minutes.





**Table 7-2: Runoff Coefficients for the Rational Method**

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	STORM FREQUENCY			
		2-Yr	5-Yr	10-Yr	100-Yr
<b><u>Business:</u></b>					
Commercial Areas	95	0.87	0.88	0.90	0.93
Neighborhood Areas	65	0.60	0.65	0.70	0.80
<b><u>Residential:</u></b>					
Single-Family	40	0.40	0.45	0.50	0.70
Multi-Unit (detached)	50	0.50	0.55	0.60	0.75
Multi-Unit (attached)	70	0.65	0.70	0.70	0.80
½-Acre Lot	30	0.30	0.40	0.45	0.65
Apartments	70	0.65	0.70	0.70	0.80
<b><u>Industrial:</u></b>					
Light Areas	80	0.75	0.80	0.80	0.85
Heavy Areas	90	0.80	0.80	0.85	0.90
<b><u>Parks, Cemeteries:</u></b>	7	0.15	0.25	0.35	0.60
<b><u>Playgrounds:</u></b>	13	0.20	0.30	0.40	0.70
<b><u>Schools:</u></b>	50	0.50	0.55	0.60	0.75
<b><u>Railroad Yard Areas:</u></b>	40	0.40	0.45	0.50	0.70
<b><u>Undeveloped Areas:</u></b>					
Historic Flow Analysis	2	0.10	0.20	0.30	0.60
Greenbelts, Agricultural	-	-	-	-	-
Offsite Flow Analysis (when offsite land use is not defined)	45	0.45	0.50	0.55	0.72
<b><u>Streets:</u></b>					
Paved	100	0.87	0.88	0.90	0.93
Gravel	7	0.15	0.25	0.35	0.65
<b><u>Drives and Walks:</u></b>	96	0.85	0.87	0.90	0.92
<b><u>Roofs:</u></b>	90	0.80	0.85	0.90	0.90
<b><u>Lawns:</u></b>					
Sandy Soil	0	0.00	0.10	0.20	0.50
Clayey Soil	0	0.10	0.20	0.30	0.60

**NOTE:** These rational formula coefficients do not apply for larger basins where the time of concentration exceeds 60 minutes.

(Source: Urban Drainage and Flood Control District)

- (5) **Intensity:** The rainfall intensity to be used in the Rational Method is be obtained from Figure 7-1, “Rainfall Intensity Duration Frequency Curve for the City of Boulder,” for the corresponding design storm frequency.

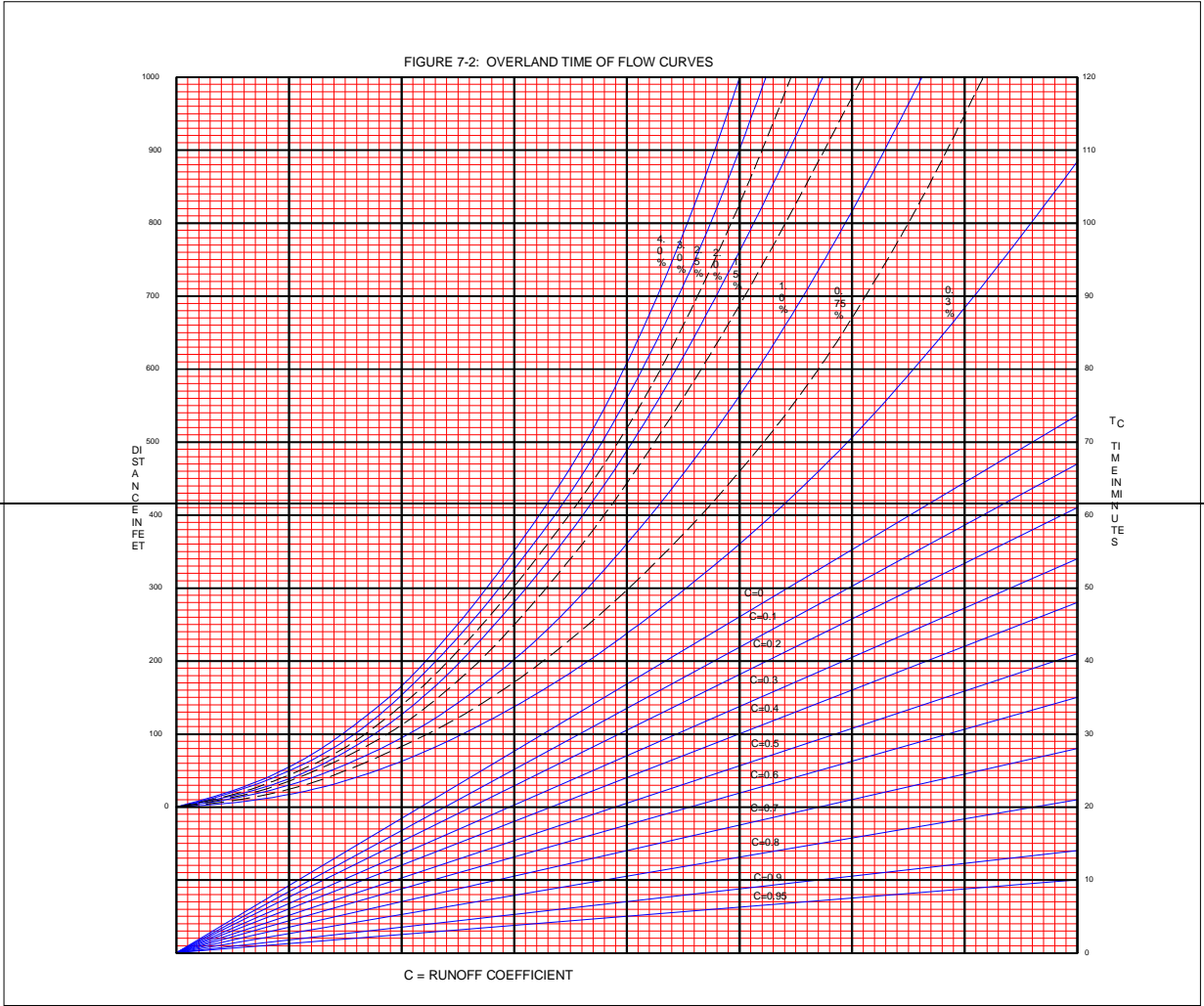
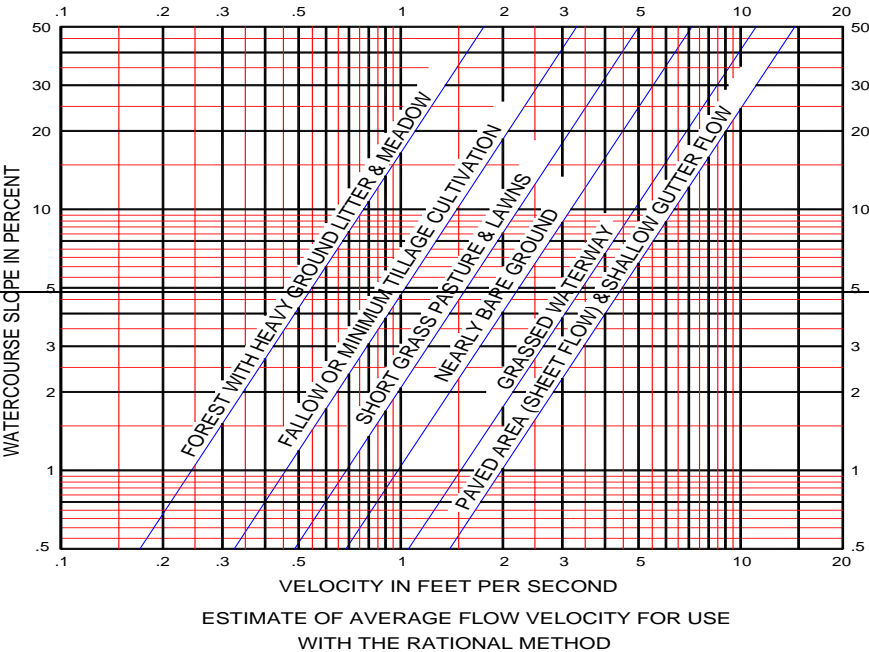


FIGURE 7-3: TIME OF TRAVEL



## 7.06 Materials and Installation

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

## 7.07 Open Drainageways

### (A) General

- (1) **Designated Major Drainageways:** The following list identifies designated major drainageways in the City for primary ~~storm water~~stormwater conveyance:

Designated Major Drainageways		
Bear Canyon Creek	Four Mile Canyon Creek	South Boulder Creek
Bluebell Canyon Creek	Goose Creek	Sunshine Canyon Creek
Boulder Creek	Gregory Canyon Creek	Two Mile Canyon Creek
Boulder Slough	King's Gulch	Viele Channel
Elmer's Two Mile Creek	Skunk Canyon Creek	Wonderland Creek
Dry Creek Ditch No. 2		

- (2) **Design Approach:** Design of public improvements for local drainageways shall ensure opportunities to provide for open conveyance corridors that may serve multiple functions, including without limitation, ~~storm water~~stormwater drainage and flood conveyance, wetlands and water quality enhancement, environmental protection and preservation, open space and wildlife areas, and recreational activities and trail corridors. ~~Storm water~~Stormwater improvements impacting local drainageways shall be designed and constructed to respect, restore and enhance these functions in order to maintain a natural ecology, environment and aesthetic value of such drainageways.

### (B) Drainageway Types

- (1) **Definition:** Drainageways in the City are defined as natural or artificial channels as follows:
- (a) Natural channels include naturally developed creeks, streams and thalwegs, which have been geologically created through the erosion process over time. Boulder Creek is considered a natural channel.
  - (b) Artificial channels include those that are designed, constructed, or developed by human effort. Artificial channels may be unlined or lined (where non-erosive conditions for unlined design cannot be met). Artificial channels also include irrigation ditches, roadside ditches, and drainage swales.
- (2) **Natural Drainageways**

- (a) The hydraulic properties of natural drainageways vary along each stream reach and are to be maintained in a naturally occurring and environmental form. Natural drainageways typically have mild slopes, are reasonably stable, and are not in a state of serious degradation or aggradation.
- (b) Where unstable conditions are created through the introduction of urbanized ~~storm-water~~stormwater runoff, which alters the nature of flow peaks and volumes and may cause erosion, mitigation measures may be proposed in the natural drainageway to maintain a stabilized and naturally occurring condition. A detailed analysis will be required for all development proposals affecting natural drainageways in order to identify the impacts of changes in flow characteristics, erosion and sedimentation, wetland losses and water quality conditions.
- (c) Analyses of natural drainageways shall be provided for each project or development application affecting the drainageway. When performed, the Engineer is to prepare cross sections of the drainageway, define water surface profile for the existing and proposed minor and major storm events, investigate the bed and bank material to determine erosion and sediment transport tendencies, identify impacts on the naturally occurring conditions and ecology and study the bank slope and stream bed stability. An analysis shall include engineering calculations to ensure that supercritical flow conditions do not result from proposed project or development activities. Natural channel improvements that would cause supercritical flow conditions shall not be permitted.

(3) **Unlined Artificial Drainageways**

- (a) Unlined artificial drainageways provide improved channel bottoms that are covered with wetlands, grass, or other vegetation, and may be used where naturally occurring drainageways are not present or as proposed under an adopted ~~storm-water~~stormwater master plan. Designs for unlined drainageways shall comply with these Standards and the ~~UDFCD Drainage Criteria Manual~~USDCM.
- (b) Unlined artificial drainageways are to provide conditions for slower flow velocities, reduced flow energy, increased flow retardance, and increased channel storage. The wetlands, grass, or other vegetation along stream beds and banks are intended to stabilize the channel, consolidate the soil mass of the bed, mitigate erosion, and control soil particles transport along the drainageway. Design of these improvements shall also consider opportunities for accommodating multiple functions along the drainageway, providing for a natural ecology, environment and aesthetic value.
- (c) Structural measures such as rock linings used for revetments, drop structures, scour aprons, or trickle channels may be approved as a means of controlling erosion for unlined artificial drainageways.

(4) **Lined Artificial Channels**

- (a) Where conditions for natural or unlined artificial drainageways are not available, including situations where limited right-of-way, supercritical velocities, or extremely erosive conditions exist, lined artificial channels may be constructed, subject to conformance with adopted ~~storm-water~~stormwater master plans and the review, discretion, and approval of the City. Designs for lined artificial channels shall comply with these Standards and the USDCM. Lined artificial channels typically include rock-lined, grouted rip-rap, and concrete-lined stream beds and

banks.

- (b) Rock-lined (rip-rapped) or grouted rip-rap channels are generally discouraged, but are much preferred to concrete lined channels. A rock-lined or grouted rip-rap channel may typically be steeper and narrower, due to the higher friction factors of rock, and may include steeper banks or side slopes. The lining shall be capable of withstanding all hydraulic and hydrodynamic forces which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining, and erode unlined areas, especially for the supercritical flow conditions. If project constraints suggest the use of a rock-lined or grouted rip-rap channels, the Engineer shall present the justification and design concept to the City for consideration.
- (c) Concrete-lined channels are least desirable, and may only be approved under severely restrictive circumstances. The concrete lining shall withstand all hydraulic and hydrodynamic forces which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining, and erode unlined areas, especially for the supercritical flow conditions. If project constraints suggest the use of a concrete lined channel, the Engineer shall present the justification and design concept, including a discussion of non-concrete-lined alternatives and why they are not feasible, to the City for consideration.
- (5) **Roadside Ditches and Drainage Swales:** Roadside ditches and drainage swales are open drainage systems that are not part of the major drainageway system, and are used to convey minor and major ~~storm water~~stormwater runoff in projects and developments and along rural-type streets. The design of these drainage swales is similar to the design of unlined artificial drainageways on a reduced scale.

## (C) Drainageway Flow Computation

Uniform flow and critical flow computations for drainageways shall be performed in accordance with ~~Sections 2.2.3 and 2.2.4, "Major Drainage,"~~the UDFCD Drainage Criteria Manual~~USDCM~~.

## (D) Drainageway Design Standards

The design standards for drainageways involve a wide range of options intended to create safe, environmental, multipurpose, and aesthetic improvements. The following planning, evaluation, and design standards shall be applied:

- (1) **Natural Drainageways**
  - (a) The drainageway and overbank areas necessary to pass 100-year storm runoff are to be reserved for ~~storm water~~stormwater purposes.
  - (b) ~~Naturally occurring drainageway velocities are to be preserved at 5 feet per second or less, having a calculated Froude number of 0.8 or less, unless greater velocities given existing conditions or velocity increases due to development are approved by the City in conformance with these Standards.~~
  - (c) ~~Water surface profiles shall be defined to identify floodplain conditions.~~
  - (d) Flood fringe filling along naturally defined drainageways, which reduces drainageway flood storage capacity and increases downstream runoff peaks, is to be avoided unless approved as part of an adopted City ~~storm water~~stormwater master plan.

- (~~ed~~) Roughness factors (n), which are representative of unmaintained channel conditions, shall be used for the analysis of water surface profiles and to determine velocity limitations
  - (~~fe~~) The Director may allow the placement of erosion control structures, such as drop structures, check dams, revetments, and scour aprons, where they may be necessary to maintain stabilized drainageway conditions, subject to the design requirement that the drainageway conditions remain as near natural as possible.
  - (~~gf~~) Design parameters applicable to artificial drainageways, including without limitation, freeboard height, bed and bank slopes, and curvature, may not necessarily apply to natural drainageways. Significant site planning advantages may be realized by maintaining the natural drainageway, without structured improvements, by allowing drainageway overtopping onto reserved flooding areas designated as open space and wetlands and maintaining irregular waterway features that naturally control flow conditions, improve water quality, preserve stream ecology and enhance community and aesthetic values.
- (2) **Unlined Artificial Drainageways:** Where not specified in these Standards, the design of unlined artificial drainageways shall conform with the ~~UDFCD Drainage Criteria Manual~~USDCM.
- (a) ~~**Flow Velocities:** Maximum normal depth velocity for the major (100 year) storm shall be 5 feet per second in sandy soils, and 7 feet per second where soil conditions permit, as demonstrated through geotechnical analysis. Additionally, the Froude number shall be less than 0.8.~~
  - (~~b~~) ~~Longitudinal Channel Slopes:~~ Channel slopes are dictated by velocity and Froude number requirements. Where natural slopes exceed design slopes, drop structures shall be provided to maintain design velocities and Froude numbers. Normally, grass lined channels will have slopes of 0.2 percent to 0.6 percent.
  - (~~eb~~) Side Slopes: Maximum side slopes shall be no steeper than 4:1, unless specific drainageway conditions warrant steeper side slopes as determined by the Director.
  - (~~ec~~) Depth: Maximum depth of flow, outside of any low flow or trickle channel, shall be 5 feet. Critical depth shall be determined for both the major and initial storms in order to ensure that supercritical flows do not occur.
  - (~~ed~~) Bottom Width: Bottom width shall be consistent with the maximum depth and velocity standards, and shall accommodate low flows and the development of wetland and water quality enhancement systems.
  - (~~fc~~) ~~**Freeboard:** The minimum depth of freeboard above normal depth flows for the major storm is to be 1 foot, or adequate to provide additional capacity for one third of the major storm design flow.~~
  - (~~g~~) ~~Horizontal Curvature:~~ The center line curvature shall have a design radius twice the top width for design flow conditions, but not less than 50 feet.
  - (~~hf~~) Roughness Coefficient: Meaning's "n," as adjusted by channel bottom conditions outlined in the ~~UDFCD Drainage Criteria Manual~~USDCM, shall be applied.
  - (~~ig~~) Cross Sections: Drainageway cross-sections may be almost any type suitable to the location and to the environmental conditions, subject to conformance with these Standards. Cross sections simulating naturally occurring drainageway

corridors are strongly recommended.

- (~~h~~) **Channel Bottom:** The channel bottom is to be designed to convey low flows and enhance water quality in conformance with environmental concerns and regulations. Acceptable channel bottoms, subject to City approval for specific site applications, may include without limitation wetlands or natural vegetation and low flow channels conveying a minimum 3 percent of the design storm flow.
  - (~~k~~) **Easement/Right-of-Way:** The minimum drainageway easement/right of way width shall include the bank to bank dimension of the drainageway section, including the normal flow depth and freeboard areas, and adequate maintenance access.
  - (~~l~~) **Maintenance Access:** Maintenance access shall be provided along the entire length of all major drainageways and shall connect with a public street to allow access by medium and large scale construction and maintenance equipment. An access road shall be at least 12 feet wide and designed to adequately support the loads of expected maintenance equipment. The maintenance road may be shared as a greenway trail, subject to approval by the City.
  - (~~m~~) **Water Surface Profiles:** Water surface profiles shall be determined for all drainageway designs using standard backwater methods, taking into consideration losses due to velocity changes produced by changing channel sections, drops, waterway openings, or obstructions. The water surface and energy gradient profiles shall be shown on the construction plans.
- (3) **Lined Artificial Channels:** Where allowed by the City, lined artificial channels shall be designed in accordance with these Standards and the ~~UDFCD Drainage Criteria Manual~~ USDCM, including the following:
- (a) **Easement/Right-of-Way:** The minimum drainageway easement/right of way width shall include the bank to bank dimension of the drainageway section, including the normal flow depth and freeboard areas, and adequate maintenance access.
  - (b) **Maintenance Access:** Maintenance access shall be provided along the entire length of all major drainageways and shall connect with a public street to allow access by medium and large scale construction and maintenance equipment. An access road shall be at least 12 feet wide and designed to adequately support the loads of expected maintenance equipment. The maintenance road may be shared as a greenway trail, subject to approval by the City.
  - (c) **Water Surface Profiles:** Water surface profiles shall be determined for all drainageway designs using standard backwater methods, taking into consideration losses due to velocity changes produced by changing channel sections, drops, waterway openings, or obstructions. The water surface and energy gradient profiles shall be shown on the construction plans.
- (4) **Roadside Ditches and Drainage Swales:** The design of roadside ditches and drainage swales is similar to the standards for unlined channels with modifications for application to minor storm drainage. The standards are as follows:
- (a) **Capacity:** Roadside ditches and drainage swales shall have a minimum capacity for the 10-year design storm.
  - (b) **Flow Velocity:** The maximum velocity for the design storm runoff peak is not to exceed 5 feet per second. The Froude number shall be less than 0.8.



- (c) Longitudinal Slope: The slope shall be limited by flow velocity of the design storm. Swale widening or check drops may be required to control velocities.
- (d) Freeboard: Freeboard above the design flow depth shall be at least 6 inches.
- (e) Curvature: The minimum radius of curvature shall be 25 feet.
- (f) Roughness Coefficient: Manning's "n," as adjusted by channel bottom conditions outlined in the ~~UDFCD Drainage Criteria Manual~~ USDCM, shall be applied.
- (g) Depth: A drainage swale shall be at least 1 foot deep. A maximum depth for drainage swales shall not exceed 5 feet, and shall be dictated by the design flow and cross-sectional standards.
- (h) Side Slopes: Side slopes shall be no greater than 3:1; however, 4:1 side slopes or flatter are recommended for landscaped areas and to enhance water quality.
- (i) Driveway Culverts: Along roadside ditches, driveway culverts shall be sized to pass the design storm flow without overtopping the driveway, having a minimum culvert diameter size of ~~42-18~~ inches in height with at least 6 inches of cover. Flared end sections or headwalls with appropriate erosion protection shall be provided. Given the depth constraints along roadside ditches, more than one culvert may be required to pass the design flow. Maintenance of all driveway culverts shall be the responsibility of the property owner served by the driveway.
- ~~(j)~~ Discharge Points: Roadside ditches and open drainage swales shall discharge directly to the receiving water and shall not discharge to a piped storm sewer system for conveyance to the receiving water body. If discharge to a piped storm sewer system is necessary, a sediment sump and debris grate shall be provided immediately upstream of the discharge point to the storm sewer system. The grate shall be hinged to allow for maintenance access.
- ~~(jk)~~ Major Drainage Capacity:
  - (i) The major drainage (100-year storm) capacity of roadside ditches is restricted by the maximum flow depth allowed at the street crown or by the ground surface at the edge of the street right-of-way.
  - (ii) The major drainage capacity of drainage swales is restricted to the maximum flow that can be passed without inundation to and damage of downstream properties.

## (E) Hydraulic Structures

- (1) **Where Required:** Hydraulic structures are used in open ~~storm-water~~ stormwater systems to control the flow of the runoff. The energy associated with flowing water has the potential to create damage to the drainage system, especially in the form of erosion. Hydraulic structures are intended to control the energy of ~~storm-water~~ stormwater flow and minimize the damage potential of ~~storm-water~~ stormwater runoff. Typical hydraulic structures may include without limitation the following:
  - (a) Channel drop and check structures,
  - (b) Rip rap and rock linings,
  - (c) Energy dissipaters and stilling basins,
  - (d) Channel rundowns,

- (e) Bridges and culverts, and
- (f) Irrigation ditch crossings.<sup>5</sup>
- (2) **Design Standards:** The standards to be used in the design of hydraulic structures shall be in accordance with these Standards and the ~~UDFCD Drainage Criteria Manual~~USDCM.

## 7.08 Storm Sewers

### (A) System Design

- (1) **Where Required:** Storm sewers shall be required when the other parts of the minor ~~storm water~~stormwater system, primarily streets, curbs, gutters, and roadside ditches, no longer have the capacity for additional runoff in the initial storm event.
- (2) **Gravity Flow Conditions:** Storm sewers shall be designed for gravity (open) flow conditions, using a “Manning’s” roughness coefficient from Table 7-~~23~~, “Manning’s “n” for Storm Sewers.”

**Table 7-~~23~~: Manning’s “n” for Storm Sewers**

Sewer Type	Manning’s “n”
Concrete	0.015
Plastic	0.013
Corrugated Metal	0.013

- (3) **Flow Depth:** Storm sewers are to be designed to carry peak flows at full pipe depth.
- (4) **Pressure Flow Prohibited:** Pressurized surcharged or depressed (inverted siphon) ~~storm water~~stormwater mains are prohibited in the City’s ~~storm water~~stormwater system.
- (5) **Continuous Drainage System:** All stormwater drainage facilities shall be a component of a connected and continuous drainage system that does not end in a sump condition and does not discharge to irrigation ditches.

### (B) Location

All storm sewer mains shall be installed in public rights-of-way or easements, in conformance with Section 4.~~03~~04, “Utilities Easements,” of these Standards.

### (C) Depth

The cover for all storm sewer mains shall be at least 18 inches deep, measured from the top of pipe to the final surface grade, and shall be capable of withstanding AASHTO HS-20 highway traffic loadings.

### (D) Size

Storm sewer mains shall be at least 18 inches in diameter, and storm sewer laterals shall be at least ~~12~~15 inches in diameter.

**(E) Slope**

- (1) **Minimum and Maximum:** Minimum allowable slope shall provide flow velocities of at least 2-feet per second and maximum allowable slope shall provide flow velocities no greater than 10 feet per second during peak flow conditions.
- (2) **Constant Slope:** All storm sewer mains shall be laid at a constant slope between manholes.

**(F) Alignment**

- (1) **Straight Alignment:** All storm sewer mains shall be laid in a straight alignment between manholes.
- (2) **Curvilinear Mains Prohibited:** Curvilinear storm sewer mains shall not be allowed.

**(G) Separations and Crossings**

All collection main separations and crossings of other City utilities shall be designed in compliance with Section 4.0506, "Separation of Utilities," of these Standards.

**(H) Taps**

All taps approved onto an existing storm sewer main shall be made by the City of Boulder Utilities Division, and shall be paid for by the applicant. A manhole shall be provided at all taps 6 inches in diameter or larger. Where taps are made to inlet boxes a manhole is not required.

**(I) Ground Water Barriers**

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

**(J) Extensions**

Where required as part of any adopted City master plan or to satisfy ~~storm-water~~stormwater design requirements as part of any proposed project or development, storm sewer mains shall be extended downstream to the major drainageway, and upstream to the far edge of the property being served, to ensure perpetuation of the ~~storm-water~~stormwater collection system.

**(K) Manholes**

- (1) **Location:** Manholes shall be provided at each storm sewer main connection with another storm sewer main or lateral line, at all changes in grade, slope, alignment and pipe size, at all tap connections 6 inches in diameter or larger, and at distances not greater than the following or every 400 feet at a minimum.:

- (a) ~~400 feet, for mains 36 inches in diameter or less, and~~
- (b) ~~500 feet, for mains greater than 36 inches in diameter.~~

(2) **Size**

- (a) Table 7-34, "Required Manhole Sizes," indicates required manhole sizes.

**Table 7-34: Required Manhole Sizes**

Sewer Main Diameter	Manhole Diameter
12 - 18 Inches	4 Feet
21 - 42 Inches	5 Feet
48 - 54 Inches	6 Feet
60 Inches and Larger	Special Detail

- (b) Special Provisions: Larger manhole diameters or a junction structure may be required when sewer alignments are not straight through or more than one sewer line passes through a manhole.
- (3) **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, minimum 12 feet in width, and shall be capable of supporting maintenance vehicles weighing up to 14 tons.
- (4) **Covers**
  - (a) Manholes that are not located within a public street, alley or driveway section shall be installed with a hinged, gasketed, and locking frame and cover assembly. The assembly shall be an "East Jordan Iron Works" ERGO or ERGO XL assembly, with a bolting type cover, to ensure safety and prevent vandalism.
  - (b) Manholes located within the 100-year floodplain, or in a location where runoff may accumulate and pond, shall be installed with a hinged, gasketed, and locking frame and cover assembly. The assembly shall be an "East Jordan Iron Works" ERGO or ERGO XL assembly, with a bolting type cover, to prevent loss of the cover. The manhole ring shall be bolted to the manhole cone to prevent possible damage due to surcharge.

(L) **Hydraulic Design**

- (1) **Rational Method for Sizing Storm Sewer System:** The rational method, as described in the USDCM, shall be used for the sizing of storm sewer systems. This method is outlined in the UDFCD Drainage Criteria Manual. The following step by step procedure should be used in conjunction with Figure 7.4, "Typical Form for Storm Drainage System Design Data," of these Standards. This procedure is for the average design situation and variations may be necessary to accommodate actual field conditions.
  - (a) ~~Column 1:~~ Determine design point locations and list. This design point should correspond to the sub-basin illustrated on the preliminary layout map.
  - (b) ~~Column 2:~~ List basins contributing runoff to this point that have not previously been analyzed.

(c) ~~Column 3: Enter the length of the flow path between previous design point and design point under consideration.~~

[illegible]

- (d) ~~Column 4:~~ Determine the inlet time for the particular design point. See the runoff part of this criteria for methods to determine inlet time.
  - (i) ~~For the first design point on a system, inlet time will be equal to the time of concentration.~~
  - (ii) ~~For subsequent design points, inlet time should also be tabulated to determine if it may be of greater magnitude than the accumulated time of concentration from upstream basins.~~
  - (iii) ~~If the inlet time exceeds the time of concentration from the upstream basin, and the area tributary to the inlet is of sufficient magnitude, the inlet time should be substituted for time of concentration and used for this and subsequent basins.~~
- (e) ~~Column 5:~~ Enter the appropriate flow time between the previous design point and the design point under consideration. The flow time of the sheet should be used if a significant portion of the flow from the basin is carried in the street.
- (f) ~~Column 6:~~ Pipe flow time should generally be used unless there is significant carry over from above basins in the street.
- (g) ~~Column 7:~~ The time of concentration is the summation of the previous design point time of concentration and the intervening flow time.
- (h) ~~Column 8:~~ Rational Method Runoff Coefficient, "C," for the basins listed in Column 2 should be determined and listed. The "C" value should be weighted if the basins contain area with different "C" values.
- (i) ~~Column 9:~~ The intensity to be applied to the basins under consideration is obtained from the Rainfall Intensity Duration Curves (see Figure 7.05-1). The intensity is determined from the time of concentration and the frequency of design for this particular design point.
- (j) ~~Column 10:~~ The area in acres of the basins listed in Column 2 is tabulated here. Subtract ponding areas that do not contribute to direct runoff.
- (k) ~~Column 11:~~ Direct runoff from the tributary basins listed in Column 2 is calculated and tabulated hereby multiplying Columns 8,9, and 10 together.
- (l) ~~Column 12:~~ Runoff from other sources, such as controlled releases from rooftops, parking lots, base flows from groundwater, and any other source, are listed here.
- (m) ~~Column 13:~~ The total of runoff from the previous design point summation plus the incremental runoff listed in Columns 11 and 12 is listed here.
- (n) ~~Column 14:~~ The proposed street slope is listed in this column.
- (o) ~~Column 15:~~ The allowable capacity for the street is listed in this column. Allowable capacities should be calculated in accordance with procedures set forth in Section 7.10, "Streets," of these Standards.
- (p) ~~Column 16:~~ List the proposed pipe grade.
- (q) ~~Column 17:~~ List the required pipe size to convey the quantity of flow necessary in the pipe.
- (r) ~~Column 18:~~ List the capacity of the pipe flowing full with the slope expressed in Column 16.

- (s) ~~Column 19:~~ Tabulate the quantity of flow to be carried in the street.
- (t) ~~Column 20:~~ List the actual velocity of flow for the volume of runoff to be carried in the street.
- (u) ~~Column 21:~~ List the quantity of flow determined to be carried in the pipe.
- (v) ~~Column 22:~~ Tabulate the actual velocity of flow in the pipe for the design Q.
- (w) ~~Column 23:~~ Include any remarks or comments that may affect or explain the design. The allowable quantity of carryover across the street intersections should often be listed for the initial design storm. When routing the major storm through the system, required elevations for adjacent buildings can often be listed in the column.

- (2) **Hydraulic and Energy Grade Line, and Design Losses:** Storm sewers shall be designed to convey the initial storm flow peaks without surcharging the sewer, and the final energy grade line shall be at or below the proposed ground surface. To ensure that this objective is achieved, the hydraulic and energy grade line shall be calculated by accounting for pipe friction losses and pipe form losses. ~~Total hydraulic losses will include frictions, expansion, contraction, bend, and junction losses. The methods for estimating these losses are presented in the following sections as provided in the UDFCD Drainage Criteria Manual~~ USDCM.

- (a) ~~Pipe Friction Losses:~~ The Manning's "n" values to be used in the calculation of storm sewer capacity and velocity are presented in Table 7-3, "Manning's "n" for Storm Sewers," of these Standards.
- (b) ~~Pipe Form Losses:~~ Generally, between the inlet and outlet the flow encounters a variety of configurations in the flow passageway such as changes in pipe size, branches, bends, junctions, expansion, and contractions. These shape variations impose losses in addition to those resulting from pipe friction. Pipe form losses are the result of fully developed turbulence and can be generally expressed as follows:

$$H_L = K(V^2/2g)$$

Where  $H_L$  = Head Loss (feet)

$K$  = Loss Coefficient

$V^2/2g$  = Velocity Head (feet)

$g$  = Acceleration of Gravity (32.2 ft/sec<sup>2</sup>)

Separate form losses attributable to pipe expansions and contractions, junctions and manholes, and at pipe outlets may be more specifically calculated in the following equations:

- (i) ~~Expansion Losses:~~ Expansion in a storm sewer conduit will result in a shearing action between the incoming high velocity jet and the surrounding sewer boundary. Much of the kinetic energy is therefore dissipated by eddy currents and turbulence. The loss of head can be calculated as follows:

$$H_L = K_e (V_1^2/2g) [1 - (A_1/A_2)]^2$$

Where  $H_L$  = Head Loss (Feet)

$K_e$  = Loss Coefficient (1.0, Sudden Expansion, 0.17, Gradual 10% Taper, Refer to Figure 7-5, "Storm



~~(Expansion/Contraction),” of these Standards)~~

~~$V_1$  — = Pipe Velocity Upstream of Expansion (feet per second)~~

~~$A_1$  — = Pipe Cross-Sectional Area Upstream of Expansion (ft<sup>2</sup>)~~

~~$A_2$  — = Pipe Cross-Sectional Area Downstream of Expansion (ft<sup>2</sup>)~~

- (ii) ~~**Contraction Losses:** The form loss of head due to contraction can be calculated as follows:~~

$$H_L = K_c (V_2^2 / 2g) [1 - (A_2 / A_1)]^2$$

~~Where  $H_L$  — = Head Loss (Feet)~~

~~$K_c$  — = Loss Coefficient (0.5, Sudden Contraction, 0.1, Gradual Contraction, Refer to Figure 7-5, “Storm Sewer Energy Loss Coefficient (Expansion/Contraction),” of these Standards)~~

~~$V_2$  — = Outfall Velocity (feet per second)~~

~~$A_1$  — = Pipe Cross-Sectional Area Upstream of Expansion (ft<sup>2</sup>)~~

~~$A_2$  — = Pipe Cross-Sectional Area Downstream of Expansion (ft<sup>2</sup>)~~

- (iii) ~~**Junction and Manhole Losses:** A junction occurs where one or more branch sewers enter a main sewer, usually at manholes. The hydraulic design of a junction is in effect the design of two or more transitions, one for each flow path. Allowances should be made for head loss due to the impact at junctions. The head loss for a straight through manhole or at an inlet entering the sewer may be calculated from the general form loss equation,  $H_L = K(V^2/2g)$ , presented at the beginning of this paragraph. The form loss of head at a junction can be calculated as follows:~~

$$H_L = V_2^2 / 2g - K_j V_1^2 / 2g$$

~~Where  $H_L$  — = Head Loss (Feet)~~

~~$V_2$  — = Outfall Velocity (Feet Per Second)~~

~~$K_j$  — = Loss Coefficient (Refer to Figure 7-6, “Manhole and Junction Losses,” of these Standards)~~

~~$V_1$  — = Inlet Velocity (Feet Per Second)~~

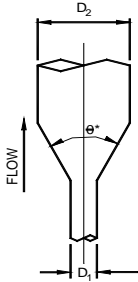
- (3) ~~**Storm Sewer Outlet Losses:** When the storm sewer system discharges into an open channel, additional losses occur at the outlet in the form of expansion losses. For a headwall and no wingwalls, the loss coefficient  $K_e = 1.0$  and for a flared end section the loss coefficient is approximately 0.5 or less.~~

FIGURE 7-5  
STORM SEWER ENERGY LOSS COEFFICIENT  
(EXPANSION, CONTRACTION)

(A) EXPANSION ( $K_E$ )

$\theta^*$	$\frac{D_2}{D_1} = 3$	$\frac{D_2}{D_1} = 1.5$
10	0.17	0.17
20	0.40	0.40
45	0.86	1.06
60	1.02	1.21
90	1.06	1.14
120	1.04	1.07
180	1.00	1.00

\* THE ANGLE  $\theta$  IS THE ANGLE IN DEGREES BETWEEN THE SIDES OF THE TAPERING SECTION.

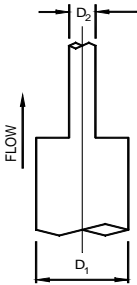


(B) PIPE ENTRANCE FROM RESERVOIR

BELL-MOUTH $H_L = 0.04$	$\frac{V^2}{2g}$
SQUARE-EDGE $H_L = 0.5$	$\frac{V^2}{2g}$
GROOVE END U/S FOR CONCRETE PIPE $H_L = 0.2$	$\frac{V^2}{2g}$

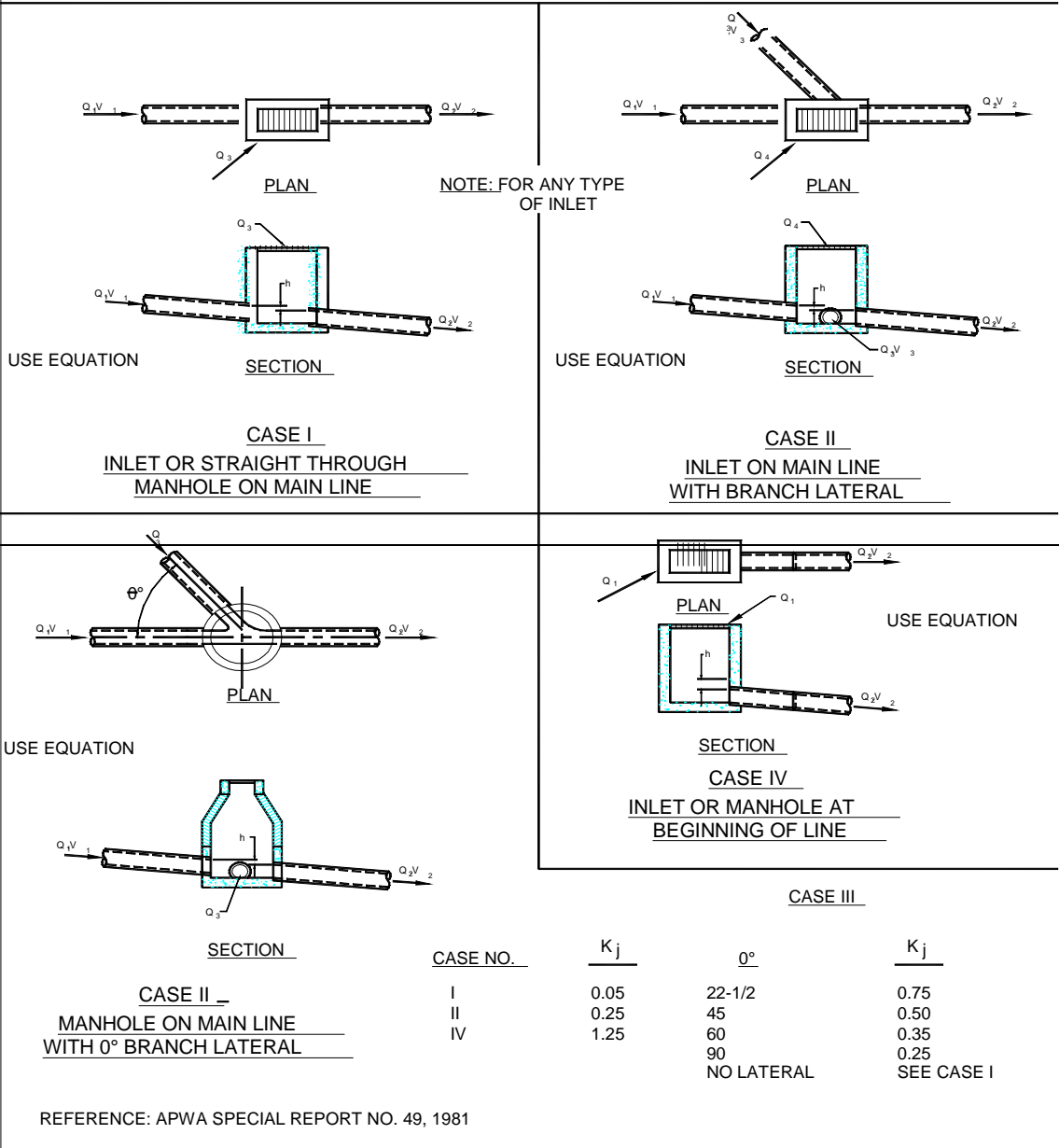
(C) CONTRACTIONS ( $K_C$ )

$\frac{D_2}{D_1}$	$K_C$
0	0.5
0.4	0.4
0.6	0.3
0.8	0.1
1.0	0



REFERENCE: LINSLEY AND FRANZINI "WATER RESOURCES ENGINEERING"  
MC GRAW-HILL, 1964

FIGURE 7-6: MANHOLE AND JUNCTION LOSSES



## 7.09 Inlets

### (A) Specifications

- (1) **Required Design:** ~~Except as modified in these Standards, storm sewer inlet design shall conform with the standards in the UDFCD Drainage Criteria Manual~~ USDCM.
- (2) **Required:** Storm inlets shall be provided ~~at where sump (low spot) conditions exist or street runoff carrying capacities are exceeded.~~
- (a) Areas where street capacity (e.g., allowable design flow spread) would be exceeded without them.
  - (b) At sumps or areas prone to ponding.
  - (c) At median breaks (e.g., where traffic turns across the median).
  - (d) Upstream of speed mitigation and pedestrian structures that would otherwise cause a damming of stormwater runoff.
  - (e) Where nuisance flows would otherwise cross a driving lane, and
  - (f) Where curb and gutter ends.
- (23) **Inlet Classification:** Inlets are classified as a sump or continuous grade condition. Sump inlets are inlets located in a low spot or submerged condition. Continuous grade inlets are inlets located along a continuous grade curb and gutter section where bypass flows may occur, and not in a low point.
- (34) **Standard Inlets:** Table 7-45, “Standard Inlets,” indicates the standard inlets permitted for use in the City.

**Table 7-45: Standard Inlets**

Inlet Type	Drainage Condition	Permitted Use	Percentage of Theoretical Capacity Allowed
Curb Opening Inlet - Type “R”	Continuous Grade or Sump	All Curb and Gutter Street Types	80% (5 Foot Length) 85% (10 Foot Length) 90% (15 Foot Length)
Combination (Curb Opening/Grated) Inlet <del>—Type “A”</del>	Continuous Grade or Sump	<u>All Curb and Gutter Street Types</u> <u>Director Approval Required</u>	66%
Grated Area Inlet <del>—Type 13</del>	Sump	Parking Lots, Alleys	60%

- (45) **Reduction Factors:** In order to account for inlet capacity reductions caused by debris plugging, pavement overlaying, parked vehicles, and other blockage factors, inlet design shall be based on the “percentage of theoretical capacity allowed” as outlined in Table 7-45, “Standard Inlets,” in these Standards.
- (56) **Inlet Spacing**
- (a) Spacing of storm inlets is dependent upon traffic requirements, contributing land use, street slope and distance to the nearest outfall system. The recommended sizing and spacing of the inlets is based upon the interception rate of 70 percent to 80 percent, which has been found to be more efficient than spacing using 100

percent interception rate.

- (b) Using recommended inlet spacing, only the most downstream inlet is designed to intercept 100 percent of the flow. In addition to recommended interception rates, considerable improvements in overall inlet system efficiency can be achieved if the inlets are located in the sumps created by street intersections.

(67) **Inlet Grates:** All inlet grates located in a street, alley, parking lot travel lane, bike path, or sidewalk, shall utilize a ~~safety grate approved for bicycle traffic~~ vaned grate on the inlet such as the Denver Type 16 inlet.

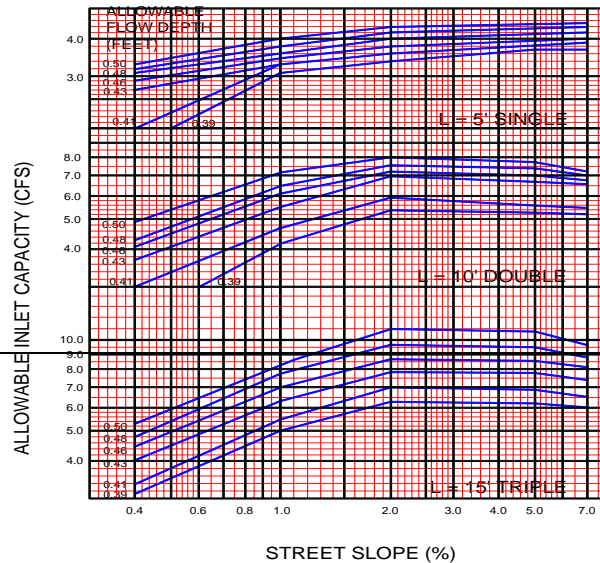
(7) ~~**Additional Standards:** Except as modified in these Standards, storm sewer inlet design shall conform with the standards in the UDFCD Drainage Criteria Manual.~~

## **(B) — Inlet Hydraulics**

~~Inlets are to be designed based on the theoretical flow capacity, considering the runoff volume and depth of flow in the gutter, as adjusted by applying a reduction factor to account for variable “in field” conditions which would limit optimal theoretical performance.~~

- (1) **Sump Inlet Condition:** Sump inlet capacity shall be determined by the depth of ponding above the inlet and the size and shape of the inlet opening. The theoretical capacity of a Type R, Combination Type A or Grated Type 13 inlet in a sump condition is to be determined from Figure 7-7, "Allowable Inlet Capacity, Sump Conditions - All Inlets," of these Standards. Design capacity is then calculated by applying the "percentage of theoretical capacity allowed" factor outlined in Table 7-5, "Standards Inlets," of these Standards.

FIGURE 7-8: ALLOWABLE INLET CAPACITY  
TYPE 'R' CURB OPENING ON A CONTINUOUS GRADE



NOTES:

1. MAXIMUM INLET CAPACITY AT MAXIMUM ALLOWABLE FLOW DEPTH. PROPORTIONALLY REDUCE FOR OTHER DEPTHS.
2. ALLOWABLE CAPACITY = 

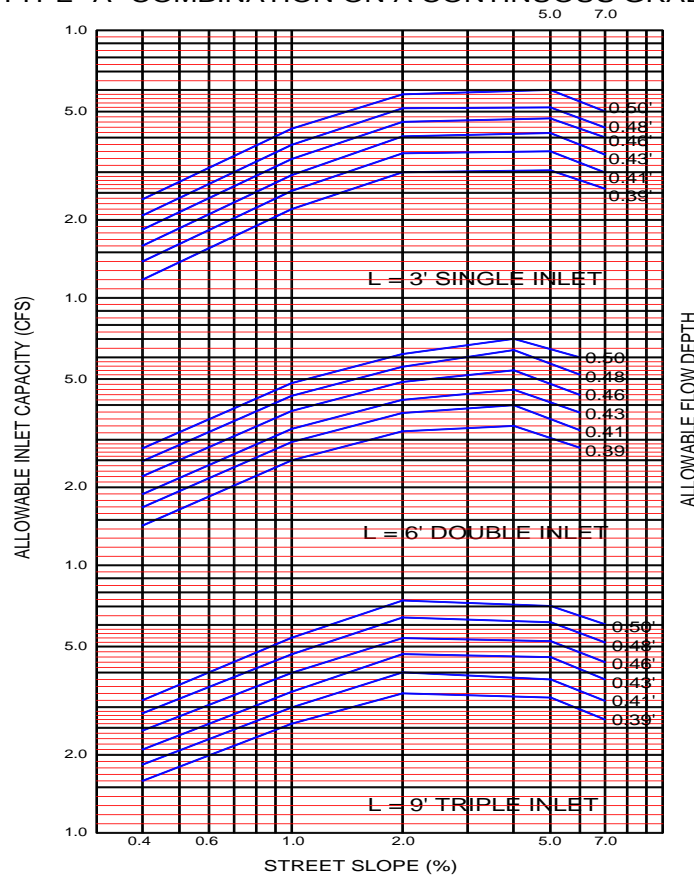
88% (L = 5')	}	OF THEORETICAL CAPACITY
92% (L = 10')		
95% (L = 15')		
3. INTERPOLATE FOR OTHER INLET LENGTHS.

- (2) **Continuous Grade Inlet Condition:** Continuous grade inlet capacity is to be determined

based upon gutter slope, depth of flow in the gutter, length and height of the curb opening, street cross slope, and the amount of depression at the inlet. In addition, continuous grade conditions limit the potential to intercept all gutter flow without very long and expensive inlet construction. Given this, continuous grade inlets are to be designed considering "inlet carryover" which includes an evaluation of the flow interception percentage at each inlet and the amount of carryover to be included at the next inlet stage.

- (a) **Type R Inlet:** The theoretical capacity of a Type R inlet in a continuous grade condition is to be determined from Figure 7.8, "Allowable Inlet Capacity, Type 'R' Curb Opening on a Continuous Grade," of these Standards. Design capacity is then calculated by applying the "percentage of theoretical capacity allowed" factor outlined in Table 7.5, "Standards Inlets," of these Standards.
- (b) **Combination Type A Inlet:** The theoretical capacity of a Type A inlet in a continuous grade condition is to be determined from Figure 7.9, "Allowable Inlet Capacity, Type 'A' Combination on a Continuous Grade," of these Standards. Design capacity is then calculated by applying the "percentage of theoretical capacity allowed" factor outlined in Table 7.5, "Standards Inlets," of these Standards.

FIGURE 7-9: ALLOWABLE INLET CAPACITY  
TYPE "A" COMBINATION ON A CONTINUOUS GRADE



NOTES:

1. ALLOWABLE CAPACITY = 66% THEORETICAL CAPACITY
2. MAXIMUM INLET CAPACITY AT MAXIMUM ALLOWABLE FLOW DEPTH. PROPORTIONALLY REDUCE FOR OTHER DEPTHS.

## 7.10 Street Drainage

### (A) Function of Streets in the Drainage System

- (1) **Primary Function of Streets:** Streets provide an integral part of the storm water system and are intended to transport local storm runoff within reasonable limits. The primary function of streets is for safe traffic movement; therefore, streets shall be designed and constructed to accommodate runoff and convey it to downstream drainage facilities in order to minimize its interference with traffic. Streets therefore provide an integral part of the stormwater system and are intended to transport local storm runoff within reasonable limits. When the stormwater runoff accumulation in the street exceeds allowable limits, storm sewers or other drainage facilities are required to collect and convey the excess runoff.



~~However, the primary function of streets is for transportation, and storm water conveyance shall not be the major function of the street. Street runoff shall be analyzed for the initial and major storm events, and necessary storm drainage facilities shall be designed in conformance with these Standards. When street runoff exceeds allowable limits, a storm sewer system or an open drainageway is required to convey the excess flows.~~

- (2) ~~——~~ **Allowable Storm Water Conveyance:** Allowable storm water conveyance on public streets is based upon a reasonable frequency and level of traffic interference. Depending on the character of the street, certain traffic lanes may be fully or partially inundated during storm events. During less intense storms, streets should be designed to efficiently convey minor and nuisance runoff to the storm sewer or open drainage system without interference to traffic movements. During major storm events, streets are needed to provide an emergency passageway for the flood flows with minimal damage to urban environment.
- (2) **Continuous Drainage System:** All stormwater drainage facilities for streets shall be a component of a connected and continuous drainage system that does not end in a sump condition and does not discharge to irrigation ditches.

## (B) Street Classification and Allowable Runoff Encroachment

- (1) **Street Classification:** City streets are classified according to the average daily traffic carried and travel routes they provide. Higher category streets, such as arterials and collectors, are required to provide a greater level of access and through travel for emergency purposes during major storm events than lower category streets.
- (2) **Allowable Runoff Encroachment:** A stormwater drainage system (storm sewer or open drainageway) shall be provided where the gutter runoff encroachment reaches the limits outlined in Table 7-56, "Allowable Street Drainage Encroachment."

**Table 7-56: Allowable Street Drainage Encroachment**

Street Classification	Minor Storm Maximum Encroachment	Major Storm Maximum Encroachment
Residential and Local Streets	No curb overtopping. Flow may spread to street crown.	Depth at flowline shall not exceed 18 inches.
Collector Streets	No curb overtopping. A minimum one travel lane width shall remain free of drainage encroachment.	Depth at flowline shall not exceed 18 inches.
Arterial Streets	No curb overtopping. A minimum two travel lanes width shall remain free of drainage encroachment.	Depth at crown shall not exceed 6 inches. Depth at flowline shall not exceed 18 inches.
Freeways	No flow encroachment is allowed.	Refer to CDOT Roadway Design Manual

**NOTE:** Flow encroachment shall not extend beyond property lines.

## (C) Hydraulic Street Capacity

- (1) **Allowable Capacity - Minor Storm:** ~~(a) ———~~ The allowable minor storm capacity of each street section is to be calculated using the modified Manning's formula as follows: described in the UDFCD Drainage Criteria ManualUSDCM.

$$Q = (0.56) (z/n) S^{1/2} y^{8/3}$$

Where Q = Discharge in Cubic Feet Per Second

z = 1/S<sub>x</sub> Where S<sub>x</sub> is the Cross Slope of the Pavement (ft/ft)

y = Depth of Flow at Face of Curb (Feet)

S = Longitudinal Grade of Street (ft/ft)

n = Manning's Roughness Coefficient

- (b) A nomograph for this equation has been developed and is included in Figure 7-10, "Nomograph for Flow in Triangular Gutters," of these Standards. The graph is applicable for all gutter configurations.
  - (c) An "n" value of 0.016 shall be used for all calculations involving street runoff. The allowable gutter capacity shall be adjusted by applying a reduction factor to account for various street conditions that decrease the street capacity. These conditions include street overlays, parked vehicles, debris and hail accumulation, and deteriorated pavement. The reduction factor also is used to minimize damaging gutter flow velocities. These factors are determined by the curves in Figure 7-11, "Gutter Capacity Reduction Curves," of these Standards. The allowable gutter flow calculated with the reduction factor shall be used in the drainage system design calculations.
  - (d) The allowable gutter capacity was computed using a symmetrical street section. Therefore, the allowable gutter capacity will need to be reduced for non-symmetrical street sections. If critical capacity areas exist on a non-symmetrical street, then individual street capacity calculations of these areas shall be submitted as part of the system design.
- (2) **Allowable Capacity - Major Storm:** The allowable street capacity for the major storm shall be calculated using Manning's formula, dividing the street cross section into the pavement area and sidewalk/grass area, and computing individual flow contributions. An "n" value of 0.016 for pavement and 0.035 for the sidewalk/grass area shall be used.

## (D) Cross Street Flow

The standards outlined in Table 7-67, "Allowable Cross Street Flow," of these Standards, shall be used for allowable cross-street flow, where flow passes from one side of the street to the other. The allowable cross-street flow shall be determined using the methods prescribed in the preceding sections, based on the design storm being considered; however, the gutter slope variable should be replaced with the cross-street water surface slope. UDFCD Drainage Criteria Manual USDCM.

FIGURE 7.10  
NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS

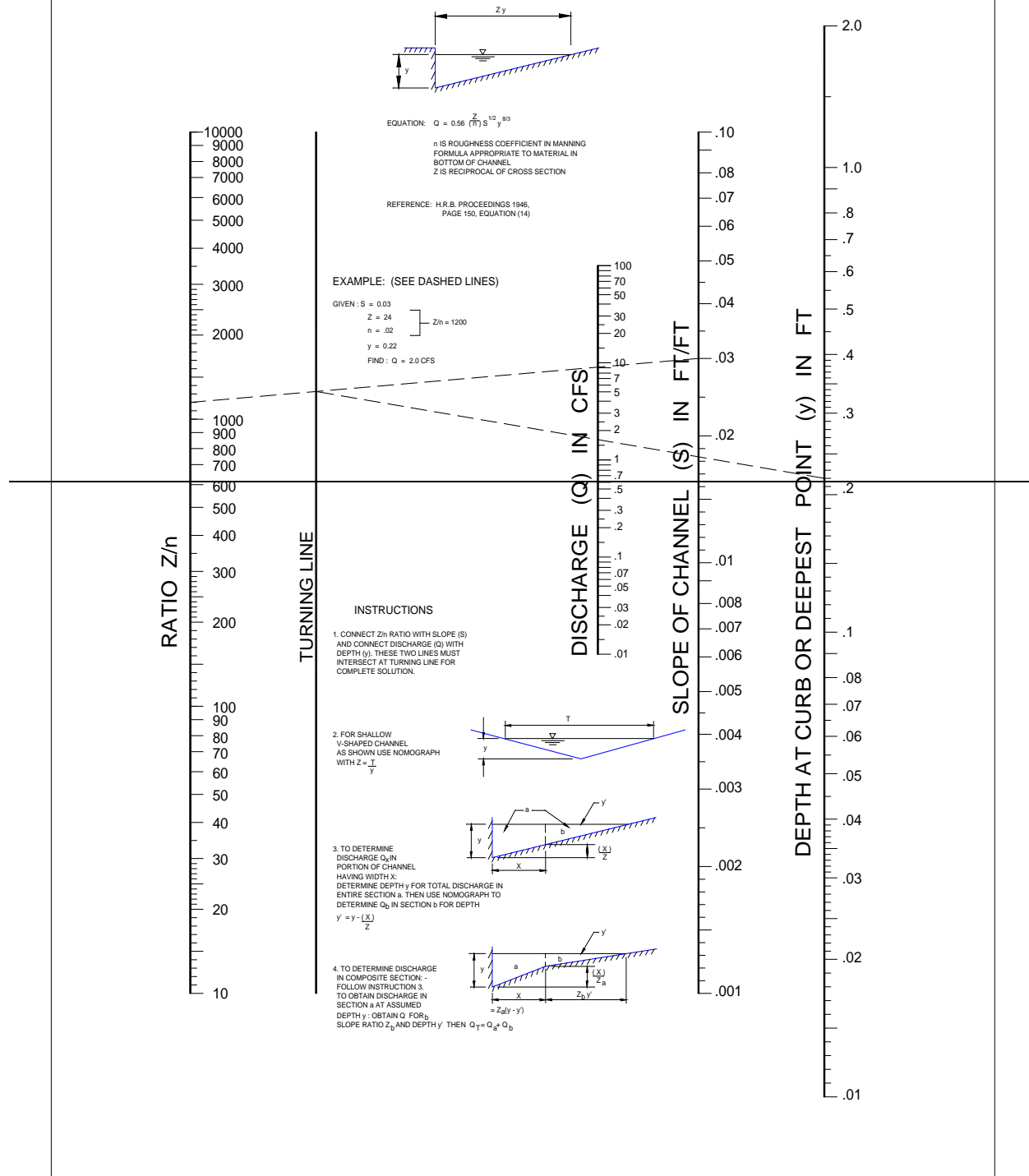
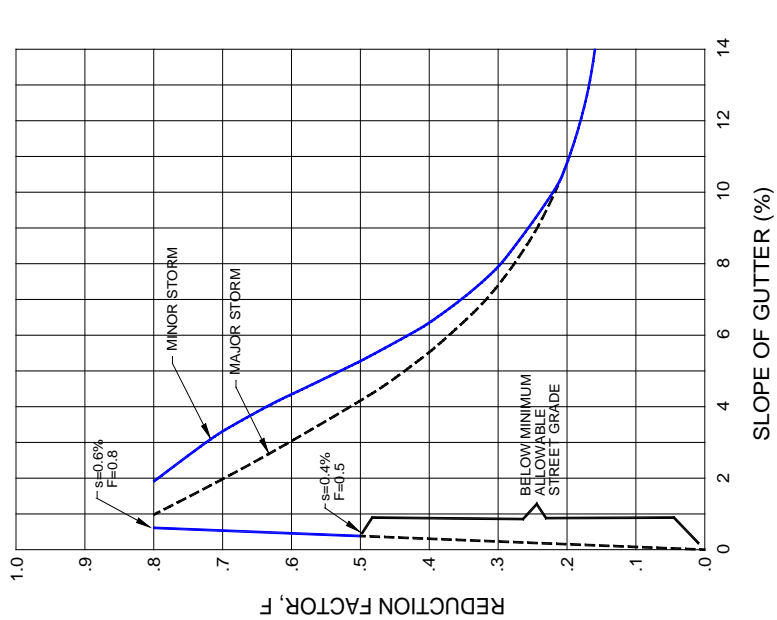
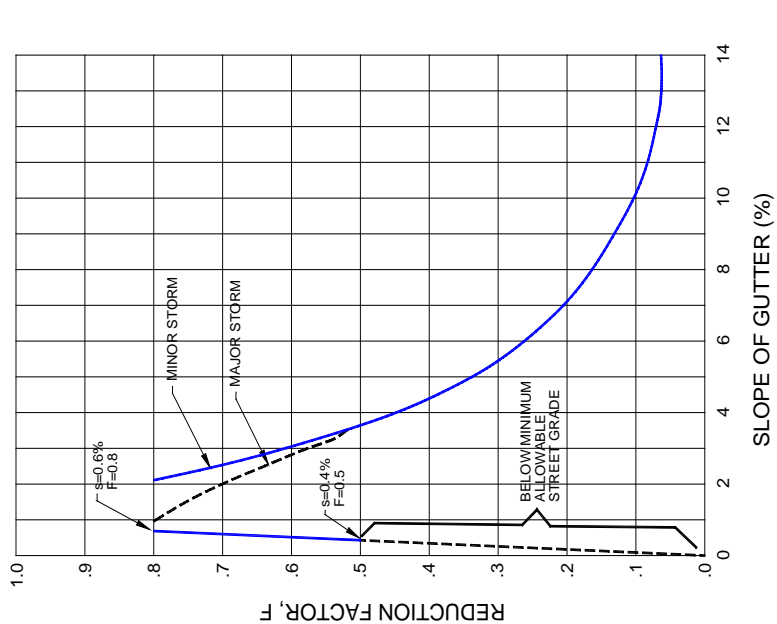


FIGURE 7-11  
GUTTER CAPACITY REDUCTION CURVES



REDUCTION FACTOR FOR ALLOWABLE GUTTER CAPACITY  
LOCAL AND COLLECTOR STREETS

APPLY REDUCTION FACTOR FOR APPLICABLE SLOPE TO THE THEORETICAL GUTTER  
CAPACITY TO OBTAIN ALLOWABLE GUTTER CAPACITY APPROACHING ARTERIAL STREET



REDUCTION FACTOR FOR ALLOWABLE GUTTER CAPACITY  
WHEN APPROACHING AN ARTERIAL STREET

APPLY REDUCTION FACTOR FOR APPLICABLE SLOPE TO THE THEORETICAL GUTTER  
CAPACITY TO OBTAIN ALLOWABLE GUTTER CAPACITY APPROACHING ARTERIAL STREET

**Table 7-67: Allowable Cross Street Flow**

Street Classification	Minor Storm Runoff	Major Storm Runoff
Residential and Local Street	Maximum Depth of 6 Inches in Cross Pan	Maximum Depth of 18 Inches Above Flowline
Collector Street	Where Allowed, Maximum Depth of 6 Inches in Cross Pan	Maximum Depth of 18 Inches Above Flowline
Arterial	Not Allowed	Maximum Depth of 6 Inches Over Street Crown

## 7.11 Culverts

### (A) System Design

- (1) **Required:** Culverts shall be provided for the conveyance of ~~storm water~~ stormwater runoff under a roadway, railroad, driveway, or other crossings of an open drainage system (such as a drainageway or roadside swale). The size, shape, and type of culvert crossings shall be based on the projected runoff volumes, as well as existing topographic conditions. All culvert designs are subject to approval by the Director.
- (2) **Culvert Types:** Typical culvert types include circular, elliptical, or arch pipe sections, and reinforced concrete box culverts.

### (B) Hydraulic Design

All culverts shall be designed ~~using the form presented in Figure 7-12, "Design Computation Form for Culverts," of these Standards. The procedures and basic design methods to be applied are in accordance with the UDFCD Drainage Criteria Manual~~ USDCM. All culvert designs are to include an analysis to determine whether inlet or outlet control conditions govern for both major and minor storm runoff conditions. ~~The following procedure is to be applied:~~

- (1) ~~Compile design data, including design discharge, allowable headwater, and proposed culvert cross section (to determine slope, length, flowline and velocity).~~
- (2) ~~Design culvert assuming inlet control, using trial culvert type and size. Apply the proper design nomographs and repeat until the allowable headwater condition is achieved.~~
- (3) ~~Design culvert assuming outlet control, beginning with the adequate culvert design for inlet control. Compute H (Head) from the proper design nomograph and TW (Tail Water) from open channel hydraulics to determine HW (Headwater). The HW must satisfy the allowable headwater conditions.~~
- (4) ~~Design appropriate outlet protection based on outlet velocity and tail water depth.~~

PROJECT: \_\_\_\_\_

DESIGNER: \_\_\_\_\_

DATE: \_\_\_\_\_

HYDROLOGIC AND CHANNEL INFORMATION

$Q_1 = \text{TAILWATER ELEVATION} = \text{_____}$

$Q_1 = \text{TAILWATER ELEVATION} = \text{_____}$

$\left( \begin{array}{l} Q_1 = \text{DESIGN DISCHARGE, SAY } Q_{25} \\ Q_2 = \text{CHECK DISCHARGE, SAY } Q_{50} \text{ OR } Q_{100} \end{array} \right)$

EL \_\_\_\_\_

HW \_\_\_\_\_

EL \_\_\_\_\_

SKETCH  
STATION: \_\_\_\_\_

$\delta = \text{_____}$

$L = \text{_____}$

EL. \_\_\_\_\_

TW \_\_\_\_\_

MEAN STREAM VELOCITY =  $\frac{L}{100s} = \text{_____}$

MAX. STREAM VELOCITY =  $\text{_____}$

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT		OUTLET CONTROL HW = $H + h_0 + L_s$						CHART					
			$\frac{HW}{D}$	Hw	$K_c$	H	$d_c$	$\frac{c_c + D}{2}$	$h_0$	$L_s$	Hw	No.				
SUMMARY & RECOMMENDATIONS:																

FIGURE 7-12: DESIGN COMPUTATION FORM FOR CULVERTS

**(C) Structural Design**

The structural design of culverts shall conform to accepted structural engineering practices, the Colorado Department of Transportation design standards and standard specifications, any methods and criteria recommended by the manufacturer for a specific culvert type, and for conditions found at the construction site. As a minimum, all culverts shall be designed to withstand an AASHTO HS-20 traffic loading.

**(D) Specifications****(1) Size**

- (a) Culvert design size shall be based upon the following:

- (i) Runoff volumes for the appropriate design storm.
- (ii) Required capacity based on roadway classification and allowable street overtopping, as prescribed in Section 7.10, "Street Drainage," of these Standards

- (b) Culverts shall be at least 18 inches in diameter or height, ~~with the exception of driveway culverts along roads with roadside drainage swales, which shall be at least 12 inches in diameter or height.~~

**(2) Inlet and Outlet Sections**

- (a) All culverts shall be designed with headwalls and wingwalls, or flared end sections at the inlet and outlet. Flared end sections are allowed only on pipe culverts with diameters of 42 inches (or equivalent) or less.
- (b) Erosion protection, such as rip-rap, boulder energy dissipators, or adequate vegetation, shall be provided at the inlet or outlet where required to mitigate potential scouring or erosive flow conditions. The Engineer shall propose the erosion protection to be used, subject to approval by the Director.

**(3) Slope and Velocity**

- (a) Culvert slopes shall be designed so that neither silting nor excessive velocities resulting in scour can occur. The minimum design velocity for minor storm conditions shall be 2 feet per second, to provide for self-cleansing of the culvert.
- (b) The maximum culvert velocity is dictated by the channel conditions at the outlet, and the amount of erosion protection or energy dissipation that can be provided to prevent scour or damage.

**(4) Allowable Headwater**

- (a) The maximum headwater / diameter (HW/D) ratio for the 100-year design flows shall be 1.5, and 1.0 for the 10-year design flow. These HW/D ratios are to be applied to culverts at street crossings, and should not be applied to outlets from detention ponds or private driveways.
- (b) Ponding above the top of a culvert is not permitted if such ponding could potentially cause property or roadway damage, culvert clogging, saturation of critical embankments, detrimental debris deposition, erosion, or inundation of existing or future utilities, structures, or buildings.

**(5) Trash Racks**

- (a) The installation of a trash rack over a culvert entrance shall be provided as required

by the Director where there exists the potential for debris clogging of the culvert or where there is a safety hazard concern for the possibility of people (especially children) being carried into the culvert.

- (b) Trash racks shall be designed to maintain adequate culvert hydraulics, considering the potential for debris buildup and blockage which may render the culvert ineffective. Careful design considerations are to be applied, including without limitation application of the following standards:
  - (i) Materials: All trash racks shall be constructed with smooth steep pipe, having an outside diameter of at least 1 ¼ inches. Trash rack ends and bracing shall be constructed with steel angle sections. All trash rack components shall have a corrosion protective finish.
  - (ii) Design: Trash racks shall be designed without cross-braces, to minimize debris clogging, and be able to withstand the full hydraulic load of a completely plugged trichroic based on the highest anticipated depth of ponding. The trash rack shall be hinged and removable for maintenance purposes.
  - (iii) Bar Spacing: Bar spacing shall provide a maximum clear opening of 6 inches. The longitudinal slope of the trash rack shall be no steeper than 3:1, horizontal to vertical. The entire trash rack shall have a clear opening at least three times the culvert opening area.
- (c) Hydraulics: Use the following equation to compute hydraulic losses through trash racks:

$$H_T = 0.11 * (TV/D)^2 * (\sin A)$$

Where:  $H_T$  = Head Loss through the Trichroic (feet)  
 T = Thickness of Trichroic Bar (inches)  
 V = Velocity normal to Trichroic (fps)  
 D = Center-to-Center Spacing of Bars (inches)  
 A = Angle of Inclination of Trichroic with Horizontal

The velocity normal to the trichroic shall be computed considering the rack to be 50 percent plugged.

## 7.12 Detention

### (A) System Design

- (1) **Intent:** Detention ponding facilities are intended to store increased runoff from developed property and release this runoff at the historic rate that existed prior to development or redevelopment. By providing detention ponding, increased runoff impacts on downstream facilities may be controlled and minimized to reduce potential damages and the need for greatly expanded ~~storm water~~stormwater conveyance facilities.
- (2) **Requirements:** Detention ponding for ~~storm water~~stormwater shall be provided for all new development or redevelopment where the runoff coefficient for the site increased unless one of the following conditions are met:
  - (a) The project site is a , other than single-family lots or a single-family lot split into two single-family lots that are is not part of a larger development, and subdivisions of one



~~single family lot into two single family lots where the runoff coefficient for the site is increased, unless~~

- (b) ~~Runoff for the project site for the initial and major storm events from the entire tributary basin can be conveyed directly to the major drainage system without adverse impact on upstream, surrounding, or downstream properties and facilities and storm waterstormwater detention to meet water quality mitigation measures is not required.~~
- (3) **Maintenance:** The property owner shall be responsible for maintaining ~~storm waterstormwater~~ detention facilities.
- (4) **Easement:** All stormwater detention facilities shall be located in a public easement. The easement shall grant to the City at a no charge a permanent right to inspect, maintain, and reconstruct the stormwater detention facilities. The easement shall be granted on a form provided by the Director. No owner of land or other applicant shall obtain a Final Drainage Plan, unless the owner first grants to the City the easement for all stormwater detention facilities. The City shall have no obligation to the property owner to inspect, maintain, or reconstruct the stormwater facilities.

## (B) Design Frequency, ~~Release Rates~~Hydraulic Design, and Storage Requirements

- (1) **Design Storms:** ~~Detention ponds shall be designed for the initial and major design storms, as a combined facility, and shall satisfy the separate storage and release conditions for each storm event. The design release rates shall be restricted such that runoff from the entire parcel and tributary basin to be developed or redeveloped does not exceed the maximum runoff, or historic runoff, for the initial and major storm that occurred prior to the proposed development or redevelopment. Where existing downstream facilities have been designed for a storm with a lesser frequency than required by this document, additional storage may be required to maintain historic release rates during that lower frequency storm event in accordance with USDCMDrainage Criteria Manual, Volume 2, Chapter 12.~~
- (2) **Storage Volume:** The storage volume of runoff to be detained on-site shall be sized to contain 110 percent of the difference between the historic runoff and the ~~initial and~~ initial and major storm ~~runoff, as defined in Table 7-1, runoff~~ projected for the ultimate developed conditions of the entire parcel and tributary basin to be developed or redeveloped.
- (3) **Undetained Site Releases:** On project sites where runoff from portions of the site cannot be detained due to topography or site conditions, free release of runoff may be approved with compensating detention storage design subject to the following conditions:
  - (a) Total maximum runoff from the entire parcel and tributary basin to be developed or redeveloped shall not exceed the historic runoff,
  - (b) Release rates from the detention ponds shall be reduced by the developed runoff rate from the undetained drainage area,
  - (c) The undetained drainage area may not exceed five percent of the entire parcel and tributary basin to be developed or redeveloped, and
  - (d) The release rate from the undetained area may not exceed 25 percent of the historic release rate from the entire parcel and tributary basin to be developed or redeveloped.

**(C) Hydraulic Design**

- (1) ~~**Required Storage Analysis – Basins Under 160 Acres:**~~ An analysis of the storage required for each detention pond shall be performed using a routed hydrograph method. Simplified routing techniques using the Rational Method, such as the triangular hydrograph, trapezoidal hydrograph, or the procedure presented in “Airport Drainage,” prepared by the Federal Aviation Agency, and outlined in Section 5.1, “Rational Method Analysis,” UDFCD Storm Drainage Criteria manual, are to be used for all basins smaller than 160 acres.
- (2) ~~**Required Storage Analysis – Basins Over 160 Acres:**~~ The CUHP method, outlined in Section 5.2, “CUHP Storage Analysis,” UDFCD Storm Drainage Criteria manual, is to be used for basins 160 acres or larger.
- (3) ~~**Single or Multiple Pond Design:**~~ The routed hydrograph method allows for designing detention systems as single ponds, multiple ponds, or multiple consecutive ponds for the entire parcel and tributary basin. Where multiple consecutive ponds are designed, flexibility may be applied to upper stage ponds in sizing and release rates to address site constraints, creative storm system layouts, and reductions in size of the final stage detention pond, subject to restricting the release rate from the final stage pond to the historic runoff rate for the entire parcel and tributary basin to be developed or redeveloped.
- (4) ~~**Undetained Site Releases:**~~ On certain parcels to be developed or redeveloped where runoff from portions of the site can not be detained due to topography or site conditions, free release of runoff may be approved with compensating detention storage design subject to the following conditions:
  - (a) ~~Total maximum runoff from the entire parcel and tributary basin to be developed or redeveloped shall not exceed the historic runoff,~~
  - (b) ~~Release rates from the detention ponds shall be reduced by the developed runoff rate from the undetained drainage area,~~
  - (c) ~~The undetained drainage area may not exceed five percent of the entire parcel and tributary basin to be developed or redeveloped, and~~
  - (d) ~~The release rate from the undetained area may not exceed 25 percent of the historic release rate from the entire parcel and tributary basin to be developed or redeveloped.~~

**(C) Detention Pond Design**

Except where inconsistent with the requirements in this Subsection 7.12(C), detention pond design shall follow all applicable criteria established in the USDCM, Volume 2 and Volume 3.

- (1) **Surface Ponding Required:** All detention ponds shall be provided as open, surface grade improvements. Underground, enclosed, or roof top detention ponds shall not be permitted unless unusual site conditions and adequate detention performance and maintenance conditions are approved by the Director.
- (2) **Location:** Detention ponds shall be located ~~wherever possible~~ in open, pervious landscaped areas to enhance site drainage and soil percolation, and to improve water quality. ~~Detention ponds located in parking lots are not encouraged given the potential for inconveniences, hazards, and damages resulting from possible water and ice buildup in public parking areas. Where detention ponding is provided in parking areas, signs meeting the standards for traffic signage shall be posted to notify users that the area is subject to ponding during rainfall events. Detention ponding provided in parking lots shall be designed so as not to exceed a depth of 12 inches.~~

- (3) **Side Slopes:** Side slopes for detention ponds shall be designed to provide for ease of maintenance and access. Landscaped side slopes are not to exceed 4:1, and vertical or steep walls used as side slopes are to be constructed of durable natural materials, such as rock or timber, with heights no greater than 30 inches to reduce safety hazards.
- (4) **Pond Bottoms:** Pond bottoms are to be pervious and sloped to prevent the collection of standing water, unless a permanent pond or wetland bottom is provided for water quality enhancements. The use of combined water quality and detention facilities shall follow criteria specification provided in the USDCM, Volume 3, Chapter 12 and applicable water quality treatment approach criteria as specified in Section 7.17 of these Standards. Hard-lined trickle channels are not to be constructed in detention ponds unless approved by the Director to address specific drainage problems or safety and environmental hazards.

## **(E) — Outlet Design**

### **(1) — Outlet Hydraulic Design**

Hydraulic design data for sizing detention ponding outlets is as follows:

#### **(a) — Weir Flows**

- (i) — Weir flow outlet design is to be calculated using the following equation:

$$Q = CLH^{3/2}$$

Where: Q — = Discharge (cubic feet per second)

— C — = Weir Coefficient (Refer to Figure 7.13, "Weir Flow Coefficients," of these Standards)

— L — = Horizontal Length (feet)

— H = — Total Energy Head (feet)

- (ii) — A "V" notch weir may also be used as calculated using the following equation:

$$Q = 2.5 \tan(A/2) H^{5/2}$$

Where: Q — = Discharge (cubic feet per second)

— A — = Angle of the Notch at the Apex (degrees)

— H — = Total Energy Head (feet)

- (iii) — When designing or evaluating weir flow, the effects of submergence should be considered.

- (b) — **Orifice Flow:** Orifice flow outlet design is to be calculated using the following equation:

$$Q = C_d A (2gh)^{1/2}$$

Where: Q — = Discharge (cubic feet per second)

—  $C_d$  — = Orifice coefficient (0.65 for "Square-Edged" entrance conditions)

— A — = Orifice Area (ft<sup>2</sup>)

— g — = Gravitational Constant (32.2 ft/sec<sup>2</sup>)

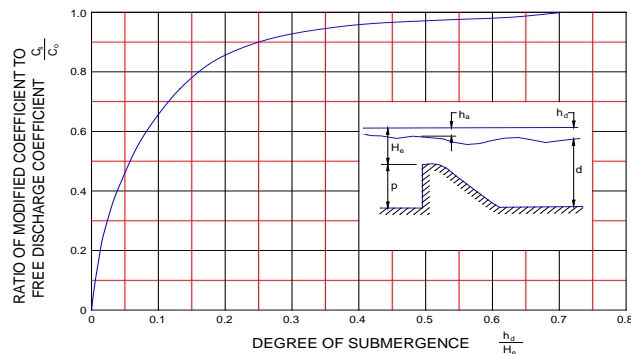
— h — = Head on Orifice measured from Centerline of Orifice (feet)

- (2) — **Placement:** All outlets for detention ponds, not including water quality ponds or portions of combined ponds, shall be placed at a location and elevation to ensure draining of the required detention storage volume within 24 hours of a storm event.

- (5) Overflow Release Feature:** All detention ponds shall include an overflow release feature to spill during storm events larger than the major design storm or when release outlets fail. This feature shall be designed to release overflows in a direction and manner that will not adversely affect properties downstream of the detention pond.

FIGURE 7-13: WEIR FLOW COEFFICIENTS

SHAPE	COEFFICIENT	COMMENTS	SCHEMATIC
SHARP CRESTED	-		
PROJECTION RATIO (H/P=0.4)	3.4	H<1.0	
PROJECTION RATIO (H/P=2.0)	4.0	H>1.0	
BROAD CRESTED	-		
W/SHARP U/S CORNER	2.6	MINIMUM VALUE	
W/ ROUNDED U/S CORNER	3.1	CRITICAL DEPTH	
TRIANGULAR SECTION	-		
A) VERTICAL U/S SLOPE	-		
1:1 D/S SLOPE	3.8	H>0.7	
4:1 D/S SLOPE	3.2	H>0.7	
10:1 D/S SLOPE	2.9	H>0.7	
B) 1:1 U/S SLOPE	-		
1:1 D/S SLOPE	3.8	H>0.5	
3:1 D/S SLOPE	3.5	H>0.5	
TRAPEZOIDAL SECTION			
1:1 U/S SLOPE, 2:1 D/S SLOPE	3.4	H>1.0	
2:1 U/S SLOPE, 2:1 D/S SLOPE	3.4	H>1.0	
ROAD CROSSINGS			
GRAVEL	3.0	H>1.0	
PAVED	3.1	H>1.0	



ADJUSTMENT FOR TAILWATER

REFERENCE: KING & BRATER, HANDBOOK OF HYDRAULICS, MC GRAW HILL BOOK COMPANY, 1963 - DESIGN OF SMALL DAMS, BUREAU OF RECLAM., 1977

## 7.13 Storm Water Quality Best Management Practices

### (A) Required

All development is required to utilize storm water quality management practices to reduce the impacts on receiving waters. Additionally, the City is an operator of a Phase II regulated small Municipal Separate Storm Sewer System (MS4) and is required by the State of Colorado to hold a permit to discharge storm water. In order to comply with the permit, all development which disturbs 1 acre of land or more must meet additional requirements.

**(B) Erosion Control Measures**

- (1) **Storm water Management Plan (SWMP):** Prior to any construction activity disturbing ~~1~~ acre of land or more, a City approved SWMP and a Storm Water Permit for Construction Activity application from the Colorado Department of Public Health and Environment (CDPHE) are required. The SWMP shall be prepared in accordance with the CDPHE requirements for “Contents of the Storm water Management Plan” and the UDFCD’s Urban Storm Drainage Criteria Manual, Volume 3, “Best Management Practices” (UDFCD Drainage Criteria Manual). Storm water quality management and erosion control measures are to be constructed and maintained in accordance with the SWMP and the UDFCD Drainage Criteria Manual.
- (a) The Operator will be required to have the SWMP on site at all times and shall be prepared to respond to maintenance of specific BMP’s.
  - (b) The Operator shall inspect all BMP’s at least every 14 days and within 24 hours after any precipitation or snow melt event that causes surface runoff. ~~Effective March 30, 2005,~~ inspections of BMP’s shall be conducted by an individual who has successfully completed formal training in erosion and sediment control by an organization acceptable to the Director of Public Works. A certification of successful completion of such training shall be provided upon request.
  - (c) The Operator shall amend the SWMP whenever there is a change in design, construction, operation, or maintenance, which has an effect on the potential for discharge of pollutants to the MS4 or receiving waters, or if the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in storm water discharges associated with construction activities.
  - (d) Records of inspection are to be maintained on site with the SWMP. Inspection records are to be available at the project site at all times and shall be made available to the City upon request.
  - (e) Prior to commencement of work, all general contractors, subcontractors and utility agencies shall obtain and comply with the approved, current SWMP for the project.
- (2) **Storm Water Quality and Erosion Control Plan:** The Director of Public Works may require the preparation of a Storm Water Quality and Erosion Control Plan in order to assess the impacts of any project or development not required to submit a SWMP. Best Management Practices (BMP’s) in accordance with the UDFCD Drainage Criteria Manual shall be applied to ensure that downstream properties and drainage ways will not be adversely impacted by site development and construction activities.
- (3) **Preparation Standards:** Design of both the SWMP in section (1) above and the Storm Water Quality and Erosion Control Plan in section (2) above shall include the following elements:
- (a) Protection for adjacent properties (including public right of way) from erosion and/or sediment deposition.
  - (b) Protection for public streets from the deposit of sediment from runoff or vehicles tracking mud.
  - (c) Stabilization for all disturbed areas as defined in the UDFCD Drainage Criteria Manual.
  - (d) Protection for all storm sewer inlets from the entry of sediment laden water.
  - (e) Long term stability of cut and fill slopes and the successful establishment of

~~permanent vegetative cover on exposed soil.~~

(f) ~~The following standard notes:~~

(i) ~~“All temporary erosion control facilities shall be installed before any construction activities take place”.~~

(ii) ~~“Solid waste, industrial waste, yard waste and any other pollutants or waste on any construction site shall be controlled through the use of BMP’s. Waste and/or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waste that may blow, wash or otherwise be released from the site is prohibited. Sanitary waste facilities shall be provided and maintained by the owner or contractor”.~~

(iii) ~~“Ready mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying it, shall be contained on construction sites for proper disposal. Release of these materials is prohibited”.~~

(iv) ~~“Cover shall be applied within 14 days to inactive soil stockpiles, and shall be maintained for stockpiles that are proposed to remain in place longer than 30 calendar days”.~~

(v) ~~“BMP’s shall be implemented to prevent the release of sediment from construction sites. Vehicle tracking of mud shall not be allowed to enter the storm water system or waters of the State. Sediment tracked onto public streets shall be removed.~~

(vi) ~~“Techniques shall be used to prevent dust, sediment or debris blowing from the site”.~~

(vii) ~~“Storm water discharges from construction activities shall not cause or threaten to cause pollution, contamination or degradation of waters of the State”.~~

(viii) ~~“All earth disturbances shall be designed, constructed and completed to limit the exposed area of any disturbed land to the shortest possible period of time”.~~

(ix) ~~“Bulk storage structures for petroleum products and other chemicals shall have adequate protection so as to contain all spills and prevent any spilled material from entering the storm water system or waters of the State”.~~

(x) ~~“Any disturbance to temporary and permanent BMP’s shall be repaired or replaced within 48 hours”.~~

(xi) ~~“The property owner and subsequent property owners will be responsible for continued compliance with the requirements of this section, during construction activity on the site”.~~

(xii) ~~“All temporary erosion and sediment control measures shall be removed and disposed within 30 days after final site stabilization is achieved, or after the temporary measures are no longer needed, whichever occurs first”.~~

## **(C) ~~Permanent Storm Water Quality Management~~**

~~The UDFCD Drainage Criteria Manual shall be applied to address permanent storm water quality management and erosion control for all proposed projects and developments.~~

- (1) ~~All proposed projects and developments, including single family residential homes shall “Minimize Directly Connected Impervious Areas” in accordance with the UDFCD Drainage Criteria Manual.~~
- (2) ~~All proposed projects and developments, other than single family lots that are not part of a larger development, shall provide Water Quality Capture Volume and a Water Quality Outlet in accordance with the UDFCD Drainage Criteria Manual unless other storm water quality facilities are approved by the Director. Projects and developments that disturb less than 1 acre of land and do not increase the impervious area or runoff shall provide storm water quality facilities to the extent practicable.~~
- (3) ~~Where detention pond facilities for the major and minor storm event are designed as combined facilities, the total volume for the minor storm shall be the required minor storm volume plus the required Water Quality Capture Volume. The total volume for the major storm shall be the full 100-year detention volume plus one-half the Water Quality Capture Volume.~~
- (4) ~~All projects and developments shall utilize “Industrial and Commercial Best Management Practices” as defined in the UDFCD Drainage Criteria Manual.~~

#### **(D) Maintenance**

The property owner shall be responsible for maintaining permanent storm water quality facilities. Maintenance shall be as recommended by the UDFCD Drainage Criteria and shall be performed such that the design properties of the facility are preserved.

### **7.13 Construction Stormwater Management**

#### **(A) Intent**

This section implements requirements of Section 11-5-6, “Stormwater Quality Management for Land Development,” B.R.C. 1981, for construction activities and sets standards for stormwater management plans (SWMP) and erosion control plans, their implementation, and the inspection and maintenance of control measures for erosion and sediment control.

#### **(B) Stormwater Management Plan Requirements**

A SWMP shall include a narrative and erosion control plans that identify the construction activities and their associated potential pollutant sources and address the selection, installation, implementation, and maintenance of control measures for erosion and sediment control that reduce the potential for the pollutant sources to enter the stormwater utility system or waters of the State. Control measures for erosion and sediment control shall prevent pollution and degradation of waters of the State. The SWMP shall include and be prepared, updated, and implemented consistent with the following requirements:

- (1) **General Standards:** Control measures for erosion and sediment control shall be constructed and maintained in accordance with the SWMP, the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE, and the USDCM, Volume 3.
- (2) **Preparation Standards:** The SWMP shall be prepared in accordance with the requirements of the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE and USDCM, Volume 3. The SWMP shall be prepared in accordance with methods, procedures, and practices that are based on scientific



facts, reflect best industry practices and standards, are appropriate for the conditions and pollutant source, and provide appropriate solutions to meet the SWMP requirements of this section, including practice based and numeric effluent limits. The SWMP shall include the following elements:

- (a) Protection for adjacent properties (including public right-of-way) from erosion and/or sediment deposition.
- (b) Protection for public streets from the deposit of sediment from runoff or vehicles tracking mud.
- (c) Stabilization for all disturbed areas as defined in the USDCM and CDPS requirements.
- (d) Protection for all storm sewer inlets from the entry of sediment-laden water.
- (e) Protection from encroachment by construction equipment, vehicles, and foot traffic into stormwater infiltration measures to eliminate the possibility of soil compaction and vegetation damage.
- (f) Long-term stability of cut and fill slopes and the successful establishment of permanent vegetative cover on exposed soil.
- (g) Selection, installation, implementation, and maintenance of control measures for erosion and sediment control.

**(3) Control Measures for Erosion and Sediment Control and Potential Pollutant Sources:**

All control measures for erosion and sediment control shall meet the following requirements:

- (a) Control measures for erosion and sediment control shall be installed and made operational prior to the start of construction activity. The control measures for erosion and sediment control shall prevent potential pollutants from leaving the construction site during each phase of construction and shall be continued through final stabilization. Structural control measures for erosion and sediment control shall be maintained in operational condition through final stabilization.
- (b) Control measures for erosion and sediment control shall be selected, designed, installed, implemented, and maintained to prevent potential pollutants such as, but not limited to, sediment, construction site waste, trash, discarded building materials, concrete truck washout, chemicals, sanitary waste, and contaminated soils in discharges to the stormwater utility system from leaving the construction site.
- (c) The SWMP shall address pollutant sources associated with the following activities (if part of the construction activity), and control measures for erosion and sediment control shall be implemented if the source is determined to be present on the site:
  - (i) Land disturbance and soil storage.
  - (ii) Vehicle tracking.
  - (iii) Loading and unloading operations.
  - (iv) Outdoor storage of construction site materials, building materials, fertilizers, and chemicals.
  - (v) Bulk material storage.
  - (vi) Vehicle and equipment maintenance and fueling.

- (vii) Significant dust or particulate-generating processes,
  - (viii) Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, and/or oils,
  - (ix) Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment,
  - (x) Dedicated asphalt and concrete batch plants,
  - (xi) Other areas or operations where spills can occur, and
  - (xii) Other non-stormwater discharges including construction dewatering not covered under the CDPS General Permit for Construction Dewatering Discharges and wash water that may contribute pollutants to the stormwater utility system.
  - (d) The SWMP shall include control measures for erosion and sediment control detail drawings for both installation and maintenance. Controls measures should be consistent with USDCM, Volume 3 or Colorado Department of Transportation M & S (Miscellaneous and Signage) Standard Plans.
  - (4) **Protection of Control Measures for Post-Construction Water Quality:** Requirements for the design and construction of control measures for post-construction water quality are provided in Sections 7.14 through 7.18 of these Standards. The SWMP shall provide provisions to protect the water quality functions of these control measures for post-construction water quality (SCMs) during construction as listed below:
    - (a) Any area consisting of native, un-compacted soil where a SCM will be installed shall be protected from vegetation removal and encroachment by heavy equipment, vehicles, and foot traffic prior to grading and construction. If the area, prior to grading and construction, consists of previously compacted or fill soil, protection from encroachment shall be provided after the soil has been amended or otherwise rehabilitated into an un-compacted condition to promote infiltration of stormwater. Methods and controls for protection of these areas shall be indicated in the SWMP.
    - (b) The use of the SCM area for construction or maintenance materials stockpiles or for storage of construction equipment, wastes, or pollutants is prohibited after construction of the SCM has commenced.
  - (5) **Erosion Control Plan:** The SWMP shall include an Erosion Control Plan. Erosion Control Plan drawings shall locate and identify all structural and non-structural control measures for erosion and sediment control for the proposed construction activities. The Erosion Control Plan shall be prepared in accordance with the requirements of the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE and include the elements listed in form(s) provided by the Director. Erosion Control Plans shall include, at a minimum, three site maps illustrating the initial, interim, and final phases of construction and their associated control measures for erosion and sediment control.
- The following Standard Notes shall also be included on Erosion Control Plan(s):
- (a) Temporary Erosion Controls: All temporary erosion control measures for erosion and sediment control shall be installed before any construction activities take place.
  - (b) Sediment Controls: Control measures for erosion and sediment control shall be implemented to prevent the release of sediment from construction sites. Vehicle tracking of sediment shall not be allowed to enter the stormwater utility system or

waters of the State. Sediment shall not be tracked onto public streets and, if so, shall be immediately removed.

- (c) Water Quality Impacts: Stormwater discharges from construction activities shall not cause or threaten to cause pollution, contamination, or degradation of waters of the State.
- (d) Waste Controls. Solid waste, industrial waste, yard waste, and any other pollutants or waste on any construction site shall be controlled using control measures. Waste and/or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waste that may blow, wash, or otherwise be released from the site is prohibited. Sanitary waste facilities shall be provided and maintained by the owner or contractor.
- (e) Concrete Waste: Ready-mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying it, shall be contained with appropriate control measures and ultimately removed for proper disposal. Release of these materials is prohibited.
- (f) Chemical Storage: Bulk storage structures for petroleum products and other chemicals shall have adequate protection so as to contain all spills and prevent any spilled material from entering the stormwater utility system or waters of the State.
- (g) Surface Cover Timing: Cover shall be applied within 14 days to inactive soil stockpiles and shall be maintained for stockpiles that are proposed to remain in place longer than 30 calendar days.
- (h) Project Phasing: All earth disturbances shall be designed, constructed, and completed to limit the exposed area of any disturbed land to the shortest possible period of time.
- (i) Dust Controls: Techniques shall be used to prevent dust, sediment, or debris from blowing off the site.
- (j) Maintenance: Any damage or required maintenance to temporary and permanent controls measures shall be repaired or replaced as soon as possible, immediately in most cases.
- (k) Removal: All control measures for erosion and sediment control shall be removed and disposed within 30 days after final site stabilization is achieved or after the temporary measures are no longer needed, whichever occurs first.
- (l) Responsibility: The erosion control permittee shall be responsible for continued compliance with the requirements of Section 7.13 of the City's Design and Construction Standards during construction activity on the site.

## **(C) Inspection and Maintenance Requirements**

The erosion control permittee shall be responsible for implementation of the SWMP or, if no SWMP is required, the Erosion Control Plan during construction, including inspection and maintenance of the control measures for erosion and sediment control in the approved SWMP and/or Erosion Control Plan. Prior to commencement of work, the erosion control permittee shall ensure that all general contractors, subcontractors, and utility agencies obtain a copy of and comply with the SWMP and/or Erosion Control Plan. The erosion control permittee shall amend the SWMP and/or Erosion Control Plan when site conditions change. The erosion control permittee shall keep the SWMP

and/or Erosion Control Plan on site and shall implement and update the SWMP and/or Erosion Control Plan throughout construction and final stabilization of the site in accordance with the following requirements:

- (1) If no SWMP is required, the erosion control permittee shall update the Erosion Control Plan to show currently implemented control measures for erosion and sediment control and installation dates.
- (2) If a SWMP is required:
  - (a) An initial site inspection by the Director is required prior to commencing construction.
  - (b) The erosion control permittee shall amend the SWMP whenever there is a change in design, construction, operation, or maintenance that affects the potential for discharge of pollutants to the stormwater utility system or receiving waters, or if the SWMP proves to be ineffective in controlling pollutants in stormwater discharges associated with construction activities.
  - (c) The erosion control permittee shall inspect all control measures for erosion and sediment control per the frequency outlined in the General Permit for Stormwater Discharges Associated with Construction Activity issued by the CDPHE for the site. Inspections of control measures for erosion and sediment control shall be conducted by an individual who has successfully completed formal training in erosion and sediment control by an organization acceptable to the Director. The erosion control permittee shall provide a certification of successful completion of such training to the Director upon request.
  - (d) The erosion control permittee shall maintain records of inspection on site with the SWMP. Inspection records shall be available at the site at all times. The erosion control permittee shall make the inspection records immediately available to the Director upon request.

## **7.14 Land Development Planning Using LID Techniques**

### **(A) Intent**

All new development and redevelopment shall reduce pollutant impacts of the development site on receiving waters and reduce or control stormwater volumes by mimicking natural hydraulic conditions using LID techniques. LID techniques seek to minimize impervious areas and protect and create well-draining vegetated areas that promote infiltration and natural hydrologic processes thereby reducing stormwater runoff and pollutant quantities.

### **(B) Requirements for All Developments**

- (1) LID techniques shall be implemented for all new development and redevelopment consistent with the standards in this section.
- (2) Compliance with the requirement to implement LID techniques, including the investigation and analysis of LID techniques and an explanation of the implementation choices made, shall be documented in the Preliminary and Final Drainage Reports when such reports are required. Otherwise, compliance shall be demonstrated in building permit construction documents, on form(s) as provided by the Director, submitted as part of the building permit application.

**(C) LID Techniques**

LID techniques shall be chosen and applied following the principles summarized in this subsection. Additional guidance on employing LID techniques is provided in USDCM, Volume 3, Chapter 1. The following LID techniques shall be investigated and implemented to the maximum extent practicable:

- (1) **Conserve Existing Amenities:** Planning efforts shall account for and, where practicable, preserve or restore existing site features that naturally retain stormwater on site, including vegetated areas, high infiltrating soils, and natural surface drainage patterns, such as meadows and trees.
- (2) **Minimize Impacts:** Planning efforts shall account for and minimize, where practicable, land disturbance, impervious surface addition, and soil compaction. This may include removing unnecessary impervious areas, minimizing driveway and sidewalk widths, and sequencing construction to minimize compacted areas.
- (3) **Minimize Directly Connected Impervious Areas (MDCIA):** Planning efforts shall account for and minimize impervious areas, such as rooftops and pavement, that directly drain to the stormwater utility system or a local stream without prior stormwater control. This may include using or integrating receiving pervious areas into the site landscape, such as vegetated swales and buffers. Where practicable, site drainage patterns shall be designed to promote sheet flow to vegetated area and roof downspouts shall be disconnected from direct discharge to the storm sewer. Receiving pervious areas shall be designed to slow run-off and promote infiltration.

**7.15 Post-Construction Stormwater Quality Requirements****(A) Intent**

All new development and redevelopment shall reduce the pollutant impacts of the development site on receiving waters. All applicable development sites shall implement post-construction stormwater quality management practices.

**(B) Applicable Development Sites**

- (1) **Applicable Development Site:** Applicable development sites are required to implement control measures for post-construction stormwater quality in accordance with the requirements of Chapter 11-5, "Stormwater and Flood Management Utility," B.R.C. 1981, and this section, unless the Director has waived the applicable development site requirements pursuant to Subsection 7.15(B)(2) of these Standards.
- (2) **Waiver:** The Director may waive the requirements for applicable development sites in this section if the applicant demonstrates that the requirement of paragraph (a) of this Subsection 7.15(B)(2) is met and that none of the circumstances described in Subsection 7.15(B)(2)(b)(i) through (vi) exist:
  - (a) One or more of the following criteria is met:
    - (i) **Pavement Management Sites:** The project proposes the rehabilitation, maintenance, and reconstruction of roadway pavement, which includes roadway resurfacing, mill and overlay, white topping, black topping, curb and gutter replacement, concrete panel replacement, and pothole repair. The purpose of the project must be to provide additional years of service life and optimize service and safety. The project must be limited to the

repair and replacement of pavement in a manner that does not result in an increased impervious area, and the infrastructure must not substantially change. The types of projects that meet these criteria include day-to-day maintenance activities, rehabilitation, and reconstruction of pavement. "Roadways" include roads and bridges that are improved, designed, or ordinarily used for vehicular travel and contiguous areas improved, designed, or ordinarily used for pedestrian or bicycle traffic, drainage for the roadway, and/or parking along the roadway. Areas primarily used for parking or access to parking are not roadways, and do not meet these criteria;

- (ii) Roadway Redevelopment: The project is the redevelopment of existing roadway and the project (1) adds less than one acre of paved area per mile of roadway to an existing roadway or (2) does not add more than 8.25 feet of paved width at any location to the existing roadway;
- (iii) Existing Roadway Areas: The project is the redevelopment of existing roadway where the project does not increase the width of the original roadway to two times or more on average. Under this criterion, the applicable development site requirements may not be waived for the entire roadway project but only for the area of the existing roadway. The area of the added new roadway shall be considered an applicable development site;
- (iv) Aboveground and Underground Utilities: The project is the installation or maintenance of underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the construction activity. The types of projects that meet these criteria include, but are not limited to, activities to install, replace, or maintain utilities under roadways or other paved areas that return the surface to the same condition;
- (v) Large Lot Single Family Residential Projects: The project involves single-family residential lots greater than or equal to 2.5 acres in size per dwelling, with a total lot impervious area of less than 10 percent, and that are not part of a common plan of development,
- (vi) Land Disturbance Only Projects: The project involves land disturbance to undeveloped land (land with no structures, such as buildings, and no pavement), and the land will remain undeveloped during and after the disturbance;
- (vii) Stream Stabilization Projects: The project is a stream stabilization project; or
- (viii) Sidewalk, Bicycle and Multi-Use Paths: The project adds, modifies, or maintains public sidewalk, bicycle path or multi-use path. Bike lanes that are a part of a roadway do not meet this criterion.

(b) The Director may not waive the requirements for applicable development sites of this section if any of the following circumstances are present:

- (i) Brownfield: The proposed project is located on a site that is considered a brownfield or is otherwise known or believed to have pollutants in the soil or on the ground that, if discharged from the property in stormwater or groundwater, may cause harm to the general public or the environment;

- (ii) TMDL: The proposed site will, after development, discharge stormwater to a waterbody that is included on the most recent State of Colorado Department of Public Health and Environment §303(d) List of Water-Quality-Limited Segments Requiring TMDLs or for which a Total Maximum Daily Load (TMDL) is in place;
- (iii) Wetlands: The proposed site will, after development, discharge stormwater to a delineated wetland or wetland buffer area as defined in Chapter 9-3, "Overlay Districts," B.R.C. 1981;
- (iv) History: A history of flooding or drainage problems is known to exist in, or downstream of, the drainage basin where the site is located, whether documented or undocumented;
- (v) Master Plan: A City-approved stormwater master plan indicates a need for more stringent regulation of stormwater in the watershed where the proposed project is located in order to avoid, or alleviate, any flood, drainage, or pollution problems; or
- (vi) Exacerbate Problems: There is reason to believe that construction of the proposed project may further exacerbate existing flood or drainage problems.
- (c) Evidence supporting the waiver pursuant to the criteria of this section shall be provided on forms provided by the Director. The Director may require additional documentation to support the waiver request.
- (d) In granting a waiver, the Director may impose specific conditions on the approval of the waiver necessary to ensure that the criteria in this section are, and will remain, satisfied.

## **(C) Requirements**

Applicable development sites are subject to the following requirements:

- (1) **Stormwater Quality Design Standard Compliance:** Each drainage basin or collection of drainage basins (treatment area) associated with an applicable development site shall meet one of the following Stormwater Quality Design Standards:
  - (a) **Runoff Reduction Standard:** Control measures for post-construction stormwater quality (SCMs) are selected, designed, and constructed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 60% of what the calculated Water Quality Capture Volume (WQCV) would be if all impervious area for the applicable development site discharged without infiltration.

None of the treatment area may be excluded when using the Runoff Reduction Standard.
  - (b) **Water Quality Capture Volume Standard:** SCMs are selected, designed, and constructed to provide treatment and/or infiltration of the runoff from the entire treatment area for the 80<sup>th</sup> percentile, 0.6-inch storm event. Evaluation of minimum drain time shall be based on the pollutant removal mechanism and functionality of the SCM(s) implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the SCM (e.g., wetland vegetation).

Up to 20 percent, not to exceed one acre, of the treatment area may be excluded when using the WQCV Standard if the Engineer demonstrates that it is not

practicable to capture runoff or implement a separate SCM before runoff drains to an offsite discharge point.

- (c) Pollutant Removal Standard: SCMs are selected, designed, and constructed to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 milligrams per liter (mg/L) or less from the entire treatment area for the 80<sup>th</sup> percentile, 0.6-inch storm event.

Up to 20 percent, not to exceed one acre, of the treatment area may be excluded when using the Pollutant Removal Standard if it is demonstrated that it is not practicable to capture runoff or implement a separate SCM before runoff drains to an offsite discharge point.

- (d) Constrained Redevelopment Site Standard: Applicable development sites having an existing impervious area greater than 35 percent and a proposed impervious area greater than 75 percent that can demonstrate the above design standards cannot be practicably met shall meet one of the following standards:

(i) Constrained Runoff Reduction Standard: SCMs are selected, designed, and constructed to infiltrate into the ground where site geology permits, evaporate, or evapotranspire a quantity of water equal to 30 percent of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration.

(ii) Constrained WQCV Standard: SCMs are selected, designed, and constructed to provide treatment and/or infiltration of the runoff from at least 50 percent of the treatment area, including at least 50 percent of the impervious area, for the 80<sup>th</sup> percentile, 0.6-inch storm event. Evaluation of minimum drain time shall be based on the pollutant removal mechanism and functionality of the SCM(s) implemented. Consideration of drain time shall include maintaining vegetation necessary for operation of the SCM (e.g., wetland vegetation).

(iii) Constrained Pollutant Removal Standard: SCMs are selected, designed, and constructed to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less for at least 50 percent of the treatment area, including at least 50 percent of the impervious area, for the 80<sup>th</sup> percentile, 0.6-inch storm event.

- (2) **Required Treatment Approach:** The selection of a required treatment approach shall be determined considering site constraints and infiltration feasibility following the procedure established in Section 7.16 of these Standards.

- (3) **Compliance Documentation Required:** The selected treatment approach and the rationale for such approach selection shall be documented on form(s) as provided by the Director. The form(s) and any supporting data, maps, charts, or calculations shall be provided as part of the Preliminary and Final Drainage Reports.

- (4) **Pretreatment Required:** Pretreatment devices shall be provided for all SCMs to reduce the inflow of trash, debris, and coarse sediment into the SCM. Allowed forms of pretreatment are grass buffers, grass swales, forebays, and inlet sumps. The Director may approve other pretreatment controls if the Director finds the proposed design adequately reduces the inflow of trash, debris and coarse sediment into the SCM.

- (5) **Irrigation Plan Required:** Provisions shall be made to provide water to vegetated SCMs after vegetation installation and in accordance with the Final Drainage Report and as



needed to maintain the health of the vegetation. The owner of the SCMs shall be responsible to replace vegetation that is damaged, dead, or otherwise shows signs of poor health to ensure the proper operation of the control measure. The use of native plants in SCMs and other vegetated areas is strongly encouraged as such plants are best suited for local seasonal and climatic conditions.

- (6) **Easement:** All SCMs shall be located in a public easement. The easement shall grant to the City at a no charge a permanent right to inspect, maintain, and reconstruct the SCMs. The easement shall be granted on a form provided by the Director. No owner of land or other applicant shall obtain a Final Drainage Plan, unless the owner first grants to the City the easement for all SCMs.

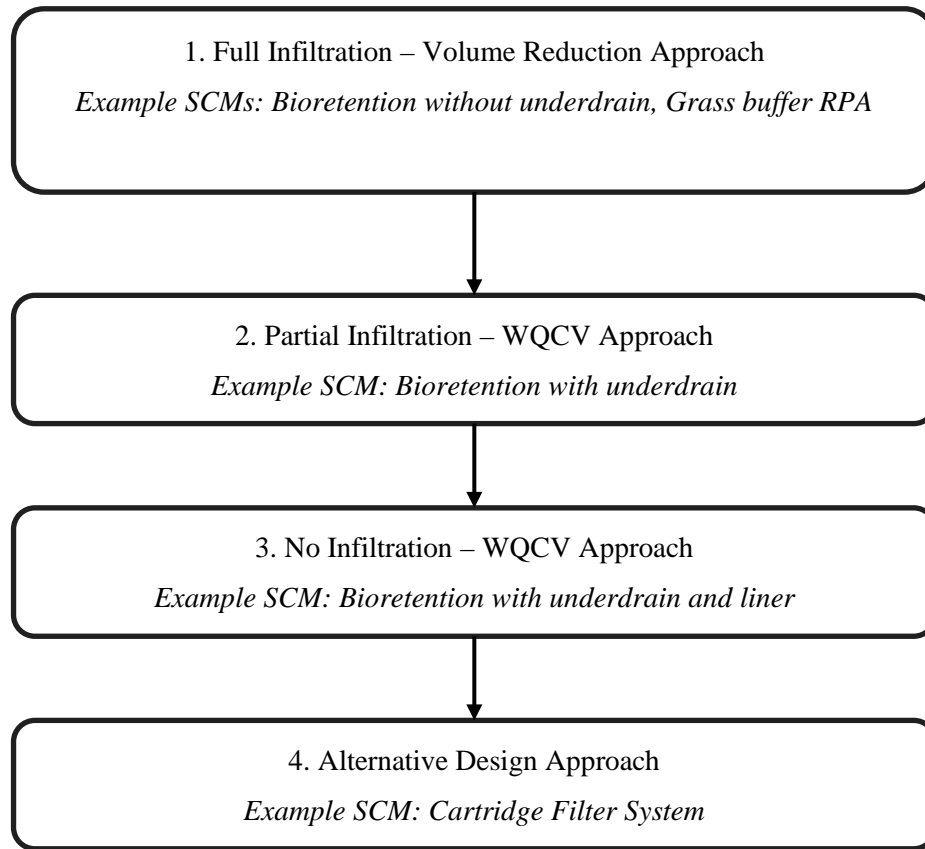
## **7.16 Post-Construction Stormwater Quality Treatment Approach**

### **(A) Selection and Design of SCMs**

The Engineer for an applicable development site shall apply the SCMs that best address pollutants of concerns and can be implemented on the development site. Infiltration of rainfall and stormwater using volume reduction/green infrastructure SCMs is the preferred treatment approach because it most closely mimics the natural hydrology of undeveloped land and reduces the volume of stormwater that is discharged into the stormwater utility system and to local streams. Therefore, non-structural LID techniques, Receiving Pervious Areas (RPAs), and infiltration-based SCMs shall be used to the degree practicable whenever it is determined that infiltration is feasible. In contrast, the removal of pollutants using underground SCMs is the least desirable treatment approach due to concerns about the practicality and effectiveness of long-term SCM maintenance and the ability of these designs to address pollutants of concern. As a result, the pollutant removal design standard is only allowed when all other treatment approaches have been demonstrated to not be feasible.

This subsection summarizes the required procedure and supporting criteria for the selection and design of SCMs on applicable development sites, which are established in the following subsections of this section:

- (1) **Preliminary Infiltration Feasibility Screening:** Site conditions shall be documented prior to SCM design to support selection of an appropriate water quality treatment approach.
- (2) **Treatment Approach Selection:** Selection of an appropriate SCM shall be based on the feasibility of onsite infiltration. The required treatment approach is selected based on the hierarchy provided in Figure 7-1. The purpose of this hierarchy is to promote the use of infiltration using green infrastructure as the preferred approach to permanent stormwater quality management.



**Figure 7-1: Water Quality Treatment Approach Hierarchy**

- (3) **Treatment Approach Design Criteria:** Upon selection of a treatment approach, the required design standard and criteria described in Subsection 7.16(D) of these Standards shall be followed to design and document SCM performance.
- (4) **Soil and Infiltration Test Requirements:** The necessity of soil and infiltration testing is dependent on the treatment approach and SCM type. Subsection 7.16.(E) of these Standards explains soil and infiltration testing required to satisfy the Treatment Approach Design Criteria.

## **(B) Preliminary Infiltration Feasibility Screening**

The Engineer shall investigate the site conditions to determine the treatment approach and the Stormwater Quality Design Standards that will be applied to each treatment area. The preliminary infiltration feasibility screening shall be conducted as soon as possible in the design process. The preliminary infiltration feasibility screening does not require field infiltration testing, soil borings, and other detailed tests; however, if the full infiltration treatment approach is indicated to be feasible through this screening process, additional field testing may be required as described in Subsection 7.16(E) of these Standards. The preliminary infiltration feasibility screening shall meet the following requirements:

- (1) Preliminary infiltration feasibility screening shall be conducted for each treatment area associated with the applicable development site prior to development of the Preliminary Drainage Report.
- (2) The Engineer shall create hydrologic soil group (HSG) maps for each treatment area. Soil gradation assessments or field infiltration testing may be used to confirm HSG mapping or

determine infiltration parameters for fill materials.

(3) The Engineer shall assess the following limitations to infiltration for each treatment area. If one of the following factors is determined to limit infiltration feasibility, documentation shall be provided with Preliminary and Final Drainage Reports:

- (a) Insufficient hydrologic storage capacity of the underlying soil attributable to shallow bedrock, hardpan layer, seasonal high-water table, or similar subsurface conditions. Underlying soil conditions are not a limitation for consideration of Unconnected Impervious Areas (UIA) to RPA.
- (b) The potential for groundwater contamination resulting from known or suspected soil contamination or from a proposed land use that is incompatible with the use of infiltration practices (e.g., a concrete batch plant or materials storage and loading site) or similar conditions.
- (c) Close proximity of SCM locations to drinking water wells or groundwater protection areas.
- (d) Limited or no suitable area for infiltration attributable to regulatory requirements for the proposed applicable development site, including building set-back or build-to requirements; location or area requirements for rights-of-way, parking, and driveways; floodplain regulations; or other state or local regulatory conditions.
- (e) Limited suitable area for infiltration attributable to the location of existing structures, pavement, utilities, or similar features that will remain; contractive or expansive soils in close proximity to buildings; or the location or extent of steep slopes, springs, seeps, wetlands, trees, or other natural features that will not or cannot be altered as a result of land development.
- (f) Close proximity to historical or archeological sites that could be damaged or otherwise negatively impacted by infiltration.
- (g) Flooding conditions that can be exacerbated by, or limit the function of, an infiltration-based SCM, including a history of frequent flooding at proposed SCM locations or a history of wet or flooded foundations, crawl spaces, or basements on or in close proximity to the applicable development site or its proposed SCM locations, and where these conditions will not be corrected by the proposed project.

(4) Infiltration feasibility screening results shall be documented in the Preliminary and Final Drainage Reports.

### **(C) Treatment Approach Selection**

The treatment approach is the methodology that will be used to design a SCM, or collection of SCMs, to meet the required Stormwater Quality Design Standard. Four treatment approaches are described in Table 7-7, "Treatment Approach Selection Criteria," and correspond with criteria requirements presented in Subsection 7.16(D) of these Standards. A single SCM design approach shall be initially selected for each treatment area of the applicable development site using the results of the preliminary infiltration feasibility screening and the guidelines presented in Table 7-7, "Treatment Approach Selection Criteria." The selection of the treatment approach shall begin at the top of the table (with full infiltration) and proceed to the next level down if either the infiltration capacity or infiltration constraints criteria cannot be met. This process continues until both sets of criteria are met for the treatment area. One treatment approach shall be selected for each applicable treatment area.

The Full Infiltration – Volume Reduction approach has two categories depending on the type of SCM being evaluated in the drainage basin:

- (1) **UIA to RPA:** This category is grass swales and grass buffers designed to infiltrate stormwater runoff via disconnection of impervious areas. Infiltration capacity for this category is dependent on identifying UIA:RPA pairs and confirming topsoil suitability.
- (2) **Infiltration SCM:** This category is bioretention, sand filter, permeable pavement or other volume-based SCMs designed to retain runoff from the treatment area. Infiltration capacity for this category is dependent on confirming the infiltration rate of the underlying in-situ soil.

**Table 7-7: Treatment Approach Selection Criteria**

<b><u>Treatment Approach</u></b>	<b><u>Design Standard</u></b> <b><u>Subsection</u></b> <b><u>7.15(E)(1)</u></b>	<b><u>Preliminary Infiltration Feasibility Screening</u></b> <b><u>Subsection 7.16(B)</u></b>	
		<b><u>Infiltration Capacity</u></b>	<b><u>Infiltration Constraints</u></b>
<b><u>1. Full Infiltration - Volume Reduction</u></b> <b><u>A. UIA to RPA</u></b> <b><u>B. Infiltration SCM</u></b> <b><u>Subsection 7.16(D)(1)</u></b>	<b><u>Runoff Reduction</u></b>	<b><u>A. UIA to RPA</u></b> <u>UIA:RPA pairs have been identified and meet run-on ratio guidelines of USDCM, Volume 3, T-0 Volume Reduction.</u> <b><u>B. Infiltration SCM</u></b> <u>HSG A or B</u> <u>OR</u> <u>Field tests indicates infiltration rate is greater than one inch per hour.</u>	<u>Underlying soil, groundwater, and geological conditions have sufficient hydrologic capacity to infiltrate 60% of the WQCV.</u> <u>AND</u> <u>No other limitations to full infiltration are present in the treatment area.</u>
<b><u>2. Partial Infiltration - WQCV</u></b> <b><u>Subsection 7.16(D)(2)</u></b>	<b><u>WQCV</u></b>	<u>HSG C or D</u> <u>OR</u> <u>Field tests indicates infiltration rate is less than one inch per hour.</u>	<u>Underlying soil, groundwater, and geological conditions have sufficient hydrologic capacity to support infiltration of a portion of the WQCV.</u> <u>AND</u> <u>No other limitations to partial infiltration are present in the treatment area.</u>
<b><u>3. No Infiltration - WQCV</u></b> <b><u>Subsection 7.16(D)(3)</u></b>	<b><u>WQCV</u></b>	<u>N/A</u>	<u>Underlying soil, groundwater, and geological conditions prevent infiltration and require a lined system.</u>
<b><u>4. Alternative Design</u></b> <b><u>Subsection 7.16(D)(4)</u></b>	<b><u>Pollutant Removal</u></b> <b><u>OR</u></b> <b><u>Constrained Redevelopment Site</u></b>	<u>N/A</u>	<u>Physical site constraints or risk factors prevent the use of Treatment Approaches 1, 2, and 3</u> <u>AND</u> <u>Alternative approach must be approved by the Director.</u>

**(D) Treatment Approach Design Criteria**

The Engineer shall design the SCMs of the selected treatment approach consistent with the requirements of this subsection. Specific types of SCMs are not prescribed for the individual approaches. Any applicable SCM may be used, provided it meets the treatment approach requirements stated herein. In addition to these requirements, SCM designs shall follow the guidance provided in USDCM, Volume 3.

For any of the treatment approaches, a treatment train using a series of SCMs may be used to meet the Stormwater Quality Design Standard for a given treatment area. The series of SCMs must adhere to the requirements of the treatment approach selected for the treatment area and must ultimately, as a group of SCMs, meet the Stormwater Quality Design Standard associated with the treatment approach.

**(1) Full Infiltration – Volume Reduction Approach:** Full Infiltration is the preferred treatment approach and is required where feasible. Full infiltration designs retain stormwater onsite through the use of RPAs or infiltration SCMs that do not have underdrains. Plugged or capped underdrains may be specified. The following criteria are applicable to full infiltration SCM designs:

- (a) Runoff Reduction Design Standard: Treatment areas using the Full Infiltration – Volume Reduction Approach shall meet, at a minimum, the requirements of the Runoff Reduction Design Standard of Subsection 7.15(C)(1)(a) of these Standards.
- (b) Required Sizing Criteria: Preliminary and Final Drainage Reports must document sizing criteria and achieved volume reduction for each SCM following methods specified in USDCM, Volume 3. SCMs must be sized for the full tributary area.
  - (i) UIA to RPAs must comply with run-on ratio, topsoil suitability, and other related criteria as specified in USDCM, Volume 3, T-0 Volume Reduction.
  - (ii) Full infiltration SCMs with a storage component must comply with surface (filter) area, geometry, and drain time requirements as specified in the USDCM, Volume 3 for the appropriate SCM type.
- (c) Field Infiltration Tests: Field infiltration tests are mandatory for full infiltration SCM designs following the standards in Subsection 7.16(E) of these Standards. Field infiltration test results must be documented in the Preliminary and Final Drainage Reports.
- (d) Minimum Field Infiltration Rate: Full infiltration SCMs require a field infiltration rate measurement equal to one inch per hour or greater. If field infiltration rates are measured to be less than one inch per hour, a partial infiltration/WQCV approach shall be used consistent with the standards in Subsection 7.16(D)(2) of these Standards.
- (e) Required Design Factor of Safety: Full infiltration SCMs shall utilize a minimum factor of safety of 2 when using the field-measured infiltration rate in drawdown time calculations.

**(2) Partial Infiltration – WQCV Approach:** This category of SCMs retains stormwater

on site to the extent practical by using underdrains or rate-controlled outlet structures. RPAs may be used as part of a treatment train to partial infiltration SCMs. The following criteria are applicable to partial infiltration designs:

- (a) WQCV Design Standard: Treatment areas using the Partial Infiltration – WQCV Approach shall meet, at a minimum, the requirements of the WQCV Design Standard in Subsection 7.15(C)(1)(b) of these Standards.
- (b) Required Sizing Criteria: Preliminary and Final Drainage Reports must document sizing criteria and achieved runoff volume capture for each SCM following the methods specified in the USDCM, Volume 3. SCMs must be sized for the full tributary area.
  - (i) UIA to RPAs must comply with run-on ratio, topsoil suitability, and other related criteria as specified in USDCM, Volume 3, T-0 Volume Reduction.
  - (ii) Partial infiltration SCMs must comply with surface (filter) area, geometry, and drain time requirements as specified in USDCM, Volume 3 for the appropriate SCM type. The use of underdrains or rate-controlled outlet structures are required components of partial infiltration designs.
- (c) Field Infiltration Tests: The following field infiltration test requirements are applicable to Partial Infiltration – WQCV designs:
  - (i) For UIA-to-RPAs, topsoil suitability must be shown with a soil graduation test as specified in Subsection 7.16(E) of these Standards.
  - (ii) For partial infiltration SCMs with underdrain or rate-controlled outlet, a field infiltration test is not required except when expressly requested by the Director due to a unique design configuration.
- (3) No Infiltration – WQCV Approach:** No infiltration SCMs are lined systems required by the necessity to prevent infiltration due to underlying soil conditions, high groundwater table, or an otherwise immitigable risk as identified during the preliminary Infiltration feasibility screening. The following criteria apply to no infiltration designs:
  - (a) WQCV Design Standard: Treatment areas using the No Infiltration – WQCV Approach shall meet, at a minimum, the requirements of the WQCV Design Standard in Subsection 7.15(C)(1)(b) of these Standards.
  - (b) Required Sizing Criteria: Preliminary and Final Drainage Reports must document sizing criteria and achieved runoff volume capture for each SCM following methods specified in USDCM, Volume 3. SCMs must be sized for the full tributary area. No infiltration SCMs must adhere to and document compliance with surface (filter) area, geometry, and drain time requirements as specified in USDCM, Volume 3 for the appropriate SCM type.
  - (c) Field Infiltration Tests: Field infiltration tests are not required for no infiltration SCMs. Proof of a watertight liner may be requested at the time of installation by the Director based on necessity for risk mitigation.
- (4) Alternative Design Approach:** The Director may approve an alternative design approach only if the Engineer demonstrates in the Preliminary Drainage Report or a letter to the Director that none of the above three treatment approaches are feasible. The Preliminary Drainage Report or letter shall explain the alternative design approach. The

following criteria are applicable to alternative designs:

- (a) Pollutant Removal or Constrained Redevelopment Site Standard. Alternative designs shall meet one of the following:
  - (i) Pollutant Removal Standard in Subsection 7.15(C)(1)(c) of these Standards.
  - (ii) Constrained Runoff Reduction Standard in Subsection 7.15(C)(1)(d)(i) of these Standards.
  - (iii) Constrained WQCV Standard in Subsection 7.15(C)(1)(d)(ii) of these Standards, or
  - (iv) Constrained Pollutant Removal Standard in Subsection 7.15(C)(1)(d)(iii) of these Standards.
- (b) Required Sizing Criteria: Preliminary and Final Drainage Reports must document sizing criteria and applicable performance metrics for each SCM following methods specified in USDCM, Volume 3.
  - (i) For pollutant Removal or Constrained Pollutant Removal Standard designs, the Engineer shall submit TSS reduction metrics applicable to the proposed design. The use and reference of third-party testing data is required when proposing the use of a proprietary device.
  - (ii) Constrained Runoff Reduction Standard designs shall adhere to sizing criteria specified in Subsection 7.16(D)(1) of these Standards.
  - (iii) Constrained WQCV Standard designs shall adhere to sizing criteria specified in Subsection 7.16(D)(2) of these Standards.
- (c) Field Infiltration Tests: The following field infiltration test requirements apply to alternative design approaches:
  - (i) Field infiltration tests are not required when using the pollutant removal or constrained site pollutant removal standard.
  - (ii) Constrained Runoff Reduction Standard designs shall adhere to field infiltration requirements specified in Subsection 7.16(D)(1) of these Standards.
  - (iii) Constrained WQCV Standard designs shall adhere to field infiltration requirements specified in Subsection 7.16(D)(2) of these Standards.

## **(E) Soil and Infiltration Test Requirements**

Requirements for field infiltration testing depend on treatment approach and SCM type as detailed in Subsection 7.16(D) of these Standards. Field infiltration tests are required for all full infiltration SCMs with a storage component. For all UIA to RPA areas, the Engineer must show topsoil suitability with a soil gradation test. When preliminary infiltration feasibility screenings indicate C or D soils, field infiltration testing is optional to explore feasibility of a full infiltration design. Documentation of field infiltration test results must be submitted in Preliminary and Final Drainage Reports.

- (1) **UIA to RPA Soil Test Requirement:** For all UIA to RPA areas, regardless of HSG, onsite topsoil sampling and testing must be conducted to confirm infiltration capacity.



Determination of HSG classification based on soil texture analysis shall follow specifications provided in USDCM, Volume 3, T-0 Volume Reduction. At least one soil gradation test shall be conducted for each proposed RPA. Proposed topsoil and soil amendment additions shall follow criteria specified in Chapter 10 of these Standards.

- (a) Post-Construction Soil Tests: Depending on site conditions, the Director may require soil tests to confirm infiltration capacity and adequacy of soil chemistry to support vegetation growth for RPAs after construction is complete. When required, soil test results shall be provided with the submission of as-built drawings.

**(2) Full Infiltration SCM Field Test Requirements: The following criteria apply to all full infiltration SCMs with a storage component using the Full Infiltration – Volume Reduction Approach of Subsection 7.16(D)(1) of these Standards:**

- (a) Soil Borings: Soil borings aid in interpretation of infiltration test results by providing information on groundwater conditions and soil stratification. Therefore, each infiltration test shall be accompanied by a soil boring test to a depth of 10 feet below the lowest planned infiltration elevation (the bottom of the infiltrating SCM). Soil borings performed for a civil site geotechnical analysis that are located within close proximity (less than 50 feet) to the footprint of the SCM may be used. An interpretation of soil boring test results with respect to infiltration shall be provided for each test. This description shall include an assessment of the anticipated seasonal high-water table based on date of soil boring with respect to rainfall patterns, and the presence of hydric soils, redoximorphic features, or other indicator of water table variation.
- (b) Allowed Test Methods: Field infiltration tests shall utilize a double-ring infiltrometer or modified Philip Dunne infiltrometer following the specifications of ASTM D3385 or ASTM 8152, respectively. Alternative infiltration test methods may only be used with approval by the Director. The use of correlation methods based on soil texture applies only to RPA designs using the T-0 factsheet of USDCM, Volume 3. The use of regional soil maps is prohibited for infiltration design or verification purposes.
- (c) Number of Tests Required: At least three infiltration tests shall be conducted for every SCM using the test spacing criteria established below. The Director may require additional tests for large SCMs, greater than 10,000 square feet, or when unique soil or geological conditions are known or suspected at the site.
  - (i) Generally, one infiltration test shall be conducted for every 3,000 to 10,000 square feet of area, depending upon the size of the SCM. Tests shall be spaced appropriately to provide sufficient infiltration rate information across the length and width of the SCM.
  - (ii) For small SCMs, at least one test shall be located within the SCM's footprint. The additional tests can be performed outside the footprint but must be located within 20 feet of the perimeter of the SCM and in soil formations that are representative of the conditions within the footprint of the SCM.
  - (iii) For SCMs that have an area greater than 10,000 square feet, one infiltration test shall be conducted for every additional 10,000 square feet

of surface area up to a maximum of five infiltration tests.

- (d) Test Elevation: The elevation of infiltration tests shall be at or below the bottom (lowest planned infiltration elevation) of the SCM. SCMs that are designed for full infiltration shall not be placed on fill material without prior infiltration tests to confirm full infiltration design feasibility.
- (e) Post-Construction Field Infiltration Tests: The Director may require field infiltration tests to confirm infiltration rates after construction is complete if soil compaction or clogging is known or suspected during construction. When required field infiltration test information shall be provided with the submission of as-built drawings.
- (f) Drainage Report Requirements: The Preliminary and Final Drainage Report shall include the following information for each infiltration test performed.
  - (i) Test location and elevation;
  - (ii) Test method used;
  - (iii) Location of soil boring(s) used to aid test interpretation; and
  - (iv) Soil boring results and how they were used.

## **7.17 Post-Construction Stormwater Approval Requirements**

### **(A) General**

- (1) Applicable development sites shall receive post-construction approval of the stormwater utility system by the Director prior to the issuance of a Certificate of Occupancy pursuant to a building permit or a Certificate of Completion for a use established pursuant to a development agreement under Chapter 9-2, "Review Processes," B.R.C. 1981. The Director will base approval on the system's conformance with the approved Final Drainage Report, the requirements of this section, and its readiness for post-construction operation.
- (2) Post-construction approval of the stormwater utility system shall be granted if the following criteria are met:
  - (a) The stormwater as-built drawing provided for the applicable development site demonstrates conformance of the constructed stormwater utility system with the approved Final Drainage Report and readiness for full post-construction operation, and
  - (b) The site's stormwater utility system and all associated SCMs are determined, based on visual inspection by the Director, to be clean; free of sediment, debris, and other obstructions; undamaged; and ready for full post-construction operation.

If these criteria are not met, the Director may require the preparation, submittal, and approval of a revised Final Drainage Report and/or corrective actions at the applicable development site before granting post-construction approval. Corrective actions may include cleaning or repair of the stormwater utility system, SCMs, or detention ponds, including, but not limited to, the removal of sediment, debris, or other obstructions; the removal of construction-related

wastes or stockpiles; the installation of permanent slope stabilization or energy dissipation measures; the removal, replacement, or installation of vegetation; and soil amendment or soil media replacement in infiltration-based SCMs.

- (3) Post-construction approval of the stormwater utility system by the Director indicates that the system was constructed in conformance with City requirements, is currently operating as expected, and stormwater as-built drawings have been approved. Approval also means that the system must comply with the requirements for post-construction inspection and maintenance established in Section 7.18 of these Standards and Chapter 11-5, "Stormwater and Flood Management Utility," B.R.C. 1981.
- (4) In no way does post-construction approval imply City ownership, maintenance, operation, or any other liability for any accepted, privately-owned, stormwater utility system, SCM, or detention pond.

## **(B) Stormwater As-Built Drawings**

The preparation of stormwater as-built drawings is required for all applicable development sites to document the as-constructed condition of SCMs. The as-built drawings shall indicate where the as-constructed condition differs from the final approved technical drawings following the provisions of Subsection 1.3(G) of these Standards. An engineering certification of elevations shall be included as an attachment to the stormwater as-built drawings.

The figures and drawings depicting the items listed below shall be included with the as-built requirements in Chapter 1 of these Standards to provide a reference for the information provided in the Final Drainage Report. Specific as-built drawings pertaining exclusively to the conditions of the SCM are required and shall depict both plan and profile views as described below:

- (1) **Plan Drawing/s:** Illustrate and label in plan view the components of the SCM, including inlet and outlet locations, embankments, treatment surface area, utility easements, vegetated cover, and other critical drainage elements. Indicate where the as-constructed conditions differ from the final approved technical drawings.
- (2) **Profile Drawing/s:** Illustrate and label in profile view the elevations of SCM components, including filter media depth, bottom elevation, embankment slopes, inlet/outlet inverts, and other critical drainage components. Indicate where the as-constructed conditions differ from the final approved technical drawings.

## **(C) Post-Construction Acceptance Inspection Required**

- (1) Each SCM must pass a post-construction inspection by the Director to confirm SCMs, including RPAs, are clean, have established vegetation, and are fully operational in keeping with their approved design. After these conditions are met, the SCM is considered fully functional and subject to Section 7.18 of these Standards.
- (2) The post-construction acceptance inspection shall occur after submittal of the complete as-built drawings to the Director. No application for inspection is required, as submittal of the stormwater as-built drawings will signify the project's readiness for inspection. An inspection will not be performed in the event of submittal of incomplete drawings. Confirmation of information on the stormwater as-built drawings will also be included in the inspection.

**(D) Vegetation Warranty Required**

The Director may require a financial guarantee for vegetation installed within SCMs consistent with the requirements of Subsection 11-5-6, “Stormwater Quality Management for Land Development,” B.R.C. 1981. The financial guarantee may be held for up to three years and will be released after an inspection confirms the vegetation within each SCM is in good health.

**7.18 Post-Construction Stormwater Quality Inspection and Maintenance Requirements****(A) Applicability**

The owner of SCMs of an applicable development site shall protect, inspect, maintain, repair, and reconstruct SCMs and associated drainage infrastructure on the property to ensure full, functional operation in accordance with the requirements in this section and pursuant to Chapter 11-5, “Stormwater and Flood Management Utility,” B.R.C. 1981.

**(B) Inspection and Maintenance Requirements for SCMs**

- (1) **Inspection and Maintenance Required:** The owner of SCMs shall inspect and maintain the SCMs as is necessary to ensure their full, functional operation at all times.
- (2) **Inspection Frequency:** The owner of SCMs shall be responsible to inspect the SCMs as often as necessary to assess the need for maintenance. The optimum inspection frequency for SCMs varies depending on a number of factors including, but not limited to, the type of SCM, whether the SCM is vegetated, and activities that have occurred in the area draining to the SCM. SCMs shall be visually inspected:
  - (a) After storms and snow melt to assess whether stormwater in the SCM is draining as expected, and
  - (b) During property landscape maintenance activities to look for build-up or blockages of trash, debris, or sediment; check for damage; and determine current maintenance needs.

Documentation of these inspections is not required. However, the owner of SCMs shall document a detailed visual inspection of their SCM(s) in accordance with the frequencies defined in Table 7-8, “Required Inspection Frequency by SCM Type.” The documented inspection shall be performed between May and August, when vegetation is not dormant and snow does not cover the SCM.

**Table 7-8: Required Inspection Frequency by SCM Type**

<u>SCM Type</u>	<u>Documented Inspection Frequency</u>
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<u>Bioretention (Rain Garden)</u>	<u>Annually</u>
<u>Constructed Wetland Channel</u>	
<u>Constructed Wetland Pond</u>	
<u>Extended Detention Pond</u>	
<u>Grass Buffer</u>	
<u>Grass Swale</u>	
<u>Permeable Pavement</u>	
<u>Receiving Pervious Area (RPA)</u>	
<u>Retention Pond</u>	
<u>Sand Filter</u>	
<u>Other SCM Designs</u>	
<u>Underground SCMs</u>	<u>Every 3 months</u>

- (3) **Inspection Documentation:** Inspections shall be documented using form(s) provided by the Director and located in the Inspection and Maintenance Guide for the SCMs in an appendix to the Final Drainage Report. Inspection documentation shall be kept by the owner of SCMs or their delegated representative for five years and shall be made available by the owner of SCMs or their delegated representative to the Director immediately upon request.
- (4) **Performed Maintenance:** Routine maintenance shall be performed to ensure that SCMs are functioning as designed. Corrective action shall be performed immediately when an inspection indicates the need for maintenance. Routine maintenance varies by SCM type but generally requires the regular removal of trash and debris (e.g., dead leaves, sticks, tree limbs) from inflow, outflow, and water storage areas; removal of sediment at inflows; repair of eroded areas; and general vegetation maintenance (if vegetation is part of the SCM).
- (5) **Transitional Regulations:** For any permanent stormwater quality facilities approved under the City of Boulder Design and Construction Standards in effect prior to the effective date of Ordinance 8324, the property owner shall be responsible for maintaining the stormwater quality facilities. The stormwater quality facilities shall be maintained as recommended in the USDCM and such that the design of the properties of the facility are preserved.

### **(C) Inspection and Maintenance Guide**

An Inspection and Maintenance Guide shall be submitted as an appendix to the Preliminary and Final Drainage Report. This guide shall be provided by the Engineer to the owner of SCMs upon completion of construction and signifies transfer of maintenance responsibilities from the erosion control permittee to the owner of the SCMs. The Inspection and Maintenance Guide shall provide inspection and maintenance guidelines specific to the SCM type and shall follow

the format provided by the Director.

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

**CHAPTER 9**  
**UTILITIES STANDARDS**

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## 9.01 General

### (A) Intent

The Utilities Standards are intended to complement the design standards specified in Chapter 4, “General Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” Chapter 7, “Storm Water Design,” and Chapter 11, “Technical Drawings,” of these Standards, and provide minimum standards for the construction of public utilities improvements in public rights-of-way and public easements.

### (B) Scope

These Standards apply to all city-operated public utility improvements within the City of Boulder service area. This chapter describes the construction of public utilities and other work within the public right-of-way and public easements including, but not limited to, work activities involved, materials used, installation methods, and required testing. The utilities construction requirements of this chapter are in addition to those set forth in Chapter 4, “General Utilities Design,” Chapter 5, “Water Design,” Chapter 6, “Wastewater Design,” Chapter 7, “Storm Water Design,” and Chapter 11, “Technical Drawings,” of these Standards and the B.R.C. 1981.

### (C) Reference Standards

Where not specified in these Standards or the B.R.C. 1981, in order 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 ~~streetscapes and the planting of trees,~~ utilities and may refer to one or more of the references listed in the References Section of these Standards.

### (D) City Approval Required

All work associated with the construction of public utilities within or upon any City of Boulder public right-of-way or public easement is subject to City of Boulder approval or permit issuance as set forth in Chapter 8-5, “Work in the Public Right-Of-Way and Public Easements,” B.R.C. 1981.

## 9.02 Excavation and Trenching

### (A) General

(1) **Scope:** This section describes excavation and trenching, which includes the following:

- (a) Necessary clearing, grubbing, and preparation of the site;
- (b) Removal and disposal of debris;
- (c) Excavation and trenching as required;
- (~~d~~e) The handling, storage, transportation, and disposal of all excavated material;
- (~~e~~d) Necessary sheeting, shoring, and protection work;
- (~~f~~e) Preparation of subgrades;
- (~~g~~f) Pumping and dewatering as necessary or required;

- (~~hg~~) Protection of adjacent property
  - (~~ih~~) Backfilling;
  - (~~ji~~) Pipe embedment;
  - (~~kj~~) Placement of fills;
  - (~~lk~~) Surfacing and grading; and
  - (~~ml~~) Other relevant work.
- (2) **Quality Assurance:** All tests required for the preliminary review of materials shall be made by an acceptable independent testing laboratory; at the expense of the contractor. Two initial gradation tests shall be made for each type of pipe bedding, fill, or backfill material, and one additional gradation test shall be made for each additional 500 tons of each material. The contractor shall pay for all in-place field density tests, Proctor moisture-density tests, and relative density tests on the materials as required.

## (B) Materials

- (1) **General:** All bedding and backfill material shall be free of frozen material, organic material, and debris.
- (2) **Pipe Bedding:** Bedding materials shall conform to the following requirements:-
- (a) **Bedding Materials:** Bedding materials shall not contain cinders or other material that may cause pipe corrosion.
  - (b) **Concrete Arch Encasement:** A concrete arch encasement is not required unless improper trenching or unexpected trench conditions require its use, as determined by the Director.
  - (c) **Granular Bedding Material:** ~~for Ductile Iron Pipe and PVC Pressure Pipe: This material shall be washed chips, 3/8 inch in nominal size. Table 9-1, "Granular Bedding Material for Ductile Iron Pipe and PVC Pressure Pipe," outlines the gradation requirements.~~ Granular bedding material shall consist of well graded sand or squeegee meeting a fine aggregate standard shown in Table 9-1, "Granular Bedding Material." Instead of a material meeting the requirements in Table 9-1, the Director may approve 3/8-inch chips conforming to the grading and composition requirements of Course Aggregate No. 8 in Table 703-1, "Concrete Aggregate Gradation Table," of the CDOT Standard Specifications for Road and Bridge Construction, 2017, due to lack of availability of the materials meeting Table 9-1 requirements.

**Table 9-1: Granular Bedding Material for ~~Ductile Iron Pipe and PVC Pressure Pipe~~**

Sieve Size or Designation	Percent Passing by Weight
1/2"	100%
3/8"	85-100%
No. 4	10-30%
No. 8	0-10%

**NOTE:** The Director may approve the use of squeegee sand conforming to the gradation in Table 9-3, "Granular Bedding for RCP Sewer Pipe," of these Standards.

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
<u>3/8-inch</u>	<u>100%</u>
<u>No. 4</u>	<u>60-100%</u>
<u>No. 8</u>	<u>0-45%</u>
<u>No. 16</u>	<u>0-30%</u>
<u>No. 50</u>	<u>0-6%</u>
<u>No. 200</u>	<u>0-2%</u>

- (d) Compaction: All granular bedding material shall be compacted by vibrating or slicing with a shovel and placed in layers no more than 6 inches thick.
- (e) ~~Granular Bedding Material for PVC and HDPE Sewer Pipe: This material shall be imported, crushed, angular quarry rock. Table 9-2, "Granular Bedding Material for PVC and HDPE Sewer Pipe," outlines the gradation requirements (ASTM D448, No. 67):~~

**Table 9-2: Granular Bedding Material for PVC and HDPE Sewer Pipe**

<b>Sieve Size or Designation</b>	<b>Total Passing (Percent by Weight)</b>
3/4"	100%
3/8"	20-55%
No. 8	0-10%
No. 200	0-5%

- (f) ~~Granular Bedding Material for RCP Sewer Pipe: This material shall be squeegee sand. Table 9-3, "Granular Bedding Material for RCP Sewer Pipe," outlines the gradation requirements:~~

**Table 9-3: Granular Bedding Material for RCP Sewer Pipe**

<b>Sieve Size or Designation</b>	<b>Total Passing (Percent by Weight)</b>
3/8"	100%
No. 200	0-5%

- (3) **Stabilization Material:** Stabilization material shall be placed on suitably prepared subgrades and compacted by vibration. Stabilization material shall be crushed rock or gravel; free from dust, clay, or trash; and graded 1 1/2 inch to No. 4 as defined in ASTM C33, and shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254.
- (4) **Trench Backfill:** Trench backfill is material placed above the pipe bedding and shall ~~meet the specifications for Class 1 structural backfill material of Subsection 703.08 "Structural Backfill Material," of the CDOT Standard Specifications for Road and Bridge Construction (2017), or shall be flowable fill as specified in Subsection 9.02(B)(6) of these Standards, or an approved equivalent as set forth in Section 8-5-12, "Standards for~~

~~Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981.~~

- (5) **Groundwater Barrier Material:** Groundwater barrier material shall be flowable fill or meet AASHTO soil classification SC or CL, free from stones, organic material or debris.
- (6) **Flowable Fill:** ~~Flowable~~ Flowable fill, meeting the standards outlined in Table 9-24, “Flowable Fill Requirements,” shall be used for trench backfill or for groundwater barriers.

**Table 9-24: Flowable Fill Requirements**

Ingredients	Lbs./C.Y.	Kg/m <sup>3</sup>
Cement	50	30
Coarse Aggregate (AASHTO No. 57 or 67)	1,700	1,009
Fine Aggregate (AASHTO M 6)	1,845	1,095
Water (39 gallons) (147L)	325 (or as needed)	193 (or as needed)

- (a) Enough water shall be used so that the flowable fill flows into place properly without excessive segregation. Approximately 39 gallons of water per cubic yard (193 liters per cubic meter) of flowable fill is normally needed. Additional water shall not be added to the mixture at the project site.
- (b) The contractor may use aggregate that does not meet the specifications in Table 9-24, “Flowable Fill Requirements,” if the cement is increased to 100 pounds per cubic yard (60 kilograms per cubic meter) and the aggregate conforms to following gradation:

Sieve Size or Designation	Percent Passing
1 <u>inch</u> (25.0 mm)	100%
No. 200	0-10%

- (c) The contractor may make the following substitutions in the flowable fill mix:
- (i) Thirty pounds per cubic yard (18 kilograms per cubic meter) of cement and 30 pounds per cubic yard (18 kilograms per cubic meter) of fly ash for 50 pounds per cubic yard (30 kilograms per cubic meter) of cement, or
- (ii) Sixty pounds per cubic yard (36 kilograms per cubic meter) of cement and 60 pounds per cubic yard (36 kilograms per cubic meter) of fly ash for 100 pounds per cubic yard (60 kilograms per cubic meter) of cement.
- (d) The City reserves the right to review the use of recycled broken glass (glass cullet) as part or all of the aggregate.
- (e) Compaction of flowable fill shall not be required
- (f) The maximum layer thickness for flowable fill shall be 3-feet. Additional layers shall not be placed until the flowable fill has lost sufficient moisture to be walked on without indenting more than 2-inches. Any damage resulting from placing flowable fill in layers that are too thick or from not allowing sufficient time between placement of layers shall be repaired at the Contractor’s expense.
- (7) **Rock Backfill Material:** Rock backfill material shall be an imported graded material that

meets either the 57/67 size requirements of ASTM C33 or the requirements for stabilization material specified in Subsection 9.02(B)(3) of these Standards.

## (C) Execution

### (1) Site Preparation

- (a) All sites to be occupied by permanent construction shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. All waste materials shall be removed from the site and properly disposed.
- (b) In natural areas where excavation will occur all topsoil shall be stripped or, in the absence of topsoil, the top 6 inches of surface material shall be stripped and stored separately from other excavated materials.
- (c) For concrete walks, roadways, parking areas, and road crossings existing pavement shall be cut full depth to a true line before excavation. For Portland Cement pavements, cuts shall be made at existing joints.

- (2) **Classification of Excavated Materials:** Excavated materials shall not be classified. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

- (3) **Unauthorized Excavation:** Undermining or tunneling under walls, footings, slabs on grade, foundations, sidewalks, concrete or bituminous asphalt pavements, or any other surface or subsurface facilities or structures shall not be permitted unless authorized by the Director. If unauthorized tunneling or undermining occurs, the contractor shall pay for all repairs and restorations the Director deems necessary. The repairs and restorations may include removing and replacing part or all of the affected facility or structure.

### (4) Stabilization of Subgrades

- (a) Subgrades for concrete structures and trench bottoms shall be firm, dense, thoroughly compacted and consolidated, and free from mud and muck.
- (b) Subgrades for concrete structures or trench bottoms that are otherwise solid, but become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel meeting the requirements for stabilization material, described in Subsection 9.02(B)(3) of these Standards and approved by the Director.
- (c) Stabilization material shall be spread and compacted to a depth of not more than 4 inches. However, if the required depth exceeds 4 inches, the subgrade for concrete structures or trench bottom shall be re-excavated and all mud and muck removed and replaced with stabilization material, as required by SubSsection 9.02(B)(3) of these Standards and approved by the Director.
- (d) This material shall be placed, and compacted, as prescribed in these Standards. The finished elevation of stabilized subgrades shall not be above subgrade elevations indicated on the drawings.

- (5) **Blasting:** Blasting or other use of explosives for excavation will not be permitted.

### (6) Shoring

- (a) All excavations shall be properly shored and braced to meet federal, state and local laws governing safe working conditions. The shoring shall be arranged so that no stress is placed on any portion of the completed work until the general construction thereof has proceeded far enough to provide ample strength.
- (b) Shoring shall be removed as the work progresses. Trench sheeting shall not be pulled before backfilling unless the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling.
- (c) Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner that will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.
- (d) The contractor shall pay to repair any damage to pipes or structures resulting from missing, failed or improper shoring, sheeting, or bracing or any negligence on the part of the contractor.

(7) **Water Control and Dewatering**

- (a) Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
- (b) All excavations for concrete structures or trenches that extend down to or below the groundwater table shall be dewatered by lowering and keeping the groundwater level 12 inches or more below the bottom of the excavation.
- (c) Surface water shall be diverted or otherwise prevented from entering the excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
- (d) The contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes. All such pipe or conduit shall be left clean and free of sediment.

(8) **Trench Excavation:** Trenches shall be excavated so that pipes can be laid according to the profiles, grades, elevations, and minimum cover shown on the drawings or specified in these Standards. Trench subgrades shall be clean and free of loose material of any kind.

- (a) **Excavation in Streets and Other Paved Surfaces:** Excavations in streets with asphalt paving must be confined to the minimum width required to maintain a safe trench condition. The contractor shall pay for replacing any pavement damage resulting from their construction work. The Director will determine the limits of the damaged pavement needing replacement.
- (b) **Minimum Cover:** Where pipe grades or elevations are not definitely fixed by the approved plans, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe as follows:
  - (i) Water lines require at least 4.5 feet of cover;
  - (ii) Sanitary sewers require at least 3 feet of cover; and

(iii) Storm sewers require at least 1.5 feet of cover.

(c) Trench Widths

(i) Trench widths shall be as shown below where the maximum trench width is measured at the top of the pipe barrel:-

Pipe Diameter Inches	Maximum Trench Inches	Pipe Diameter Inches	Maximum Trench Inches
4	24	24	48
6	26	27	52
8	28	30	56
10	30	33	60
12	34	36	68
14	36	39	72
15	37	42	76
16	38	48	82
18	40	54	90
20	42	72	110
21	44		

(ii) If the stated maximum trench widths are exceeded, and if the Director determines that the combined dead- and live-loads will exceed the design loadings on the pipe, the Director may require the contractor to either cradle the pipe in concrete or use a pipe of a stronger class. Remedial measures shall be entirely at the contractor's expense.

(iii) As illustrated on Drawing No. 4.03 in Chapter 11, "Technical Drawings," of these Standards, the pipe trench shall be excavated to a depth below the bottom of the pipe, backfilled with the specified granular bedding material, and compacted to the requirements of these Standards.

(d) Trench Walls

(i) The contractor may slope or bench trench sidewalls in areas where an increased trench width will not interfere with surface features or other utilities. Such sloping or benching shall terminate at least 1 foot above the top of the pipe barrel; from that point down, the trench wall shall be vertical.

(ii) The trenching operation, including the spoil bank and the sloping of trench sidewalls, shall be confined to the width of any permanent and temporary rights-of-way or easements.

(iii) A sufficient clear area shall be maintained away from the top edge of the excavation to avoid overloading that may cause slides or caving of the trench walls. The excavated material shall be kept trimmed to avoid inconveniencing the public and adjoining property owners. Unless otherwise authorized by the Director, all public thoroughfares and crossroads shall be kept open to traffic. When required by the Director,



the contractor shall, at their own expense, provide open-cut bridging at street crossings, sidewalks, and other necessary points to prevent serious travel interruptions and to provide access to fire hydrants and public and private premises.

(e) **Trench Preparation**

- (i) The trench shall be excavated only so far in advance of pipe laying as permitted by the Director. Trench preparation shall also conform to the details shown on the drawings in Chapter 11, "Technical Drawings," of these Standards.
- (ii) Bell holes in the trench bottom shall be provided at each joint to permit the jointing to be made properly and to prevent the pipe from bearing on the pipe bells.
- (iii) After excavation, the trench bottom shall be uniformly graded and hand-shaped so that the pipe barrel (exclusive of the joint) will have uniform and continuous bearing on thoroughly compacted pipe bedding material throughout the length of the pipe.
- (iv) The trench grade shall permit the pipe spigot to be accurately centered in the preceding laid pipe joint, without lifting the pipe above the grade and without exceeding the permissible joint deflection. If raising the pipe subgrade is necessary, and approved by the Director, compacted bedding material may be used at the contractor's expense.
- (f) **Excavation Material:** Excess excavated material shall be removed from the construction site and disposed of by the contractor.
- (g) **Rock Excavation:** In the event of rock excavation, the bottom of the trench shall be lowered so that the bottom of the trench is 6 inches below the outside surface of the pipe. The space between the rock and the pipe shall be filled with granular bedding material. During its placement, the bedding material shall be shaped to provide support along the full length of pipe.

(9) **Installation of Pipe Bedding**

- (a) Pipe bedding material shall consist of the material as specified in Subsection 9.02(B)(2) of ~~these Standards~~ <sup>is chapter</sup>. Bedding material shall be placed to provide the grade and elevation specified on the approved plans.
- (b) After bedding material has been placed and approved, and after the pipe has been installed and approved, the additional granular bedding material shall be installed to an elevation 12 inches above the top of the pipe.

(10) **Installation of Trench Backfill**

- (a) Backfilling during freezing weather shall not be performed, except by permission of the Director. No backfill shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill.
- (b) Unless accurate results cannot be obtained, the compaction requirements shall conform to maximum dry density according to ASTM D698, Moisture- Density Relations of Soils (Standard Proctor). When the ASTM D698 test is not applicable, the percentage compaction requirements shall conform to ASTM D2049 Test for Relative Density of Cohesionless Soils.

- (c) When required by the Director, the contractor shall excavate backfilled trenches for purposes of performing compaction tests at locations and depths determined by the Director. The contractor shall be responsible for reinstalling and recompacting the test excavations.
- (d) All backfill above the bedding material shall be carefully placed and compacted. Except for the backfill requirements as set forth under Section 8-5-12, "Standards for Repairs and Restoration of Pavement or Sidewalks," B.R.C. 1981, approved backfill material shall be placed in loose lifts, not exceeding 8 inches thick, and shall be compacted by equipment and means approved by the Director. If the contractor wishes to use equipment and means other than what was approved for the project by the Director, the contractor shall submit, in writing, a request for approval of the proposed equipment and means to the Director for review and approval. Any approval by the Director, of an alternate method of compaction shall not relieve the contractor from providing a finished product that meets or exceeds all the intents and requirements of the approved plans and these Standards.
- (e) All backfill shall be compacted to 95 percent of maximum laboratory dry density or 70 percent relative density. The material shall be within 2 percent of optimum moisture content.
- (f) A loose layer of backfill material not more than 8 inches deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.

(11) **Structural Excavation and Backfill**

- (a) All structural excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
- ~~(b) Backfilling during freezing weather shall not be performed, except by permission of the Director. No backfill shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill.~~
- (be) The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for earthfills and embankments. Backfill materials shall be placed in loose lifts, not to exceed 8 inches in thickness, and shall be compacted to at least 95 percent of maximum dry density at optimum moisture content as determined by ASTM D698. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. Compaction of structure backfill by inundation with water will not be permitted.
- (ce) No backfill shall be deposited or compacted in water.
- (de) Particular care shall be taken to compact structure backfill that will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item

to be constructed or placed thereon.

(12) **Restoration**

- (a) **Streets and Roadways:** Any pavements disturbed during construction shall be repaired in accordance with the requirements as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981. All dirt and debris, including dust shall be removed from streets and paved surfaces within 3 days of the restoration of streets and paved surfaces. Initial removal of dirt and debris shall be made using a vacuum sweeper, after which the paved surfaces shall be cleaned using water hoses.
- (b) **Fencing and Culverts:** Restore all existing structures to conditions equal to or exceeding existing structures.
- (c) **Landscape**
  - (i) After other outside work has been finished, and backfilling and embankments completed and settled, all areas that are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas that have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.
  - (ii) Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to hand work. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.
  - (iii) Final grading and surfacing shall be smooth, even, and free from clods and stones larger than 1 inch in greatest dimension, weeds, brush, and other debris.
  - (iv) The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than, that underlying adjoining lawn areas.
  - (v) The Director will clarify restoration of other minor items as construction proceeds. Such items must be restored to equal or exceed existing conditions.
- (13) **Cleanup:** The contractor shall maintain a clean site at all times. Prior to final inspection and acceptance, the contractor shall remove all rubbish and excess materials and leave the area in a neat, satisfactory condition.
- (14) **Maintenance of Backfill:** ~~All~~ All backfill shall be maintained in a satisfactory condition and all places showing signs of settlement shall be filled and maintained for a period of 2 years following the date of final acceptance of all work. When the contractor discovers or is notified by the City that any backfill is not in compliance with City standards, the contractor shall correct such conditions. Any utilities and road surfacing damaged by such settlement shall be repaired by the contractor to the satisfaction of the City. In addition, the contractor shall be responsible for the cost of all claims for damages due to settlement of backfilled areas.

## 9.03 Ductile Iron Pipe (DIP)

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of ductile iron pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4 inches to ~~24~~30 inches.
- (2) **Quality Assurance:** ~~Manufacturer's~~Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) Ductile Iron Pipe:

- (a) Unless revised on the approved drawings, the ductile-iron pipe shall conform to ANSI A21.51, AWWA C151, Class 52 thickness. The interior of each length of pipe shall have a cement-mortar lining, conforming to the requirements set forth in ANSI A21.4, AWWA C104, of standard thickness. The exterior of the pipe shall be coated with standard bituminous-coating approximately 1 mil thick.
- (b) Unless otherwise specified, the pipe joint shall be the "push-on" type, made in accordance with ANSI A21.11, AWWA C111, and the gaskets shall be standard for buried water service and as provided by the pipe manufacturer.
- ~~(c) The fittings shall be ductile iron or cast iron conforming to the requirements set forth in ANSI A21.10, AWWA C110. All cast iron fittings 12 inches and smaller shall be Class 250, and fittings larger than 12 inches shall be Class 150. The interior of the fittings shall be epoxy or cement mortar lined, as is required for the pipe with a 1 mil bituminous exterior coating. The fittings shall have mechanical joints in accordance with ANSI A21.11, AWWA C111. The gaskets for the joints shall be suitable for potable water service.~~

- (2) **Polyethylene Encasement**~~Wrap~~: The ductile iron pipeline and fittings shall be encased in polyethylene film in accordance with the following requirements of ANSI A21.5, AWWA C105:

#### (a) ~~Polyethylene:~~

- ~~(i) The polyethylene film shall be manufactured of virgin polyethylene material conforming to the requirement of ASTM D 1248. The raw materials shall be Type 1, Class A (natural) or C (Black) Grade E 1 with flow rate of 0.4 maximum of dielectric strength of 1015 ohm-cm<sup>3</sup> minimum.~~
- ~~(ii) The finished polyethylene film shall have a minimum nominal thickness of 0.008 inch (8 mil), and the minus tolerance on thickness shall not exceed 10 percent of the nominal thickness. The film shall have a minimum tensile strength of 1200 pounds per square inch (psi) with an elongation of 300 percent minimum. The dielectric strength shall be 800-volts/mil thickness minimum.~~

- (a) All ductile iron pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in

accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices - Ductile Iron Pipe and Fittings.

- (b) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.
- (c) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.
- (d) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
- ~~(b)(c)~~ (e) Tube Size or Sheet Width: Table 9-35, “Tube Size and Sheet Width for Pipe Diameter,” shows the tube size or sheet width for each pipe diameter.

**Table 9-35: Tube Size and Sheet Width for Pipe Diameter**

Nominal Pipe Diameter (Inches)	Flat Tube (Inches)	Minimum Sheet Width (Inches)
4"	16"	32"
6"	20"	40"
8"	24"	48"
10"	27"	54"
12"	30"	60"
14"	34"	68"
16"	37"	74"
18"	41"	82"
20"	45"	90"
24"	54"	108"

### (C) Thrust Restraint

Where designated by the Engineer with expertise in thrust restraint systems, or where existing conditions do not permit the use of concrete thrust blocks, individual joint restraint systems shall be provided as follows:

- (1) **Alternative A:** Full length tie rods between joints. “Star” systems fabricated from “Cor-Ten” steel or equal or equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings.
- (2) **Alternative B:** Pacific States Lock Mechanical Joint with Tyton Joint Core, or equivalent. ~~Assembly of the Tyton Joint portion of the product shall be in accordance with AWWA C600-77. Fittings with ductile iron the joint restraint features shall be ductile iron and shall conforming to ANSI Standard A21.10. Push-on joints for such fittings shall be in accordance with AWWA Standard A121.11. Assembly of the joint portion of the product shall be in accordance with AWWA C600-77~~

(3) **Alternative C**

- (a) Follower gland type systems may be used for 12-inch diameter pipe and smaller. Pipe clamps shall be fabricated from “Cor-Ten” steel or an equivalent according to the requirements of ASTM A-242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings. The follower gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to AWWA C111 and C153.
- (b) The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. Twist-off nuts, sized the same as tee head bolts, shall be used to ensure proper actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain. The device shall have a working pressure of at least 200-psi with a minimum safety factor of 2:1.
- (c) Follower gland joint restraint devices shall be of the type listed below:
  - (i) “EBAA Iron, Inc.,” Megalug 1100 Series (4" -12" inches)
  - (ii) “Uniflange,” 1400 Series (4" -12" inches)

**(D) Connections to the Existing System**

- (1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.
- (2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved drawings.
- (3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the affected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.
- (4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the contractor shall advise such customer in writing ~~48~~24 hours in advance of when the supply will be disconnected and reestablished.

**(E) Execution**

- (1) **Installation of Ductile Iron Pipe:** Except as specified herein or unless specifically authorized by the Director, all installation of pipe shall conform to the recommendations contained in “~~A Guide for Installation~~ Guide for Ductile Iron Pipe,” published by the Ductile Iron Pipe Research Association. The contractor shall assure that a copy is available at the job site.
  - (a) Pipe Laying
    - (i) Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Director. Pipe shall be laid on the bedding with support over the full length of the pipe barrel.

- (ii) Table 9-46, "Ductile Iron Pipe Deflection," shows the maximum allowable pipe joint deflections.
- (iii) The information in the columns referring to the deflection and the approximate radii shall be adjusted for pipe lengths different than 18-foot lengths. Shorter pipe lengths will be required if a shorter radius is called for on the approved construction plans. Double hubs may be used to lay pipelines on curved alignment.

**Table 9-46: Ductile-Iron Pipe Deflection**

Size of Pipe (inches)	Approximate Radius of Curve Produced by:		
	Bend in One Joint (%)	Deflection in One 18-Foot Length (Inches)	Succession of 18-Foot Joints (Feet)
4	4	15	250
6	4	15	250
8	4	15	250
10	4	15	250
12	4	15	250
14	2	7.5	510
16	2	7.5	510
18	2	7.5	510
20	2	7.5	510
24	2	7.5	510

<u>Size of Pipe (Inches)</u>	<u>Approximate Radius of Curve Produced by:</u>		
	<u>Bend in One Joint (%)</u>	<u>Deflection in One 18-Foot Length (Inches)</u>	<u>Succession of 18-Foot Joints (Feet)</u>
<u>4 - 12</u>	<u>4</u>	<u>15</u>	<u>250</u>
<u>14 - 24</u>	<u>2</u>	<u>7.5</u>	<u>510</u>

- (iv) Vertical deflections shall not exceed any of the above values.
  - (v) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.
  - (vi) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed. The pipe end shall be beveled and free of sharp edges that could damage the gasket during installation.
- (b) Mechanical Joints: Mechanical joints shall be installed per the manufacturer's specifications and guidelines.

- (i) ~~The last 8 inches of the pipe spigot and the inside of the bell of the mechanical joint shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter from the joint, and then painted with a soap solution made by dissolving ½ cup of granulated soap in one gallon of water. The cast iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the spigot end. The gasket shall be painted with the soap solution and placed on the spigot end of the pipe to be laid, with the thick edge toward the gland.~~
- (ii) ~~The entire section of the pipe being laid shall be pushed forward to seat in the spigot end of the bell of the pipe in place. The gasket shall then be pressed into place within the bell, being careful to have the gasket evenly located around the entire joint. The cast iron gland shall be moved along the pipe into position for bolting, all of the bolts inserted, and the nuts screwed up tightly with fingers. All nuts shall then be tightened with a suitable (preferably torque limiting) wrench. The range of torque for various sizes of bolts shall be as follows:~~

Range of Torque	
Size (Inches)	Torque (Ft-Lb)
5/8	45-60
3/4	75-90
1	100-120
1 1/4	120-150

- (iii) ~~Nuts spaced 180 degrees apart shall be tightened alternately to produce an equal equivalent pressure on all parts of the gland.~~
- (c) Push-On Joints: For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. The proper gasket supplied with the pipe shall be placed in the bell ~~as described by the pipe manufacturer in compliance with the~~ manufacturer's specifications and guidelines so it will spring into its proper place inside the pipe bell. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket. ~~Then the pipe shall be forced all the way into the belt by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position.~~
- (d) Installation of Polyethylene ~~Encasement~~ Wrap
- (i) ~~The polyethylene encasement shall prevent contact between the pipe and the surrounding backfill and bedding material, but is not intended to be a completely air and watertight enclosure. Overlaps shall be secured by the use of 2-inch wide, 10-mil thick, polyethylene pressure sensitive tape.~~



- ~~(ii) The polyethylene wrap tubing shall be cut to provide for at least 1 foot of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using 3 circumvential turns of tape.~~
- ~~(iii) The loose wrap on the barrel is to be pulled snugly around the barrel of the pipe and the excess folded over at the top. This fold will be held in place by means of 6 inch strips of the tape placed at intervals of 3 feet along the pipe barrel.~~
- ~~(iv) All fittings, bends, reducers, and offsets shall be wrapped in the same manner as pipe.~~
- ~~(v) Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with tape. The valve bodies are then wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.~~
- (i) All pipeline and fittings shall be wrapped in polyethylene film in accordance with the requirements of ANSI A21.5, AWWA C105 and in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices -Ductile Iron Pipe and Fittings.
- (ii) The polyethylene wrap shall be overlapped 1 foot in each direction at all connections.
- (iii) The polyethylene wrap shall consist of three layers of co-extruded linear low-density polyethylene (LLD PE), fused into a single thickness of not less than 8 mils.
- (iv) The inside surface of the polyethylene wrap to be in contact with the pipe exterior can be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

(2) **Installation of Thrust Restraint**

- (a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.
- (b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on each side of the pipe. The tie rod nut should first be hand tightened with a 12-inch wrench (approximately 50 to 100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.
- (c) Follower gland type joint restraint systems shall be assembled according to manufacturer's instructions.

(3) **Testing:** Testing of ductile iron pipe shall be as specified in Section 9.13~~2~~, "Testing of Water Pipes," of these Standards.

- (4) **Backfilling and Restoring Surface Conditions:** Surface conditions shall be backfilled and restored as specified in Section 9.02, "Excavation and Trenching," of these Standards.
- (5) **Disinfecting Potable Pipelines:** Ductile iron pipe shall be disinfected as specified Section 9.124, "Disinfecting Waterlines," of these Standards.

## 9.04 Polyvinyl Chloride (PVC) Pressure Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) pressure pipe and appurtenances for potable water mains, water services and fire lines in the pipe diameter size range of 4" to 12" inches.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) PVC Pressure Pipe

- (a) ~~PVC pressure pipe shall be similar and equal to Class 200, and shall conform to AWWA C900, "Polyvinyl Chloride (PVC)" Pressure Pipe, 4 inch through 12 inch, for Water. All Class 200 pipe shall meet the dimension requirements of DR14 and shall have an equivalent cast iron pipe outside diameter.~~
- (b) ~~Unless otherwise specified the pipe joint shall be the "push-on" type, made from clean, virgin, NSF Approved Class 12454 A or 12454 B PVC conforming to requirements of ASTM D1784 (latest revision).~~
- (c) ~~Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Pipe shall be supplied in laying lengths of 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe shall have marked on the exterior the following:~~
  - (i) ~~Nominal size and OD base;~~
  - (ii) ~~Material Code Designation;~~
  - (iii) ~~Dimension Ratio number "DR 14" (iv) AWWA Pressure Class "PC 200;"~~
  - (v) ~~AWWA Designation, AWWA C900;~~
  - (vi) ~~Name or Trademark of Manufacturer; and~~
  - (vii) ~~National Sanitation Foundation Seal for Potable Water~~
- (d) ~~The fittings shall be ductile iron or cast iron conforming to the requirements set forth in ANSI A21.10, AWWA C110. Cast iron fittings 12-inch size and smaller shall be Class 250. The interior of the fittings shall be cement mortar or epoxy lined with a 1 mil bituminous exterior coating. The fittings shall have mechanical joints in accordance with ANSI A21.11, AWWA C111. The gaskets for the joints shall be suitable for potable water service.~~

- (a) All PVC pipe shall meet the requirements of AWWA C-900-16, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (4 – 12 inches) and shall be Pressure Class 305 psi (DR 14), or shall meet the requirements of AWWA C-905-08, Polyvinyl Chloride Pressure Pipe and Fabricated Fittings (14 – 48 inches) and shall be Pressure Class 235 psi (DR 18).
- (b) All pipe shall be suitable for use as a pressure conduit. Provisions must be made for expansion and contraction at each joint with a rubber ring. The bell shall consist of an integral wall section with a solid cross-section rubber ring which meets the requirements of AWWA C-900-07.
- (c) Laying length of pipe shall be 20 feet for all sizes of pipe.
- (d) Each length of pipe shall bear the date manufactured, type, grade, length, manufacturer's name, and NSF seal of approval.
- (e) Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint.
- (f) Solvent cement joints are prohibited.
- (g) The manufacturer shall furnish a certified statement that all specified tests and inspections have been made and the results thereof comply with the AWWA standards specified in this Subsection 9.04(B). A copy of the certification shall be sent to the City upon request.

(2) **Polyethylene Encasement**

- (a) All pipeline fittings and appurtenances shall be encased in polyethylene film in accordance with the ~~following~~ requirements of ANSI A21.5, AWWA C105.
- (b) The finished polyethylene film shall have a minimum nominal thickness of 0.008-inch (8 mil), and the minus tolerance on thickness shall not exceed 10 percent of the nominal thickness. The film shall have at least 1200-psi tensile strength of with an elongation of 300 percent minimum. The dielectric strength shall be at least 800 volts per mil thick.

- (3) **Tracer Cable:** Tracer wire shall be Type THHN, AWG size #12, UL listed with a single copper conductor, PVC insulation, and nylon jacket. Test stations at fire hydrants shall be CP Test Services, Glenn Series Glenn-4 with locking lid, 3½" x 4" inches, or approved equal.

**(C) Thrust Restraint**

- (1) ~~Where designated by the Engineer with expertise in thrust restraint system, or where existing conditions do not permit the use of concrete thrust blocks, individual joint restraint systems shall be provided as follows:~~
  - (a) ~~Alternative A: Full length tie rods between joints. "Star" systems fabricated from "Cor Ten" steel or equal according to the requirements of ASTM A 242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail drawings.~~
  - (b) ~~Alternative B: Follower gland type systems may be used for 12 inch diameter pipe and smaller. Pipe clamps shall be fabricated from "Cor Ten" steel or equal according to the requirements of ASTM A 242 with a minimum yield stress of 46,000 psi. The number and diameter of tie rods shall be as shown on the detail~~

~~drawings. The follower gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to AWWA C111 and C153.~~

- ~~(c) The restraint mechanism shall consist of either numerous individually activated gripping surfaces to maximize restraint capability, or a series of machined serrations designed to grip the entire pipe surface. Twist off nuts, sized the same as tee head bolts, shall be used to insure proper actuating of restraining devices. When the nut is sheared off, a standard hex nut shall remain. The device shall have a working pressure of at least 200 psi with a minimum safety factor of 2:1.~~
- ~~(d) Follower gland type joint restraint devices shall be of the type listed below:~~
  - ~~(i) "EBAA Iron, Inc." Megalug 2000 PV Series (4" -12")~~
  - ~~(ii) "Uniflange" 1300 and 1390 Series (4" -12")~~

(1) **Required:** All fittings and joints shall be restraint from movement due to hydraulic forces with concrete thrust blocks as shown in Chapter 11, "Technical Drawings," of these Standards except where existing conditions or other practical difficulties do not permit the use of concrete thrust blocks. Where the applicant demonstrates to the satisfaction of the Director that existing conditions or other practical difficulties do not permit the use of concrete thrust blocks, individual restraint systems shall be provided meeting one of the following:

- (a) **Alternative A - Full Length Threaded Tie Rods:** Threaded rods shall be Type 316L stainless steel coated with an anti-galling compound. Connecting T-bolts and nuts shall be Type 316L stainless steel coated with an anti-galling compound or corrosion resistant fluorocarbon coating such as "NSS Industries" Cor-Blue or "Star Pipe Products" Core Blue. The number and diameter of tie rods shall be as shown on the approved plans.
- (b) **Alternative B - Follower Gland Type Mechanical Joint Restraint Systems:** Follower gland type mechanical joint restraint systems may be used only for 16-inch diameter and smaller pipe. Restraint rings shall be manufactured of ductile iron conforming to ASTM A536, Grade 65-45-12 with a factory applied fusion epoxy coating. The mechanical joint follower gland shall be incorporated into the restraint. Connecting T-bolts and nuts shall be as required in Alternative A.
- (c) **Alternative C - Bolt-Through Positive Restraint Mechanisms:** A bolt-through positive restraint mechanism may be used only for connecting 12-inch diameter and smaller mechanical joint valves and fittings. It shall not be used for pipe attachment or fire hydrant connections. Adaptor body shall be made of ductile iron, conforming to ASTM A536 80-55-06 with styrene butadiene rubber gaskets conforming to AWWA C111. Connecting T-bolts and nuts shall be as required in Alternative A.

(2) **Bell-And-Spigot Joints:** Restraint devices for PVC pipe bell-and-spigot joints may be used, if approved by the Director, for sizes 4 to 16 inches. Devices shall be of ductile iron conforming to ASTM A536. Connecting T-bolts and rods as required in Alternative A.

(3) **Mechanical Joint Restraint Required:** Mechanical joint restraint devices are required for the following installations:

- (a) Fire hydrants;
  - (b) Fire line connections;
  - (c) Three inch and larger domestic line connections;
  - (d) Reducers;
  - (e) Vertical and horizontal offsets (all angles);
  - (f) Bends, line valves, and fittings;
  - (g) Bulkheads and plugs;
  - (h) Bored casing carrier pipe; and
  - (i) When the bearing capacity of the soil is not sufficient to provide adequate restraint, as determined by the Director.
- (4) **Mechanical Joint Restraint Design Requirements:** The mechanical restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability; or a series of machined serrations designed to grip the entire pipe surface; or a system that is integral to the gasket. For twist-off nut-type designs, the nuts shall be sized the same as T- bolts and be used to insure proper actuating of restraining devices. When the nut head is sheared off, a standard hex nut shall remain. All devices shall have a working pressure of at least 200 psi with a minimum safety factor of 2:1.
- (5) **Follower Gland Type Joint Restraints:** Follower gland type joint restraint devices shall be of the type listed below:
- (a) “EBAA Iron”
    - (i) Megalug 2000 Series for PVC (4 to 16 inches)
    - (ii) Megalug 1600 Series for PVC (4 to 12 inches) Pipe Bell Joints
    - (iii) Megalug 2800 Series for PVC (14 inches and larger)
  - (b) “Star Pipe Products”
    - (i) Domestic PVC Stargrip Series 4000 (4 to 12 inches)
    - (ii) Domestic 1100C Bell Restrainers Series 1100 for PVC Pipe Bell Joints
  - (c) “U.S. Pipe”: MJ FIELD LOK Gasket with MJ FIELD LOK Gland, Series for PVC (4 to 12 inches)
  - (d) “Romac Industries”: PVC RomaGrip Series, fusion bonded polyester coating is required if using C909 PVC
- (6) **Bolt-Through Mechanical Joint Restraints:** Bolt--through mechanical joint restraint devices shall be of the type listed below:
- (a) “Infact Corporation”: Foster Adaptor (4 to 12 inches) with fusion bonded epoxy coating. Standard foster adaptor accessory pak is required for restraining C153 compact fittings and valves

**(D) Connections to the Existing System**

- (1) **System Operation:** Operation of the existing system must at all times remain under the control of the Director. The contractor shall operate no valves or hydrants on the system without permission from the Director.
- (2) **Connections:** All points at which the existing water systems are to be disconnected and connected to the new mains must be shown on the approved construction plans.
- (3) **Utility Service Interruptions:** The contractor shall take all precautions necessary to minimize interruption of all utility services and will be responsible for the restoration of the effected service. The contractor shall schedule existing valve locates with the Director at least 3 days before scheduling a shutoff.
- (4) **Customer Notification:** Unless otherwise specified, at any time a customer on the existing system will be deprived of a supply of water, the owner-developer-contractor shall advise such customer in writing 2448 hours in advance of when the supply will be disconnected and when the supply will again be available.

**(E) Execution**

- (1) **Installation of PVC Pressure Pipe:** Unless specifically authorized by the Director, all pipe shall be installed as follows:
  - (a) Pipe Laying
    - (i) Pipe shall be laid with bell ends facing in the direction of laying. No deflection in the joints shall be allowed. Whenever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or to plumb valve operators, the pipe itself may be uniformly curved as shown in Table 9-57, "Pipe Laying."

**Table 9-57: Pipe Laying**

Approximate Pipe Size (Inches)	Offset in 20-Foot Length (Inches)	Radius of Curve (Feet)
4"	15"	120'
6"	15"	160'
8"	15"	250'
10"	15"	300'
12"	15"	400'

- (ii) Pipe deflection for curvature shall not be permitted at temperatures less than 32° F ambient temperature.
- (iii) When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Director.
- (iv) The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. ~~The flame cutting of pipe by means of an oxyacetylene torch will not be allowed.~~

Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field cut pipe.

- (v) Tracer wire shall be attached to the pipe as shown in Chapter 11, "Technical Drawings," of these Standards.
- (b) Mechanical Joints: ~~The outside of the spigot and the inside of the bell shall be wiped thoroughly clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell manually, with blocking and bar, or with special jacks. Position the completed joint so that the mark on the pipe end is in line with the end of the bell. Pipe joint shall not be assembled using power or trenching equipment. Mechanical joints shall be installed per the manufacturer's specifications and guidelines.~~
- (c) Push-On Joints: For push-on joints, the exterior 4 inches of the pipe at the spigot end and the inside of the adjoining bell and particularly the groove for the gasket shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter. A thin film of the pipe manufacturer's joint lubricant shall be applied to the gasket over its entire exposed surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket. ~~Then the pipe shall be forced all the way into the bell by crowbar, or by jack and choker slings. The location of the gasket shall be checked with a gauge or tool designed for that purpose to assure that the gasket is in the proper position. Position the completed joint so that the joint mark on the pipe end is in line with the end of the bell.~~
- (d) ~~Installation of Polyethylene Encasement~~
  - (i) ~~The polyethylene encasement shall prevent contact between the pipe fittings and the surrounding backfill and bedding material, but is not intended to be a completely air and watertight enclosure. Overlaps shall be secured by the use of 2-inch wide, 10-mil thick, polyethylene pressure sensitive tape.~~
  - (ii) ~~The polyethylene wrap tubing shall be cut to provide for at least 1 foot of lap over both the adjoining pipes. The ends of the tubing shall be wrapped using 3 circumvential turns of tape.~~
  - (iii) ~~The loose wrap on the barrel is to be pulled snugly around the barrel of the fitting and the excess folded over at the top. This fold will be held in place by means of two, 6-inch strips of the tape.~~
  - (iv) ~~Valves shall be wrapped by bringing the tube wrap on the adjacent pipe over the bells of the valve and sealing with tape. The valve bodies are then wrapped with flat sheets passed under the valve bottom and brought up around the body to the stem and fastened with the tape.~~

## (2) Installation of Thrust Restraint

- (a) Thrust blocks shall be poured between undisturbed solid ground and the fitting to be anchored. The area of bearing on the undisturbed trench wall shall be that shown on the thrust block detail or directed by the Director. The concrete shall be

placed so that the pipe or fitting joints will be accessible for repair. A bond breaker shall be placed over the fitting before placing concrete.

- (b) Full length tie rods between joints with pipe clamps shall be assembled using clamps on each side of pipe bells with tie rods extending the full pipe length for the dimensions shown on the drawings each direction from the restrained fitting, valve or joint. Clamps shall be installed tight enough to prevent twisting around the pipe. A washer shall be used at each clamp and tie rods shall be located on each side of the pipe. The tie rod nut should first be hand tightened with a 12-inch wrench (approximately 50-100 foot-pounds torque). Threaded tie rods shall extend two full threads past each nut in the final position.
  - (c) Follower gland type joint restraint systems shall be assembled according to manufacturer's instructions.
- (3) **Installation of Tracer Cable:** Tracer wire shall be spirally wrapped around the pipe exterior, 2 wraps minimum per 20-feet of pipe, as it is installed in the trench or taped to the top of the pipe. Splices due to breaks in wire continuity shall be made by stripping insulation coating from each wire with wire stripper pliers. Wires shall be joined with a solderless connector, 3M Direct Bury Splice Kit or approved equivalent equivalent in suitability, strength, effectiveness, and durability as approved by the Director. The join shall be made in accordance with manufacturers instructions. The solderless connector shall be covered with Emmerson Electric Seal-A-Conn II putty or approved equal.
- The wire shall form a continuous electrical circuit between any 2 contact points on the new pipeline, including branch lines and fire hydrant laterals. Wire shall be stubbed out to the point where the new pipe connects to the existing main unless otherwise directed by the Director. Where the wire terminates at a point where there is not an installed wire, the ends of the wire shall be stripped bare a minimum of 18-inches and grounded into the native soil material. Special care should be taken to avoid contact from the tracer wire to steel gas service lines.
- (4) **Testing:** Testing of PVC pressure pipe shall be as specified in Section 9.132, "Testing of Water Pipes," of these Standards.
  - (5) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.
  - (6) **Disinfecting Potable Pipelines:** PVC pressure pipe shall be disinfected as specified Section 9.124, "Disinfecting Waterlines," of these Standards.

## 9.05 Water Services

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of water services and fire lines in the pipe diameter size range of 3/4 to 2 inches. For water services and fire lines greater than 2 inches in diameter refer to Section 9.03, "Ductile Iron Pipe," Section 9.04, "Polyvinyl Chloride (PVC) Pressure Pipe," Section 9.06, "Gate Valves," and Section 9.08, "Tapping Sleeves and Valves," of these Standards.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.



**(B) Materials**

- (1) **Pipe:** Pipe shall be Type K copper, soft drawn, in accordance with ASTM B88.
- (2) ~~**Fittings:** Use flared fittings to match pipe such as “Mueller” H 15400, “Ford” C22, or approved equivalent. Use bends such as “Mueller” H 15525, “Ford” L22, or approved equivalent.~~
- (2) **Curb Stops:** All curb stops shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). Curb stop valves shall be ball type with a maximum working pressure of 300 psi and shall have compression fittings.
- (3) **Corporation Stops:** ~~Corporation stops shall be “Mueller” H 15000, “Ford” F600, or approved equivalent.~~
  - (a) All corporation stops and threaded brass fittings shall be manufactured in accordance with AWWA C800-05, Underground Service Line Valves and Fittings, and shall be constructed of brass in accordance with ASTM-B62 (common trade name 85-5-5-5). All corporation stops shall be tested at the factory and shall meet the following minimum physical requirements:
    - (i) Tensile strength 30,000 PSI minimum.
    - (ii) Yield Strength 14,000 PSI minimum.
    - (iii) Elongation in 2 inches 20 percent minimum.
  - (b) Corporation stops shall be ball valve type designed for a maximum working pressure of 300 psi. The inlet side shall have AWWA taper thread (CC thread) and the outlet side shall have a compression fitting.
  - (c) Corporation stops shall be the following type or a corporation stop approved by the Director as equivalent in design and composition to the following types:
    - (i) Ford – FB1000-3-NLG.
    - (ii) Mcdonald – 74701BQ No lead brass.
    - (iii) Mueller – B25008N.
- (4) **Water Meters:** ~~Water meters, meter pit and cover, interior piping and yoke shall be purchased from the City of Boulder.~~
  - (a) General: All water meter installations shall be in accordance with the following standards and the drawings in Chapter 11, “Technical Drawings,” of these Standards for all water services:
    - (i) All meters shall be “Badger” meters.
    - (ii) No connections shall be made in the meter pit other than those related to the meter and bypass. Sprinkler system or backflow preventer connections shall be made no closer than 5 feet from the meter pit or vault on the downstream side of the meter.
    - (iii) The City will own and maintain the service line and fittings up to and including the meter.

- (iv) Residential 3/4-inch meters with transponders shall be provided and installed by the City upon the contractor's request for a final meter inspection. All other meters and associated transponders shall be purchased by the contractor and then provided to the City for testing prior to installation.
- (v) The contractor shall contact the City's Meter Shop prior to purchasing meters and transponders to verify the type of meter that will be required. The contractor shall also contact the City's Meter Shop to make an appointment for delivery of the meter(s) to the City for testing. The location of installation and manufacturer's information shall accompany the meter when delivered by the contractor to the City. The meter will be tested and a schedule set for picking up the meter within two working days by the contractor.
- (b) 3/4-Inch and 1-Inch Meter Installations: 3/4-inch and 1-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

  - (i) The meter shall be installed within right-of-way or a public easement.
  - (ii) No meter shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces.
  - (iii) In attached sidewalk areas, the meter shall be located a minimum of 18 inches from the back of the sidewalk to the edge of the meter lid.
  - (iv) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back edge of the curb.
  - (v) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.
  - (vi) The dome or meter lid shall be level and 2 inches above the approved final grade.
  - (vii) The copper setter shall be a minimum of 15 inches and a maximum of 17 inches below the meter pit lid.
  - (viii) Meter pits shall be constructed of modified hi-density polyethylene. The size shall be as specified in the detail drawing in the appendix of this Chapter. Grade adjustment shall be made at the top of the pit using concrete rings. The trench floor under the concrete rings shall be compacted earth. The concrete pit shall not bear on the service pipe.
  - (ix) Lids shall be a 12-inch cast iron lid and bonnet and shall have a 2-inch diameter hole in the center to accommodate the transponder.

- (x) Final inspections of the meter pit will be made at the time the meter is set. The permit applicant is responsible for any required adjustments to the copper setter or meter lid at that time.
- (c) 1-1/2-Inch and 2-Inch Meter Installations: 1-1/2 -inch and 2-inch meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

  - (i) The meter model shall be Badger E112 SS 1 ½ Model 120 or Badger E2 SS 2 Model 170.
  - (ii) 1-1/2-inch and 2-inch meters shall be installed in a manhole.
  - (iii) A meter manhole shall be installed within the right-of-way or a public utility easement.
  - (iv) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.
  - (v) In attached sidewalk areas, the meter manhole shall be located a minimum of 3 feet behind the sidewalk and in no case shall the manhole be located more than 25 feet from the back edge of curb.
  - (vi) Where no sidewalk exists, the meter manhole shall be located a maximum of 6 feet behind the back of curb.
  - (vii) In detached sidewalk areas, the meter manhole shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.
  - (viii) Meter manhole lids shall be a maximum of 2 inches above the approved final grade.
  - (ix) A curb stop is required on the service line behind the back of curb and outside of the manhole.
  - (x) Meter manholes shall use a 24-inch aluminum ring and cover, and the outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch thick concrete collar shall be placed around the manhole ring.
  - (xi) The manhole cover shall have a 2-inch diameter recessed hole in the center of the cover for the transponder, and the cover shall have the lettering "Water Meter" cast into the lid.
- (d) 3-Inch and Larger Meter Installations: 3-inch and larger meter sets shall be installed in accordance with the following standards and the drawings in Chapter 11, "Technical Drawings," of these Standards:

- (i) 3-inch and larger meters shall be installed in a vault.
- (ii) The entry hole through the roof of the vault shall be aligned perpendicular to the service line and adjacent to the water meter.
- (iii) Vaults shall be sealed at all joints and made watertight.
- (iv) Meter vault lids shall be a maximum of 2 inches above the approved final grade.
- (v) In attached sidewalk areas, the meter vault shall be located a minimum of 5 feet behind sidewalk or back of curb and no more than 25 feet from the back of curb.
- (vi) Where no sidewalk exists, the meter shall be located a maximum of 6 feet behind the back of curb.
- (vii) In detached sidewalk areas, the meter shall be located a maximum of 6 feet behind the back edge of curb but no closer than 18 inches from the front edge of the sidewalk to the edge of the meter lid.
- (viii) A curb stop is required on the service line behind the back of curb and outside of the vault.
- (ix) The meter vault shall be installed within the right-of-way or a public utility easement.
- (x) No meter manhole shall be set in a street, sidewalk, driveway alignment, or other traffic or concrete area except where existing conditions or other regulatory requirements prevent installation consistent with this requirement. Where existing conditions or other regulatory requirements prevent installation consistent with this requirement, the Director may approve an alternative design that minimizes the impact of meter maintenance and replacement activities on adjacent structures, infrastructure, and paved surfaces. If the meter manhole is approved for construction in streets or other traffic areas the manhole shall use a 24-inch cast iron ring and cover and shall be designed to accommodate and protect the transponder.
- (xi) Meter vaults shall use a 24-inch aluminum cover and shall have the lettering "Water Meter" cast into the lid.
- (xii) A 24-inch x 36-inch aluminum cover adaptor and ring shall be used to enlarge the access opening, and the adaptor shall have a 2-inch diameter hole for the transponder. The outside of the aluminum ring shall have 8 mils of tar applied. Once the tar is set, a 12-inch wide by 6-inch thick concrete collar shall be placed around the manhole ring.
- (xiii) PVC pressure pipe shall be used on the service line outside the vault except where the PVC pipe stubs through the vault walls. Ductile iron pipe shall be used inside the vault.
- (xiv) For all 3-inch and 4-inch meter settings, 4-inch service pipe will be required on the City side of the meter. A reducer will be required before the meter and on the bypass for 3-inch settings. Insulators shall be provided between connections of dissimilar metals. Meter installations

larger than 4 inches shall require submittal of drawings for approval by the Director.

(xv) A minimum of distance 5 times the pipe diameter of straight, unobstructed pipe is required upstream of the meter.

(xvi) Final inspections of the meter vault will be made at the time the meter is set.

- (5) **Service Saddles:** ~~Corporation stops require the installation of a double strap bronze service saddle, similar and equivalent to "Rockwell" No. 323, with PVC pipe or brass service saddles similar and equivalent to "Ford" No. S90. No direct taps to PVC pipe shall be allowed.~~ Corporation stops require the installation of a bronze or brass bodied service saddle with 304L stainless steel double straps and studs, equivalent in design and composition to "Mueller" BR 2 S series or "McDonald" 3855 series for cast iron or PVC. All saddles require an AWWA tapered thread (CC) outlet. No direct taps to PVC pipe are allowed.
- (6) **Insulators (Ferrous Pipes only):** Insulators shall be installed at the inlet end of the corporation stop and shall be Ford Service Insulators or an approved equivalent for service lines.

## (C) Execution

### (1) General

- (a) Size as shown, lay to grades and lines in accordance with pipe manufacturer's specifications. Thoroughly clean pipe interiors of foreign matter before placing into trench. Replace with new pipe any laid section of pipe found damaged or defective. All pipe fittings, valves, and appurtenances shall be installed according to manufacturer's instructions. Corporation stops shall be installed with the appropriate tapping machine in the presence of the Director after the waterline has been pressure tested.
- (b) All bedding, pipe zone backfill, compaction, polyethylene sheathing and other details of the water pipeline construction shall be returned to original condition after service connections are completed.
- (c) Service connections to all ferrous mains shall be electrically insulated by means of a City approved insulating fitting.

(2) **Pipe Cutting:** ~~Cutting~~ Cutting shall be done neatly by methods that will not damage pipe.

~~(3) **Water Meters:** Water meters shall be installed as indicated in Chapter 11, "Technical Drawings," of these Standards for all water services. Before water meters are installed, the Director will determine the location for their placement.~~

(34) **Testing:** Testing of water service pipe shall be as specified in Section 9.132, "Testing of Water Pipes," of these Standards.

(45) **Backfilling and Restoring Surface Conditions:** Backfilling and Restoring surface conditions shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.

(56) **Disinfecting Potable Pipelines:** Water service pipe shall be disinfected as specified Section 9.124, "Disinfecting Waterlines," of these Standards.

## 9.06 Gate Valves

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of gate valves and appurtenances for potable water service in the pipe diameter size range of 4 to 12 inches.
- (2) **Quality Assurance**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) All valves shall be tested in accordance with AWWA C500 or C509. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

- ~~(1) **Gate Valves:** Gate valves shall be iron bodied, resilient seat or epoxy coated double disc, with non rising stem conforming to AWWA C500 or C509. Valves shall open counterclockwise and shall be rated for a design working pressure of 200 psi. Double disc type valves shall be bronze mounted with parallel seats. All buried valves shall have one 2 inch square operating nut. Mechanical or push on joints appropriate for buried installations shall be provided. Where valves are installed at tee connections, a swivel adaptor shall be used to restrain the valve to the tee. Bolts, studs, and nuts shall be cadmium plated or zinc coated.~~
- ~~(2) **Extension Stems**~~
  - ~~(a) Extension stems with a 2 inch square operating nut and a support for the upper end of the extension shall be provided for all valves installed more than 5 feet deep. The operating nut shall be located within 5 feet of the finished grade. Extension stems shall be mechanically connected to the operating nut. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from galvanized steel pipe having an ID not smaller than the OD of the valve stem. Extension stems shall be connected to the valve by a flexible socket type coupling. All connections shall be pinned, keyed, or socket type. Pipe couplings will not be acceptable.~~
  - ~~(b) Each extension stem for a buried valve shall extend to within 6 inches of the ground surface, shall be provided with spacers that will center the stem in the valve box, and shall be equipped with a wrench nut.~~

#### (1) **Gate Valves**

- (a) Gate valves are required for 4-inch through 12-inch valve sizes. The Director may approve a different valve type where practical installation of a gate valve is not feasible.
- (b) Gate valves shall be iron body, resilient-seated gate valves with non-rising bronze stems with design, construction, and pressure ratings conforming to AWWA Specifications C-509-01, Resilient Seated Gate Valves, or C515-01, Reduced Wall Resilient Seated Gate Valves, and with modifications specified herein.

- (c) Stem seals shall be triple "O" ring seals designed so that the seals above the stem collar can be replaced with the valve under pressure and in full open position.
- (d) Gate valves shall be one of the following types:
  - (i) American Flow Control, Series 2500 (C515 only).
  - (ii) Mueller, Series 2360 (C509 only).
  - (iii) American AVK.
  - (iv) Series 45 CLOW Valves, Models 2639 and 2640.
- (e) With the exception of tapping valves and valves in vaults, gate valves shall have mechanical joint ends.
- (f) All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.
- (g) The resilient seat gate valve stem shall have external break-off capabilities for over-torquing and positive stop to prevent over compression.
- (h) All external bolts, nuts, and washers used in conjunction with valves shall be stainless steel, and tee-bolts shall be "Cor-blu".
- (i) Valves shall be delivered complete with bolts, glands, and rubber gaskets in conformance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

**(32) Valve Boxes**

- (a) All buried valves shall be provided with valve boxes. Valve boxes shall be of cast iron, 3 piece screw type, suitable for the depth of cover required by the drawings. Valve boxes shall be 5 ½ inches in diameter, shall have a minimum thickness at any point of 1/16 inch, and shall be provided with suitable cast iron bases and stay-put covers. Covers shall have cast thereon "water" on the top. They shall be Tyler 6860 series or approved equal.
- (b) The valve box shall have at least 6 inches adjustment above and below specified depth of cover over pipe.
- (c) All parts of valve boxes, bases, and covers shall be coated by dipping in bituminous varnish.
- (d) Valves and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

- (4) **Special Wrenches and Keys:** All tools needed to operate valve and to open valve box lid. At least one of each type as required for each style and size of box and lid shall be furnished by the contractor. Provide 1 key for each valve. Key lengths shall be as approved by the Director.

## (C) Execution

- (1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.
- (2) **Installation:** Install valves as indicated in Chapter 11, "Technical Drawings," of these Standards, and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation.
- (3) **Valve Boxes:** Install a valve box over the gate valve with the base section centered over the operating nut and resting on well-compacted backfill. The top section shall be so set as to allow equal movement above and below finished grade, with the final elevation to be 1/4 inch below finished grade in roadways and 1 to 2 inches above grade outside of roadways. The top of base section shall be placed approximately on line with the operating nut at the top of the valve stem, and the entire assembly shall be plumb.
- (4) **Tests:** Gate valve tests shall be with and part of the general tests on the companion water lines.
- (5) **Disinfection:** Gate valve disinfection shall be done with and as a part of the disinfection to the companion water lines.

## 9.07 Butterfly Valves

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of ~~gate-butterfly~~ valves and appurtenances for potable water service in the pipe diameter size range of 12 inches to 24 inches.
- (2) **Quality Assurance:** Manufacturer's installation recommendations and certificates of compliance shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
- (3) **Testing:** All valves shall be tested in accordance with Section 3.8 of AWWA C504. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

- (1) **Butterfly Valves**
  - (a) Butterfly valves shall be rubber-seated conforming to the AWWA C504 and designed for buried service. The valves shall be designed to operate as open or closed with a design velocity of 8 feet per second. The valves shall have a cast-iron body with mechanical joint ends conforming to ANSI 21.11, AWWA C111 and shall be rated for a design working pressure of 150 psi. ~~Valves shall be manufactured by Keystone or equal.~~ Butterfly valves shall be one of the following types: Mueller, Lineseal III and XP11 (sizes up to 48 inches), Pratt, Triton XR-70



(sizes 24 inches to 72 inches), or K-Flo 500 Series (sizes up to 20 inches); unless a butterfly valve equivalent in design and composition to these types has been approved by the Director.

- (b) Discs shall be cast or ductile iron with stainless steel, type 304, either stub or one piece shafts. Discs shall be secured to shafts by means of solid, smooth sided, stainless steel or monel pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of bolts, setscrews, knurled or fluted dowel pins, expansion pins, roll pins spring pins, or other devices in lieu of the pins specified herein will not be acceptable.
- (c) Shaft bearings shall be the bushing type of nylon or Teflon. Thrust bearings that are directly exposed to line liquid and that consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable. Shaft seals may be rubber ring or chevron packing.
- (d) Seats shall be rubber vulcanized to the body and designed to provide bubble tight shutoff with mating surface of Type 304 or 316 stainless steel or monel mounted on the discs. Valve seat configurations that rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.
- (e) The valve operator shall be the traveling-nut type designed for previous stated conditions, in an enclosed body, sealed to prevent the entrance of groundwater up to the depth of 5 feet above the valve. The operator shall have travel limiting devices to prevent over closing or opening damage to the valve. Valves shall open counterclockwise with the use of a valve key on a 2-inch square operating nut. The housing of traveling-nut type actuators shall be fitted with a removable cover that shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve.
- ~~(f) Extension stems, valve boxes and special wrenches and keys shall be as specified in Section 9.06(B), "Materials," of these Standards.~~

### (C) Execution

- (1) **Handling:** All valves and actuators shall be transported and stored in a manner that will protect them from damage.
- (2) **Installation:** Install valves with the shaft horizontal according to the manufacturer's recommended installation procedures. Operate all valves from full open to full close before installation. Check all seats, seat rings, shaft sleeves, disc connections, etc. prior to installation.
- (3) **Valve Boxes:** Install valve boxes over the valve operator with the base section centered over the operator nut and resting on well-compacted backfill. The top section shall be set to allow equal movement above and below finished grade, with final elevations to be 1/4 inch below finished grade in roadways and 1 inch to 2 inches above grade outside of roadways. The top of base sections shall be placed approximately on line with the operator nut at the top of the valve stem, and the entire assembly shall be plumb.
- (4) **Tests:** Butterfly valve tests shall be done with and as a part of the general tests on the companion water lines.

- (5) **Disinfection:** Butterfly valve disinfection shall be done with and as a part of the general disinfection to the companion water line.

## 9.08 Tapping Sleeves and Valves

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of tapping sleeves and valves for potable water service in the pipe diameter size range of 4 inches to 12 inches.
- (2) **Quality Assurance**
- (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) The manufacturer of tapping sleeves and valves shall be experienced in their design and construction, shall be regularly engaged in their manufacture, and shall have produced tapping sleeves and valves of the sizes specified herein that have given successful service for a period of at least 5 years.

### (B) Materials

#### (1) General

- (a) All tapping sleeves shall be constructed of stainless steel that meets or exceeds the requirements of ASTM A240 Type 304 UNS designated S30400. Tapping sleeves shall be "Romac Industries" SST, "Mueller" H-304L, "Ford" FTSS, "JCM" 432, or a tapping sleeve of equivalent design, material, and rating approved by the Director.

~~All steel plate used in fabrication of the tapping sleeves shall conform to ASTM Designation A 36 or A 285, Grade C. Tapping sleeves shall be Mueller "No. H-615" or equivalent for standard pipes and Ford "FTSS" or equivalent for oversized pipes~~

- (b) Extension stems, valve boxes, and special wrenches and keys shall be as specified in Section 9.06(B), "Materials," of these Standards.
- (2) **Flanges:** Flanges shall be fabricated from steel plate, and all dimensions shall conform to AWWA Standard C207, Class D. Flanges shall be machined to a flat rate with finish of 250 micro inches or machined to a flat surface with a serrated finish in accordance with AWWA Standard C207. In addition, the machined face shall also be recessed for tapping valves in accordance with the MSS Standard SP-60.
- (3) **Gaskets:** Gaskets shall be compounded from new materials, and the shape and cross-section of the gasket shall provide adequate seal for the design pressure. Gaskets shall be shop glued to the groove provided in the body section.
- (4) **Fasteners:** Bolts and hex nuts shall be stainless steel, "Usalloy", "Dresserloy", "Cor-Ten" or an approved equivalent for corrosion control.
- (5) **Testing Outlet:** A 3/4 inch NPT by welded coupling shall be attached to the outlet nozzle of each tapping sleeve assembly, complete with a 3/4 inch square head pipe plug.

- (6) **Tapping Valves:** With the exception of the valve ends and other modifications necessary for tapping service, tapping valves shall be as specified in Section 9.06(B), "Materials," of these Standards. Each tapping valve shall be provided with a flanged inlet end designed, faced and drilled for attachment to the outlet flange of the tapping sleeve; an outlet end provided with a tapping flange for attachment of a standard drilling machine; and a mechanical joint bell end for connection of the branch main. The size of the waterway shall include the appropriate clearance for the diameter of the tapping machine cutter recommended by the valve manufacturer. Tapping valves shall be Mueller "No. H-667" or equal.
- (7) **Painting:** ~~All ferrous metal surfaces of tapping sleeves, valves and accessories, both interior and exterior, shall be shop painted for corrosion protection. The valve manufacturer's standard paint will be acceptable provided it is functionally equivalent to the specified paint and is compatible with the specified field painting.~~
- (a) ~~Materials:~~
- (i) ~~Asphalt Varnish: Fed. Spec TT-V-51;~~
  - (ii) ~~Coal Tar: Koppers "Bitumastic Super Tank Solution;"~~
  - (iii) ~~Epoxy: Mobil "78-D-7 Tank Lining Epoxy;"~~
  - (iv) ~~Rust Preventative: Houghton "Rust Veto 344;" or~~
  - (v) ~~Rustoleum Compound "R-9."~~
- (b) ~~Surfaces to be painted:~~
- (i) ~~Unfinished Surfaces;~~
  - (ii) ~~Interior: Asphalt varnish (two coats), coal tar or epoxy;~~
  - (iii) ~~Exterior (Buried or Located in Manholes): Asphalt varnish or coal tar;~~
  - (iv) ~~Polished or Machined Surfaces: Rust preventative compound; and~~
  - (v) ~~Operators and Accessories: Rust inhibitive primer.~~

All ferrous internal and external surfaces of the valves shall be epoxy coated in conformance with AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings, and C550-05, Protective Interior Coatings for Valves and Hydrants. The coating shall be a two-part thermosetting epoxy suitable for field over coating and for touch-up with the same coating material without special surface preparation. The supplier shall furnish detailed performance tests of adhesion, hardness, and abrasion resistance of the furnished coatings when requested by the City. The coating shall have a successful record of performance in valves, pipe, or other fittings for a minimum of ten years.

## (C) Execution

- (1) **Tapping Valves:** Install tapping valves in the lines as indicated on the drawings, and set plumb on a firm base. All foreign matter shall be removed from the valve interior prior to installation. Valves shall be securely bolted to the tapping sleeve in accordance with the manufacturer's instructions using the fasteners specified in Subsection 9.08(B)(4), ~~above~~ of these Standards.

- (2) **Tests:** Valve tests shall be done with and as a part of the general tests on the companion waterlines.
- (3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterline.

## 9.09 Fire Hydrants

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of fire hydrants for potable water service.
- (2) **Quality Assurance**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) All valves shall be tested in accordance with Section 5.1 of AWWA C502. Certified copies of the results of all tests, together with an affidavit of compliance shall be provided to the City inspector prior to construction.

### (B) Materials

~~Hydrants may be purchased from the City of Boulder Fire Department, and shall be Mueller Centurion A 423, with mechanical joint bottom connection and shall comply with AWWA C502 having the following requirements:~~

Fire hydrants shall be "Mueller" Super Centurion 250 A-423 or "CLOW" Medallion 395" (the "CLOW" Medallion shall be a higher-pressure rating with chain tagged "heavy duty"), with mechanical joint bottom connection and meet the following requirements:

- (1) **Inlet Pipe:** 6-inch, mechanical joint inlet shoe and accessories.
- (2) **Trench Depth:** 4-1/2 feet cover; ~~minimum~~ (Note: standard shipping depth is 5.0').
- (3) **Operating Nut:** 1-1/2 ~~5/8~~ inch ~~p~~ Pentagon National Standard Threads.
- (4) **Open:** Left (CCW).
- (5) **Connection:** Two 2-1/2-inch hose nozzles and one ~~4-1/2~~ 5-1/4-inch pumper nozzle.
- (6) **Threads:** National Standard Hose Threads.
- (7) **Pressure:** 150 psi working pressure, 300 psi pressure.
- (8) **Break-Off Flange:** Hydrants shall be provided with traffic break-off flange.
- (9) **Mechanical Joint Bolts and Nuts:** The mechanical joint bolts and nuts shall be anti-galling coated stainless steel, "NSS" Cor-Blue, or an equivalent in design, material, and specifications.
- (10) **Shoe Nuts and Bolts:** Shoe nuts and bolts shall be corrosion resistant stainless steel, Grade 304.

- (911) **Color:** Color shall be Rustoleum No. 831 “restful green” or KWAL “hydrant green” except for bonnet, weather caps and nozzle caps, which must be Rustoleum No. 2766 “reflectorized white.”
- (129) **Spare Parts:** A set of spare break-off parts shall be furnished.

## (C) Execution

- (1) **Hydrants:** Where applicable, hydrants shall be installed with pumper outlet facing the adjacent roadway or parking area. Set hydrants at such elevations that the connecting pipe shall drain to the main with a grade of not less than 1 percent, and upon a concrete foundation not less than 6 inches thick and 18 inches square. The centerline of nozzles shall be at least 18 inches above finished grade. Firmly block the back of the hydrant opposite the pipe connection with a concrete thrust block braced against the vertical face of the trench to prevent the hydrant from blowing off the line.
- (2) **Drainage Aggregate and Backfill:** Place not less than 1/3 cubic-yard of approved clean gravel or crushed rock around the base of each hydrant and 12 inches over the top of the supply pipe to insure drainage. A layer of 30-pound asphalt-saturated felt paper or heavy vinyl sheet shall be placed over gravel to keep backfill material from sifting into gravel. Thoroughly compact the backfill around hydrants, to the grade line, in an approved manner.
- (3) **Operations Check:** Clean hydrant interiors of all foreign matter before installation. Stuffing boxes shall be tightened and the hydrant inspected in opened and closed positions to see that all parts are in working condition.
- (4) **General:** Hydrants shall be tagged “out-of-service” until the water system is operational. It is the responsibility of the contractor to notify Boulder Police Communications regarding the location of the tagged hydrants.

## 9.10 Combination Air Valve

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of combination air valves for potable water service.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **Manholes:** Refer to Section 9.165, “Manholes and Inlets,” of these Standards.
- (2) **Combination Air Valve:** The valve shall be a 2-inch combination air release vacuum valve, “Vent-O-Mat” Series 050 RB X 25 2 1 “Clow” No. 5403-B, 250 psi, or approved equivalent in design, material, and specifications. The combination air valve shall be provided with a 2-inch diameter hand wheel operated gate valve.
- (3) **Hose Gate Valve:** A 3/4-inch hose gate valve is to be installed in the air release valve manhole. The valve shall have a bronze body, threaded end, solid wedge, union bonnet,

inside screw rising stem gate valve. These valves shall be “Powell” 375 HS. Each hose gate valve shall be equipped with a brass cap and chain.

- (4) **Ball Valve:** Ball valves shall be of bronze or brass construction with two-piece end entry body, bronze or brass ball, Teflon or Viton stem seal, reinforced Teflon seats and thrust washer, a removable operating lever, and threaded ends. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be drip-tight in both directions. Valves shall be “Conbraco Industries” Apollo 70-100 Series, “Powell” Fig 4210T, or “Stockham” S-216.
- (5) **Corporation Stop:** A corporation stop shall be as referenced in Subsection 9.05(B)(3), of these Standards in this chapter.
- (6) **Insulators:** Insulators shall be as referenced in Subsection 9.05(B)(6f), in this chapter of these Standards.

## (C) Execution

- (1) **Installation:** Install valve, manhole, and appurtenances as indicated on Drawing No. 5.22, in Chapter 11, “Technical Drawings,” of these Standards, and in accordance with applicable provisions of the related sections.
- (2) **Tests:** Valve tests shall done be with and as a part of the general tests on the companion waterlines.
- (3) **Disinfection:** Valve disinfection shall be done with and as a part of the general disinfection to the companion waterlines.

## 9.11 Pipeline Fittings

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of pipeline fittings for potable water service.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **Gray or Ductile Iron:** Fittings shall be made from gray iron or ductile iron and manufactured in accordance with AWWA C110-08, Ductile Iron and Gray Iron Fittings, or AWWA C153-06, Ductile Iron Compact Fittings.
- (2) **Rubber Gasket Joints:** Fittings shall be furnished with rubber gasket joints in accordance with AWWA C111-07, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- (3) **Design:** Fittings shall be rated for a design working pressure of 350 psi pressure rating and shall conform to the dimensions and weights shown in the tables of the AWWA standards referenced in this Section 9.11(B) of these Standards.
- (4) **Certification:** The manufacturer shall prepare a certified statement that the inspection and all specified tests have been performed and the results thereof comply with the requirements of the applicable AWWA standard(s) specified in Section 9.11(B) of these

Standards. The contractor shall cause a copy of the certification to be sent to the City upon request.

- (5) **Ductile Iron Flanged Fittings:** Ductile iron flanged fittings shall be manufactured in accordance with the following:
  - (a) Integrally cast flange fittings: AWWA C110-08, Ductile Iron and Gray Iron Fittings.
  - (b) Threated flange fittings: AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
  - (c) Ductile iron flanged fittings shall be rated for 250 psi working pressure and shall be installed with special gaskets that achieve 350 psi working pressure.
- (6) **4 Through 6 Inch Fittings:** 4 through 16-inch diameter fittings shall be furnished with a fusion bonded epoxy inside and out, with a standard thickness as defined in AWWA C116-03, Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings. The Director may waive the requirement for fusion bonded epoxy on fittings if the Director finds that specific fittings are not available.
- (7) **Bolts and Nuts:** Fittings shall be furnished with tee-head mechanical joint bolts and hexagon nuts, fabricated from corrosion resistant high strength, low alloy steel such as "Cor-Ten" or "Blue Bolts."
- (8) **Connection fitting:** Mechanical joint anchoring fittings (swivel) shall also be used. Infact Corporation's "Foster Adaptor" may also be used to connect between mechanical joint fittings, valves and hydrant connections.

## 9.124 Disinfecting Waterlines

### (A) Scope

This section describes the disinfecting of all portions of the potable water system, including buried piping, valves, hydrants, and any portion of the existing connecting system that might have become contaminated during construction activities, and also any temporary water service piping used during construction.

### (B) Materials

- (1) **Chlorinating Material:** The chlorinating material shall either be a hypochlorite solution, tablets or granules.
- (2) **Tablet Attachment:** The hypochlorite tablets shall be fastened to the top of the pipe using Permatex No. 1.

### (C) Execution

- (1) **Disinfection**
  - (a) Care shall be taken to prevent contaminating materials from entering the water mains during construction or repair. Such materials that may accidentally enter the main shall be removed by flushing. This flushing shall be done prior to disinfection unless the tablet method of disinfection is used. If, in the opinion of the Director, the contaminated material that has entered cannot be removed by

flushing, the interior of the pipe shall be cleaned by mechanical means and then swabbed with a 1 percent hypochlorite solution.

- (b) Upon completion of the water pipelines, all new pipe, valves, hydrants, etc. shall be thoroughly flushed and disinfected, using a continuous-feed method of hypochlorite and water mixture or hypochlorite tablets or granules in accordance with AWWA Standard C-651, latest revision.
  - (c) The chlorinating material shall be introduced into the water lines and distribution systems in a manner approved by the Director. After a contact period of not less than 24 hours, the treated water in the lines shall contain not less than 10 mg per liter chlorine using the continuous-feed method or 25 mg per l chlorine using the tablet or granular method throughout the length of the line. The system shall be flushed after successful completion of disinfection with clean water until the residual chlorine content is no more than 1.0 mg per liter. All valves in lines being disinfected, except those being used as bulkheads, shall be opened and closed several times during the contact period. During flushing and disinfection the contractor shall make sure that none of the disinfection solution enters any existing water main.
  - (d) Flushing shall be done with a flushing velocity of at least 2 ½ feet per second. The contractor shall provide all fittings required to flush the line. Flushing will be accomplished in such a manner that no erosion will occur and there will be no damage to street, fish, animals, plants or other property.
- (2) **Bacteriological Examination:** After the system has been thoroughly flushed and before the new water line is connected to the distribution system, samples shall be taken from representative points in the system, at intervals of 1200 feet, in sterile bottles treated with sodium thiosulfate. Labeled samples shall be submitted to the City Drinking Water Program staff, or designated certified laboratory, for bacteriological examination. Submitted samples shall meet all City and State bacteriological standards, showing the absence of both coliform and heterotrophic bacterial growths. If the initial disinfection fails to produce satisfactory bacteriological results, the new main shall be reflushed and resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous feed or slug method until satisfactory results are obtained.
- (3) **Disposal of Solution:** Following testing, the solution and flushing water shall be disposed of by the contractor into the nearest sanitary sewer line. The solution and flushing water shall not be dumped into any lakes, streams, waterways, irrigation ditches or stormwater drainage systems. If wasted water cannot be safely discharged into a sanitary sewer system, and then a reducing agent shall be applied to the wasted water to thoroughly neutralize the chlorine residual remaining in the water.

## 9.132 Testing of Water Pipes

### (A) General

This section describes the testing of all water pipe including water mains, fire lines and services.

### (B) Materials

The contractor shall provide all necessary test equipment including test pumps, pipe, connectors, meters, gauges, instruments, and other equipment required. Pressure gauges used shall be



graduated in increments no more than 5 psi and shall have a range of approximately twice the test pressure. Gauges meters and other instruments shall be calibrated prior to testing.

## **(C) Execution**

### **(1) Notification and Witness**

- (a) The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.
- (b) The pipe may be subjected to hydrostatic pressure and inspected and tested for leakage at any convenient time after the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director. Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least 2 days have elapsed after the concrete was installed.

### **(2) Pressure Test**

- (a) All new pipe shall be pressure tested prior to connection to the existing system. All pipe shall be tested at a pressure of 150 psi at the lowest point in each section or 1½ times the working pressure, whichever is greater.
- (b) Prior to testing, all equipment that would be damaged by the test pressure shall be removed. This equipment shall be replaced in the system after testing is complete. All pipe and appurtenances shall be backfilled except for joints unless otherwise permitted by the Director.
- (c) The contractor shall slowly fill the pipe with water prior to testing and remove all air from the piping system. Each valved section, unless otherwise directed by the Director, shall be tested prior to connection to the existing system. The duration of each pressure test shall be at least 2 continuous hours. Test time will be accrued only while full test pressure is on the system. All water used in testing the pipelines shall be provided by the contractor from a potable water source.
- (d) The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Director. The contractor shall furnish all necessary labor, equipment, and connection corporation stops to the pipeline to perform the test.
- (e) No testing shall be permitted against valves or fittings that are part of the existing system unless specifically approved by the Director. All exposed pipes, fittings, valves, hydrants, and joints will be carefully examined during the test. Any cracked or defective pipe, fittings, valves, or hydrants discovered during the pressure test shall be removed and replaced by the contractor with sound material. The test shall be repeated until the test is satisfactory to the Director.

### **(3) Leakage Test**

- (a) A leakage test shall be conducted after the pressure test has been completed, unless the pressure test indicates that there are no leaks. The contractor shall furnish the pump, pipe, connections, meters and all other necessary apparatus, and shall furnish all necessary assistance to conduct the test. The duration of each leakage test shall be two hours, and, during the test, the main shall be subjected to a hydrostatic pressure specified.

- (b) No pipeline installation will be accepted until the leakage is less than the amount computed by the following formula:

$$L = \frac{SD(P)^{0.5}}{133,200}$$

Where: L = Allowable Leakage (Gallons Per Hour)

S = Tested Length of Pipe (Feet)

D = Nominal Diameter of Pipe (Inches)

P = Average Test Pressure During the Test (psi)

- (c) The contractor shall, at their own expense, locate and repair the points of leakage until the leakage is within the specified allowance.

## 9.143 Polyvinyl Chloride (PVC) Non-pressure Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of polyvinyl chloride (PVC) non-pressure pipe and appurtenances for storm ~~drains~~sewer mains, sanitary sewer mains and sewer services in the pipe diameter size range of ~~4inches"~~ to 15inches".
- (2) **Quality Assurance:** **Manufacturer's** certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

- (1) **PVC Non-pressure Pipe**
  - (a) PVC non-pressure pipe shall be type PSM polyvinyl chloride (PVC) having a cell classification of 12454-B or 12454-C or 13364-B (with a minimum tensile modulus of 500,000 psi) as defined in ASTM D1784. All PVC pipe and fittings shall meet or exceed all of the material requirements of ASTM D3034 and thickness requirements of SDR 35.
  - (b) Provisions must be made for contraction and expansion at each joint with a rubber ring and integral thickened bell as part of each joint. Gaskets shall conform to ASTM F477. Pipe shall be supplied in laying lengths of 19-1/2 to 20 feet. All pipe and fittings shall be assembled with a non-toxic lubricant. Each length of pipe and all fittings shall have marked on the exterior the following:
    - (i) Manufacturer's Name or Trademark;
    - (ii) Nominal Pipe Size;
    - (iii) PVC Cell Classification (e.g. 12454-B);
    - (iv) Legend - Type PSM SDR-35 Sewer Pipe; and
    - (v) ASTM - D3034.
  - (c) All fittings and plugs to be used with the PVC pipe shall be those manufactured by the manufacturer of the pipe. Each special fitting shall be a completely manufactured unit with either bells or spigots on each connection that are an exact

duplication of the bells and spigots on the pipeline. Fittings with any other type of connections will not be accepted.

- (2) **Plugs:** Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation ~~without permanently sealing the joint.~~
- (3) **Couplings**
  - (a) Couplings shall be used only where shown on the approved drawings or where approved in writing by the Director. The contractor shall provide a description of an exact location of any couplings used.
  - (b) Flexible couplings shall consist of a rubber gasket or boot, with a stainless steel shield and tightening bands. ~~The eCouplings shall conform to requirements of the~~ ASTM C425-C1173 Type B couplings and shall be ~~“Mission” ARC “Fernco Strong Back”~~ or an approved equivalent.
- (4) **Grout**
  - (a) Grout shall conform to the specifications defined in Section 9.165(B)(5e). The contractor may substitute a two-component, 100 percent solids epoxy resin ~~(Sikadur Hi-Mod LV)~~ for the specified grout.
  - (b) Grout used for sealing service connections shall be a 2-component, waterproof epoxy grout specifically manufactured for this application. The grout shall adhere to any of the dissimilar materials.
- (5) **Sealants:** Sealants used on manholes or pipe connections shall be equal to SIKAFLEX-1a, a one component polyurethane base, elastomeric sealant. When required due to moisture or immersion, provide SIKAFLEX 429 or an equivalent primer for application onto the substrate according to manufacturer’s recommendation.

## (C) Execution

- (1) **General**
  - (a) Each pipe length and fitting interior, interior surface of bells, and exterior surface of spigots shall be cleaned of all foreign material before placement in the trench and shall be kept clean at all times thereafter. Each item shall also be examined for cracks and other defects before installation.
  - (b) Pipe shall be cut, only whenever necessary, to conform to location of manholes or connections. All cuts shall be straight, true, and at right angles to the axis of the pipe. The cutting process shall leave a smooth end without damaging the pipe. All burrs shall be removed from the ends of cut pipe, and the end lightly rasped or filed. All tools used in cutting pipe will be subject to the Director’s approval.
  - (c) Pipe laying shall proceed with the spigot ends of pipe pointing in the direction of the flow, unless otherwise approved by the Director. Each pipe length shall be laid true to line and grade in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets to the flow line. Pipe shall be laid in a dewatered trench and shall not be used for draining water from the trench. Do not lay pipe when trenches or weather conditions are unsuitable for such work.

- (d) Whenever the pipe is left unattended or pipe laying is not in progress, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent debris and animals from entering the pipe. All temporary plugs will be subject to approval by the Director.
- (e) The contractor shall install the materials in accordance with the manufacturer's recommendations. If there is a conflict between the methods prescribed in the approved plans and the manufacturer's instructions, the contractor shall obtain resolution from the Director, before proceeding with the work.

(2) **Pipe Installation**

- (a) Pipe Laying: (i) ~~————~~ No deflection in the joints shall be allowed. All pipe shall be fully supported along the full length of pipe barrel without support by the bell mounding.
- (ii) ~~————~~ When curved sewers are approved in the construction plans, the alignment curve shall be completed by installing the pipes on uniform curves by deflecting the pipe barrel. The minimum curves are shown in Table 9-8, "Curvilinear Sewer Pipe Laying," of these Standards.

**Table 9-8: ~~————~~ Curvilinear Sewer Pipe Laying**

<b>Pipe Diameter (Inches)</b>	<b>Minimum Radius (Feet)</b>	<b>Offset 20' Length (Inches)</b>
4	150	16
6	200	12
8	250	10
10	300	8
12	350	7
15	400	6

- (b) **Pipe Joints**
  - (i) The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
  - (ii) Bevel the end of cut pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

(3) **Connection of Pipe to Concrete Manhole Base**

- (a) The pipe shall be encased in the concrete poured for the manhole base as detailed in Drawing No. 6.01, "Standard Sewer Manhole," in Chapter 11, "Technical Drawings," in these Standards. Special provisions shall be made for water tightness of the connection.

- (b) The exterior circumference of the pipe where encased in concrete for water tightness shall be uniformly roughened or scarified by sanding with coarse sandpaper or emery cloth for at least 6 inches encased length.
  - (c) Additionally, gasket as specified elsewhere shall be stretched onto the pipe to form a weep ring where encased in concrete. Any alteration to the above specified methods for pipe connection to concrete shall be submitted to the Director for approval.
- (4) **Grouting**
- (a) Any opening between the manhole wall and pipe made during construction shall be closed and sealed with watertight grout. The opening shall be of sufficient size to accommodate the pipe, “O” rings, and grout. The grout shall extend no less than the full width of the manhole barrel.
  - (b) Channels that have been cut into concrete bases shall be smoothed to the specified contour with grout. The grout shall extend no less than the full width of the manhole barrel.
- (5) **Temporary Plugs:** Where required on construction plans and at the end of each sewer service stub out, the pipe shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation without permanently sealing the joint.
- (6) **Sewer Services:** The general location of the sewer service lines is detailed in Drawing No. 6.06, “Sewer Service Line,” in Chapter 11, “Technical Drawings,” in these Standards. Actual locations of the service lines shall be determined by the approved construction plans and in the field by the Director. The contractor shall notify the Director prior to constructing each sewer main so that the Director may have adequate time to determine the final location of each service tee or wye fitting to be installed in the sewer main. Failure of the contractor to properly notify the Director as noted above may result in the contractor’s removal of any portion of the sewer main that is necessary to install the fittings in their proper location as determined by the Director.
- (a) The contractor will be allowed to tap and install a service saddle to new sewer mains only at those locations approved by the Director. Connections onto sewer mains shall be made only by boring or drilling with equipment designed for this purpose. Connections shall not be made by impact equipment. The contractor shall request, in writing, Director approval of methods and equipment proposed to be used for performing connections.
  - (b) The contractor shall remove from the sewer main all debris created by making connections before the service line is connected.
  - (c) Service line saddle connections shall be attached to the sewer main with an epoxy-bonding agent. Where the sewer main has been lined, the original sewer main shall be removed and the saddle shall be attached directly to the liner. The bonding agent shall be applied to a clean, dry surface. The connection shall remain dry until the bonding material has set, depending upon environmental conditions. Backfill around the connection shall not be attempted until the material has hardened and been accepted by the Director.

- (d) At the end of all sewer services, the contractor shall provide plugs and furnish and set two marker posts. One marker post shall be buried at least 3 feet and shall extend at least 2 feet above the ground surface and shall have a piece of green flagging at the top or be painted green. The second marker shall extend from the end of the service to 18 inches below the existing surface. The marker posts shall be wood 2 x 4, 4 x 4 or #4 rebar.
- (7) **Backfilling and Restoring Surface Conditions:** Shall be as specified in Section 9.02, "Excavation and Trenching," of these Standards.
- (8) **Testing:** Testing of PVC non-pressure pipe shall be as specified in Section 9.176, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

## 9.154 Reinforced Concrete Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of reinforced concrete pipe and appurtenances for culverts and, storm drains ~~and sewers~~ in the pipe diameter size range of 12 inches to 144 inches. Reinforced concrete pipe shall not be used for sanitary sewer mains.
- (2) **Quality Assurance:**
  - (a) Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.
  - (b) The pipe will be tested by the manufacturer based on the three-edge bearing test for both the 0.01 inch crack and the ultimate strength as set forth in ASTM C-497. The pipe shall be tested at the manufacturer's plant. Not more than 1 percent of the number of pipe lengths, but no fewer than two pipes, for each size of pipe, will be tested. The contractor shall provide copies of the test results to the Director for approval. The Director may select pieces to be tested.

### (B) Materials

- (1) **Reinforced Concrete Pipe**
  - (a) The reinforced concrete pipe shall comply with the requirements of ASTM C76. The pipe shall be Class III unless noted otherwise on the approved construction plans. The cement for the pipe shall conform to the requirements set forth in ASTM 150 and shall be type II and shall have a minimum compressive strength of 4,000 psi. All wall thicknesses shall be those established in "Wall B" in table 3, of said C76 specification, and the reinforcement shall be shown in the same "Wall B." Each section, or "stick", of pipe shall be 7 feet-6 inches or greater in length.
  - (b) No elliptical reinforcement will be permitted except for any elliptical reinforced concrete pipe designated on the construction plans.
  - (c) Lifting holes will not be permitted in any of the pipe. The following shall be clearly marked on the exterior surface of the pipe:
    - (i) ASTM Specification;

- (ii) Date of manufacture;
  - (iii) Class and size; and
  - (iv) Name or trademark of manufacturer.
- (d) The joint design shall be tongue and groove, or bell and spigot. Joints for the circular reinforced concrete pipe shall be all rubber gasket conforming to ASTM C-443, latest revision. The gasket shall be attached to the spigot of the pipe and shall make the joint flexible and watertight. The contractor may use butyl mastic joint sealant in rope or trowel applied form in lieu of rubber gaskets for circular pipe if approved in writing by the Director. For all non-circular pipe and culverts, butyl mastic joint sealant may be used. The contractor shall submit test results and material specifications on the sealant to the Director before the Director gives written approval of its use. This sealant shall be made specifically for permanently sealing joints in tongue and groove concrete sewer pipe, must adhere tightly to the pipe surface, and form a tight flexible joint. The gaskets or sealants shall be installed as directed by the manufacturer of the pipe.
- (e) Flared end sections, bends and tees shall comply with the requirements of ASTM C76 and shall be the same class and shall have the same joint design as the pipe described above.
- (f) Visual inspections of all materials shall be made at the job site, and pipe will be rejected on account of any deficiencies covered by ASTM Specification Designation C76 or on account of the following:
- (i) Porous spots, inside or outside, having a greater area than 10 square inches and a depth of more than 1/4 inch;
  - (ii) Patched or repair of porous spots or other defects that are not approved by the Director; or
  - (iii) Exposure of reinforcement that indicates the reinforcement has been replaced.

## **(C) Execution**

### **(1) Laying Pipe**

- (a) All materials shall be carefully lowered into the trench piece-by-piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage. Under no circumstances shall materials be dropped or dumped into the trench. All pipe shall be inspected for defects prior to installation. Any defective, damaged or unsound pipe shall be rejected.
- (b) All foreign matter or dirt shall be removed from the inside of the pipe and fittings before the pipe is lowered into its position in the trench. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew is unable to place the pipe into the trench without getting foreign matter or dirt into it, the Director may require that, before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size be placed over each end and left there until the connection is to be made to the adjacent pipes.

- (c) An approved snug-fitting stopper or plug shall be installed in each pipe immediately after it is laid and prior to any further excavating, or backfilling. All openings along the line of the main shall be securely closed as directed and, in the suspension of work at any time, stoppers shall be placed to prevent dirt or other substances from entering the main. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.
- (d) Pipes shall be laid to a true line and at uniform rates of grade between manholes as shown on the approved construction plans. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying. The grade shall be accurately established for each joint by laser beam, or other means approved in writing by the Director. The laser beam shall be checked with a level each time it is moved and each day before construction proceeds, and thereafter as required to assure that it is set at the correct alignment. If any errors of grade are observed, pipe laying shall stop until the grade is corrected.
- (e) Pipe laying shall proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work. The contractor shall make all connections of pipe to the manholes that have previously been constructed. When connecting to existing sewers, the contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines.
- (f) Bedding shall be placed under and on both sides of the pipe as each length of sewer pipe is installed.

(2) **Joining Pipe**

- (a) Use a method of joining pipe sections that ensures that ends are fully entered and inner surfaces are flush and even. The equipment used to force the joints together must be adequate enough to overcome the gasket pressure involved.
- (b) Just prior to joining the pipes, the ends of the pipe shall be thoroughly cleaned ~~with a wire brush~~ to remove all foreign substances that may have adhered to the pipe surface. All dust and dirt shall be removed with a clean rag. A lubricating solution that is not injurious to the gasket or concrete, such as flax soap or water glass, shall be liberally applied to the gasket groove and to the entire surface of the bell ring. Following this operation, a thin film of lubricant shall be applied to the gasket that shall then be snapped into place in the groove, after which a small diameter smooth steel rod shall be inserted between the gasket and groove and run completely around the gasket to equalize the gasket tension.
- (c) In the event that any foreign matter becomes imbedded in the lubricant, or the lubricant becomes contaminated by water or other substances before the joint is started, the area affected shall be re-cleaned and new lubricant shall be applied.
- (d) The pipe being jointed shall be carefully moved into position, be line and grade checked, and as the spigot end is started into the bell of the section previously laid, the gasket position shall be checked to ensure uniform entry into the bell at all points.

(3) **Testing and Flushing Pipe**

- (a) Prior to acceptance of each section of storm sewer line, the contractor shall jet clean all sewers up through 18 inches in diameter. Larger storm sewers shall be



cleaned by other appropriate methods approved by the Director. All dirt and debris shall be prevented from entering the existing storm sewer system by means of watertight plugs or other suitable methods.

- (b) If the Director finds it necessary to clean the mains immediately after construction by rodding, jetting, or both, the Director shall assess the contractor for the cleaning at a set per foot charge with a minimum dollar amount.
- (c) The Director will televise all mains as part of public inspection, and will bill the contractor for the televising at a set per foot charge with a minimum dollar amount. Any defects found during the televising shall be repaired by the contractor, in a manner approved by the Director.
- (d) Any visible infiltration, that the Director finds to be the result of poor installation of the specified materials, shall be repaired by the contractor in a manner approved by the Director before the work will be accepted.
- (e) Before acceptance of the work, the Director will survey the manhole invert and surface elevations. Any inverts or surface elevations not meeting the approved design in the construction plans shall not be approved and shall be redone to the satisfaction of the Director.
- (f) Upon completion of construction, the Director will carefully inspect all sewers and appurtenances. Any unsatisfactory work shall be removed and replaced by the contractor in a proper manner. The invert of sewer and manholes shall be left smooth, clean, and free from any obstructions throughout the entire line. Manhole rings and covers must be raised to finished grade before final acceptance of the sewer.
- (g) For sanitary sewers, testing shall be as specified in Section 9.176, “Testing of Gravity Sewer Pipelines and Manholes,” of these Standards.

## 9.165 Manholes and Inlets

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of precast concrete manholes, storm sewer inlets and appurtenances.
- (2) **Quality Assurance:** Manufacturer’s certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) General

- (a) Manholes shall be constructed of precast concrete riser sections, in accordance with Drawing No. 6.01, “Standard Sewer Manhole,” in Chapter 11, “Technical Drawings,” of these Standards. The concrete sections shall conform to ASTM C478. The top section required for change of diameter shall be concentric cone or flat slab. Invert channel shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. The minimum internal diameter of the

manhole barrel shall be in Table 9-~~69~~, “Required Manhole Diameters,” for all manhole installations:

**Table 9-~~69~~: Required Manhole Diameters**

Pipe Size (Diameter)	Inner Manhole Section Diameter
18 Inches (and Smaller)	4 Feet
21 - 36 Inches	5 Feet
42 - 48 Inches	6 Feet
54 Inches (and Larger)	Special Detail

- (b) The minimum internal diameter of the manhole barrel may also be determined by the number and size of pipes junctioning at a manhole. In such cases, the Director may modify the minimum internal diameter of the manhole barrel as required.
- (c) To bring the manhole cover to the correct elevation, the adjustment section of each manhole shall be constructed of brick that is sound and true in shape and size and shall be Grade S-W from clay or shale. Precast concrete grade adjustment rings may be substituted for the brick. These rings shall be not less than 6 inches wide and furnished in heights to allow for 1 $\frac{1}{2}$ -inch adjustment. Total adjustment height, with grade rings or bricks, shall not exceed 12 inches.
- (2) **Joints:** Precast manhole and inlet joints shall be made watertight with RUB’R-NEK, Kent Seal No. 2, or LO-MOD GEL material, or approved equivalent. The diameter of gasket shall be as recommended by the manufacturer.
- (3) **Frame and Cover:** Manhole frames and covers shall be of heavy duty traffic lids, Colorado Springs pattern, round base, 22-1/8 inch opening lids 1 inch thick, non-locking type with frame and cover weighing approximately 327 pounds. The cover and frame seat shall be machine finished to prevent any rocking of the cover in its associated frame. The cover shall have the word “SEWER” for sanitary sewer manholes, or “STORM SEWER” for storm sewer manholes clearly cast on the surface. Covers for other utility manholes shall also be marked with the appropriate utility designation. Frames and covers shall be CASTINGS, INC. MH 310 COVER B, or approved equivalent.
- (4) **Manhole Steps:** Manhole steps shall be built into and thoroughly anchored to the manhole walls at time of fabrication and shall be positioned as shown on the approved construction plans, and in accordance with the technical drawings in Chapter 11, “Technical Drawings,” of these Standards. The steps shall be made of polypropylene coated reinforcing steel. The material for extruded aluminum steps shall conform to Federal Specifications QQ-A 200/8 for aluminum alloy 6061-T6510 or T6511. The material for cast aluminum steps shall conform to ASTM B26 for aluminum alloy 535.0-F and be equal to ALCOA No. 12653B. Aluminum steps shall have plastic inserts or be coated with bituminous paint to protect against corrosion wherever they come into contact with cement. Copolymer polypropylene coated steel steps Model PS-2 PF, as manufactured by M.A. Industries, are also acceptable.
- (5) **Grout:** Grout shall be “non-shrink” type with aluminum filings; grout with iron filings is not acceptable. Grout shall be “Five Star Grout,” “Embeco Grout” or equivalent.
- (6) **Concrete:** Concrete for cast-in-place manhole bases shall have a 28-day compressive strength of not less than 3,000 psi. The maximum water content shall be 0.5 pounds of

water per pound of cement. Entrained and entrapped air shall be between 4 and 9 percent. All reinforcement shall be standard deformed reinforcement conforming to the requirements set forth in ASTM, A615, Grade 60.

- (7) **Inlets:** Inlets shall be constructed of reinforced concrete and shall conform to the dimensions and specifications as set forth for Type “R” Curb Inlets in Chapter 11, “Technical Drawings,” of these Standards, and CDOT’s M & S Standards. Inlet steps shall be built into and thoroughly anchored to the walls at the time of inlet construction. These steps shall conform to the requirements for manhole steps; and shall be positioned as shown on the technical drawings.

## (C) Execution

### (1) Construction of Manholes

- (a) Concrete bases shall be poured on undisturbed ground. Pipe sections shall be flush on the inside of the structural wall (except as noted below) and project outside sufficiently for proper connection to the next pipe section. All pipelines into a manhole shall have a joint located no more than 12 inches from the exterior wall. Where incoming pipes enter a storm drain manhole at an elevation 3 feet or greater above the base, the incoming pipe shall project 2 inches inside the manhole. All annular spaces around the pipe opening shall be grouted.
- (b) For all precast manhole bases, the ground surface below precast concrete bases shall be excavated 6 inches below the elevation of the bottom of the base and backfilled with bedding material, meeting the requirements of Subsection 9.02(B) of these Standards. The bedding material shall be carefully leveled and smoothed as to give uniform support to the precast base over its entire area.
- (c) The invert channels of manholes shall be constructed in accordance with the Drawing No. 6.03, “Manhole Invert,” in Chapter 11, “Technical Drawings,” of these Standards. They shall be smooth and semicircular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Where differences of 24 inches or less in invert elevations are called for, sloped flow channels shall be formed so the water does not undergo a vertical drop. A drop manhole shall be installed where the specified distance in the manhole inverts exceeds 24 inches. The inlet channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside of the channel shall be smooth and shall slope towards the channel not less than 1 inch per foot nor more than 2 inches per foot. The manhole covers shall be set with a final elevation of 1/4 inch below the finished grade in roadways and 1 to 2 inches above grade outside of roadways. When a manhole is located in the pavement area, it shall not be constructed to final grade until the pavement has been completed, unless directed otherwise by the Director.
- (d) Install joint material per manufacturer’s instructions so that no voids are present. Grout all joints inside and outside after manhole assembly is completed.
- (e) Gaskets for connecting PVC pipe to manhole sections shall be specifically manufactured for that purpose. The gasket shall provide for at least five bearing points on the pipe surface. The interior circumference of the gasket shall be approximately 5 percent less than the exterior circumference of the pipe. The

gasket shall be as manufactured by Hamilton Kent Mfg. Co. of Kent, Ohio, or approved equivalent. All annular spaces around pipe openings must be grouted.

- (f) Stubs shall be provided at manholes when indicated on the construction plans. Such stubs shall be sealed with a removable plug. Plugs shall be specifically manufactured for the pipelines where they are to be installed. The plug shall be constructed of a material approved by the Director and shall provide a permanent watertight installation.
- (2) **Adjusting Manhole Tops:** When grade adjustment of an existing structure is specified, remove frames and covers and reconstruct as required. Reset cleaned frames at the indicated elevation. Prior to final acceptance, clean structures of accumulations of silt, debris, or foreign matter.
- (3) **Testing Manholes:** Refer to Section 9.176, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.

## 9.176 Testing of Gravity Sewer Pipelines and Manholes

### (A) General

This section describes the testing of gravity sewer pipelines and manholes including sanitary sewers and storm drains.

### (B) Materials

The contractor shall provide all equipment and material specifically designed for the testing specified in this section.

### (C) Execution

- (1) **Notification and Witness:** The contractor shall notify the Director of all tests at least 48 hours prior to testing so that the Director can witness the tests.
- (2) **When to Test:** The pipe shall be tested for leakage after the pipe has been installed and the trench has been partially backfilled, except at the joints, or backfilled as permitted by the Director. ~~Where any section is provided with concrete thrust blocks, the pressure test shall not be made until at least 2 days have elapsed after the concrete was installed.~~
- (3) **Testing Procedures**
  - (a) **General:** ~~The contractor shall flush the pipelines, as the work progresses, by means that are in accordance with good construction practice, to insure that earth, sand, rocks, or other foreign materials are removed from the interior of the pipeline. Care shall be taken to insure that foreign material is not transported downstream into the existing system. All sanitary sewer mains and appurtenances shall be cleaned, tested, and PACP TV inspected after backfill operations have been completed. The contractor shall furnish all labor, materials, tools, and equipment necessary to clean the pipe and appurtenances, perform the tests and all work incidental thereto. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the contractor~~
  - (b) **Alignment and Grade:** Gravity sewer pipelines will be checked by the Director to determine whether any displacement of the pipe has occurred after the trench

has been bedded. The maximum vertical deflection allowed for PVC pipe is five percent. The City may require the contractor to perform deflection tests of the pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the City. To ensure accurate testing, the line shall be thoroughly cleaned prior to testing. to an elevation 6 inches above the pipe and tamped as specified. The test will be as follows:

- ~~(i) A light will be flashed between manholes, or if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, earth, or other debris in the pipe, or any other kinds of defects, as determined by the Director, these deficiencies shall be corrected at the contractor's expense. The test will be repeated after completion of backfilling.~~
- ~~(ii) For sewers on curved alignment, a heavy rubber ball shall be passed through the pipe between manholes, or the location of manholes if not constructed, after the pipe has been laid and backfilled. The outside diameter of the ball shall be the same as the inside diameter of the sewer pipe. The ball shall be placed at the upper manhole of the sewer to be cleaned. A head of water shall be placed against the ball to force the ball through the sewer and debris flushed from the line shall be collected at the lower manhole, or its location. The ball shall be secured by a line to control the rate at which the ball is allowed to pass through the sewer.~~

**(4) Air Tests**

- (a) Air testing of sanitary sewer pipes shall be done on all sections of pipe between manholes. The pipe shall be cleaned and may be wetted before air testing. The section of pipeline being tested shall be plugged at each manhole with pneumatic balls.
- (b) Low-pressure air shall be introduced into the plugged line until an internal pressure of 4 psig greater than the average backpressure of any ground water pressure that may submerge the pipe would cause. At least 2 minutes shall pass to allow air temperature to stabilize before the test time is started.
- (c) No pipeline installation will be accepted if the pressure drops 0.5 psig or more during the time and for the length of pipe shown in Table 9-7+0, "Specifications for Air Testing of Sanitary Sewer Pipes," of these Standards:
- (d) If the pipeline installation fails the air test, repairs shall be made and the pipe shall be retested until it passes the air test.

**(5) Deflection**

- (a) All PVC non-pressure pipes shall be tested for vertical deflection after placement and compaction of backfill. The maximum deflection allowed is 5 percent.
- (b) Method of testing shall be by calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the Director, deflectometer of the rigid GO/NO-GO type device. Any and all pipe with vertical deflection greater than the allowable shall be excavated,

and removed from the pipeline, replaced, backfilled and compacted as specified, and retested at the contractor's expense.

**Table 9-710: Specifications for Air Testing of Sanitary Sewer Pipes**

Pipe Diameter (Inches)	Minimum Test Time for Pipe Lengths up to Lengths in Column 3 (min:sec)	Maximum Pipe Length for Minimum Time Testing in Column 2 (Feet)	Minimum Test Time for Pipe Lengths Greater than Column 3 (Seconds)
4	1:53	597	0.190 x Pipe Length (Feet)
6	2:50	398	0.427 x Pipe Length (Feet)
8	3:47	298	0.760 x Pipe Length (Feet)
10	4:43	239	1.187 x Pipe Length (Feet)
12	5:40	199	1.709 x Pipe Length (Feet)
15	7:05	159	2.671 x Pipe Length (Feet)

- (6) **Television:** ~~All PVC non-pressure pipes shall be televised. Any defects found during televising shall be repaired.~~
- (a) ~~Following completion of sewer line work, the contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer. TV inspections shall be performed by a PACP certified inspector. Prior to performing the TV inspection, the sewer improvements must be complete, accessible, and cleaned using pressurized water sufficient to allow for a detailed inspection. The City will not accept inspections for lines that have not been cleaned.~~
- (b) ~~Following TV inspections and any necessary repairs that the contractor may have identified, the City will review the inspection data. If the condition of the pipe is determined to be free of structural defects, deflections, debris, defects in pipe material, and other installation errors, the work will be eligible for acceptance.~~
- (7) **Exfiltration Test**
- (a) ~~Sanitary sewer pipes and manholes may be leak tested using the exfiltration test when the air or vacuum testing is impractical.~~
- (b) ~~The test section shall be bulkheaded and the pipe subjected to a hydrostatic pressure produced by a head of water at a depth of 2 feet above the crown of the sewer at the upper manhole under the test. In areas where ground water exists, this head of water shall be 2 feet above the existing water table.~~
- (c) ~~The head of water shall be maintained for a period of 1 hour during which it is presumed that full absorption of the pipe body has taken place, and thereafter for further period of 1 hour for the actual test of leakage. During this 1 hour test period, the measured maximum allowable rate of exfiltration for any section of sewer, including service stubs, shall not be greater than 200 gallons per inch of pipe diameter per mile of pipe per day. To determine the allowable leakage in manholes, the manholes shall be treated as pipe of equivalent diameter.~~
- (d) ~~If the pipeline installation fails the exfiltration test, repairs shall be made and the pipe shall be retested until it passes the exfiltration test. All repairs or pipe replacements required to meet the leakage specifications must be acceptable to the Director.~~

- ~~(e) The contractor shall furnish all material and labor required to perform the test, and shall assist the Director in making measurements required by the test. The contractor shall be responsible for all costs associated with making the leakage tests or corrective work necessary to reduce leakage below the maximum allowed by these Standards.~~

## (D) Sanitary Sewer Manholes

### (1) General

- (a) During the construction of the manholes, the contractor shall, in accordance with good construction practice, insure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the sections. The Director shall check each manhole to determine whether the manhole fulfills the requirements of the construction plans and these Standards.
- (b) The Director shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies that might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, any repairs deemed necessary by the Director shall be made by the contractor.
- (c) Exfiltration tests as specified above shall be performed on all sanitary sewer manholes.

### (2) **Vacuum Testing:** When required by the Director, sanitary sewer manholes shall be vacuum tested with the following procedure:

- (a) Each manhole shall be tested immediately after assembly and prior to backfilling.
- (b) All lift holes shall be plugged with an approved non-shrink grout.
- (c) No grout will be placed in the horizontal joints before testing.
- (d) All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole.
- (e) The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation.
- (f) A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for one 48 inch diameter manhole, 75 seconds for 60 inches, and 90 seconds for 72 inches.
- (g) If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

## 9.187 Corrugated Metal Pipe

### (A) General

- (1) **Scope:** This section describes the furnishing and installation of corrugated metal pipe and appurtenances for drainage culverts in the pipe diameter size range of 12 to 54 inches.

- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

## (B) Materials

### (1) Corrugated Metal Pipe

- (a) Pipe shall be fabricated from zinc-coated (galvanized) iron or steel sheets conforming to AASHTO M-218 except as modified herein. The diameter or span by rise dimensions indicated on the drawings shall mean the nominal inside dimensions of the conduit. The widths of the laps and depths or corrugations shall be as specified in AASHTO M-36. The pipe shall have the following minimum gauge (specified thickness) for the sizes shown in Table 9-~~811~~, "Corrugated Base Metal Specifications," of these Standards:

**Table 9-~~811~~: Corrugated Base Metal Specifications**

Diameter (Inches)	Gauge Number	Specified Galvanized Thickness (Inches)	Specified Galvanized Thickness (Inches)
21 and Smaller	16	0.064	0.0598
24	14	0.079	0.0747
30 - 54	12	0.109	0.1046

- (2) **Dimpled Coupling Bands:** The dimpled coupling bands shall be the same thickness as that used for the pipe and shall be at least 12 inches wide. The dimples shall conform substantially to the shape and depth of pipe corrugations and shall be in circumferential rows. Each row shall contain dimples so spaced as to effectively engage all corrugations of the pipe ends. All bands shall have at least two zinc coated bolts per connection, conforming to ASTM A 307, grade A, electroplated in accordance with ASTM A 164, Type RS, not less than ½ inch in diameter. The bands shall have end connection angles, conforming to ASTM A 36, zinc-coated in accordance to ASTM A 153, not less than 2 inches by 2 inches by 3/16 inch by 11 inches, adequately fastened to the band.
- (3) **Fittings (Including Flared End Sections) -and Specials:** Fittings and specials shall be of the same material, coating, and wall thickness, including the same structural qualities, as the adjoining pipe. Steel flared end sections shall be furnished complete with field-bolted toe plates.
- (4) **Repair of Damaged Spelter Coatings:** Units such as tees, angles or bends on which the spelter coating has been burned by flame cutting and gas or arc welding, or otherwise damaged in fabrication or shipping, shall be wire-brushed and painted with two coats of Haltz-Rust HR-54-53 or equal conforming to Federal Specification and Standards, TT-P-641, or as otherwise approved by the Director. Culverts, pipes, fittings, specials, etc., on which the spelter coating has been bruised or broken either in the shop or in shipping, or that shows defective workmanship, will be rejected.



**(C) Execution**

Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the “Handbook of Steel Drainage and Highway Construction Projects,” published by the American Iron and Steel Institute.

**(1) Bedding**

- (a) All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.
- (b) The bedding material shall be placed evenly on both sides of the pipe to a point 12 inches above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.

- (2) **Backfilling:** After the pipe has been properly installed and bedded, the remaining trench excavation shall be restored as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement or Sidewalks,” B.R.C. 1981. Pipe installed outside of public rights-of-way where no pavement is impacted may be backfilled in the following manner. The backfill shall be placed in 8 inch loose lifts and compacted to 90 percent Standard Proctor density (AASHTO T-180) with mechanical hand tampers, for the first 2 feet. At least 4 feet of cover over the top of pipe shall be provided before the use of wheel-mounted mechanical tampers (free drop hammer), hydraulic tampers, (Hydraulic ram hammers) or other heavy tamping equipment will be permitted. Puddling or jetting will not be allowed.

- (3) **Removal of Trench Protection:** Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point 1 foot above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for “flexible conduits” and create excessive lateral soils pressures and pipe deflections.

- (4) **Protection of Conduit During Construction:** Maximum supporting strength in flexible conduits does not develop until the fill consolidates. Therefore, excessive concentrated loads or heavy equipment on top of or along side if the pipe shall be avoided.

## 9.198 Cured-in-Place Pipe (CIPP)

### (A) General

- (1) **Scope:** This section describes the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is inserted into the original non-pressure conduit ~~by use of a hydrostatic head.~~
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### (B) Materials

#### (1) Resin-Impregnated Tube

- (a) The tube shall meet the requirements of ASTM F1216 and shall have a uniform thickness that, when compressed at installation pressures, will equal the specified nominal tube thickness, with a -5 percent manufacturing tolerance. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during insertion. The minimum length shall be that deemed necessary by the contractor to effectively span the distance between respective access points unless otherwise specified. The contractor shall verify the lengths and diameters in the field before fabricating the tube. Individual insertion runs can be made over one or more manhole sections as determined in the field by the contractor. The maximum allowed insertion run is 1,200 feet. Intermediate manholes will be reopened as directed by the Director.
- (b) The outside layer of the tube (before insertion) shall be translucent plastic coated with a flexible material that clearly allows inspection of the resin impregnation (wet-out) procedure. The translucent plastic coating on the tube will allow visual proof that the resin has wet-out the entire tube and that there are no dry areas. A vacuum shall be used to ensure the resin fills all dry areas. The plastic coating shall not be subject to delamination after curing of the CIPP.
- (c) The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials will be allowed in the tube that is subject to delamination of the cured CIPP.
- ~~(d) The wall color of the interior pipe surface of the CIPP after installation shall be white or light brown so that a clear detail examination with closed circuit television inspection equipment can be made.~~
- (2) **Resin:** The resin system shall meet the requirements of ASTM F1216.
- (3) **Structural Requirements**
  - (a) The CIPP wall thickness will be measured in accordance with the applicable sections of ASTM Test Method D2122. Sufficient readings, at least eight, will be made to ensure that the minimum thickness has been determined. A cylindrical anvil tubing micrometer accurate to +0.02mm (+0.001 in) will be used. The minimum wall thickness at any cross section shall meet or exceed those shown on the proposal forms and the approved plans, with the allowable minus five (-5)

percent tolerance. The wall thickness tests will be performed by a Certified Independent Laboratory, approved by the Director. All costs, for testing, shall be borne by the contractor.

- (b) The layers of the CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly of the probe or knife blade moves freely between the layers, nor shall separation of any layers occur during testing performed under the requirements of this specification.
- (c) The cured pipe material (CIPP) shall conform to the minimum structural standards, as follows:
  - (i) Flexural Stress (ASTM D-790) 4,500 psi
  - (ii) Modulus of Elasticity (ASTM D-790) 250,000 psi

(d) The liner shall be designed assuming a fully deteriorated host pipe.

## (C) Execution

### (1) Cleaning

- (a) The contractor shall be required to remove all internal debris from the ~~sewer~~ line by use of water jet equipment prior to inserting the CIPP tube. The cleaning operation shall remove any and all debris so that each joint of pipe can be thoroughly inspected and successfully reconstructed.
- (b) All sludge, dirt, sand, rocks, grease and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole to another will not be permitted.
- (c) All such debris resulting from the cleaning operations shall be removed from the site and disposed of in the proper manner. The contractor shall bear all costs associated with testing of debris and proper dumping. Dumping of the debris shall be in accordance with all local, state, and federal regulations.
- (d) All debris shall be removed from the downstream manhole and the site no less often than at the end of each workday. The contractor shall leave no debris unattended at the site. Under no circumstances will the contractor be allowed to accumulate debris beyond the stated time. In the event the contractor has not removed the debris generated by the cleaning operation, the contractor will not be allowed to proceed with the work until the debris is properly removed.
- (e) During all sewer cleaning operations, satisfactory precautions shall be taken to protect the sewer lines from damage that might occur by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public or private property being served by the section of sewer line being cleaned. The contractor shall bear all costs associated with any flooding or damage to basements or structures.

- (2) **Bypassing Flows:** The contractor shall provide for flows around the section(s) of pipe designated for ~~reconstruction~~ rehabilitation. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and

service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.

- (3) **Inspection of Pipelines:** Inspections of pipelines shall be performed by trained personnel experienced in locating breaks, obstacles and service connections by closed circuit television. The inspection of pipelines is also to determine active service connections and the addresses that they serve. The interior of the pipe shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the CIPP into the pipeline and it shall be noted so these conditions can be corrected. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining. A videotape and suitable log shall be submitted to the Director, and shall be kept for later reference.
- (4) **Line Obstructions:** It shall be the responsibility of the contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of the CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional sewer-cleaning equipment, then the contractor shall repair the excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Director prior to the commencement of the work.
- (5) **CIPP Installation**
  - (a) CIPP installation shall be in accordance with ASTM F1216, Section 7, with the additional following requirements. The resin shall be cured by circulating hot water within the tube. After curing, the finished pipe (CIPP) shall be continuous and tight fitting.
  - (b) The contractor, and the Director, shall designate a location where the tube will be impregnated with resin prior to installation, in order that an inspection can be made to determine proper materials and procedures. A resin and catalyst system compatible with the requirements of this method shall be used.
  - (c) The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply. Another such gauge shall be placed at the remote manhole to determine the temperature at that location during the cure. If air pressure and steam are used with styrene based resins, the compressed atmosphere shall be monitored with a safety gas detector to ensure that it does not reach the explosive limit.
  - (d) The finished CIPP shall be continuous over the entire length of an insertion run between two manholes and be free, as commercially practicable, from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. It shall also meet the leakage/pressure test requirements specified below (water tightness).
  - (e) Before the insertion process begins, the minimum pressure required to hold the tube tight against the existing conduit and the maximum allowable pressure so as not to damage the tube shall be provided by the tube manufacturer, and it will be the contractor's responsibility to obtain and submit this information to the Director. Once the insertion has started, the pressure shall be maintained between the minimum and maximum pressures until the operation has been completed. If air pressure is used for inversion, the equipment shall be fitted with a pressure gauge accurate to 0.01 psi. Should the pressure deviate from within the range of

minimum and maximum pressures, the installed tube will be rejected and the contractor will remove and dispose of the tube, at their expense.

- (f) Before the curing process begins, the pressure required to hold the flexible tube tight against the host pipe shall be provided by the tube manufacturer and submitted to the Director prior to any inversion process. Once the cure has started and dimpling for laterals is completed, the required pressure shall be maintained until the cure is complete. Should the pressure deviate more than 1 psi (2.3 feet of water) from the required pressure during the critical curing period, the tube will be rejected and the contractor will be responsible for its removal and disposal and replacement with new CIPP at, at their expense. A complete log of the pressures shall be maintained on site and shall be offered to the Director after each inversion.
- (6) **Sealing at Manholes:** ~~If the CIPP fails to make a tight seal against the original pipe at its termination point(s), the space between the pipes shall be sealed by filling with a resin mixture compatible with the cured in-place pipe and as recommended by the manufacturer. A hydrophilic end seal shall be installed at the upstream and downstream manholes prior to installation of the CIPP liner. The end seals shall be LMK Insignia End Seals or equivalent.~~
- (7) **Service Connections**
  - (a) After the curing of the CIPP is completed, the contractor shall restore the existing active service connections and branch connections. ~~It is the intent of these Standards that active service and branch~~ The connections shall be reopened without excavation, and in the case of non-man entry pipes, from the interior of the pipeline utilizing a remotely controlled cutting device, monitored by a closed circuit television camera, that re-establishes them to not less than 95 percent capacity, while conforming to the shape of the existing opening. All reinstated openings shall be smoothed by brushing with a wire brush.
  - (b) The contractor shall verify the possession of at least two complete cutting devices in good working order before each insertion.
  - (c) If excavations for the purpose of re-opening connections are required, the contractor will be responsible for all costs and liability associated with such excavation and restoration work.
  - (d) No service connection shall remain out of service for more than 24 hours at a time unless the contractor has provided temporary facilities or other appropriate accommodations for the affected service.
- (8) **Testing:** CIPP samples shall be prepared and tested in accordance with ASTM F1216, Section 8.1, using both methods 8.1.1 and 8.1.2 if so required by the Director. The test will be performed by a Certified Independent Laboratory, approved by the City. Tests results shall be submitted to the Director. Costs of the tests are considered to be incidental to the project.
- (9) **Visual Inspection:** Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.4. The contractor shall perform and supply the City with a PACP TV inspection report and digital video of the sewer prior to and after installation of the CIPP lining. The contractor shall furnish the Director with a color video tape that contains both the before and after conditions, and the restored service and branch connections with the addresses each connection serves.

- (10) ~~**Exfiltration Tests:** In the absence of ground water, and if so ordered by the Director, an exfiltration test shall be performed. Leakage testing of the CIPP shall be accomplished after curing when the CIPP has cooled down to ambient temperatures and while under a positive head and before any service connections are reinstated. This test is limited to pipe diameters of 36 inches or less. The allowable water exfiltration for any length of pipe between termination points shall not exceed 50 gallons per inch of internal pipe diameter per mile per day, providing all trapped air has been purged from the line. During exfiltration testing, the maximum internal pipe pressure at the lowest point shall not exceed 10 feet of water or 4.3 psi and the water level inside the inversion standpipe shall be 2 feet higher than the top of the pipe being tested or 2 feet higher than the groundwater level, whichever is greater. The leakage quantity shall be gauged by the water level in the temporary standpipe placed in the upstream plug. The test shall be conducted for 1 hour. CIPP products where the pipe wall is cured while not in direct contact with the pressurizing fluid (e.g., a removable bladder) must be tested by an alternative method approved by the Director.~~

## **9.20 Pipe Bursting Non-Pressure Pipe**

### **(A) General**

- (1) **Scope:** This section describes the reconstruction of pipelines and conduits by which a bursting unit splits the existing pipe while simultaneously installing a new polyethylene pipe of the same size or larger where the old pipe existed.
- (2) **Quality Assurance:** Manufacturer's certificates of compliance and installation recommendations shall be provided to the City inspector prior to construction. Installation recommendations shall be followed during construction.

### **(B) Materials**

- (1) **Polyethylene Plastic Pipe:** The pipe shall be high density polyethylene pipe and meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR). Sizes of the insertions to be used shall be such to renew the pipe to its original or greater flow capacity. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
- (2) **Dimension Ratios:** The polyethylene pipe shall meet or exceed the thickness requirement of SDR 17.

### **(C) Execution**

- (1) **Bypassing Flows:** The contractor shall provide for flow around the section(s) of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes any main lines and service lines, street gutters or open excavations. Any spills that occur must be immediately cleaned and the affected area disinfected.
- (2) **Inspection:** Inspection of work shall be in accordance with Section 9.17, "Testing of Gravity Sewer Pipelines and Manholes," of these Standards.
- (3) **Equipment:** The pipe bursting tool shall be designed and manufactured to force its way

through existing pipe material by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall be pneumatic and shall generate sufficient force to burst and compact the existing pipeline. The bursting tool shall be selected in accordance with the manufacturer's recommendations to meet the project specific requirements for the type and size of pipe being burst and upsized if specified. The pipe bursting tool shall be pulled through the sewer by a winch located at the receiver pit. The bursting unit shall pull the polyethylene pipe with it as it moves forward.

## **9.1921 Telecommunication or Cable System Standards**

The installation and construction of telecommunication or cable systems shall comply with the requirements as set forth in Chapter 11-6-5, "Boulder Cable Code," B.R.C. 1981<sub>2</sub> and these Standards.

### **(A) General**

- (1) **Applicable National Standards:** All telecommunications and cable system construction shall conform to the requirements of the following standards:
  - (a) American National Standards Institute, Inc. (ANSI), Electronic Industries Association (EIA), and Telecommunications Institute of America (TIA) Standards: EIA/TIA Standards Proposal No. 2840-A, Proposed Revision of EIA/TIA-568 (if approved to be published as EIA/TIA-568-A), EIA/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces, and TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
  - (b) National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.
  - (c) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).
  - (d) Federal Communications Commission.
  - (e) Colorado Public Utilities Commission.
  - (f) Williams-Steiger Occupational Safety and Health Act (OSHA).
- (2) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific underground and/or aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director's office for review and approval.
- (3) **Protection of Systems:** All systems shall be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

### **(B) Underground Facilities**

- (1) **Cable Protection**
  - (a) All buried telecommunications cable, shall be installed in conduit, PVC Schedule 40 or equivalent. Cable placement by means of direct plow-in will not be allowed within the City's rights-of-way.

- (b) Major conduit duct banks (more than 4 conduits) and those comprising a portion of the City's telecommunications conduit backbone infrastructure shall be encased in concrete with a minimum strength of 2000 psi. When encased in concrete, conduit may be PVC Type EB, DB or equivalent. The concrete encasement shall have a minimum thickness of 4 inches around the entire conduit or duct bank.
  - (c) Multiple duct systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.
  - (d) Conduit placed by directional bore method will be allowed subject to approval by the Director.
- (2) **Depth of Cover:** The minimum depth of cover over the conduit shall be 30 inches.
- (3) **Trench Specifications - Roadway and Other Paved Surfaces**
  - (a) All trenches shall ~~be~~ open cut unless otherwise permitted by the City.
  - (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
  - (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement and Sidewalks," B.R.C. 1981.
- (4) **Trench Specifications - Landscaped Areas**
  - (a) All trenches shall be open cut unless otherwise permitted by the City.
  - (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
  - (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
  - (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.
- (5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.
- (6) **Joint Use Trench Requirements**
  - (a) Joint trenching operations require advanced planning and coordination with the utilities involved.
  - (b) Vertical and horizontal separations between telecommunications or cable systems and other facilities shall be maintained as required by NESC Section 32, Underground Conduit Systems. Conduit systems for telecommunications and cable systems shall be separated from conduit systems for power supply systems by:
    - (i) 3 inches of concrete,
    - (ii) 4 inches of masonry, or
    - (iii) 12 inches of well-tamped earths.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.



**(8) Manholes**

- (a) All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane, road shoulders, sidewalk, multi-use path, or bike lane.
- (b) Manholes or handholes shall be placed at maximum 1,200 feet intervals. In no case shall conduit bend radius exceed 180 degrees between manholes. Manholes shall be installed at each street intersection at a minimum. Manholes shall be rectangular: 6 feet wide by 7 feet long by 4 feet deep; or circular 4 feet diameter with a nominal depth of 4 feet minimum.
- (c) Manholes or handholes shall be installed flush or ¼" below the surrounding grade.

**(C) Aboveground Facilities**

- (1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.
- (2) **Obstruction to Traffic Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.
- (3) **Clearances:** All aboveground telecommunications facility construction shall conform with the minimum clearances as specified in Section 23 of the NESC.
  - (a) Cables shall maintain the following minimum clearances between any adjacent or crossing power cables under all conditions of cable loading:
    - (i) Horizontal clearances shall be at least 5 feet from power cables at a potential of up to 129 kV, and at least 5 feet plus 0.4 inches per kV over 129 kV from power cables exceeding a potential of 129 kV.
    - (ii) Vertical clearances shall be at least 4 feet from power cables at a potential of up to 750 V, at least 6 feet from power cables at a potential of 750 V to 22 kV, at least 6 feet plus 0.4 inches per kV over 22 kV from power cables at a potential between 22 kV and 470 kV. Vertical clearances shall comply with NESC Rule 233C3 for minimum clearance from cables at a potential greater than 470 kV.
  - (b) Cables, poles, and stubs shall maintain the following minimum clearances from power conductors, power poles and other objects:
    - (i) Poles shall have a minimum clearance of 4 feet from fire hydrants, signal pedestals, and call boxes.
    - (ii) Cables shall have a minimum horizontal clearance from power poles in no wind conditions.
    - (iii) Poles and stubs shall have a minimum horizontal clearance of 5 feet in no wind condition from power wires up to 50 kV.
  - (c) Poles shall have a minimum separation of at least 2 feet from the street side of the curb to the nearest part of the pole and shall be located a sufficient distance from the street side of the curb to avoid contact with ordinary vehicles using the road.

- (d) Poles shall have at least 12 feet horizontal clearance from the nearest rail to the nearest part of the pole.
- (e) Cables shall have at least 2 feet vertical clearance from Police and Fire Alarm facilities.
- (f) Cables shall have at least 3 feet clearance in all directions from signs, chimneys, tanks, and other installations.
- (g) Cables shall maintain the following minimum vertical clearances as measured from the lowest point of the cable when crossing the following objects:
  - (i) Roads, Streets, and all areas subject to truck traffic: 18 feet.
  - (ii) Alleys, Driveways, and Parking Lots: 18 feet.
  - (iii) Railroad tracks: 28 feet.
  - (iv) Roofs, not accessible: 4 feet.
  - (v) Spaces and Ways, accessible to pedestrians only: 12 feet.
  - (vi) Roofs, accessible to vehicular traffic, but not trucks: 12 feet.
- (h) Cables shall maintain a minimum vertical clearances of 16 feet as measured from the lowest point of the cable when running alongside but not overhanging roads, streets, or alleys.
- (i) A minimum vertical clearance of 40 inches shall be maintained between telecommunications cables and power cables at the attachment points on joint use poles.

## **9.2210 Electric Power Facility Standards**

The following standards shall apply to all electric power related facilities constructed within the City's public rights-of-way or easements.

### **(A) General**

- (1) **Undergrounding Required:** All electric power facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.
- (2) **National Standards:** All electric power facility construction shall conform to the requirements of the following standards:
  - (a) 1993 National Electrical Safety Code (NESC) C2-1993, published by the Institute of Electrical and Electronics Engineers (IEEE), Inc.
  - (b) National Electrical Code (NEC), published by the National Fire Protection Association (NFPA).
  - (c) Colorado Public Utilities Commission.
  - (d) Williams-Steiger Occupational Safety and Health Act (OSHA).
- (3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, "General Requirements," of these Standards, showing the specific underground and/or

aerial cable routing and associated conduit, manhole and/or pole locations and specifications, shall be submitted to the Director for review and approval.

- (4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

## **(B) Underground Facilities**

### **(1) Underground Cable Protection**

- (a) All primary circuits (greater than 600 volts) located under concrete road surfaces, where circuit density is high, and in all arterial roads shall be installed in conduit, 4 inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.
- (b) All secondary circuits (600 volts or less) supplying services larger than 800 amperes shall be installed in conduit, 2-inch minimum diameter, PVC Type EB, DB or equivalent. All conduit joints shall be solvent welded. The conduit shall be encased in concrete with a minimum strength of 2000 psi and have a minimum thickness of 4 inches around the entire conduit or duct bank.
- (c) Multiple duct bank systems shall have spacers installed at intervals to allow the concrete mix encasement throughout the entire duct structure.

### **(2) Depth of Cover**

- (a) The minimum depth of cover over primary circuits (greater than 600 volts) shall be 42 inches.
- (b) The minimum depth of cover over secondary circuits shall be 30 inches (600 volts or less).
- (c) The minimum depth of cover over circuits for street lighting and signals shall be 18 inches.

### **(3) Trench Specifications - Roadways and Other Paved Surfaces**

- (a) All trenches shall be open cut unless otherwise permitted by the Director.
- (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
- (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, "Standards for Repairs and Restoration of Pavement and Sidewalks," B.R.C. 1981.

### **(4) Trench Specifications - Landscaped Areas**

- (a) All trenches shall be open cut unless otherwise permitted by the Director.
- (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
- (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
- (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to trees, shrubs or other landscaping or if construction is within 5 feet of a tree.

- (5) **Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.
- (6) **Joint Use Trench Requirements**
  - (a) Joint trenching operations require advanced planning and coordination with the utilities involved.
  - (b) Vertical and horizontal separations between electric power facilities and other facilities shall be maintained as required by the NESC section 32 Underground Conduit Systems.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit or cable in the trench.
- (8) **Manholes:** All cavities required for cable pulling purposes shall be constructed as load bearing manholes or handholes. Handholes shall not be placed in any traveled lane including road shoulders, sidewalks, multi-use paths, or bike lanes.

### (C) Aboveground Facilities

- (1) **General**
  - (a) All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.
  - (b) All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.
- (2) **Clearances:** The minimum overhead transverse clearance shall conform to National Electrical Safety Code Standards, but shall not be less than 18 feet measured from the highest point of the road prism to the bottom of the cable.

## 9.234 Gas Distribution Facility Standards

The following standards shall apply to all gas distribution related facilities constructed within the City's public rights-of-way or easements.

### (A) General

- (1) **Undergrounding Required:** All gas distribution facilities constructed in the City's public rights-of-way or easements shall be underground unless otherwise permitted by franchise or the Director.
- (2) **National Standards:** All gas distribution facility construction shall conform to the requirements of the following standards:
  - (a) Minimum Federal Safety Standards for Natural Gas Pipelines in the Code of Federal regulations 49 Part 192.
  - (b) Colorado Public Utilities Commission.
  - (c) Williams-Steiger Occupational Safety and Health Act (OSHA).

- (3) **Construction Plans Required:** Detailed construction plans, as outlined in Chapter 1, “General Requirements,” of these Standards, showing the specific gas distribution line and appurtenances locations and specifications, shall be submitted to the Director for review and approval.
- (4) **Protection of Facilities:** All facilities must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the facility to move or fail.

## **(B) Underground Facilities**

### **(1) Materials**

- (a) Steel or plastic material shall be used for the gas distribution pipe.
- (b) All plastic pipe must be installed below ground level.

### **(2) Depth of Cover**

- (a) Depth of cover shall be measured from the final grade to the top of the pipe.
- (b) Minimum depth of cover for shall be 36 inches for transmission lines and 30 inches for distribution lines.
- (c) Minimum depth of cover for service lines shall be 24 inches.
- (d) Transmission and distribution lines installed under streams and ditches must have minimum cover of 48 inches.

### **(3) Trench Specifications - Roadways and Other Paved Surfaces**

- (a) All trenches shall be open cut unless otherwise permitted by the Director.
- (b) Trenches shall have a minimum width of 10 inches.
- (c) Trench backfill and surface restoration shall comply with the standards as set forth in Section 8-5-12, “Standards for Repairs and Restoration of Pavement and Sidewalks,” B.R.C. 1981.

### **(4) Trench Specifications - Landscaped Areas**

- (a) All trenches shall be open cut unless otherwise permitted by the Director.
- (b) Trenches shall ~~be~~ have a minimum width of 10 inches.
- (c) Trenches shall be backfilled and compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D698.
- (d) The City shall be contacted if there is any question whether or not the proposed work will cause any damage to treegss, shrubs or other landscaping or if construction is within 5 feet of a tree.

### **(5) Alternative Installation Methods:** Boring methods may be allowed by the Director if the Director finds that these methods are advantageous to the City or if open trench methods are impractical.

### **(6) Joint Use Trench Requirements**

- (a) Joint trenching operations require advanced planning and coordination with the utilities involved.

- (b) Vertical and horizontal separations between gas distribution facilities and other facilities shall be 6 inches minimum.
- (7) **Warning Tape:** A cable warning tape shall be placed 12 to 18 inches above the conduit in the trench.
- (8) **Components**
  - (a) Transmission line valves shall be installed in boxes or be otherwise readily accessible.
  - (b) Transmission line pressure relief and pressure limiting devices shall be installed in underground vaults, unless aboveground installation is permitted by the Director.
  - (c) All service lines shall be equipped with shutoff valves.
  - (d) An electrically conductive tracer wire shall be installed with all plastic and non-conductive pipes.
- (9) **Casing Pipe:** Gas pipe shall be installed in casings under all highways. Casing pipe shall be steel pipe with a wall thickness of 1/4 inch minimum extending at least 5 feet beyond the limits of any highway improvements.
- (10) **Corrosion Protection**
  - (a) All pipes susceptible to corrosion shall be cathodically protected and have a protective coating.
  - (b) All corrosion susceptible pipes must also be electrically isolated from other metallic structures.

## (C) Testing Requirements

All newly constructed pipes shall be tested prior to placing the line in service. No pipe shall be placed in service, or returned to service, with leaks or without adequate corrosion protection.

- (1) **Pressure Testing:** All pipes shall be pressure tested for leakage as described in CFR 49 part 192. In order to establish the maximum allowable operating pressure (MAOP), pipes shall be tested at 1-1/2 times the MAOP.
- (2) **Corrosion Control Testing:** Corrosion control devices shall be tested whenever the pipe is exposed for maintenance or repair. Additionally, all corrosion control devices must be tested at least once each calendar year.
- (3) **Records Retention:** Records of the testing shall be maintained for the life of the pipe.

## (D) Aboveground Facilities

- (1) **Facility Protection:** All aboveground facilities shall be protected from accidental damage by vehicular traffic impacts or similar causes either by being located a safe distance away from traffic or by structural barricades.
- (2) **Traffic Obstruction Prohibited:** All aboveground facilities shall be located so as not to cause unnecessary obstruction to pedestrian and vehicular traffic.

**CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS**

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## CHAPTER 11 TECHNICAL DRAWINGS

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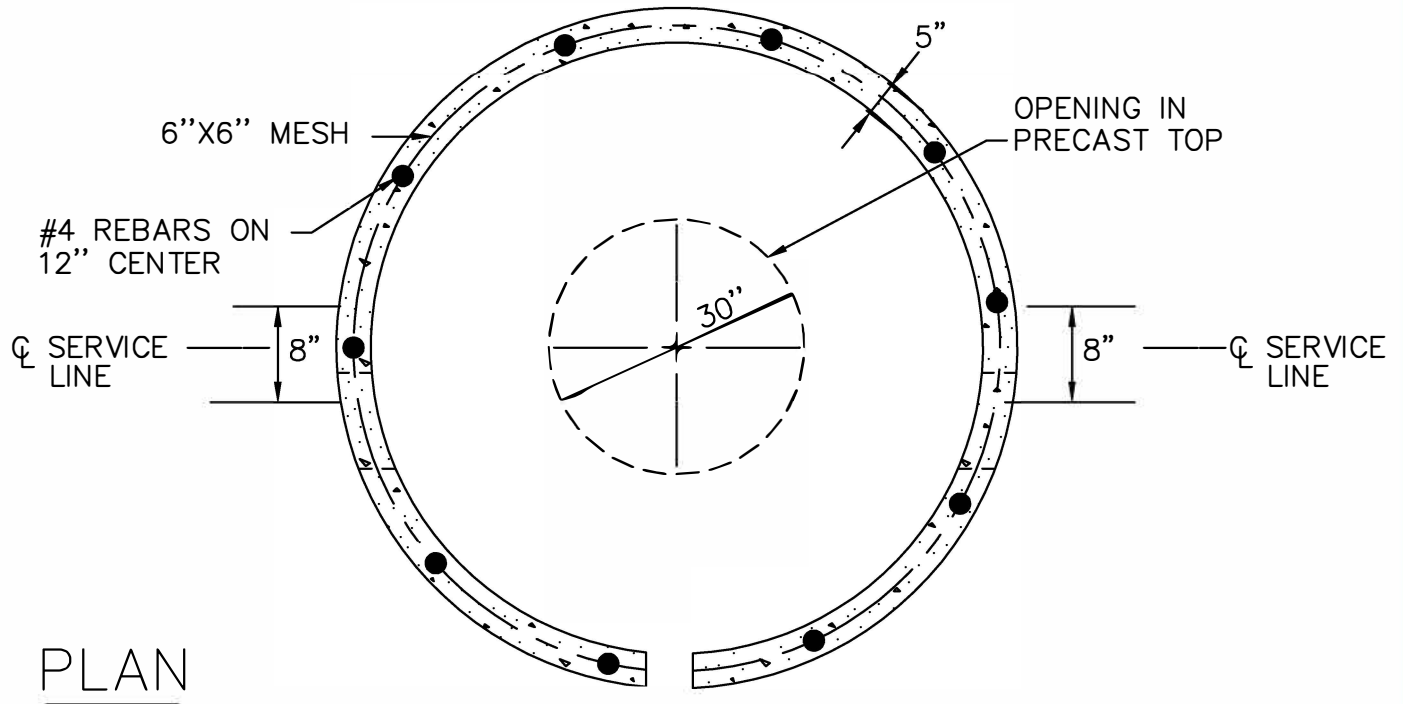
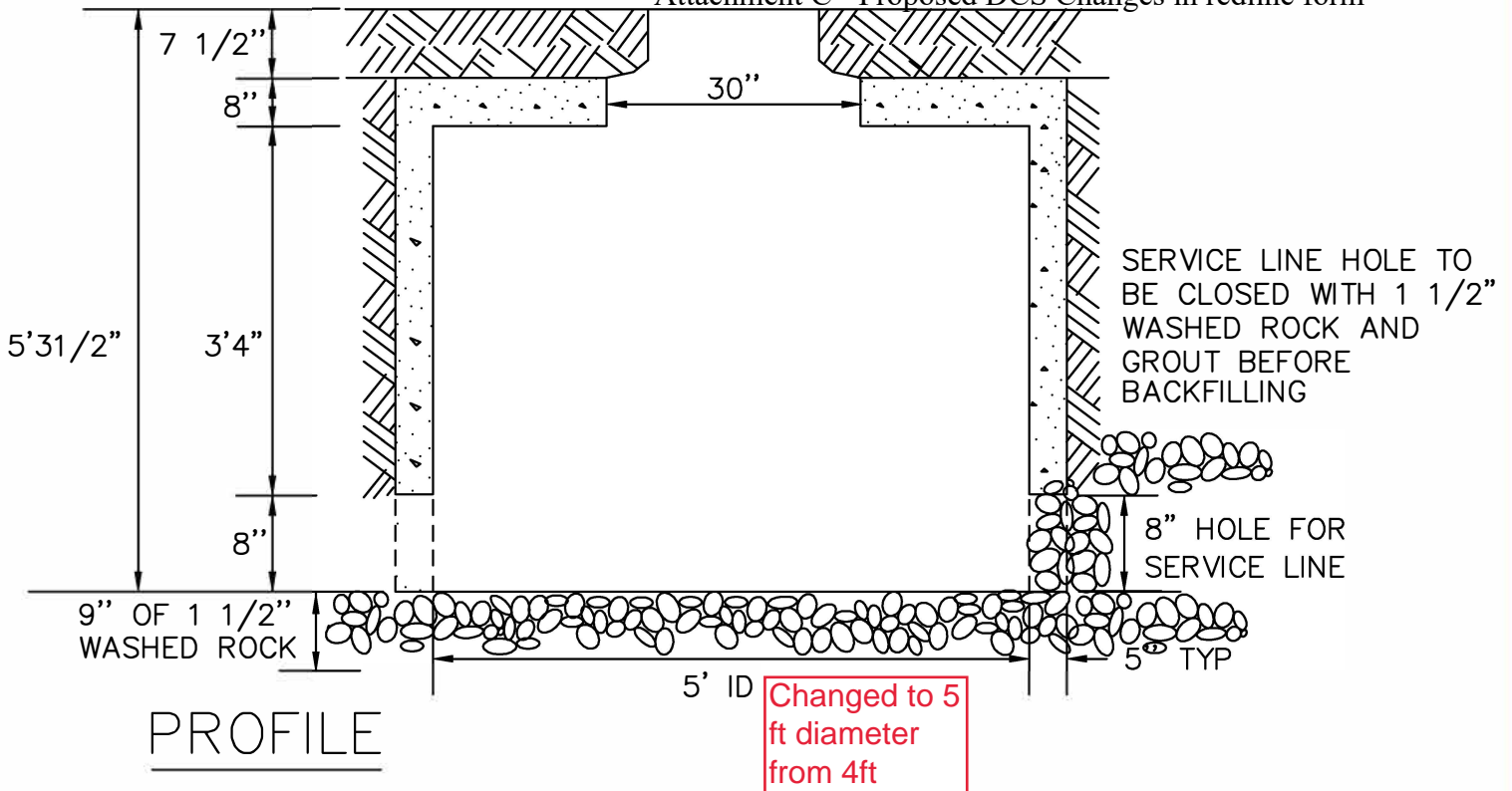
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Attachment C - Proposed DCS Changes in redline form



NOTE: PRECAST CONCRETE STRUCTURES SHALL MEET ASTM C-478.

DRAWN BY: JSH

CHECKED BY: RJH

APPROVED BY:  
DIRECTOR OF PUBLIC WORKS

Item 3E - Stormwater and DCS Updates

CITY OF BOULDER, COLORADO

STANDARD METER PIT

1 1/2" - 2" SERVICE

ISSUED: JULY 2, 1998

REVISED: OCT. 17, 2000

DRAWING NO.

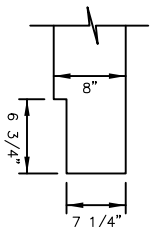
5.17B

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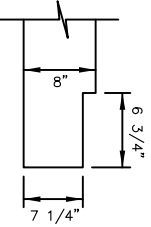


THE ROOF SLAB MAY BE CAST IN SECTIONS FOR FUTURE ACCESS. THE INDIVIDUAL SECTION WEIGHT MUST NOT EXCEED 7,500 POUNDS ACCORDING TO MS-26.

- NON-SKID LID  
NO SCALE



SLAB BASE-NON-SKID  
NO SCALE



		PRECAST VAULT DIMENSIONS				SUMP			
PIPE SIZE Ø	METER SIZE	C	D	E	F	G	H	I	J
3"	9"-6"	8'-0"	2'-0"	2'-6"	6"	12'6"	2'-2"	1'-6"	
4"	10'-6"	8'-0"	2'-6"	2'-6"	6"	12'6"	2'-2"	1'-6"	

CITY OF BOULDER, COLORADO  
LARGE METER IN  
PRECAST VAULT  
3" OR LARGER

ISSUED: JULY 2, 1998  
REVISED: SEPT 29, 2010

DRAWING NO.  
5.18A

Diagram illustrating the installation of a signal wire to an air device, showing dimensions and components:

- EXIST GRADE** (Existing Ground Level)
- CONC EXT COLLARS** (Concrete Extension Collars)
- SIGNAL WIRE TO AIR DEVICE**
- LADDER RUNGS**
- CONC SPT** (Concrete Support)
- 1/2" SPACE FOR SHIMS**
- Dimensions:**
  - 3'-0"
  - 8"
  - 6"
  - 6"
  - 7 1/4"
  - 7 1/4"
  - 12" MIN
  - 18" MAX
  - 9"
  - 6"
  - 6"

- 
- NON-SKID LID  
NO SCALE
- 8"
- 6  $\frac{3}{4}$ "
- 7  $\frac{1}{4}$ "

- 
- SLAB BASE - NON-SKID
- NO SCALE

METER SIZE	BP SIZE	PRECAST VAULT DIMENSIONS							SUMP
		C	D	E	F	G	H	I	
6"0K<	4"	10'-6"	8'-0"	2'-0"	2'-6"	6"	12'	2'-2"	1'-6"

CITY OF BOULDER, COLORADO  
LARGE METER IN  
PRECAST VAULT  
6" OR LARGER

ISSUED: JULY 2, 1998  
REVISED: July 13, 2015

DRAWING NO.  
5.18B

**CITY OF BOULDER  
DESIGN AND CONSTRUCTION STANDARDS**

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## GLOSSARY

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### SECTION 1: ABBREVIATIONS

Wherever the following abbreviations are used in these Design and Construction Standards (Standards), or in association with these Standards, the intent and meaning shall be as follows:

<b>AAN</b>	American Association of Nursery-men	<b>ASME</b>	Architects American Society of Mechanical Engineers
<b>AAR</b>	Association of American Railroads	<b>ASTM</b>	American Society for Testing and Materials
<b>AASHTO</b>	American Association of State Highway and Transportation Officials	<b>ATSSA</b>	American Traffic Safety Services Association
<b>ABC</b>	Aggregate Base Course	<b>AWG</b>	American Wire Gauge
<b>AC</b>	Asphaltic Cement	<b>AWPA</b>	American Wood Preservers Association
<b>ACI</b>	American Concrete Institute	<b>AWS</b>	American Welding Society
<b>ADT</b>	Average Daily Trips	<b>AWWA</b>	American Water Works Association
<b>AGCA</b>	Associated General Contractors of America		
<b>AI</b>	Asphalt Institute	<b>BFD</b>	Boulder Fire Department
<b>AIA</b>	American Institute of Architects	<b>BMP</b>	Best Management Practices
<b>AISC</b>	American Institute of Steel Construction	<b>BRC</b>	Boulder Revised Code, 1981
<b>AISI</b>	American Iron and Steel Institute	<b>CCA</b>	Colorado Contractors Association
<b>AITC</b>	American Institute of Timber Construction	<b>CDOT</b>	Colorado Department of Transportation
<b>ANSI</b>	American National Standards Institute, Inc.	<b>CDPHE</b>	<u>Colorado Department of Public Health and Environment</u>
<b>APWA</b>	American Public Works Association	<b>CDPS</b>	<u>Colorado Discharge Permit System</u>
<b>ARA</b>	American Railway Association	<b>CFR</b>	Code of Federal Regulations
<b>AREA</b>	American Railway Engineering Association	<b>CFS</b>	Cubic Feet per Second
<b>ARTBA</b>	American Road and Transportation Builders Association	<b>CLOMA</b>	Conditional Letter of Map Amendment
<b>ASCE</b>	American Society of Civil Engineers	<b>CLOMR</b>	Conditional Letter of Map Revision
<b>ASLA</b>	American Society of Landscape Architects	<b>CMP</b>	Corrugated Metal Pipe

<b>CP</b>	Colorado Procedure	<b>IMSA</b>	International Municipal Signal Association
<b>CPUC</b>	Colorado Public Utilities Commission	<b>IPCEA</b>	Insulated Power Cable Engineers Association
<b>CRS</b>	Colorado Revised Statutes, 1973, as amended	<b>ISO</b>	Insurance Service Office
<b>CRSI</b>	Concrete Reinforcing Steel Institute	<b>ITE</b>	Institute of Transportation Engineers
<b>CUHP</b>	Colorado Urban Hydrograph Procedure	<b>LID</b>	<u>Low-Impact Development</u>
		<b>LLD PE</b>	<u>Linear low-density polyethylene</u>
		<b>LOMA</b>	Letter of Map Amendment
		<b>LOMR</b>	Letter of Map Revision
		<b>LOS</b>	Level of Service
<b>DHV</b>	Design Hour Volume		
<b>DIP</b>	Ductile Iron Pipe		
<b>DRCOG</b>	Denver Regional Council of Governments		
<b>DWG</b>	Drawing		
<b>EDLA</b>	Equivalent Daily Load Applications	<b>MDCIA</b>	<u>Minimizing Directly-Connected Impervious Areas</u>
<b>EIA</b>	Electronic Industries Association	<b>MIL</b>	Military Specifications
<b>EPA</b>	Environmental Protection Agency	<b>MPH</b>	Miles Per Hour
		<b>MUP</b>	Master Utility Plan
		<b>MUTCD</b>	Manual on Uniform Traffic Control Devices
<b>FEMA</b>	Federal Emergency Management Agency		
<b>FHWA</b>	Federal Highway Administration		
<b>FL</b>	Flowline	<b>NCAR</b>	National Center for Atmospheric Research
<b>FPS</b>	Feet Per Second	<b>NEC</b>	National Electrical Code
<b>FSS</b>	Federal Specifications and Standards	<b>NEMA</b>	National Electrical Manufacturers Association
<b>GIDM</b>	Gallons Per Inch Diameter Per Mile	<b>NESC</b>	National Electrical Safety Code
<b>GPAD</b>	Gallons Per Acre Per Day	<b>NFPA</b>	National Fire Protection Association
<b>GPCD</b>	Gallons Per Capita Per Day	<b>NIST</b>	National Institute of Standards and Technology
<b>GPM</b>	Gallons Per Minute	<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>HCM</b>	Highway Capacity Manual		
<b>HBP</b>	Hot Bituminous Pavement		
<b>HGL</b>	<u>Hydraulic Grade Line</u>		
<b>HSG</b>	<u>Hydrologic Soil Group</u>	<b>NPK</b>	Nitrogen-Phosphorus-Potassium
<b>ICBO</b>	International Conference of Building Officials	<b>NSF</b>	National Sanitation Foundation
<b>IEC</b>	<u>International Fire Code</u>	<b>OSHA</b>	Occupational Safety and Health Administration
<b>IPC</b>	<u>International Plumbing Code</u>		
<b>IEEE</b>	Institute of Electrical and Electronics Engineers	<b>PC</b>	Point of Curve
<b>IES</b>	Illuminating Engineering Society	<b>PCC</b>	Portland Cement Concrete or

<b>PLS</b>	Point of Compound Curve Pure Live Seed	<b>VPC</b>	Vertical Point of Curve
<b>PMR</b>	Physical Map Revision	<b>VPI</b>	Vertical Point of Intersection
<b><u>POTW</u></b>	<u>Publicly Owned Treatment Works</u>	<b>VPT</b>	Vertical Point of Tangent
<b>PRC</b>	Point of Reverse Curve	<b><u>WQCV</u></b>	<u>Water Quality Capture Volume</u>
<b>PRV</b>	Pressure Reducing Valve		
<b>PT</b>	Point of Tangent		
<b><u>PVC</u></b>	<u>Polyvinyl Chloride</u>		
<b>RCP</b>	Reinforced Concrete Pipe		
<b>ROW</b>	Right of Way		
<b><u>RPA</u></b>	<u>Receiving Previous Area</u>		
<b>SAE</b>	Society of Automotive Engineers		
<b><u>SCM</u></b>	<u>Stormwater Control Measure or Control Measure for Post-Construction Stormwater Quality</u>		
<b><u>SDR</u></b>	<u>Standard Dimensional Ratio</u>		
<b>SEO</b>	State Engineer's Office		
<b>SHAC</b>	State Highway Access Code		
<b><u>SWMP</u></b>	<u>Stormwater Management Plan</u>		
<b>TC</b>	Top of Curb		
<b>TIA</b>	Telecommunications Institute of America		
<b><u>TMDL</u></b>	<u>Total Maximum Daily Load</u>		
<b>TMP</b>	Transportation Master Plan, City of Boulder		
<b>UBC</b>	Uniform Building Code		
<b>UDFCD</b>	Urban Drainage and Flood Control District		
<b><del>UFC</del></b>	<del>Uniform Fire Code</del>		
<b><u>UIA</u></b>	<u>Unconnected Impervious Area</u>		
<b>UL</b>	Underwriters Laboratories, Inc.		
<b>UMC</b>	Uniform Mechanical Code		
<b><del>UPC</del></b>	<del>Uniform Plumbing Code</del>		
<b>USDCM</b>	Urban Storm Drainage Criteria Manual		
<b>USGS</b>	United States Geological Survey		



## SECTION 2: DEFINITIONS

Words and phrases contained in these Standards shall be read in context and construed according to the rules of grammar and common usage. Words and phrases that have acquired a technical or particular meaning, whether by definition, adoption herein, or otherwise, are intended to be construed accordingly.

Wherever the phrases "**as directed**", "**as required**", "**as permitted**", or phrases of like meaning are used, it shall be understood that the direction, requirements or permission of the Director of Public Works (Director) is intended. Similarly, use of the words "**approved**", "**acceptable**", and "**satisfactory**" shall refer to approval of the Director.

The definitions in this Glossary apply throughout these Standards. The words or phrases presented have the following meaning unless the context clearly indicates otherwise:

**“Alteration”** means a request to use a substitute or alternative material, method, or process which will perform the same function as that provided in a particular standard.

**“Approach”** means the portion of an intersection leg which is used by traffic approaching the intersection.

**"Approved plan"** means the engineering design and construction drawings for public improvements, prepared by an engineer, which has been granted final approval by the Director of Public Works in accordance with these standards.

**"As-built"** means an engineering drawing of record, prepared under the direction of a licensed Colorado registered professional engineer, reflecting the actual construction of public improvements in the service area, including, but not limited to, final grading, alignments, dimensioning, elevations, locations and materials sizing and type.

**“Average Daily Trips (ADT)”** means the volume of traffic passing through a given point during a given time period, divided by the number of days in that time period.

**"Backflow"** means the reversal of the direction of flow of water or mixtures of water and other liquid, gases, or other substances into the distribution pipes of a potable water supply from any source or sources caused by backpressure and/or back-siphonage.

**"Backflow prevention assembly"** means any approved assembly, method, or type of construction designed to prevent backflow or back-siphonage into a public water supply by isolating the owner's water system from the public water system. In addition, see Section I. of these rules.

**“Caliper”** means a diameter measurement of a tree's trunk, and is measured around the trunk of the tree, six inches above tree base grade for one to four inch caliper trees and 12 inches above tree base grade for five to eight inch caliper trees. Trees measuring between four and five inch caliper shall be rounded off to the nearest inch.

**“Capacity”** means the maximum number of vehicles that have a reasonable expectation of passing over a given roadway or section of roadway in one direction during a given time period.

**“Certified Backflow Prevention Device Tester”** means any person who has passed a State of Colorado approved or sponsored certification examination, and who is listed as a certified backflow prevention device tester with the Colorado Department of Public Health and Environment.

**"City"** means the City of Boulder, a Colorado home rule city in Boulder County, Colorado.

**"City water system"** means the source and distribution facilities of the water system to the point of delivery to the owner water system. The source includes all components of the facilities utilized in the production, treatment, storage, and delivery of water to the distribution system. The distribution system includes the network of conduits used for the delivery of water from the source to the owner water system.

**"Contractor"** means a person, firm, partnership, subcontractor or corporation, licensed by the City that is responsible for the construction of approved public improvements associated with a specific project, or projects, within the City of Boulder service area. This term also includes the contractor's superintendent and on-site manager.

**"Colorado Cross Connection Control Manual"** means a manual published by the Colorado Department of Public Health and the Environment addressing cross connection control practices, Fourth Edition - Revised.

**"Cross connection"** means any physical arrangement whereby the city's water supply system is connected, directly or indirectly, with any other water supply system, sewer, drain, conduit, pool, storage reservoir, plumbing fixture, or other device which contains, or may contain, contaminated water, sewage, or other waste or liquid of unknown or unsafe quality which may be capable of imparting contamination to the public water supply as a result of backflow. Bypass arrangements, jumper connections, removable sections, swivel or changeover assemblies, and other temporary or permanent assemblies through which, or because of which, backflow could occur are considered to be cross connections.

**“Delay”** means the stopped time per approach vehicle, in seconds per vehicle.

**“Design Hour Volume”** means the hourly traffic volume used for street design and capacity analysis, usually one (1) or more peak hours during a 24 hour period.

**“Design Speed”** means five (5) to 10 miles per hour above the proposed or desired speed limit of the facility under design.

**“Design Vehicle”** means that all public and private streets must be designed to accommodate an SU-30 vehicle. The definition of this vehicle type is found in AASHTO's Geometric Highway Design Standards.

**"Developer"** means the person, owner, firm, or corporation responsible for the development and completion of all public improvements associated with a proposed project in accordance with these standards.

**“Diameter”** means the diameter size measurement of a tree's trunk, and is measured around the trunk at 4.5 feet above the tree base grade for trees greater than eight (8) inch caliper.

**“Director” or “Director of Public Works”** means the authorized City employee, or his/her designee, responsible for the enforcement of these standards and approval of the design and construction of public improvements within the City of Boulder service area, and the overall management and direction of the Public Works Department.

**“Dripline”** means the outermost edge of a tree's canopy, projected on the ground.

**"Engineer"** means the Colorado registered professional engineer responsible for the design of all public improvements submitted to the City for a proposed project in accordance with these standards, including all plans, calculations, specifications, and coordination of field surveys.

**"Construction plan"** means the engineering design and construction drawings for public improvements, prepared by an Engineer which has been submitted for final approval by the Director of Public Works in accordance with these standards.

**“Hourly Volume”** means the number of vehicles that pass over a given section of a lane or roadway during one hour.

**"Inspector"** means the Director of Public Works, or his/her designee, responsible for the inspection of public improvements construction.

**“Level of Service (LOS)”** refers to the definitions of LOS provided in the Highway Capacity Manual, “Definitions and Concepts.”

**"May"** means is authorized to, or a permissive condition which indicates a choice between two (2) or more alternatives.

**“Modification”** means a request to change or modify a standard or the parameters of a standard because the particular application may not require the degree of rigor which the standard requires.

**“Peak Hour”** means the concept referring to the hour of a day when the highest volume of traffic occurs on a transportation facility.

**“Planting Strip”** means the landscape area within a street median, the landscape planting strip between the curb and detached sidewalk, or the landscape area between the back edge of a public sidewalk (attached or detached) and the right-of-way/property line.

**"Public improvements"** means any public facility, system or infrastructure in the City of Boulder service area including, but not limited to: earthwork or landscaping, streets, sidewalks, bike paths, trails, parking and traffic control devices; water supply, treatment, storage and distribution systems; wastewater collection and treatment systems; and stormwater and flood control collection and conveyance systems in public easements or right-of-way.

**“Public Sign”** means any sign that is posted by a governmental entity within the right-of-way for the purpose of directing traffic or parking.

**"Record Set"** means the engineering design and construction drawings for public improvements, sealed and signed by an engineer, approved by the Director of Public Works in accordance with these standards, and maintained on file in public records as the final approved construction document.

**"Root Protection Zone"** means the ground area surrounding the entire tree that extends from trunk to dripline, or a minimum of fifteen feet for column-shaped trees, whichever is greater.

**"Shall"** means a mandatory duty to conform to the specified standard. Where certain requirements in these standards are described with the "shall" stipulation, it is mandatory that these requirements be met or exceeded.

**"Should"** means an advisory condition. Where "should" is used, it is considered to be recommended or advisory, but not mandatory.

**"Sidewalk, Attached"** means a sidewalk and curb that are attached as one (1) continuous element.

**"Sidewalk, Detached"** means a sidewalk that is separated from the curb by a landscape planting strip.

**"Sight Distance"** means the length of roadway ahead visible to the driver. The minimum sight distance available must be long enough to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

**"Speed Change Lane"** means a separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase (acceleration lane) or decrease (deceleration lane) its speed to a rate at which it can more safely merge or diverge with through traffic. Includes tapered areas.

**"Standards"** means the "Design and Construction Standards" manual for the City of Boulder.

**"Storage Lane"** means additional length added to a deceleration lane, to store the maximum number of vehicles likely to accumulate during a critical period without interfering with the through lanes.

**"Street Tree"** means any tree in the public right-of-way.

**"Streetscape"** means landscaping design for any streetside area, generally including but not limited to planting strips and medians.

**"Transportation Demand Management"** means any action or set of actions aimed at reducing the impact of traffic by influencing people's travel behavior.

**"Trips"** means a vehicle moving from an origin point to a destination point. Trips are one-way.

**"Waiver"** means a request to delete or omit the application of a particular standard.

**"Work"** means any activity involved in the performance of constructing, installing, repairing or maintaining public improvements.

**CITY OF BOULDER**  
**DESIGN AND CONSTRUCTION STANDARDS**

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## REFERENCES

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Where not specified in these Standards or the Boulder Revised Code (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 improvements and may refer to one or more of the following references:

### GENERAL REFERENCES

Code of Federal Regulations (CFR)

Colorado Revised Statutes (CRS)

### TRANSPORTATION REFERENCES

Institute of Transportation Engineers (ITE) *Guidelines for Major Urban Street Design*

ITE *Trip Generation Manual*

*Manual on Uniform Traffic Control Devices* (MUTCD)

### STREETSCAPE AND TREE PROTECTION REFERENCES

*American Standard for Nursery Stock*, American Association of Nurserymen.

*Guide for Plant Appraisal*, International Society of Arboriculture.

*Species Ratings and Appraisal Factors Guide*, Rocky Mountain Chapter, I.S.A.

*Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance* (ANSI. A300), American National Standard Institute.

*Streetscape Standards* for the Boulder Valley Regional Center.

*Himelick's Tree and Shrub Transplanting Manual*, International Society of Arboriculture.

*Valuation of Landscape Trees, Shrubs, and Other Plants*, International Society of Arboriculture.

### UTILITIES REFERENCES

*Manual of Water Supply Practices*, American Water Works Association (AWWA)

~~*Uniform Plumbing Code (UPC)*~~

~~*Uniform Fire Code (UFC)*~~

Effective: ~~TBD~~ July 2, 1998

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Insurance Services Office (ISO)

Denver, Colorado, Board of Water Commissioners, Engineering Standards

*Colorado Cross Connection Control Manual*

American Society of Civil Engineers (ASCE) *Manuals and Reports on Engineering Practice - Gravity Sanitary Sewer Design and Construction*

Colorado Department of Health *Design Criteria for Wastewater Treatment Works*

*International Plumbing Code (IPC)*

*International Fire Code (IFC)*

CDOT Standard Specifications for Road and Bridge Construction. 2017

*Installation Guide for Ductile-Iron Pipe*, Ductile Iron Pipe Research Association

*Handbook of Steel Drainage and Highway Construction Projects*, American Iron and Steel Institute

#### **STORM WATER REFERENCES**

Urban Drainage and Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3.*

US Army Corps of Engineers *Users and Programmers Manuals for HEC-1 (Flood Hydrograph Package), HEC-2 (Water Surface Profiles), and HEC-RAS.*

*State of Colorado Department of Public Health and Environment §303(d) List of Water-Quality-Limited Segments Requiring TMDLs or for which a Total Maximum Daily Load (TMDL) (Note: with this list, adopted in 5 CCR 1002-93, the State of Colorado implements the requirements of §303(d) of the federal Clean Water Act.)*