City of Commerce City

Storm Drainage Design and Technical Criteria Manual

STORM DRAINAGE DESIGN

AND

TECHNICAL CRITERIA

MANUAL

August 2021

Table of Revisions

The following summary of changes details revisions to the Commerce City Storm Drainage Design and Technical Criteria Manual subsequent to its most recent version.

Affected Section or Subsection	Revision Date	Revision Description

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Acknowledgments

In 2021, the City of Commerce City Public Works Department completed a major revision to the version of the Commerce City Storm Drainage Design and Technical Criteria Manual that had been in effect since 1989. With support from Mile High Flood District and Wright Water Engineers, Inc., the updated manual incorporates contemporary storm drainage, floodplain, and stormwater quality management requirements, criteria, and guidelines that are consistent with the standard of practice in the Front Range region and the State of Colorado.

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
CDPHE	Colorado Department of Public Health and Environment
CDOT	Colorado Department of Transportation
CDPS	Colorado Discharge Permit System
cfs	cubic feet per second
CDPHE	Colorado Department of Public Health and Environment
CLOMR	Conditional Letter of Map Revision
CLOMR-F	Conditional Letter of Map Revision based on Fill
CRS	Colorado Revised Statutes
CSU	Colorado State University
CUHP	Colorado Urban Hydrograph Procedure
CWCB	Colorado Water Conservation Board
EDB	Extended Detention Basin
EGL	Energy Grade Line
EPA	U.S. Environmental Protection Agency
ESC	Erosion and Sediment Control
EURV	Excess Urban Runoff Volume
FEMA	Federal Emergency Management Agency
FHAD	Flood Hazard Area Delineation
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FSD	Full Spectrum Detention
ft	feet
ft/sec	feet per second
GI	Green Infrastructure
GSI	Green Stormwater Infrastructure
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HGL	Hydraulic Grade Line
HSG	Hydrologic Soil Group
in	inches
LID	Low Impact Development
LOMC	Letter of Map Change
LOMR	Letter of Map Revision
LOMR-F	Letter of Map Revision based on Fill
MDCIA	Minimizing Directly Connected Impervious Area
MDP	Major Drainageway Plan
MHFD	Mile High Flood District
MS4	Municipal Separate Storm Sewer System
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program

NPL	National Priority List
NRCS	Natural Resources Conservation Service
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
OPS	Colorado Division of Oil and Public Safety
OSHA	Occupational Safety and Health Administration
OSP	Outfall System Plan
PUD	Planned Unit Development
RCRA	Resource Conservation and Recovery Act
RECP	Rolled Erosion Control Product
ROW	Right-of-Way
SCM	Stormwater Control Measure
SFHA	Special Flood Hazard Area
SEO	Office of the State Engineer
SPCC	Spill Prevention, Control, and Countermeasure
SWMM	Stormwater Management Model
SWMP	Stormwater Management Plan
TMDL	Total Maximum Daily Load
UMTRA	Uranium Mill Tailings Remedial Action
UST	Underground Storage Tank
VCUP	Voluntary Cleanup Program
WEF	Water Environment Federation
WQCV	Water Quality Capture Volume
WSE	Water Surface Elevation

1.0 General Provisions

1.1 Enactment Authority

The Commerce City Department of Public Works developed this Storm Drainage Design and Technical Criteria Manual (Manual or Storm Drainage Criteria Manual), working with the Mile High Flood District (MHFD). The City Council of Commerce City has adopted this Manual by ordinance.

1.2 Administrator

The City Manager, or his or her designee (hereinafter called "Administrator"), is responsible for administration and enforcement of this Manual, including review of all drainage studies, plans, and specifications for drainage improvements; interpretation and enforcement of the provisions of this Manual; and application of sound engineering judgement in implementing the requirements found in this Manual.

1.3 Purpose

The purpose of this Manual is to establish minimum storm drainage criteria for the public safety, health, comfort, convenience, welfare, and economic well-being of residents and owners of property within the City. This Manual presents the policies and minimum technical criteria for the planning, analysis, design, and maintenance of storm drainage systems in Commerce City and incorporates by reference the Mile High Flood District's Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 (MHFD Manual). All subdivisions, planned unit developments, or any other proposed construction must include adequate and appropriate storm drainage systems that meet or exceed the criteria in this Manual.

1.4 Jurisdiction and Applicability

This Manual applies to all land within the current and subsequently annexed boundaries of Commerce City, including all City-owned lands (Figure 1-1). This Manual applies to all storm drainage systems and facilities constructed in or on Commerce City rights-of-way, easements dedicated for drainage across public or private property, easements for public use, and to all privately owned and maintained stormwater conveyance, detention, retention, and water quality facilities.

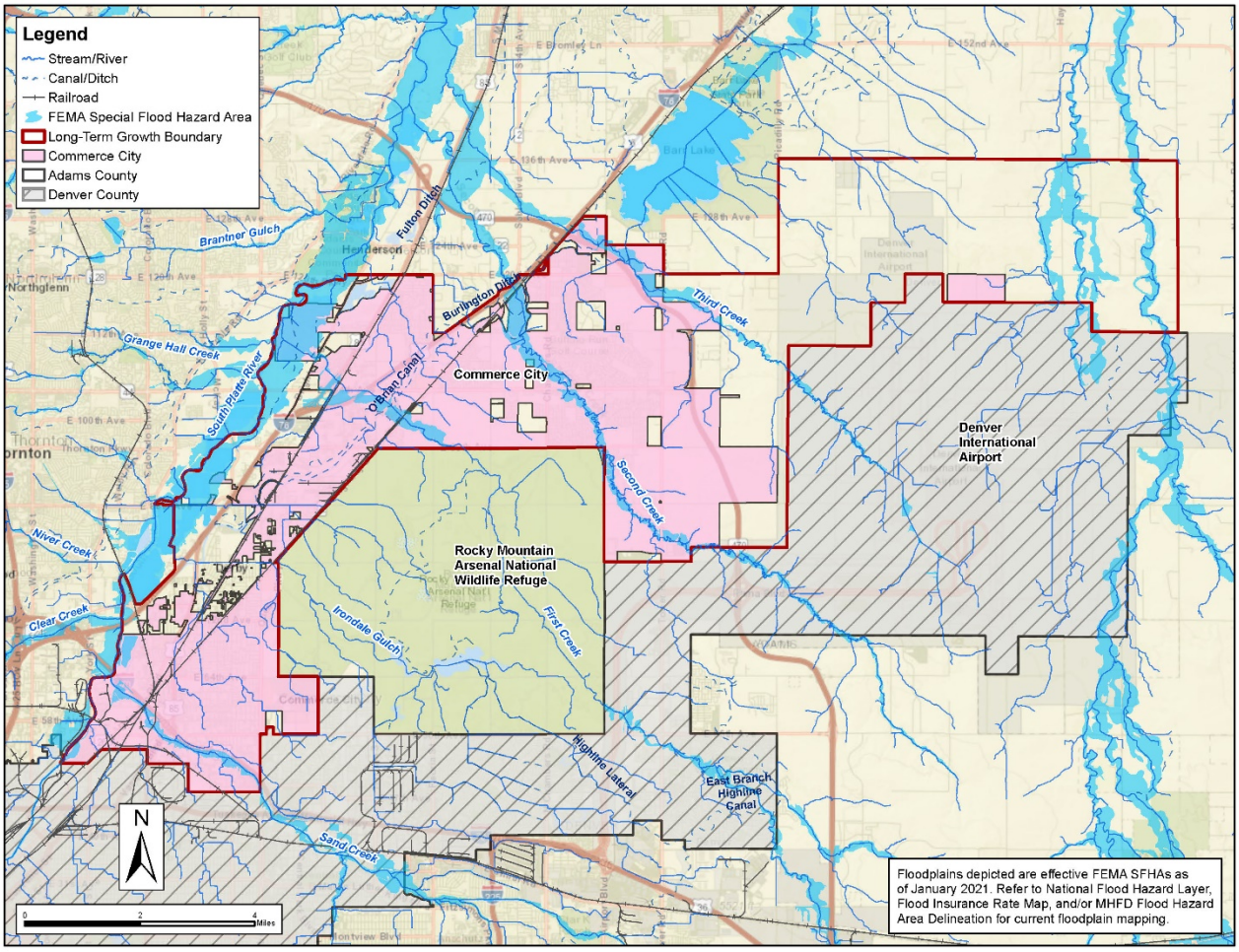
This Manual applies to the administration of drainage, floodplain, and water quality provisions of the Commerce City Land Development Code and all other ordinances and regulations that require a review of drainage conditions on any property within the City.

This Manual applies to all new development and redevelopment projects in Commerce City. For projects with a cumulative disturbed area of 5,000 square feet or more, drainage and water quality treatment systems must be designed to address runoff from all disturbed portions of the development site, including all new areas of imperviousness. When the City Engineer has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measure, the

applicant may deviate from the WQCB Standard in a manner that is consistent with the City's CDPS General Permit COR0900000 - Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4) -Certification Number: COR090032.

A hydrologic analysis and hydraulic design for storm drainage must be completed in accordance with the criteria in this Manual and submitted to Commerce City for approval.

Figure 1-1. Commerce City Vicinity Map, Major Drainageways, and Floodplains



1.5 Review and Approval

The City will review all submittals of drainage studies and plans for general compliance with this Manual. An approval by the City does not relieve the owner, engineer, or designer from responsibility for ensuring that the calculations, plans, specifications, construction, and record drawings are in compliance with the Manual, as stated in the certification of the owner's engineer, as specified in the Submittals chapter of this Manual.

The City may request that the Floodplain Administrator review reports and construction plans required by this Manual. Where major drainageway improvements or floodplain delineation are involved, Floodplain Administrator approval will be required, and administration of the subject area must be in accordance with Chapter 21 Article IV of the Commerce City Land Development Code.

The City will refer reports and construction plans required by this Manual to the MHFD where major drainageway improvements, outfalls to major drainageways, regional detention or water quality facilities, or floodplain modifications are proposed. Per Colorado Revised Statute (CRS) §32-11-221(1), MHFD approval will be required for the design and construction of the improvements, including meeting all vegetation requirements and guidelines. All MHFD maintenance-eligible stormwater facilities constructed in Commerce City must meet the MHFD's currently applicable maintenance eligibility guidelines.

Submittals that impact FEMA-designated floodplains must be submitted through Commerce City to FEMA for review in accordance with the provisions of Chapter 4 of this Manual.

The City may, but is not required to, refer submittals to other agencies that have an interest or responsibility for drainage and/or water quality issues. Other review agencies may include federal and state agencies responsible for floodplains, water quality, wetlands, water rights, and other stormwater related issues, as well as other impacted jurisdictions. The City will refer development submittals to irrigation companies on any development adjacent to canals that could impact the water quality, flow rate, or quantity of those canals.

The Commerce City Department of Public Works will inspect and approve constructed storm drainage systems prior to use. The property owner and subsequent owners of the property are responsible for maintaining the constructed drainage system as designed and constructed (with any subsequent City-approved modifications). All regional drainage infrastructure such as regional ponds and major drainageways must be designed to meet MHFD Maintenance Eligibility Program requirements. Long-term operation and maintenance plans are required for all drainage improvements. Operation and maintenance plans must be approved by the City and recorded so that future owners will understand maintenance requirements. The permittee shall retain maintenance records consistent with the City's MS4 Permit.

1.6 Interpretation

In the interpretation and application of the provisions of this Manual by the Administrator, the following will govern:

- This Manual provides the minimum requirements to protect the public health, safety, comfort, convenience, prosperity, and welfare of the residents of Commerce City, protect property, and minimize adverse impacts to the environment.

- Whenever a provision of this Manual and any other provisions of the Commerce City Land Development Code, law, ordinance, resolution, rule, or regulation of any kind, contains any requirement(s) covering any of the same subject matter, the requirements that are more restrictive or impose higher standards will govern.

- This Manual does not abrogate or annul any easements, permits, drainage reports, or construction drawings, recorded, issued, or accepted by Commerce City prior to the effective date of this Manual.

- The Administrator has final authority to resolve any conflicting interpretations of this Manual.

1.7 Variances

1.7.1 Applicability

Variances are considered an extraordinary form of relief and are highly disfavored. Nevertheless, the City recognizes that in certain limited instances it may be exceptionally difficult to both conform to these criteria and maintain the special character and environmental values of Commerce City. In such situations, a variance may be sought. Variances will be considered on a case-by-case basis. The procedures of this Section shall apply to requests for variances from the standards or submittal requirements of this Manual.

1.7.2 Criteria of Approval

A variance application may be approved only if the City Engineer finds by clear and convincing evidence that the applicant has met all of the following criteria:

1. The variance applicant is unable to comply with the underlying standard or submittal requirement, and not due to the applicant's fault.

2. The variance will address a unique condition not experienced by other property owners of the same classification in the same zoning district.

3. The variance sought:

    a. Represents the least deviation from the standard or submittal requirement that will afford relief;

    b. Does not increase costs of maintenance and repair of public storm drainage facilities or other public facilities;

    c. Meets the stated principles found in Section 2.2 of this Manual;

    d. Does not cause property damage to upstream or downstream properties;

    e. Does not impose undue adverse environmental impacts;

f. Ensures access to the property and safe traffic flow will not be compromised; and

g. Does not cause undue negative impact to public safety, health, welfare, and environment.

The City Engineer may, at their discretion, utilize a third party (or third parties) to provide expertise or input when reviewing a variance application. In such situations, the variance applicant shall be subject to Special Application Review Services fees as set forth in the Directory of City Fees and Charges, as may be amended from time to time.

1.7.3 Submittal Requirements

Variance requests shall be submitted to the City Engineer in writing and shall be accompanied by the Drainage Variance application fee. Failure to submit payment of the applicable fee shall cause the Variance application to be summarily denied. To support the requested variance, the applicant must provide the following:

1. Details identifying the standard or submittal requirement from which the applicant seeks a variance and including a description of conditions and constraints that prevent the applicant from meeting the requirements of this Manual. The application must provide specific reference to applicable sections of this Manual and the City's CDPS MS4 Permit relevant to the proposed variance request.

2. Alternate criteria or standards that are proposed to comply with the intent of the criteria underlying the standard or submittal requirement the applicant seeks to vary. Additionally, the applicant must provide documentation, including necessary calculations, analyses, and other relevant information supporting the alternate criteria. The supporting documentation, calculations, and analyses must be signed and stamped by an engineer licensed in the State of Colorado.

3. If applicable, the applicant must provide alternatives to meeting flood attenuation, water quality, and any other requirement of this Manual. If the analysis identifies the use of off-site or regional drainage facilities to meet the requirements of this Manual, the applicant must also include:

    a. Location of proposed facility.

    b. Owner of proposed facility.

    c. Analysis of available capacity of facility.

    d. Proposed modifications to the facility to accommodate proposed use (if applicable).

    e. Analysis of storm drain system capacity to convey flows to the facility.

    f. Agreement for use and maintenance of the facility.

4. A complete description of the cumulative impacts of the proposed variance and similar potential variances for similar properties in the same major drainage basin in the City. The applicant must provide a description of potential adverse impacts of the proposed variance on major drainageways and downstream public and private drainage facilities and properties.

5. Any other information that would support the validity of the variance.

6. Additional information that may be required by the City Engineer and upon the request of the City Engineer.

1.7.4 Disposition of Variance

Upon receipt and review of a complete application for a variance, the City Engineer will review the application and provide a disposition approving, denying, or approving with modifications or conditions.

If a variance application is denied, the applicant shall be prohibited from submitting a variance request seeking the same or significantly similar relief absent a showing of significantly changed circumstances.

1.8 Amendment of Manual

The policies and criteria contained in this Manual are basic guidelines that may be amended as new technology is developed or more experience is gained in the use of this Manual. Amendments will be published and posted as required by the City Charter for adoption of ordinances and will become effective as provided by the City Charter. Final drainage reports or construction plans submitted to the City for approval within 30 days after the effective date of any amendment to this Manual are exempt from the requirements of any newly adopted amendment.

1.9 Relationship to Other Standards

Policies and technical criteria not specifically addressed in this Manual must follow the provisions of the MHFD Manual, which is incorporated in this Manual by reference.

1.10 Use of Modeling Software and Design Spreadsheets

MHFD and other computer software programs, models, and spreadsheets are referenced in this Manual as design aids that may be useful in designing drainage and water quality improvements. Use of these design aids is in no way a substitute for sound engineering judgment, proper engineering qualifications, and common sense. Although the design aids recommended in this Manual have been developed using a high standard of care, it is likely that some nonconformities, defects, bugs, and errors with the software programs will be discovered as they become more widely used. Commerce City does not warrant that any version of these design aids will be error-free or applicable to all conditions encountered by the designer, and Commerce City will not be held liable for their use.

2.0 Stormwater Management Policy and Principles

2.1 Introduction

Stormwater and floodplain management are necessary to preserve and promote the general health, welfare, safety, and economic and environmental well-being of Commerce City. When considered in a comprehensive manner on a regional level with public and private involvement, stormwater management facilities can enhance the general health and welfare of the region and support optimum economic and social relationships. This chapter describes the principles that Commerce City follows to manage drainage and summarizes policies followed for planning, design, operation and maintenance, irrigation facilities, flood control, and water quality. These principles and policies form the underlying basis of the criteria established in this Manual.

2.2 Principles

Commerce City follows well-established principles for urban stormwater management adapted from Mile High Flood District's (MHFD's) Urban Storm Drainage Criteria Manual (MHFD Manual):

1. Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between properties. This makes it necessary to formulate programs that include both public and private involvement. Overall, the governmental entities most directly involved must provide coordination and master planning, but drainage planning must be integrated on a regional level if optimum results are to be achieved. The manner in which proposed drainage systems fit into existing regional systems must be quantified and discussed in drainage master plans.

2. A storm drainage system is a subsystem of the total urban water resources system. Stormwater system planning and design for any site must be compatible with comprehensive regional plans and should be coordinated with planning for land use, open space, and transportation. Erosion and sediment control, flood control, site grading criteria, and water quality are integral to urban stormwater management. Any individual master plan or specific site plan should normally address all of these considerations.

3. Every urban area has an initial (i.e., minor) and a major drainage system, whether or not they are actually planned and designed. The initial drainage system, sometimes referred to as the "minor system," is designed to provide public convenience and to accommodate moderate, frequently occurring flows. The major system carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system. Both systems should be carefully considered.

4. Runoff routing is primarily a space allocation problem. The volume of water present at a given point in time in an urban region cannot be compressed or diminished. Channels and storm drains serve both conveyance and storage

functions. If adequate provision is not made for drainage space demands, stormwater runoff will conflict with other land uses, result in damages, and impair or disrupt the functioning of other urban systems.

5. Planning and design of stormwater drainage systems should not be based on the premise that problems can be transferred from one location to another. Urbanization tends to increase downstream peak flow by increasing runoff volumes and velocities. Stormwater runoff can be stored and slowly released via detention facilities to manage peak flows, thereby reducing the drainage capacity required immediately downstream.

6. An urban storm drainage strategy should be a multi-objective and multi-means effort. The many competing demands placed on space and resources in an urban region warrant a drainage management strategy that meets multiple objectives, including water quality enhancement, groundwater recharge, recreation, wildlife habitat, wetland protection, control of erosion and sediment deposition, protection of landmarks/amenities, and creation of open spaces.

7. Design of the storm drainage system should consider the features and functions of the existing drainage system. Every site contains natural features that may contribute to the management of stormwater without significant modification. Existing features such as natural streams, depressions, wetlands, floodplains, permeable soils, and vegetation provide for infiltration, help control the velocity of runoff, extend the time of concentration, filter sediments and other pollutants, and recycle nutrients. Each development plan should carefully map and identify the existing natural system. Techniques that preserve or protect and enhance the natural features are encouraged. Good designs improve the effectiveness of natural systems rather than negate, replace, or ignore them.

8. In conjunction with new development and redevelopment, efforts should be coordinated to minimize increases in, and reduce where possible, stormwater runoff volumes, flow rates, and pollutant loads to the maximum extent practicable. Key practices include:

    - The perviousness of the site and natural drainage paths should be preserved to the extent feasible. Areas conducive to infiltration of runoff should be preserved and integrated into the overall runoff management strategy for the site.

    - The rate of runoff should be slowed. Preference should be given to stormwater management systems that maximize vegetative and pervious land cover. These systems will promote infiltration, filtering, and slowing of runoff. Due to the principle of mass conservation, it is virtually impossible to prevent increases in post-development runoff volumes for all storm events when an area urbanizes. Existing stormwater regulations typically require control of peak flows to predevelopment levels to the maximum extent practicable, and increasingly, regulatory agencies are implementing requirements focused on the control of runoff volumes for smaller, frequently occurring events. Increased flow volumes may not cause

flooding problems if a watershed has a positive outfall to a stream or river; however, increases in runoff volumes may cause problems for small, enclosed watersheds (i.e., draining to a lake) or into streams of limited capacity. Increases in runoff volumes, if not appropriately managed, can also adversely affect stream stability.

- Pollution control is best accomplished by implementing a series of measures that can include source controls, minimizing directly connected impervious area, and construction of on-site and regional facilities to control both runoff and pollution. Implementing measures that reduce the volume of runoff produced by frequently occurring events through infiltration and disconnection of impervious areas is one of the most effective means for reducing the pollutant load delivered to receiving waters.

- Historic subsurface contamination may be present at some development and redevelopment sites in Commerce City. In such cases, appropriate investigation should be conducted to determine whether infiltration practices should be avoided to prevent subsurface pollutant transport.

9. The stormwater management system should be designed beginning with the outlet or point of outflow from the project, giving full consideration to downstream effects and the effects of offsite flows entering the system. The downstream conveyance system should be evaluated to ensure that it has sufficient capacity to accept design discharges without adverse upstream or downstream impacts such as flooding, stream bank erosion, and sediment deposition. Additionally, the design of a drainage system should take into account the runoff from upstream sites, recognizing their future development runoff potential (e.g., imperviousness).

10. The stormwater management system requires regular maintenance. Failure to provide proper maintenance reduces both the hydraulic capacity and pollutant removal efficiency of the system. The key to effective maintenance is clear assignment of responsibilities to an established entity and a regular schedule of inspections to determine maintenance needs and to ensure that required maintenance is conducted. Local maintenance capabilities should be considered when planning and designing the stormwater management system for a given site or project.

11. Floodplains should be preserved whenever feasible and practicable. Nature has claimed a prescriptive easement for floods, via its floodplains, that cannot be denied without public and private cost. Floodplain encroachment must not be allowed unless competent engineering and planning have proven that flow capacity is maintained, risks of flooding are defined, and risks to life and property are strictly minimized. MHFD's policy is to preserve floodplains to manage flood hazards, preserve habitat and open space, create a more livable urban environment, and protect the public health, safety, and welfare.

12. Sufficient right-of-way for lateral movement of incised floodplains must be reserved. Whenever an urban floodplain is contained within a narrow non-engineered channel, its lateral movement over time can cause extensive damage to public and private structures and facilities. For this reason, whenever such a condition exists, it is recommended that, at a minimum, the channel be provided with grade control structures and a right-of-way corridor be preserved with a width corresponding to normal depth calculations for the future stable channel geometry, plus maintenance access requirements.

2.3 Policies

In keeping with the principles of storm drainage planning, Commerce City has developed specific policies that must be followed. These policies are discussed in the following categories: drainage planning and design, flood detention and stormwater quality facilities, drainage design, operation and maintenance, and the relationship between storm drainage and irrigation facilities.

2.3.1 Drainage Planning

1. All land development and redevelopment proposals must receive full site planning and engineering analyses. A drainage study and plan consistent with the submittal requirements in this Manual is required for all new development and redevelopment in Commerce City's jurisdiction.

2. Stormwater management planning is required in the initial planning stages for all developments and redevelopments to ensure that adequate space is allocated for the drainage facilities.

3. Commerce City encourages multi-purpose uses of storm drainage and detention facilities that are safe, maintainable, and compatible with adjacent land uses, Colorado Water Law and water quality enhancement objectives. Special care must be taken when storm drainage facilities are located in recreational, park, and open space areas to ensure that uses are compatible.

4. Commerce City supports and pursues a jurisdictionally unified approach to drainage to ensure an integrated comprehensive regional drainage plan.

5. In partnership with MHFD and other local governments, Commerce City will continue to participate in and encourage the development of detailed regional master plans that establish site drainage requirements for development and identify the required public improvements. Master plans will be approved, adopted, and revised as necessary to accommodate changes that occur within the specific drainage basin.

6. Where practicable and feasible, site planning and design techniques should minimize directly connected impervious areas in order to decrease the volume and velocity of stormwater runoff from a site.

7. Commerce City defines a major drainageway as any drainage flow path with a tributary area of 130 acres or more. Per Colorado Revised Statues (CRS) §32-11-221(1), design, construction, and vegetation requirements for these drainage facilities must be approved by MHFD.

8. Major drainageways must remain in open channels and must not be piped.

9. Commerce City considers stormwater runoff to be an integral part of the Commerce City's surface and groundwater resource and recognizes its potential for other uses.

10. Commerce City recognizes that some intra-watershed transfer or diversion of runoff occurs within major drainageway watersheds, as sub-watershed boundaries are changed with development. Such diversions and transfers should be minimized to the extent possible. Historic outfall locations to natural drainageways must be maintained, and any potential adverse impacts resulting from drainage transfers must be mitigated with the stormwater management design.

11. Historic major drainage pathways must be maintained, and inter-basin transfers of storm drainage must be avoided to the maximum extent practicable. Deviations from this policy may be granted on a case-by-case basis, but only when the following criteria are met:

    a. No other viable alternative exists.

    b. No additional potential damage is created by the proposed transfer.

    c. No impairment of water rights is caused.

    d. No other regulatory requirement is violated.

12. Drainage improvements included in applicable regional drainage master plans, MHFD Outfall Systems Planning Studies, or as required by the City in the accepted Final Drainage Study must be designed and constructed with all new development and redevelopment. Prior to implementing master plan recommendations based on modeling, Commerce City may require reasonableness checks of modeling results based on site observations and other information (e.g., maintenance records, flooding problems due to existing pipe size), where such information is reasonably available. Improvements, as designed and approved, must meet the intent of master plan recommendations.

13. In areas with known drainage problems or water quality impairments, development and redevelopment project plans must include measures that minimize further impacts.

14. All development and redevelopment projects must drain to an acceptable outfall in accordance with the Commerce City-approved Final Drainage Study for the initial drainage system and the applicable master drainage plan for the major

drainage system. Where no approved master drainage plan exists, the applicant must prepare and obtain approval for a master drainage plan for the affected area.

15. In areas where downstream outfall systems are inadequate or non-existent and where provision of outfall facilities cannot be reasonably accomplished, retention ponds may be used to meet stormwater quality requirements when designed in accordance with MHFD criteria and when adequate water rights have been obtained. Retention ponds are not allowed for stormwater detention and must drain within time limits specified by the CRS §37-92-602(8).

16. Commerce City regulates and manages floodplains in accordance with floodplain requirements in Commerce City's Land Development Code and as described in Chapter 4 of this Manual.

17. Commerce City recognizes the possible effects of the drainage system on water rights. In such cases, the Office of the State Engineer should be consulted.

18. Groundwater can adversely impact the construction, capacity, long-term function, and maintainability of stormwater management facilities. Those potential impacts must be quantified to the extent possible and considered during the design of stormwater management facilities. Water quality and pipe capacity will be evaluated by Commerce City before accepting discharges of groundwater to the storm drain system. Any detention system must be 2 feet above the seasonal high groundwater. Groundwater inflow into detention systems is not allowed.

2.3.2 Flood Detention (Storage) and Stormwater Quality Facilities

1. On-site Full Spectrum Detention (FSD) of flood flows for all development and redevelopment projects is required to reduce urban drainage problems and the costs of drainage facilities. Figure 2-1 summarizes requirements for drainage and stormwater quality for development and redevelopment projects described further in this section and in Chapters 13 and 14.

Figure 2-1. Requirements for Detention and Stormwater Quality in Commerce City

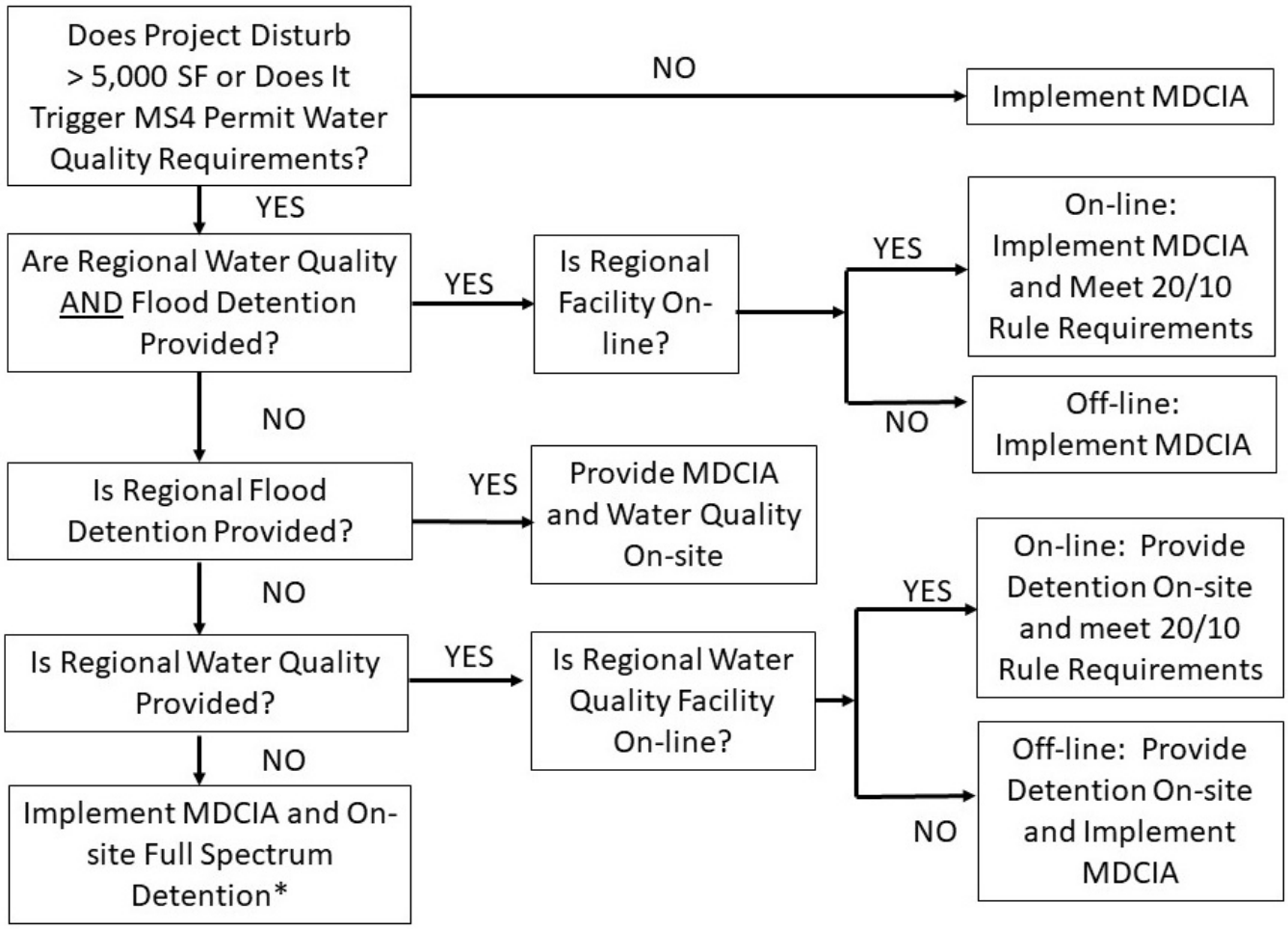


Figure 2-1 Notes:

MS4 Permit: Municipal Separate Storm Sewer System (MS4) permit. See Chapter 14 Stormwater Quality for more detailed information on MS4 Permit requirements.

MDCIA: Minimize Directly Connected Impervious Area.

20/10 Rule: Applies to sites draining to a regional water quality facility. Before discharging to a Water of the State, at least 20% of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10% of the upstream impervious area.

*On-site Full Spectrum Detention: Although Full Spectrum Detention with water quality integrated meets both flood control and water quality requirements, the applicant has the option to meet water quality requirements through other methods described in Commerce City's MS4 Permit certification.

2. Variances from FSD may be granted under these conditions:

    a) Cumulative disturbance is less than 5,000 square feet. Projects with less than 5,000 square feet of disturbance are required to reduce runoff volumes to the maximum extent practicable. This can be done by minimizing directly connected impervious area and using other low impact development practices.

    b) Project is immediately adjacent to a major drainageway, precedes the fully developed peak runoff to the first major drainageway, or is located within the 100-year floodplain. On these sites, the following conditions must be met:

        i. The Excess Urban Runoff Volume (EURV), as defined in Chapter 13, must be managed to provide minor event flood attenuation and to protect downstream channel stability.

        ii. The major drainageway must be capable of safely conveying the fully developed basin 100-year flood.

        iii. The fully developed 100-year flow from the project must be safely conveyed to the major drainageway without adversely impacting private properties or right of way. At a minimum, a safe conveyance determination must meet the requirements for streets in Table 7-2, not impact light rail operation, and consider other site-specific factors.

    c) Project is tributary to a publicly owned and maintained regional detention facility designed to accommodate flows from a fully developed basin, and safe and adequate conveyance of 100-year developed flows is provided from the development to the regional facility.

    All variances are subject to approval at the sole discretion of the City Engineer and may require additional analysis to demonstrate that no adverse effects to the overall drainage system will result from the variance.

3. Flood detention and water quality facilities must be designed to be safe, maintainable, and aesthetically pleasing, serving as community assets rather than liabilities.

4. Planning for water quality and flood detention must be integrated for all development and redevelopment projects. In this context, site planning and design techniques must reduce runoff volumes and velocities to the maximum extent practicable by implementing measures that minimize directly connected impervious area, as specified in Volume 3 of the MHFD Manual, as may be amended from time to time, and Chapter 14 of this Manual.

5. All development and redevelopment projects must comply with the terms and conditions of Commerce City’s Colorado Discharge Permit System (CDPS)

Municipal Separate Storm Sewer (MS4) discharge permit to minimize the discharge of pollutants to receiving waters to the maximum extent practicable through implementation of stormwater control measures.

6. Permanent stormwater control measures must be designed to treat stormwater runoff from the fully developed project site, as specified in Chapter 14 of this Manual.

7. All development and redevelopment projects in Commerce City must implement stormwater control measures (SCMs) to control erosion, sedimentation, and pollutant-laden stormwater discharges during construction activities in accordance with Chapter 15 of this Manual and Volume 3 of the MHFD Manual, as may be amended from time to time.

8. Commerce City may require implementation of temporary construction SCMs on development and redevelopment sites less than 1 acre in size.

9. Regional or subregional detention and stormwater quality facilities must be designed and constructed prior to development of any properties that are to be served by the facility.

2.3.3 Drainage Design

1. The design criteria presented in this Manual are minimum requirements for stormwater management. This Manual will be revised and updated as necessary to reflect advances in the field of urban drainage engineering and water resources management. All storm drainage facilities must be planned and designed in accordance with this Manual, the Commerce City Land Development Code, and the MHFD Manual.

2. All development and redevelopment projects must include planning and design for both the minor (initial) and major drainage systems. The design storm recurrence interval for the minor system is 5 years and for the major storm is 100 years. The minor drainage system must be designed to transport runoff with minimum disruption to the urban environment and to discharge to an acceptable outfall. Initial storm drainage may be conveyed in the curb and gutter of the street, roadside ditch, storm drain, channel, or other conveyance facility, provided that capacity exists under fully developed future conditions. Street conveyance must comply with encroachment limits specified in Table 7-1. The minor drainage system must be sized without accounting for peak flow reductions from upstream detention.

3. The capacity of the minor system of the downstream development must be equivalent to, or greater than, the capacity of the upstream system.

4. The major drainage system must be designed to convey runoff from the 100-year recurrence interval flood to minimize health and life hazards, damage to

structures, and interruption to traffic and services and must discharge to an acceptable outfall.

5. The major drainage system must be designed and sized without accounting for peak flow reductions from onsite or offsite detention unless permanently dedicated, publicly maintained detention facilities have been constructed.

6. Storm runoff must be determined by the Colorado Urban Hydrograph Procedure (CUHP) Method or the Rational Method, depending on the catchment size and complexity, as determined by the criteria provided in Table 6-1.

7. Streets are an integral part of the urban drainage system and may be used for drainage in accordance with the limitations identified in Tables 7-1 through 7-3 and Table 12-1 of in this Manual. Streets must not be used for drainage in a manner that unduly restricts the primary purpose of streets, which is for traffic.

2.3.4 Operation and Maintenance of Drainage Facilities

1. Storm drainage facilities, including channels, flood detention and water quality facilities, storm drains, and related appurtenances require ongoing maintenance and periodic repair and restoration to ensure proper functioning. Safe and adequate maintenance access must be provided in designs for all storm drainage facilities. Maintenance requirements and access provisions must be clearly defined in the drainage plan, storm drain construction plan and site plan submittals.

2. Easement widths must be provided in accordance with Table 2-1 and should be based on maintenance access needs and overflow widths, if any. Drainage easements must be shown on all plats, the drainage plan, and the storm drain construction plan and state that Commerce City has the right of access on the easements, which must be kept clear of obstructions restricting flow or maintenance access.

3. For detention and stormwater quality facilities, Commerce City requires submittal of an Operation and Maintenance Plan as part of the Final Drainage Study.

4. The landowner is responsible for maintenance of private drainage facilities located on their land unless the facilities are designated as public facilities and are within dedicated public easements.

5. The City will refer reports and construction plans required by this Manual to MHFD where major drainageway improvements, outfalls to major drainageways, regional detention facilities, or floodplain modifications are proposed. Per CRS §32-11-221(1), MHFD approval will be required for the design and construction of the improvements, including meeting all vegetation requirements and guidelines. All MHFD maintenance-eligible stormwater facilities constructed in Commerce City must meet the MHFD’s currently adopted maintenance eligibility guidelines.

Table 2-1. Required Maintenance Easements for Drainage Facilities[1]

Facility Type	Minimum Easement Width
Pipe less than 36-inch diameter	20 feet
Pipe of 36-inch diameter or larger	25 feet
Open Channels and Swales	Q_{100} less than 20 cfs: 20 feet Q_{100} less than 100 cfs: 25 feet Q_{100} greater than 100 cfs: See MHFD Manual
Detention Basins/ Retention Ponds	Width as required to contain storage, freeboard and associated facilities plus no less than 10 feet at appropriate locations for maintenance access. When multiple lots are involved, a dedicated tract of land is required.

[1]Easement widths shown are minimum widths to allow for construction and potential future repair or replacement. For pipes, if the minimum width in Table 2-1 is less than that required by Occupational Safety and Health (OSHA) for safe access, then the more stringent OSHA requirements apply. Larger easements may be needed for deep, large, or multiple pipe installations.

2.3.5 Storm Drainage Planning and Irrigation Facilities

Irrigation facilities and storm drainage facilities are designed for separate purposes and must comply with the following criteria:

1. Irrigation facilities such as ditches and reservoirs must not be used as drainage facilities, except where the requirements of this section are met.

2. Irrigation ditches must not be used as basin boundaries when evaluating the interaction of irrigation ditches with a major drainageway for the purpose of basin delineation. Drainage analysis must assume that irrigation ditches do not intercept storm runoff from the upper basin and that the upper basin is tributary to the basin area downstream of the ditch. During major storms, ditches will generally be flowing full, nearly full or sometimes overflowing; therefore, the tributary basin runoff would flow across the ditch.

3. Development and redevelopment projects must avoid discharging into irrigation canals and ditches, except as required by water rights, and must instead direct runoff into historic and natural drainageways. As a general rule, the flat slopes, limited carrying capacities, and potential for abandonment of ditches make them inappropriate for storm drainage usage.

4. Discharge of runoff into irrigation ditches will be approved if all of the following conditions are met:

    a. The discharge is consistent with the relevant master drainage plan.

    b. Thorough hydrologic and hydraulic analysis indicates the discharge does not cause adverse impacts.

    c. The owner's liability for ditch failure is clearly defined.

    d. Written consent of the ditch company is submitted to Commerce City.

    e. The practice is determined to be in Commerce City's best interest.

5. Whenever irrigation ditches cross major drainageways within a developing area, the developer must design and construct appropriate structures to separate storm runoff from ditch flows.

6. Any modifications to existing topography or placement of drainage structures that affect water quality or drainage patterns to ditches or other utilities must comply with the criteria listed above.

7. For hydrologic purposes, all private dams must be ignored in the definition of floodplains.

8. For all development and redevelopment projects downstream of irrigation storage facilities, Commerce City requires:

    a. The developer must obtain flood hazard maps from the Office of the State Engineer to determine dam hazard classifications pursuant to CRS§37-87-123.

    b. All development and redevelopment projects must be located outside of the reservoir's high-water line based on the design flood for the structure's emergency spillway.

    c. All development and redevelopment projects must be located outside of the high-water line based on the breach of a dam (except high hazard classified dams that have passed inspection by the Office of the State Engineer in accordance with CRS §37-87-105 et seq.

9. All development and redevelopment projects must be located outside existing or potential future emergency spillway paths, beginning at the dam and proceeding to the point where the flood water returns to the natural drainage course.

3.0 Drainage Report and Construction Drawing Submittal Requirements

This chapter describes requirements for preliminary and final drainage reports and requirements for construction drawings and record (as-built) drawings.

3.1 Drainage Report Requirements

All subdivisions, re-plats, re-zonings, planned unit developments (PUDs), or other development(s) (excluding “in-fill” single family residential lots) within the jurisdiction of Commerce City shall submit a Preliminary Drainage Study, a Final Drainage Study, and as-built drawings in accordance with the requirements of this chapter. The drainage study shall be submitted to the City for review by the Department of Public Works, Engineering Division. An electronic copy in pdf format, including supporting information, attached spreadsheets, and/or model files is also required. One unaltered copy and one copy with comments will be retained by the City. A redlined copy of the drainage report or a letter summarizing the comments will be provided to the applicant. The submittal shall include a declaration of the type of study submitted (i.e., Preliminary or Final). Standard Form SF-1, completed and submitted by the applicant, will be used to determine the adequacy of the submittal. Incomplete or absent information may result in the report being rejected for review. Drainage studies are valid as long as the Development Plan (for properties with a standard zone designation) or PUD Permit (for properties with a PUD zone designation) remains active. If the development plan or permit expires, updated drainage studies will be required. The general requirements and conditions for the subdivision of land in the City of Commerce City are set forth in §III.2.D. of the City of Commerce City Land Development Code.

Review and approval by other agencies, such as state or federal agencies, other local governments, affected jurisdictions, and other referral agencies; including but not limited to irrigation companies, and MHFD, may be required for some submittals. The applicant must address referral agency comments and obtain approvals when necessary.

A pre-application consultation meeting is suggested for all applicants to understand requirements before undertaking a drainage study. Items to be reviewed in the pre-application consultation may include the required procedures, site-specific drainage issues, and specific submittal requirements.

All studies must be signed and stamped on the submittal cover sheet in accordance with Table 3-1. All plan sheets must be signed and stamped on <u>each</u> sheet.

Table 3-1. Certification Requirements for Drainage Submittals

Submittal	Certification Required
Drainage Conformance Letter	Engineer
Preliminary Drainage Study	Engineer
Final Drainage Study	Engineer
Plan Sheet Designs	Engineer
Record (As-Built) Drawings	Engineer or Land Surveyor

3.1.1 Drainage Conformance Letter

A Drainage Conformance Letter may be substituted in lieu of a Drainage Report for development sites that meet all of the following qualifying criteria:

1. Prior approval must be obtained from Public Works Development Review Manager.
2. The property is included in a previously approved drainage plan.
3. No off-site surface drainage passes through the site.
4. The development does not alter the existing drainage pattern.
5. The site currently discharges to an improved drainage channel or existing storm sewer system maintained by a municipal agency.
6. The adjacent surface drainage system will hydraulically accommodate post-development runoff.

Drainage Conformance Letters are primarily used for pad sites within previously approved sites or for minor changes to existing properties. The letter shall be addressed to the Public Works Department, to the attention of the Development Review Manager. It is not required to be bound as in a full report. The letter must be signed and sealed by a qualified professional engineer licensed in the State of Colorado.

The letter must identify the full subdivision plat name, the project location, the project land use, any minor drainage changes to the previously approved drainage study and describe how it will be in general conformance with the previously approved drainage study. Calculations and plan sets may need to be attached documenting the proposed changes to basin areas, impervious values, runoff coefficients, stormwater flow rates, volumes, or other drainage characteristics established in a previously approved drainage report and this Manual.

3.1.2 Preliminary Drainage Study

The purpose of a Preliminary Drainage Study is to identify and define conceptual solutions to the problems that may occur on site and off site as a result of the proposed

development. In addition, problems that exist on site prior to development must be addressed during the preliminary phase. All studies shall be typed on 8-1/2" x 11" paper and bound. As noted above, a pdf submittal with supporting attachments is also required. The drawings, figures, maps, and tables shall be bound with the study report or included in a folder/pocket attached inside the back cover of the study. Spreadsheets, models and other input/output from technical analyses shall be included in the study and provided electronically in a format that City staff can review. The study shall include a cover letter that presents the preliminary design for review and shall be prepared by or under the supervision of a professional engineer who is licensed in Colorado. The study shall be certified as follows:

> "I hereby certify that this preliminary study for the (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Commerce City's *Storm Drainage Design and Technical Criteria Manual* for the owners thereof."
>
> _____
>
> Name
>
> Registered Professional Engineer
>
> State of Colorado No. _____
>
> (Affix Seal)

3.1.2.1 Study Format and Required Information

The Preliminary Drainage Study shall be in accordance with the following outline and contain the applicable information listed.

I. General Location and Description

A. Location

1. Describe city, county, and local streets within and adjacent to the site or the area to be served by the drainage improvements.
2. Identify township, range, section, ¼ section, lot(s) and block(s).
3. Identify major drainageways and drainage and water quality facilities.
4. Provide names of surrounding developments.
5. Provide location map.

B. Description of Property

1. Provide the area in acres (or square feet).
2. Describe ground cover (type of existing and proposed ground cover and vegetation).
3. Describe characteristics of major and minor drainageways.
4. Provide a general project description.
5. Describe the proposed land use.
6. At a minimum, provide soil types, depth to water table, soil boring logs, and location map. If infiltration-based stormwater practices will be used, provide infiltration test results. If a geotechnical study has been performed, it may be referenced or appended.
7. Identify existing major irrigation facilities such as ditches and canals.
8. Describe the history of flooding on the property, if any.
9. Identify the applicable flood zone as indicated on FEMA FIRM panels for the site.
10. Show and describe easements within and adjacent to the site.
11. Identify any areas of known or suspected contamination on or near the site that may have the potential to affect water quality either through soils that are exposed during construction of the site or from infiltration of runoff into soils with existing contamination. Potential resources for identifying known or suspected contamination are provided in Table 3-2. If known or suspected contamination is anticipated for the site, the applicant must demonstrate coordination with appropriate regulatory agencies, including the Colorado Department of Public Health and the Environment, and provide documentation of remediation plans or other measures that will be used to avoid exposing runoff and infiltrated water to contamination.

Table 3-2. Resources for Identification of Known or Suspected Contamination on Project Sites and within a 1-mile Radius[1]

Map/Database	Description
CDPHE Environmental Records Map	Colorado Department of Public Health and Environment (CDPHE) Database and map including solid waste facilities, Voluntary Cleanup (VCUP) sites, sites with institutional controls such as covenants required by the state, brownfield sites, National Priority List (NPL) sites, Resource Conservation and Recovery Act (RCRA) sites, Uranium Mill Tailings Remedial Action (UMTRA) program sites.
OPS Petroleum Release Events in Colorado	Underground Storage Tank (UST) system and Aboveground Storage Tank (AST) system petroleum release events, with their associated locations, contacts for remediation, and status in relation to currently being investigated, assessed, remediated, obtaining closure, or closed, dating back to 1986. Data provided by the State of Colorado, Department of Labor & Employment, Division of Oil & Public Safety (OPS).
Denver Area Historical Fill Areas	Database and mapping of historical fill sites in and near Denver, including portions of Commerce City, including historical dump sites.

[1]These resources are provided for reference purposes only. This is not intended to be a comprehensive list of resources. It should be used as an initial screening tool only. If there is known or suspected contamination on or near a site, it is the responsibility of the applicant to identify such conditions through appropriate tools including the ones listed below, others, or an environmental site assessment conducted by a qualified environmental professional and to coordinate, as necessary, with appropriate regulatory agencies.

II. Drainage Basins and Sub-basins

A. Major Basin Descriptions

1. Reference major drainageway planning studies such as Flood Hazard Area Delineation (FHAD) reports, Major Drainageway Planning (MDP) reports, Outfall Systems Plans (OSPs) and Flood Insurance Rate Maps (on file with the Department of Community Development). Current MDPs, OSPs and FHADs are available through the Mile High Flood District (MHFD).

2. Describe major basin drainage characteristics, including area, existing and proposed land uses, imperviousness, hydrologic soil groups, overland and channelized slopes, and other physical parameters used for drainage calculations or analyses. This applies to on-site and off-site drainage basins.

3. Identify all nearby irrigation facilities within 100 feet of the property boundary, which may influence or be influenced by the local drainage.

4. Identify all outfalls to major drainageways.

B. Sub-basin Descriptions

1. Discuss existing/historical on-site and off-site sub-basin drainage patterns of the property and the area 100 feet adjacent thereto.

2. Discuss proposed on-site and off-site sub-basin characteristics and impacts of development.

3. Describe key sub-basin characteristics for existing and proposed conditions including area, existing and proposed land uses, imperviousness, hydrologic soil groups, overland and channelized slopes, and other physical parameters used for drainage calculations or analyses.

III. Drainage Design Criteria

A. Development Criteria References and Constraints

1. Discuss previous drainage studies (i.e., project master plans) for the site that influence or are influenced by the drainage design – describe how previous studies are considered and affect the drainage design for the site.

2. Discuss the relationship to and implications of adjacent drainage studies.

3. Discuss drainage impacts of site constraints such as streets, utilities, ditches, existing structures, and development of site plan.

B. Hydrologic Criteria

1. Specify design rainfall and design storm recurrence intervals.

2. Identify hydrologic soil groups on the site and in off-site drainage basins.

3. Calculate imperviousness.

4. Describe the runoff calculation method.

5. Identify detention discharge and storage calculation method.

6. Discuss and justify other criteria or calculation methods used that are not presented in or referenced by the criteria in this Manual.

C. Hydraulic Criteria

1. Provide capacity analysis of existing and proposed drainage infrastructure.

2. Perform floodplain analyses (if required) – describe methods used, regulatory requirements (Commerce City Floodplain Development Permit, Conditional Letter of Map Revision, etc.), modifications to floodplain, etc.

3. Discuss other drainage facility design criteria used that are not presented in this Manual.

D. Stormwater Quality

1. Describe how the project will satisfy Municipal Separate Storm Sewer System (MS4) Permit construction phase requirements and discuss necessary permit coverage, as applicable.

2. Describe how the project will satisfy MS4 post-construction requirements and which of the post-construction design standards in the MS4 Permit that the project is intended to meet.

IV. Drainage Facility Design

A. General Concept

1. Discuss general drainage concepts and typical drainage patterns.

2. Explain off-site runoff considerations.

3. Discuss the content of tables, charts, figures, and drawings presented in the study.

4. Describe anticipated and proposed drainage patterns.

B. Specific Details

1. Discuss drainage problems encountered and proposed solutions.

2. Provide design flows and detention storage volumes.

3. Describe existing stormwater conveyance and storage facilities.

4. Describe proposed stormwater conveyances, storage facilities, and outlet structures. Discuss the relationship to both upstream and downstream properties and the impact of the development’s drainage on these properties. Include discussion of off-site drainage flow

patterns and the impact on development under existing and fully developed basin conditions.

5. Discuss maintenance access and aspects of the design.

6. Identify easements and tracts for drainage purposes, including the conditions and limitations for use.

7. Discuss compliance with other local, state, and federal requirements.

8. Describe structural and non-structural stormwater control measures (SCMs) that will be part of stormwater management design.

9. For pumped drainage systems provide the following at a minimum:

    a. Hydraulic criteria for sizing pumps including pump types, pump station capacity for design events, station design head, pump and system performance curves, storage upstream of pumps, inflow rates for design events, expected inflow quality, and discharge conditions including tailwater.

    b. Types of pumps and power sources, including backup pumps and backup power.

    c. Detailed description of pump maintenance requirements and plans and schedule for routine and emergency maintenance and repair.

    d. Description of and plans for access for maintenance, including stable path for emergency maintenance during flood events.

    e. Information on soils and station foundation design criteria.

    f. Evaluation of pump station surroundings, including any necessary mitigation measures for adverse aesthetics or noise conditions.

    g. Description of telemetry systems (if used) and pump controls.

    h. Cost estimate for pump station, including funding sources for long term operations and maintenance and eventual replacement.

C. Variances: Describe and justify any requested variances from the Commerce City drainage criteria and/or any variations from approved master plans (MDPs, OSPs, and development-scale master plans). Detailed justification must be provided for any variances requested.

V. Conclusions

A. Compliance with Standards

1. State compliance with criteria in Commerce City Storm Drainage Design and Technical Criteria Manual and summarize any requested variances.

2. Describe how the project complies with Commerce City's Colorado Discharge Permit System (CDPS) MS4 Permit, including construction and post-construction requirements.

3. Demonstrate compliance with Commerce City and Federal Emergency Management Agency (FEMA) floodplain rules and regulations.

B. Drainage Concept

1. Describe how the drainage design will control damage from storm runoff.

2. Discuss compatibility of proposed development with approved master plans (MDPs, OSPs, and development-scale master plans).

3. Describe drainage impacts of proposed development on upstream and downstream properties.

C. Water Quality

1. Discuss compliance with construction and post-construction requirements in Commerce City's MS4 Permit – specifically describe how the project will comply with these requirements, including if a stormwater management plan (SWMP) is required for compliance with the State of Colorado General Permit for Stormwater Discharges Associated with Construction Activities and which of the MS4 Permit post-construction standards the project will meet.

2. Identify which of the post-construction design standard in the MS4 Permit that the project will meet.

VI. References: List all criteria and technical information used. The Preliminary Drainage Study must be a stand-alone document including portions relevant documents referenced in the report. This supporting information may be included in appendices.

VII. Appendices

A. Hydrologic Computations

1. State land use assumptions for adjacent properties (upgradient and downgradient).

2. Provide a connectivity diagram showing relationship/connectivity of basins, conveyance facilities, detention basins, and design points.

3. Provide historic and fully developed runoff computations for existing and proposed land uses. This should include, at a minimum, minor and major storm runoff calculations for each sub-basin and design point.

4. Provide calculations for the water quality capture volume (WQCV), excess urban runoff volume (EURV), detention storage volumes, release rates, and drain times.

B. Hydraulic Computations

1. Provide culvert capacity calculations, if applicable.

2. Provide street capacity and inlet calculations.

3. Include storm drain capacity calculations including hydraulic and energy grade lines (HGLs and EGLs), if applicable.

4. Provide detention area/volume capacity and outlet capacity calculations. Provide stage-area-storage-discharge tables for all water quality and detention facilities.

5. Provide documentation of open channel design, low-flow and trickle channel design, stabilization, and grade control improvements. Provide water surface profiles for all open channels for the minor and major event. For open channels that are major drainageways, provide water surface profiles for all recurrence intervals in the FHAD.

6. Describe energy dissipation at storm drain and culvert outlets, and provide supporting calculations.

7. Document downstream/outfall system capacity to the major drainageway system.

3.1.2.2 Drawing Contents

A. **General Location Map:** All drawings shall be 18” x 24” or 24” x 36” in size and shall include a title block, legend, engineering firm name, professional engineer stamp, signature and date, north arrow, and flow arrows. The General Location Map shall

be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns, along with all existing or proposed major stormwater management facilities located upstream of, downstream of, and within the site. The map shall be at a scale of 1" = 1000' or 1" = 2000' and show the path of all drainage from the upper end of any off-site basin(s) to the defined major drainageways. The scale shall be clearly identified on the map.

B. **Floodplain Information:** A copy of the appropriate Flood Insurance Rate Map (FIRM) showing the location of the subject property shall be included with the report. All major drainageways shall have the flow path defined and be shown on the report drawings. The Community Development Department can be contacted for detailed information on floodplains and FIRMs.

C. **Drainage Plan**: Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on an 18" x 24" or 24" x 36" drawing shall be included. The drawing shall show the following:

1. Existing and proposed contours at 2-foot maximum intervals tied to USGS datum unless topography is too shallow (flat), then use 1-foot contours. The contours shall extend a minimum of 100 feet beyond the property lines.

2. Property lines and easements with purposes noted.

3. Streets, including right-of-way width, flowline width, curb type, sidewalk, and approximate slopes.

4. Major basin and sub-basin boundaries.

5. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, drainageways, gutter flow directions, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.

6. Proposed types of street flow (curb and gutter, roadside ditch, cross pans, etc.) and extents of encroachment in minor and major events. Provide pipe/ditch materials, slopes, and flow directions.

7. Proposed storm drains and open drainageways, including inlets, manholes, culverts, and other appurtenances, including riprap protection.

8. Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.

9. Routing and accumulation of flows at various critical points for the initial storm runoff listed on the drawing using the format shown in Table 3-3.

10. Routing and accumulation of flows at various critical points for the major storm runoff listed on the drawing using the format shown in Table 3-3.

11. Volumes and release rates for detention storage facilities and information on outlet works shall be provided on the drawing using the format shown in Table 3-4.

12. Location and elevations of floodplain boundaries, based on the most current information (e.g., FIRM or FHAD).

13. Location and (if known) elevations of all existing and proposed utilities affected by or affecting the drainage design.

14. Any off-site feature influencing development and routing of off-site drainage flow through the development.

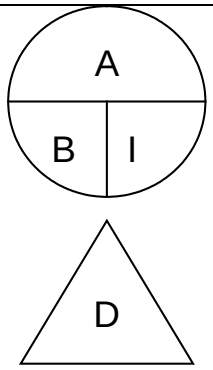
15. Definition of flow path leaving the development through the downstream properties ending at a major drainageway.

16. Legend to define map symbols (see Table 3-3 for symbol criteria).

17. Title block in lower right-hand corner.

18. Locations and footprints of water quality and/or detention facilities.

Table 3-3. Drawing Symbol Criteria and Hydrology Review



A = Basin Designation

B = Area in Acres

I = % Imperviousness

D = Design Point Designation

Summary Runoff Table
(to be placed on Drainage Plan)

Design Point	Contributing Basin(s)	Contributing Area (acres)	5-Year Runoff (cfs)	100-Year Runoff (cfs)
x	xx	xx.xx	xx.x	xx.x

Table 3-4. Detention Basin Summary Table to be Placed on Drainage and Construction Plan

Design Volume	Water Surface Elevation (feet)	Volume (cubic feet or acre-feet)	Maximum Release Rate (cfs)
Water Quality Capture Volume			
Excess Urban Runoff Volume			
100-year Storage Volume			

3.1.3 Final Drainage Study

The purpose of the Final Drainage Study is to update the concepts, and to present the design details for the drainage facilities discussed in the Preliminary Drainage Study. Also, any change to the preliminary concept must be presented. The Final Drainage Study shall follow the same format and organization as the Preliminary Drainage Study. The applicant shall provide a cover letter with the Final Drainage Study that explains how comments from the City and comments from referral agencies have been addressed and how plans have changed as a result.

All studies shall be typed on 8-1/2" x 11" paper and bound. The drawings, figures, and tables shall be bound with the study or included in a folder/pocket attached inside the back cover of the study. The study shall include a cover letter that presents the final design for review and shall be prepared by or under the supervision of a professional engineer who is licensed in Colorado. The Final Drainage Study shall be certified as follows:

> "I hereby certify that this final drainage study for the (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Commerce City *Storm Drainage Design and Technical Criteria Manual* for the owners thereof. I understand that the City of Commerce City does not, and will not, assume liability for drainage facilities designed by others."
>
> _____
>
> Name
>
> Registered Professional Engineer
>
> State of Colorado No. _____
>
> (Affix Seal)

Additional information that should be provided in the Final Drainage Study includes:

A. **Description of Property:** Describe, in detail, any areas of known or suspected contamination on or near a project site, provide documentation of coordination with applicable regulatory agencies and their requirements, and describe remedial measures that will be implemented to minimize the potential for exposure of areas of existing contamination to stormwater.

B. Hydrology:

a. For each sub-basin and design point, document the peak discharge rates for the minor and major events and other recurrence intervals included in the applicable FHAD for the area. If a FHAD is unavailable, the same recurrence intervals used in the FIS shall be used in hydrologic analysis for the proposed project.

b. Provide input and output listings for all models and spreadsheets used for hydrologic analysis and document rationale for input and assumptions.

c. In cases where hydrograph-based analysis is used, provide representative minor and major event hydrographs at key design points.

C. Hydraulics:

a. Detailed documentation of HGL and EGL calculations including methods used, loss coefficients and other assumptions. Plan and profiles are required for all conveyances and storage facilities.

b. Model input and output for hydraulic models used such as HEC-RAS, HY-8, and MHFD spreadsheets.

c. Description of hydrologic or hydraulic routing methods used and input parameters.

D. Water Quality:

a. Completed MHFD worksheets for computation of WQCV, EURV, and 100-year storage volume and release rates.

b. Detailed documentation of design elements including the outlet, inlets and forebays, facility bottom/trickle channel, and other details.

c. Statement of design standard(s) in MS4 Permit that water quality design is intended to satisfy.

d. Stormwater Detention and Infiltration Design Data (SDI) Worksheet, or acceptable alternative calculations for upload to State Compliance Portal, demonstrating compliance with state law regarding maximum detention drain times.

e. Facility Operation and Maintenance Plan: this is required for all stormwater management facilities. The Operations and Maintenance Plan at a minimum must include:

   i. As-built drawings stamped by professional engineer.

   ii. Identification of the party legally responsible for maintenance.

   iii. Narrative description of routine (scheduled) and non-routine (emergency) maintenance activities, including frequency of activities.

   iv. List of equipment needed to perform maintenance.

   v. Inspection and maintenance checklist forms.

   vi. Form for annual maintenance reporting to Commerce City.

f. Landscaping plan and acceptance criteria.

g. Detailed discussion of known or suspected contamination on a project site or within a 1-mile radius with references to mapping, tables, design drawings or other documentation of how stormwater management on the site will prevent contact of stormwater that may run-on, runoff, or infiltrate on a project site.

E. **Variances:** Documentation of approved variances from criteria, including reference to specific criterion that is the subject of the variance, the rationale and supporting documentation for the variance, a description of the alternative criteria to be applied, and a description of how the intent of the original criteria will be satisfied with the proposed variance.

F. **Design Drawings:** All hard copy design drawings submitted as a part of the Final Drainage Study shall bear the original stamp, signature, and date of the professional engineer in responsible charge of the design. Electronic copies may be facsimiles of the original stamp, signature, and date.

3.2 Construction Drawings and Specifications

The information required for the plans shall be in accordance with sound engineering principles, this Manual, the City of Commerce City *Engineering Construction Standards and Specifications,* and the City requirements for subdivision designs. Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, and other details as needed to construct the storm drainage facility. Construction plans shall be signed by a registered professional engineer as being in accordance with the City-approved drainage report/drawings. Refer to the Colorado Department of Transportation's Standard Plans ("M-Standards") for additional design details not covered in these Standards and Specifications.

Where drainage improvements are to be constructed in accordance with the approved Final Drainage Study, the construction plans and specifications shall be submitted for review and approval at time of application for a building permit. A reproducible copy of the approved plans shall be submitted to the City for file. The plans and specifications for the drainage improvements shall include:

A. General Information Required for All Drainage Improvement Projects

1. Cover sheet including:

    i. Vicinity map.

    ii. Professional engineer certification.

    iii. Title block, sheet index.

    iv. Standard notes.

2. Overall utility plan showing water, sanitary, and storm drain lines and facilities.

3. Grading plan using the North American Vertical Datum of 1988 (NAVD88).

4. Drainage plan using NAVD88.

5. Site information including:

    i. Property and right-of-way lines, existing and proposed easements, tracts, structures, fences, and other land features.

    ii. Relation of site to current floodplain boundaries.

    iii. Maintenance access.

    iv. Utilities adjacent to or crossing stormwater management facilities.

    v. Additional design details as required.

    vi. Any non-Commerce City standard details.

B. Specific Design Feature Information

1. Storm drains and culverts

    i. Plan and profile of proposed pipe installations, inlets, manholes, junction boxes, and outlet structures with pertinent elevations, dimensions, types, designs, and pipe-full flow rates and horizontal controls shown. Plan and profile must be included on same sheet.

ii. Minor storm HGLs.

iii. Major storm HGLs and EGLs if the facility is designed for events greater than the minor storm.

iv. Pipe outlet protection shown on plan and profile views.

v. Utilities adjacent to or crossing storm drain or culvert alignment in plan and profile.

vi. 1" = 20' scale, minimum, grading details for all pipe and culvert inlets and outlets.

2. Detention/storage facilities

i. Detention basin grading, trickle channel, inlet, outlet, and emergency overflow spillway locations.

ii. Detention facility summary – provide Table 3-4 on plans.

iii. Forebay, micropool, trickle channel, and outlet construction details, including safety features, such as racks and openings.

iv. Finished floor elevations of all existing and proposed structures within the property.

v. Supporting calculations/information for spillway design is included

vi. Spillway design includes a determination of WSE during a 100% blocked outfall structure.

3. Open channels, swales, and channel stabilization

i. Plan view showing horizontal locations of existing and proposed channels and swales, including locations of grade control structures and stabilization measures, such as check structures, drop structures, toe protection, bank stabilization, low-flow or trickle channels, with appropriate horizontal controls, safety features, etc.

ii. Profile along channel alignment with all invert elevations and top-of-channel bank elevations and design flow rates.

iii. Water surface limits in plan view.

iv. Water surface profiles for all flood profiles provided in the Flood Insurance Study (FIS) or FHAD if a drainageway is not included in FIS.

v. Side tributary channels and pipe outlets.

4. Stormwater Control Measures

    i. Plan and profile of improvements.

    ii. Maintenance access to facility at inlets and outlet and access to facility to clean out accumulated sediment and pollutants.

    iii. Design details for inlets and outlet, including hydraulic outlet control.

    iv. Provide SCM volumes and release rates in format of Table 3-4 on plans.

3.3 Record Drawings (As-built Drawings) and Final Acceptance Certificate

Record drawings for all improvements are to be submitted to the City with the request for Probationary Acceptance. Copies of record drawings with the certification below must be submitted as well as an electronic copy in pdf format including the certification and engineer or surveyor's stamp, signature, and date.

A professional engineer or land surveyor registered in the State of Colorado shall undertake such investigation as may be necessary to determine or confirm the as-built detention pond volumes and surface areas at the design depths, outlet structure sizes and elevations, storm drain sizes and invert elevations at inlets, manholes and discharge location, representative open channel cross-sections, and dimensions of all the drainage structures. If the improvements for a project are constructed in phases, as-built drawings may be required at the completion of each phase. Certification of the record drawings is required as follows:

> "To the best of my knowledge, belief, and opinion, the drainage facilities were constructed in accordance with the design intent of the approved drainage report and plan sheet(s)."
>
> _____
> Name
> Registered Professional Engineer or Land Surveyor
> State of Colorado No. _____
> (Affix Seal)

The City Engineer will compare the certified record drawing information with the construction drawings. A Certificate of Acceptance will be issued only if:

1. The record drawing information demonstrates (with accompanying calculations) that the construction is in compliance with the design intent, and

2. The record drawings are certified by a professional engineer or land surveyor.

Storm Drainage & Technical Criteria Form SF-1				
Drainage Study Submittal Checklist and Review Sheet				
Prepared by:			Date:	
The drainage study with plan drawings, as noted below, has been received and found to lack the information noted. This information must be submitted before the study will be accepted for review. Please provide the required information and return this checklist with your submittal.				
Subdivision:				
Location:				
Date Submitted:				
Type of Study (check one):	Preliminary _____		Final _____	
Submitted by (firm):				
Contact:			Phone:	
Submitted Date:	(1)	(2)	(3)	(4)
Date Approved:				
Item	**Description**		**Received (Y, N, or Not Applicable)**	**To be Submitted (Y or N)**
Overall Submittal	Typed, bound study or PDF equivalent			
P.E. Certification	Signed and sealed certification statement and stamps and signatures on reports and plans			
I. General Location and Description				
A. Location	City, county, and local streets within and adjacent to the site			
	Township, range, section, ¼ section, lot(s) and block(s)			
	Major drainageways and drainage and water quality facilities			
	Names of surrounding developments			
	Location map			
B. Description of Property	Site area			
	Ground cover			
	Drainageway characteristics			
	General project description			
	Proposed land use(s)			

Storm Drainage & Technical Criteria Form SF-1			
	Soil types, depth to water table, soil boring logs, and location map		
	Infiltration test results or geotechnical study		
	Irrigation facilities on site or nearby related to site drainage		
	History of flooding		
	Easements within and adjacent to the site		
	Documentation of areas of known or suspected contamination and regulatory coordination		
II. Drainage Basins and Sub-basins			
A. Major Basin Descriptions	Reference relevant MHFD FHADs, MDP reports, OSP reports, and FEMA FIRM panels		
	Areas, existing and proposed land uses, imperviousness, soils information, overland and channelized slopes, and other parameters used in calculations		
	All nearby irrigation facilities that may be affected by local drainage		
	All outfalls to major drainageways		
B. Sub-basin Descriptions	Historical on-site and off-site sub-basin drainage patterns of the property and surrounding areas		
	Proposed on-site and off-site sub-basin characteristics and impacts of development		
	Sub-basin characteristics for existing and proposed conditions including area, existing and proposed land uses, imperviousness, hydrologic soil groups, overland and channelized slopes, and other physical parameters used for drainage calculations or analyses		
	Determine whether exemptions in Section 2.3.2 applicable.		
	Determine if the conditions for 20/10 Rule apply.		

Storm Drainage & Technical Criteria Form SF-1			
III. Drainage Design Criteria			
A. Development Criteria References and Constraints	Previous drainage studies		
	Adjacent drainage studies		
	Drainage impacts of site constraints		
B. Hydrologic Criteria	Design rainfall and design storm recurrence intervals		
	Hydrologic soil groups		
	Calculate imperviousness		
	Runoff calculation method		
	Detention discharge and storage calculation method		
	Other criteria or calculation methods		
C. Hydraulic Criteria	Capacity analysis of existing and proposed drainage infrastructure		
	Storm drains must be designed to convey the minor storm flood peaks while flowing at most 80% of the full pipe capacity		
	Floodplain analyses (if required)		
	Other drainage facility design criteria used		
D. Stormwater Quality	Describe how the project will satisfy MS4 Permit		
	Describe how the project will satisfy MS4 post-construction requirements		
IV. Drainage Facility Design			
A. General Concept	General drainage concepts and drainage patterns		
	Off-site runoff considerations		
	Discuss tables, charts, figures, and drawings		
	Anticipated and proposed drainage patterns		
B. Specific Details	Drainage problems and solutions		
	Design flows and detention storage volumes		
	Existing stormwater conveyance and storage facilities		
	Proposed stormwater conveyance, storage facilities, and outlet structures		

Storm Drainage & Technical Criteria Form SF-1			
	Maintenance access and aspects		
	Easements and tracts		
	Compliance with local, state, and federal requirements		
	Structural and non-structural Control Measures (SCMs)		
	Spillway design included		
	Spillway design includes 100% blocked flow condition of outfall structure.		
	For pumped drainage systems:		
	Hydraulic criteria for sizing pumps		
	Types of pumps and power sources		
	Description of pump maintenance requirements		
	Plans for access for maintenance		
	Soils and station foundation		
	Pump station surroundings		
	Telemetry systems (if used) and pump controls		
	Cost estimate for pump station		
C. Variances	Any requested variances from Commerce City drainage criteria or approved master plans		
V. Conclusions			
A. Compliance with Standards	Compliance with criteria in Commerce City Manual		
	Compliance with CDPS MS4 Permit		
	Compliance with Commerce City and FEMA floodplain rules and regulations		
B. Drainage Concept	Drainage design will control damage from storm runoff		
	Compatibility of proposed development with approved master plans		
	Drainage impacts of proposed development on upstream and downstream properties		

Storm Drainage & Technical Criteria Form SF-1			
C. Water Quality	Compliance with Commerce City MS4 Permit		
	Post-construction design standards in the MS4 Permit will be met		
VI. References	**Criteria and technical information used**		
VII. Appendices			
A. Hydrologic Computations	Land use assumptions for adjacent properties		
	Connectivity diagram		
	Historic runoff computations		
	Calculations for WQCV, EURV, detention storage volumes, release rates, and drain time		
B. Hydraulic Computations	Culvert capacity calculations		
	Street capacity and inlet calculations		
	Storm drain capacity calculations		
	Detention area/volume capacity and outlet capacity calculations		
	Documentation, water surface profiles for open channel. Designs for low-flow and trickle channel, stabilization (erosive velocities), and grade control		
	Energy dissipation and calculations		
	Downstream/outfall system capacity		
Drawing Contents			
A. General Location Map	Size 18" x 24" or 24" x 36"		
	Title block		
	Legend		
	Engineering firm name		
	Professional engineering stamp		
	Signature		
	Date		
	North arrow		
	Flow arrows		
	Drainage flows and patterns		
	Existing and proposed stormwater management facilities		
	Scale 1" = 1000' or 1" = 2000'		

Storm Drainage & Technical Criteria Form SF-1			
B. Floodplain Information	FIRM		
	Flow path for major drainageways		
C. Drainage Plan Map(s)	Scale 1' = 20' to 1" = 200'		
	Size 18" x 24" or 24" x 36"		
	Existing and proposed contours at 2-foot maximum intervals		
	Property lines and easements		
	Streets, right-of-way, flowline, curb type, sidewalk, and slopes		
	Major basin and sub-basin boundaries		
	Existing drainage facilities and structures		
	Proposed types of street flow		
	Proposed storm drains and open drainageways		
	Proposed outfall – consistent with drainage calculations		
	Spillway design – 100% blocked outfall condition		
	Routing and accumulation of flows at critical points for initial and major storm runoff		
	Volumes and release rates for detention storage facilities		
	Location and elevations of floodplain boundaries		
	Location and elevations of existing and proposed utilities		
	Off-site feature influencing development		
	Definition of flow path		
	Legend		
	Title block		
	Locations and footprints of water quality and/or detention facilities		

4.0 Floodplain Rules and Regulations

4.1 Introduction

The City of Commerce City is a participant in the National Flood Insurance Program (NFIP) and has adopted regulations that meet or exceed the minimum requirements for participation in the NFIP. These include adoption of a floodplain ordinance and floodplain overlay district, designation of a floodplain administrator, and management of activities within the floodplain overlay district through a floodplain permitting process. This chapter provides an overview of the City's Floodplain Rules and Regulations. For additional information, consult the City's Land Development Code, as may be amended from time to time, including Sections 21-2270 Floodplain Administrator, 21-3213 Floodplain Development Permits, 21-4400 FP Floodplain Overlay District and other sections referring to flooding or the 100-year floodplain. This chapter summarizes these sections of the Land Development Code and is not intended to be a comprehensive presentation of the Land Development Code or its requirements. To the extent there are any inconsistencies in interpretation between this chapter and the Land Development Code, the interpretation based on the Land Development Code will prevail.

The focus of this chapter is on local floodplain rules and regulations. The City also incorporates the Colorado Water Conservation Board (CWCB) Rules and Regulations for Regulatory Floodplains in Colorado (2 CCR 408-1) and Federal Emergency Management Agency (FEMA) requirements under the NFIP by reference. Readers may find additional information in the Mile High Flood District's (MHFD's) Urban Storm Drainage Criteria Manual, Flood Risk Management chapter, which provides guidance on floodplain management fundamentals, FEMA Letters of Map Change (LOMCs), flood insurance, and floodproofing, among other topics. Definitions of terms used in this chapter can be found in the Land Development Code.

4.2 Floodplain Compliance Required

All development proposals shall conform to the requirements of the City floodplain regulations and policies. In addition, all developments within floodplains shall comply with these additional regulations:

1. All development proposals shall be consistent with the need to minimize flood damage.

2. All development proposals shall have public utilities and facilities such as sewer, gas, electrical, and water located and constructed to minimize flood damage.

3. All development proposals shall have adequate drainage provided by the developer to reduce exposure to flood damage.

4. All lots within the floodplain shall be noted. When deemed necessary for the health, safety, or welfare of the present and future population of the area, the City may prohibit the development of any portion of the property that lies within the floodplain of any stream or drainage course.

5. The base flood elevation data shall be provided for development proposals that contain at least 50 lots or 5 acres, whichever is less. In these cases, a Conditional Letter of Map Revision (CLOMR) must be issued by FEMA prior to the City issuing a building permit. "As-built" surveys, which verify that construction matches the plans, must be submitted for construction in or near the floodplain prior to issuance of a certificate of occupancy.

4.3 Floodplain Administrator

The Floodplain Administrator is a City Official, appointed by the City Manager, who is responsible for reviewing and processing all floodplain development permit applications and interpreting floodplain maps within the City. The Floodplain Administrator approves, conditionally approves, or denies floodplain development permit applications based on state and local floodplain regulations.

4.4 Floodplain Overlay District

The purpose of the floodplain overlay district is to promote public health and minimize losses due to floods. The floodplain overlay district includes all Special Flood Hazard Areas (SFHAs) and areas removed from the floodplain by the issuance of a FEMA Letter of Map Revision Based on Fill (LOMR-F) within the jurisdiction of the City. The SFHA shall be defined based on the most recent effective floodplain mapping produced by FEMA. FEMA's National Flood Hazard Layer provides the current effective floodplain mapping including the effects of LOMRs since the effective date of Flood Insurance Rate Map (FIRM) Panels. In areas where a FEMA-defined floodplain does not exist but

FIRMS and FHADs

In some cases, FIRMs may not provide the most current floodplain and/or floodway mapping due to more recent studies including Flood Hazard Area Delineations (FHADs) that may be in various stages of adoption as official floodplain mapping or that establish floodplain and/or floodway mapping for streams that are not mapped by FEMA. While the FEMA LOMR process requires using the effective mapping from the FIRM or National Flood Hazard Layer (NFHL) as the basis for map revisions and floodplain requirements, the local Floodplain Administrator shall have the discretion to apply more current floodplain mapping as the basis for floodplain regulation and permitting in Commerce City. In general, when two or more different sources of floodplain and/or floodway mapping are available, the Floodplain Administrator will require use of the most restrictive mapping unless there are sound technical justifications for use of less restrictive mapping such as changed conditions or errors in modeling or mapping.

a Flood Hazard Area Delineation (FHAD) from the MHFD is available, the City will require regulation to the floodplain in the FHAD.

4.4.1 Allowable Uses

The Commerce City Land Development Code, as may be amended from time to time, describes allowable uses in the floodplain. These allowable uses are summarized below for convenience. See the most currently applicable Land Development Code for additional information.

4.4.1.1 Agricultural Uses

Agricultural uses not requiring structures, such as general farming and the raising of plants, flowers, livestock, and nursery stock, shall be a use-by-right in areas of the SHFA that lie outside of the floodway (flood fringe) to the extent such use is permitted by the underlying zoning district classification. In areas where a floodway has not been established, agricultural uses not requiring structures will be a use-by-right so long as they are located outside of the bed and banks of the active channel.

4.4.1.2 Allowable Uses in the Flood Fringe

The following uses may be allowed within the flood fringe, subject to obtaining an approved floodplain development permit and satisfying any additional state or federal floodplain permitting requirements:

1. Public or private recreational uses, such as parks and recreation fields; golf courses; hiking, biking, and horse trail; and accessory parking lots.

2. Public or private utility facilities, not requiring buildings, such as transmission lines, pipelines, utility lines, roadways, railroad spurs, and bridges.

3. Wildlife and nature preserve, game farm, and fish hatchery uses not requiring buildings.

4. Regional public stormwater management facilities, including detention or water quality enhancement facilities.

5. Barbed wire and split rail fences. Other types of fences such as chain link or solid screen types are allowed only if necessary for safety or security reasons, provided the fence is specially designed to minimize impeding the flow of flood waters, accumulation of debris or being subject to being easily moved during flood periods. Fence designs that meet the above criteria, such as certain breakaway fencing, or fencing with slatted design allowing water to pass through, will be allowed if certified by a registered professional engineer as meeting the identified performance standards. Fences within the floodplain and floodway require a floodplain permit to check for “impeding flow” conditions.

6. The cumulative maximum allowable rise in the 100-year water surface elevation due to placement of fill in flood fringe areas is 0.5 feet. Floodways in Commerce City shall be defined based on this 0.5-foot maximum allowable rise criterion.

4.4.1.3 Allowable Uses in Approximate Flood Zones

For approximate flood zones (Zone A) where a floodway has not been established, the uses identified above in Section 4.4.1.2 may be allowed, subject to obtaining an approved floodplain development permit and satisfying any additional state or federal floodplain permitting requirements. Because a floodway is not established in approximate flood zones, the applicant must demonstrate that the 100-year recurrence interval peak flow can be conveyed through the portion of the floodplain remaining unobstructed with a rise of no more than 0.5 feet.

4.4.1.4 Allowable Uses in Floodplains not Designated by FEMA

In cases where the floodway and flood fringe are not delineated by FEMA and the drainage area is 130 acres or greater, the Floodplain Administrator will require the applicant to demonstrate, through documentation provided by a registered professional engineer, that the proposed use is outside of the floodway in the fringe area. In areas where a FHAD has been published, the FHAD may be used to define the floodway and fringe areas. In areas without a FHAD, the applicant must perform analysis to delineate the 100-year floodplain and demonstrate that the 100-year recurrence interval peak flow can be conveyed through the portion of the floodplain remaining unobstructed with a rise of no more than 0.5 feet.

4.4.2 Prohibitions

Residential and commercial buildings and structures, long term storage of materials (> 4 weeks), trash/recycling facilities, lumber yards, etc., are prohibited in the floodplain overlay district.

4.4.3 Other Uses

Uses not identified in this section shall be submitted to the Floodplain Administrator for review. If approved, the Floodplain Administrator may require any conditions and restrictions deemed necessary to protect the public health, safety, and welfare, provided they are consistent with these standards and regulations.

4.4.4 General Standards

When allowed, all new construction or substantial improvements in the floodplain, as defined by the NFIP, shall be anchored to prevent flotation, collapse, or lateral movement of the structure and be capable of resisting hydrodynamic and hydrostatic loads.

All new construction or substantial improvements shall be constructed:

1. With the lowest floor or floodproofing of the structure, together with attendant utility and sanitary facilities, at least 2 feet above the base flood elevation;

2. With materials and utility equipment resistant to flood damage;

3. Using methods and practices that minimize flood damage; and

4. With electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed or located to prevent water from entering or accumulating within the components during conditions of flooding.

All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system. Similarly, new and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the system and discharge from the systems into flood waters, and on-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

4.4.5 Structures

Nonresidential structures, if permitted, shall either have the lowest floor (including the basement) elevated to 1 foot above the base flood elevation or, together with the attendant utility and sanitary facilities, comply with the following standards:

1. Be flood-proofed so that below the required elevation the structure is watertight with walls substantially impermeable to the passage of water;

2. Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy; and

3. Be certified by a registered professional engineer or architect that the design and method of construction are in accordance with the accepted standards of practice for meeting the provisions of this code. Such certification shall be provided to the Floodplain Administrator. No new, substantially improved, or additions to critical facilities shall be permitted in the floodplain unless the lowest floor or floodproofing of the structure, together with attendant utility and sanitary facilities, are at least 2 feet above the base flood elevation. New critical facilities shall, when practicable as determined by the City, have continuous non-inundated access (ingress and egress for evacuation and emergency services) during a 100-year flood event.

4.4.6 Floodways

Floodways are extremely hazardous areas due to the depth and velocity of flood waters that carry debris and have significant erosion potential. Accordingly, all encroachments are prohibited. Specifically, but without limitation, this means that no fill, construction, substantial improvements, or other development shall be permitted within the floodway

unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment will not result in any increase in flood levels within the boundaries of the City during the occurrence of the base flood discharge. If so demonstrated, any new construction or substantial improvements shall comply with the standards in the Land Development Code.

Public recreation uses such as parks, golf courses; hiking, biking, and horse trails; and public/utility facilities such as transmission lines, pipelines, roadways, and bridges may be permitted in the floodway subject to a floodplain development permit and certification of no rise greater than 0.00 feet. A No-Rise Certification must be supported by technical data and signed by a licensed Colorado professional engineer.

The following or similar language may be used for the No-Rise Certification:

> This is to certify that I am a registered professional engineer licensed to practice in the State of Colorado. It is further to certify that the attached technical data supports the fact that the proposed _____ (name of development) will not impact the 100-year flood elevations, floodway elevations, or floodway widths on _____ (name of flood source) at published or unpublished cross-sections in the FEMA flood insurance study or the most current Flood Hazard Area Delineation (FHAD) study dated _____ (study dates) in the vicinity of the proposed development. Attached are the following documents that support my findings:
>
> 1.) _____
> 2.) _____
> 3.) _____
>
> SIGNATURE: _____
> NAME (PRINTED): _____
> COMPANY NAME: _____
> DATE: _____
> PHONE NUMBER: _____
> ADDRESS: _____

P.E. STAMP _____

CITY ACCEPTANCE

_____

FLOODPLAIN ADMINISTRATOR DATE

4.4.7 Properties Removed from the Floodplain by Fill

If permitted, new residential and non-residential structures and additions to existing or substantially improved structures must have the lowest floor (including basement), electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork), elevated to at least 1 foot above the base flood elevation that existed prior to the placement of fill.

4.4.8 Elevation Certificates

Elevation certificates must be submitted to the City prior to issuance of the certificate of occupancy for all structures built within floodplain boundaries as defined by FEMA Flood Insurance Rate Maps.

4.5 Floodplain Development Permits

A floodplain development permit is required prior to commencement of any construction, development activity, or storage of materials within the floodplain overlay district. The Floodplain Administrator reviews applications for floodplain development permits to determine the specific flood hazard at the site and evaluate the suitability of the proposed use in relation to the flood hazard and is authorized to approve, approve with conditions, or deny the application based on the approval criteria below. The City's policy is to require a Conditional Letter of Map Revision (CLOMR) prior to construction when a FEMA map revision (LOMR) will be required following construction. This policy also applies to CLOMRs and LOMRs based on fill (CLOMR-Fs/LOMR-Fs). All analysis and associated costs of obtaining a CLOMR and LOMR are the responsibility of the developer. All necessary documentation must be approved by the City and submitted to FEMA and MHFD to process the CLOMRs and LOMRs.

A floodplain development permit may be approved if the Floodplain Administrator finds that the following criteria are met:

1. The applicant has obtained all necessary federal, state, and local permits.

2. If alteration or relocation of any watercourse is involved, the applicant has notified all adjacent communities and the CWCB of the alteration or relocation and has submitted evidence of such notification to FEMA. The Floodplain Administrator must also find that the flood-carrying capacity within the altered or relocated portion of the watercourse is not diminished.

3. The danger that materials may be swept onto other lands or cause the injury to others is minimal.

4. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner and adjacent upstream and downstream property owners is minimal.

5. The proposed use is compatible with existing and anticipated development as set forth in, or reasonably inferred from, the comprehensive plan.

6. The safety of access to the property in times of flood for ordinary and emergency vehicles is adequate.

7. The costs of providing governmental services during and after flood conditions including maintenance and repair of streets and bridges, flood channels, and stream corridors, and public utilities and facilities such as sewer, gas, electrical, and water systems is not excessive.

8. The expected heights, velocity, duration, rate of rise, and sediment transport of the flood waters and the effects of wave action, if applicable, expected at the site is minimized.

9. Alternative locations for the proposed use that are not subject to flooding or erosion damage do not exist.

10. The proposed use minimizes disturbing the natural topography of the floodplain (or restores degraded sections of stream and floodplains), promotes passive flood mitigation strategies, and preserves native wildlife habitat and recreational opportunities to the maximum extent feasible given the benefits of the proposed development.

The Floodplain Administrator has the authority to place conditions on approval of floodplain development permits as described in the Land Development Code. If the work described in any floodplain development permit is not commenced within 6 months or substantially completed within 2 years of the date the permit was issued, the permit shall automatically lapse and be null and void.

4.6 Variances

The applicant may request variances from floodplain regulations described in this chapter and in the Land Development Code. The applicant requesting a variance must first obtain input from the Floodplain Administrator on whether a variance would be considered at all (many of the floodplain rules and regulations are minimum requirements that are inflexible). If the Floodplain Administrator determines that a variance may be considered, the applicant shall prepare a written request for the variance with supporting technical analysis, signed, and stamped by a registered professional engineer.

In general, the variance must pertain to the land itself – not to the structure, its inhabitants, or the property owner. A variance will not be granted for a problem that can be resolved through other means, even if the alternative is more expensive, more complicated, requires that the parcel be put to a different use, or requires the applicant to build elsewhere (FEMA 2005).

Federal regulations (44 CFR 60.6(a)) state that a community can only issue a variance upon “a determination that failure to grant the variance would result in exceptional hardship to the applicant.”

Additional federal guidance (44 CFR 60.6(a)) states: “The applicant has the burden of proving unnecessary hardship. Reasons for granting the variance must be substantial; the proof must be compelling. The claimed hardship must be exceptional, unusual, and peculiar to the property involved. Financial hardship, inconvenience, aesthetic considerations, physical handicaps, personal preferences, or the disapproval of one’s neighbors do not qualify as exceptional hardships.”

Applications for variances to the floodplain regulations will be reviewed and approved or denied by the Floodplain Administrator.

5.0 Rainfall

5.1 Introduction

The design rainfall data to be used to complete hydrologic analyses described in the Runoff chapter of this Manual are presented in this section. More specifically, this chapter provides: 1) point precipitation values for Commerce City, 2) information on the Colorado Urban Hydrograph Procedure (CUHP), and 3) an intensity-duration-frequency table for use with the Rational Method. All hydrological analyses within Commerce City must use the rainfall data presented herein for calculating storm runoff. There may be cases where the designer needs to consider events more extreme than the 100-year storm (e.g., for public safety, critical facilities).

The design storms and intensity-duration-frequency tables for Commerce City were developed using the rainfall data from the *National Oceanic and Atmospheric Administration Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8* (NOAA Atlas 14).

5.2 Rainfall Depth-Duration-Frequency Values

Based on mapping and data presented in the NOAA Atlas 14, variations in rainfall depths across Commerce City are minimal, and rainfall characteristics for Commerce City can be represented by a single rainfall zone. Rainfall depth-duration-frequency data are needed for both the Rational Method and for CUHP. The 1-hour point rainfall depth is used by CUHP to generate a hyetograph that is used for rainfall-runoff computations. For watersheds 15 square miles and larger, the 6-hour rainfall depth is also required for use with CUHP. Table 5-1 summarizes point rainfall values for various durations. The point rainfall depths in Table 5-1 were taken from NOAA Atlas 14 for the Commerce City Civic Center. The values in this table must be used for design rainfall in Commerce City.

Table 5-1. Point Rainfall Depths

	Rainfall Depth (inches)							
Return Period	**5-minute**	**10-minute**	**15-minute**	**30-minute**	**1-hour**	**2-hour**	**3-hour**	**6-hour**
2-year	0.27	0.40	0.48	0.68	0.84	1.00	1.09	1.29
5-year	0.36	0.53	0.65	0.90	1.12	1.33	1.44	1.68
10-year	0.45	0.65	0.80	1.11	1.37	1.63	1.76	2.04
50-year	0.68	1.00	1.22	1.69	2.08	2.47	2.66	3.05
100-year	0.80	1.17	1.43	1.97	2.43	2.88	3.10	3.54
500-year	1.11	1.63	1.98	2.72	3.35	3.98	4.27	4.83
Date: July 2019		Reference: NOAA Atlas 14, Volume 8, Version 2, 2013. Data reported for Commerce City Civic Center.						

These point rainfall depths must be distributed temporally (e.g., 5-minute increments) for use with the CUHP model. Area adjustment of these point rainfall values is required based on watershed size when using CUHP. CUHP automatically generates the rainfall hyetograph and calculates temporal adjustments to rainfall distribution for various storm events and watershed sizes in accordance with the Rainfall chapter of the MHFD Manual.

Table 5-2 provides the rainfall depth-duration-frequency values calculated for use with the Rational Method in small watersheds that are 90 acres or less in size, and Table 5-3 provides intensity-duration-frequency data. If the computed value of the time of concentration falls between the values listed in Table 5-2 or 5-3, apply linear interpolation to find the depth or intensity associated with the calculated time of concentration.

Table 5-2. Rainfall Depth-Duration-Frequency Values for Use with the Rational Method

Time (minutes)	Rainfall Depth (inches)				
	2-year	5-year	10-year	50-year	100-year
5	0.27	0.36	0.45	0.68	0.80
10	0.40	0.53	0.65	1.00	1.17
15	0.48	0.65	0.80	1.22	1.43
20	0.55	0.73	0.90	1.38	1.61
25	0.61	0.82	1.01	1.53	1.79
30	0.68	0.90	1.11	1.69	1.97
35	0.71	0.94	1.15	1.76	2.05
40	0.73	0.98	1.20	1.82	2.12
45	0.76	1.01	1.24	1.89	2.20
50	0.79	1.05	1.28	1.95	2.28
55	0.81	1.08	1.33	2.02	2.35
60	0.84	1.12	1.37	2.08	2.43

Table 5-3. Rainfall Intensity-Duration-Frequency Values for Use with the Rational Method

Time (minutes)	Rainfall Intensity (inches/hour)				
	2-year	5-year	10-year	50-year	100-year
5	3.24	4.34	5.35	8.20	9.60
10	2.38	3.18	3.92	6.00	7.02
15	1.93	2.58	3.18	4.88	5.72
20	1.64	2.20	2.70	4.13	4.83
25	1.47	1.96	2.41	3.68	4.30
30	1.36	1.81	2.22	3.38	3.94
35	1.21	1.61	1.98	3.01	3.51
40	1.10	1.46	1.80	2.73	3.19
45	1.01	1.35	1.65	2.51	2.93
50	0.94	1.26	1.54	2.34	2.73
55	0.89	1.18	1.45	2.20	2.57
60	0.84	1.12	1.37	2.08	2.43

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6.0 Runoff

6.1 Introduction

Proper calculation of runoff is critical to proper planning and sizing of storm drainage facilities. Erroneously high runoff calculations can result in higher cost facilities, while erroneously low runoff calculations can result in damage or loss of life or damage to infrastructure, property, and natural resources. This chapter identifies the methodology to be used for determining the storm runoff design peaks and volumes for preparation of storm drainage studies, plans, and facility designs in Commerce City. The background, equations, examples, and spreadsheets (e.g., UD-Rational) for these methods should be obtained from the Runoff chapter of the MHFD Manual. The Colorado Urban Hydrograph Procedure (CUHP) and the Stormwater Management Model (SWMM) computer models for calculating and routing runoff may be downloaded from the MHFD's website.

6.2 Runoff Calculation Methods

There are several methods for calculating runoff acceptable for use in Commerce City: the Rational Method, CUHP, and CUHP combined with SWMM, as described in Table 6-1. In some cases, MHFD or Commerce City have completed detailed hydrologic studies that may also be used. Criteria determining appropriateness of use are also summarized in Table 6-1. All criteria specified in the MHFD Manual must be followed for preparation of drainage reports and storm drainage facility designs in Commerce City.

Table 6-1. Runoff Calculation Methods Acceptable for Use in Commerce City

Runoff Calculation Method	Application Criteria	Requirements for Use in Commerce City
Rational Method	Simple catchments less than 90 acres in size. Should not be used when routing of hydrographs is required.	Follow MHFD Manual procedures to determine first design point Time of Concentration (T_c) for urban catchments.
CUHP	Appropriate for use in basins greater than 20 acres in size; required for areas greater than 90 acres in size. Use in combination with SWMM when routing of hydrographs is required. Can be used for smaller catchments 5-20 acres in size with smaller unit hydrograph time step.	Use design storm data from Table 5-1 for input to the CUHP computer model.
SWMM	Used to route and combine hydrographs for sub-catchments developed using CUHP. Appropriate for use in more complex basins.	Use hydrographs developed from CUHP as inputs. Provide a copy of input/output listings for the model and an electronic copy of the modeling results in the Final Drainage Report submittal.
Published hydrologic information	May be used where MHFD or Commerce City have developed detailed hydrologic studies appropriate for use in the study area.	Use values in published reports unless compelling reason to modify published values.

6.3 Assumptions for Storm Flow Analysis

When determining design storm flows, the engineer must follow the criteria and guidelines specified in the MHFD Manual and summarized in Table 6-2 to ensure that minimum design standards and uniform drainage approaches are maintained throughout Commerce City.

Table 6-2. Assumptions for Onsite and Offsite Storm Flow Analysis in Commerce City

Analysis Type	Requirements for Use in Commerce City
Onsite Analysis	The proposed fully developed land use plan must be used to determine runoff coefficients. Changes in flow patterns (from the undeveloped site conditions) caused by the proposed street alignments must be considered. The maximum time of concentration to the first design point in an urbanized area is 10 minutes.
Offsite Analysis for the Minor Storm Event	The fully developed minor runoff will be used without consideration of onsite detention. Inadvertent storage provided by road crossings, railroad embankments, and similar structures will not be credited as runoff reduction.
Offsite Analysis for the Major Storm Event	Where the offsite area is fully or partially undeveloped, the runoff must be calculated assuming the basin is fully developed as defined by the Planning Department. If this information is not available, then the runoff must be calculated using the coefficients defined in the Runoff chapter of the MHFD Manual. No runoff reduction credit will be given for onsite detention in the offsite area for any design frequency unless otherwise approved by Commerce City; however, credit may be given for permanent, publicly maintained detention facilities. Inadvertent storage provided by road crossings, railroad embankments, and similar structures will not be credited as runoff reduction.

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7.0 Streets

7.1 Introduction

The criteria presented in this chapter must be used in the evaluation of the allowable drainage encroachment within public streets. The criteria, evaluation techniques, and design examples provided in the Streets/Inlets/Storm Drains chapter of the MHFD Manual are hereby incorporated by reference and not repeated herein. MHFD's Street Capacity and Inlet Sizing software program (downloadable from MHFD's website) may be used in the hydraulic evaluation of street flows and was used to prepare the figures that are presented in this chapter.

7.2 Function of Streets in the Drainage System

The primary function of urban streets is for safe traffic movement; therefore, stormwater drainage and conveyance in streets is subservient to this function and must be properly designed to prevent interference with traffic, especially at intersections. When the drainage in the street exceeds allowable limits set forth in Section 7.3, a storm drain system (Chapter 9) or an open channel (Chapter 10) is required to convey the excess flows. Streets are also part of the major drainage system when they carry flows in excess of the minor storm, also subject to the limitations of Section 7.3.

7.3 Allowable Use of Streets for Storm Flows

Allowable use of streets for storm flows is summarized in Tables 7-1 through 7-3. The minor storm referenced in these tables is the 5-year event and the major storm is the 100-year event. No curb overtopping during the minor storm is allowed for any street regardless of classification. The maximum allowable street flow for the minor storm runoff is the product of the flow calculated at the "Maximum Theoretical Street Encroachment" and the required reduction factor, following the hydraulic evaluation techniques in the Streets/Inlets/Storm Drains chapter of the MHFD Manual, or 10 cfs, whichever is more restrictive.

Table 7-1. Allowable Use of Streets for Minor Storm Runoff

Street Classification	Maximum Street Encroachment
Local	No curb overtopping. Flow may spread to crown of street.
Collector	No curb overtopping. Flow spread must leave at least one lane free of water.
Arterial	No curb overtopping. Flow spread must leave at least one lane (10 feet) free of water in each direction, and should not flood more than two lanes in each direction.

Table 7-2. Allowable Use of Streets for Major Storm Runoff

Street Classification	Maximum Depth and Inundated Area
Local, Collector	Residential dwellings, public, commercial, and industrial buildings must not be less than 12 inches above the 100-year water surface elevation at the ground line or lowest water entry into the building. The depth of water over the gutter flow line must not exceed 12 inches. The extent of flooding shall not extend beyond the street ROW.
Arterial	Residential dwellings, public, commercial, and industrial buildings must not be less than 12 inches above the 100-year water surface elevation at the ground line or lowest water entry into the building. To allow for emergency vehicles, the depth of water must not exceed the street crown or 12 inches at the gutter flow line, whichever is more restrictive. The extent of flooding shall not extend beyond the street ROW.

Table 7-3. Allowable Cross-street Flow When Cross Pans Are Allowed[1]

Street Classification	Minor Storm Flow	Major Storm Flow
Local (only allowed at intersections controlled with stop signs)	6 inches of depth in cross pan, if cross pan allowed.	12 inches of depth in cross pan or gutter flow line.

[1]Cross pans are not allowed to convey flow across collector or arterial streets or where a storm drain is available. Cross pans are allowed only at intersections controlled by stop signs on local streets.

7.4 Hydraulic Evaluation Techniques

Hydraulic calculations must be completed to determine the capacity of street gutters and the resulting encroachment onto the street section. These calculations use the hydrology developed in the Rainfall and Runoff chapters (Chapters 5 and 6 of this Criteria Manual) and are subsequently to be used in calculations for inlets and storm drain sizing.

At a minimum, the following factors should be taken into consideration when designing street flow:

- Public safety.
- Pedestrian nuisance in areas with high pedestrian use.
- Pavement overlays.

7.4.1 Allowable Gutter Flow Depths and Spreads

Table 7-4 summarizes the allowable gutter flow depth and flow spread into the roadway for various Commerce City street cross sections with a 6-inch curb and a 2% cross slope for the minor storm. For the minor storm, the allowable flow depth in the gutter does not overtop the curb and is limited by the maximum permitted flow of 10 cfs. Table 7-5 provides the same information for the major storm.

Table 7-4. Street Types, Permitted Flow Spread and Depths for Minor Storm for 6-inch Curb and 2% Cross Slope

Street Type	Flowline to Flowline Street Width (ft)	Minor Event Criterion	Maximum Allowable Spread (ft)	Maximum Allowable Depth at Gutter Flow Line (ft)
Local	34	No curb overtopping/spread to crown	17	0.47
	36		18	0.49
Collector	40	No curb overtopping/one 10-foot lane free	15	0.43
	52		18.5	0.50
Arterial (median present, street width based on 1/2 street)	20	No curb overtopping/one lane free each direction	10	0.33
	27		17	0.47
	39		18.5	0.50

Table 7-5. Street Types, Permitted Flow Spread and Depths for Major Storm for 6-inch Curb and 2% Cross Slope

Street Type	Flowline to Flowline Street Width (ft)	Major Event Criterion	Maximum Allowable Spread (ft)	Maximum Allowable Depth at Gutter Flow Line (ft)
Local	34	Depth not to exceed 1 foot max @ gutter flow line	17	0.47
	36		18	0.49
Collector	40	Depth not to exceed 1 foot max @ gutter flow line	20	0.53
	52		26	0.65
Arterial (median present, street width based on 1/2 street)	20	Depth not to exceed crown/1 foot max @ gutter flow line (whichever is more restrictive)	20	0.53
	27		27	0.67
	39		39	0.91

Note: See https://www.c3gov.com/government/code-central for typical street cross sections.

7.4.2 Allowable Street Capacities and Assumptions for Capacity Curves

Figure 7-1 provides the allowable street capacity for the minor and major storm events based on the allowable spread and depths from Tables 7-1, 7-2, 7-4 and 7-5. The calculations to generate these figures used the UD-Inlet (Version 4.05) spreadsheet model, which completes a hydraulic evaluation of street capacity by calculating street gutter flow capacity based on allowable spread and gutter depth for the minor and major design storms. The following assumptions were used to develop these curves:

1. The maximum allowable flow rates presented in Figure 7-1 are primarily dictated by the allowable spread criteria (e.g., at the maximum allowable spread, the maximum depth at the gutter flow line is less than 6 inches [i.e., no curb overtopping in a minor event]). The curves are provided as a guide only and individual hydraulic calculations should be performed using the latest version of UD-Inlet. Other street cross slopes, alternate gutter dimensions, assumptions about capacity behind the curb, and other factors will yield different results.

2. The reduction factor has been applied based on Figure 7-4 in the Streets/Inlets/Storm Drains chapter of the MHFD Manual. The UD-Inlet workbook automatically incorporates the reduction factor.

3. The allowable spread for the minor storm is provided in Table 7-4 for all street types.

4. The maximum allowable flow depth at the gutter flowline is 12 inches for the major event for all street types.

5. The allowable spread for the major storm is to the crown for arterial streets (local and collector streets do not have a spread criterion). The allowable spread is typically the more restrictive criterion for standard street cross sections, as opposed to the allowable 12-inch flow depth at the gutter flowline.

6. Gutter depression (“a”) is 1.52 inches, based on a standard gutter section.

7. Gutter width is 2 feet, based on a standard gutter section.

8. Manning’s “n” is 0.016.

9. Cross-slope is 2%.

7.5 Design Considerations

Representative considerations that the designer must address include:

1. The primary function of urban streets is for safe traffic movement. Where a storm drain is available, inlets must be provided at intersections.

2. Provide an inlet where a catch curb changes to a spill curb.

3. The maximum allowable street capacity for the minor event is 10 cfs or gutter capacity, whichever is less.

4. Allowable street capacity for major and minor storms is subject to safety considerations using the reduction factor taken from Figure 7-4 in the Streets/Inlets/Storm Drains chapter of the MHFD Manual. The UD-Inlet workbook incorporates the reduction factor.

5. Nuisance flows must be carried by gutters or pans to an inlet. Nuisance flows are not allowed to cross a driving lane.

6. Cross pans are not allowed to cross collector or arterial streets or where a storm drain is available.

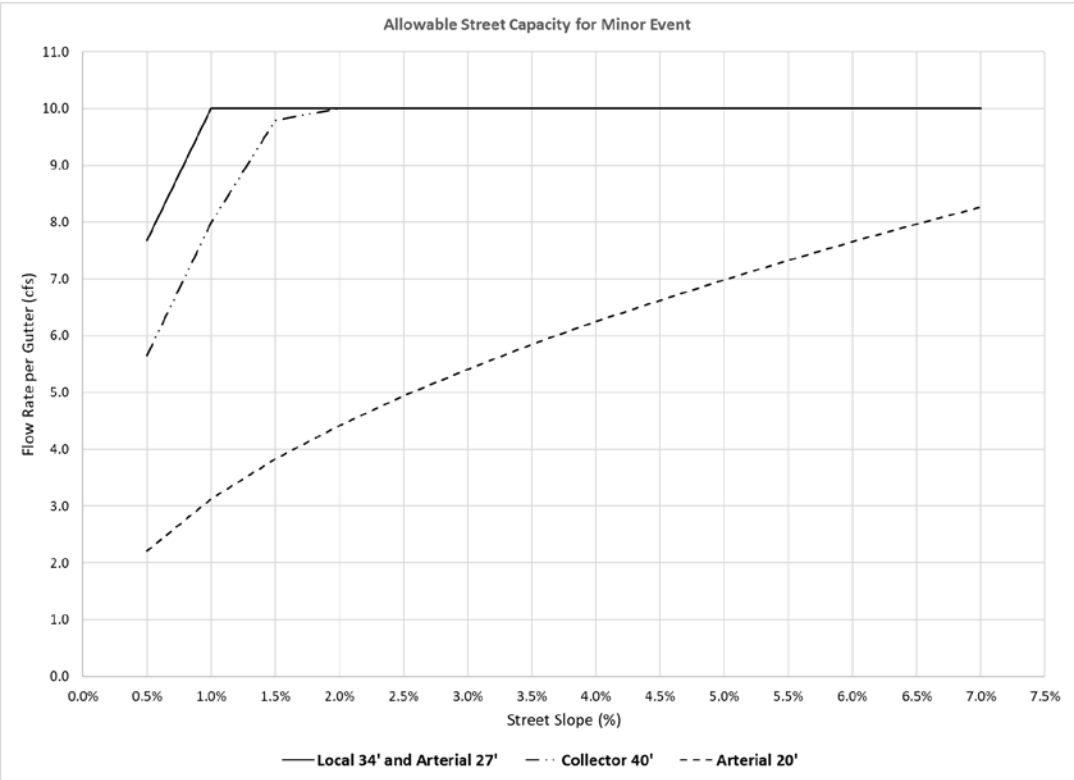
7. Cross pans are allowed only at intersections controlled by stop signs on local streets.

8. Bulbouts (curb extensions) tend to reduce street capacity. Care needs to be taken that bulbout effects to surface flows will not violate any depth or spread criteria found in this chapter.

9. In areas of minimal or no setback from curb line, care needs to be taken to protect buildings from street flooding. In these cases, the developer must analyze potential flood depths in the minor and major storm events and take appropriate measures such as relocation of the building, revision of the design, and/or floodproofing to provide flood protection to prevent damages in the minor and major storm events.

10. Manholes in the cross pans are discouraged, but will be considered on a case by case basis.

Figure 7-1. Allowable Street Capacity for Minor and Major Events
(Note: See Section 7.4.2 for assumptions used to generate these curves)



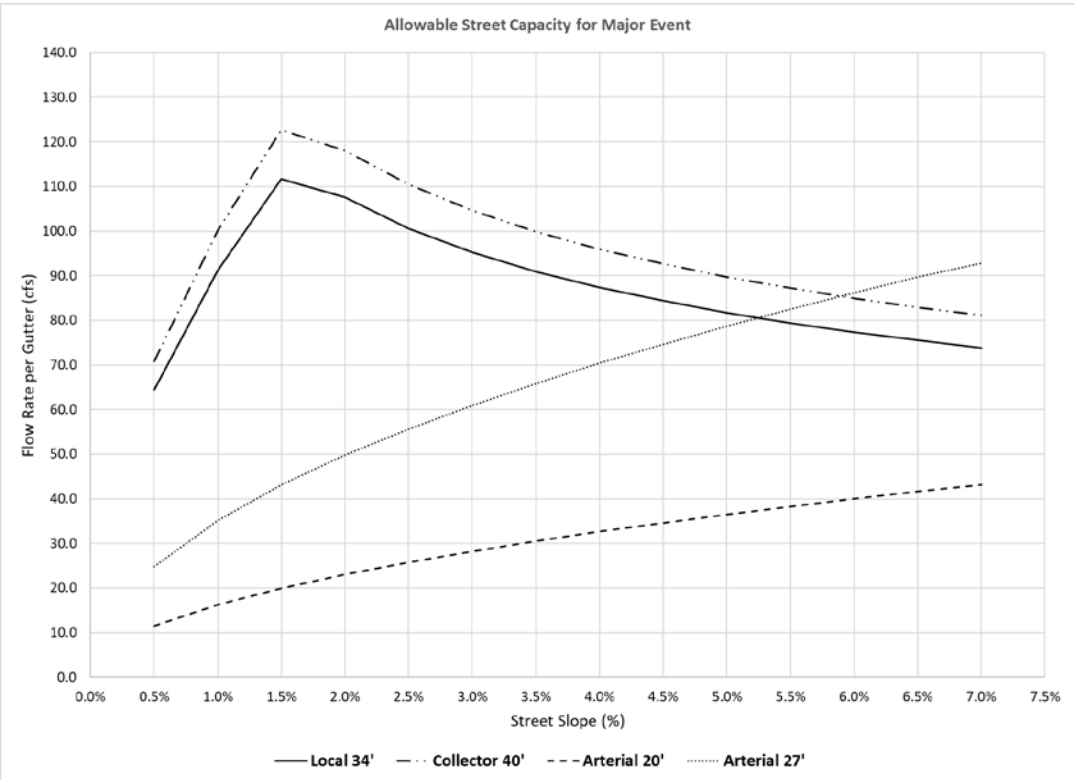
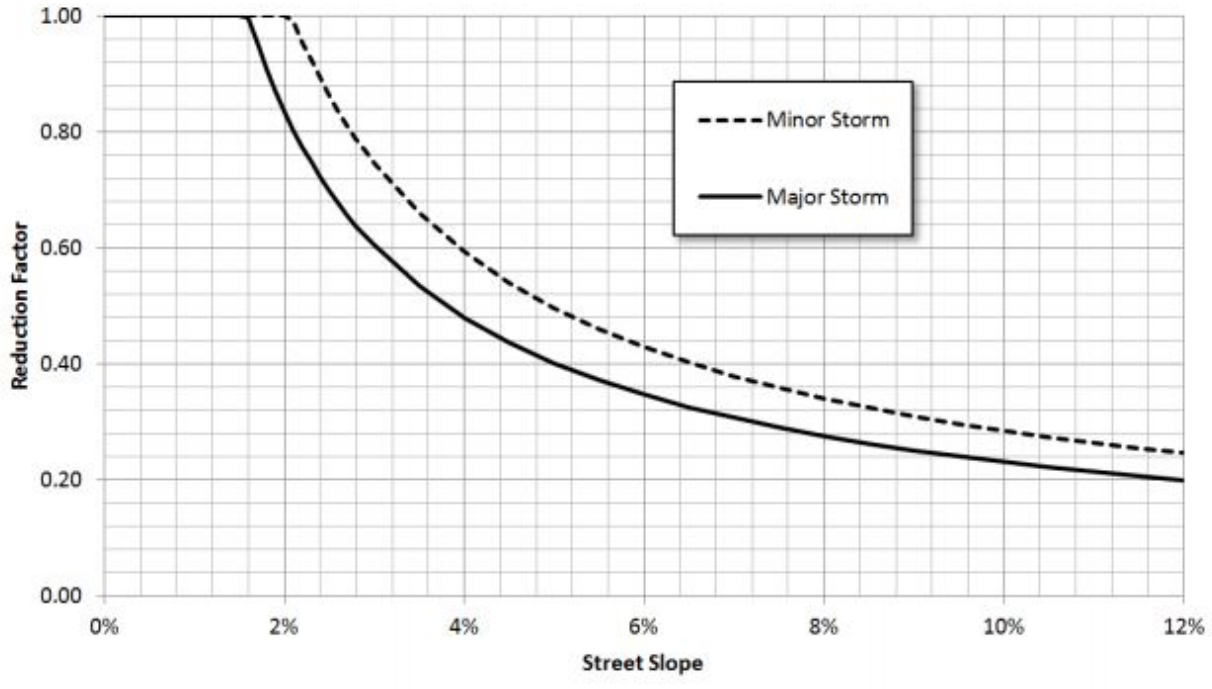


Figure 7-2. Reduction Factors for Gutter Flow
(Source: Guo 2000, as shown in MHFD Manual)



Note: A reduction factor is applied only to a gutter depth of 6 inches or greater for maximum gutter capacity based on allowable gutter depth, per UD-Inlet.

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8.0 Inlets

8.1 Introduction

This chapter presents the criteria and methodology for design and evaluation of storm drain inlets located in Commerce City. Except as modified herein, all storm drain inlet criteria must be in accordance with the Streets/Inlets/Storm Drains chapter of the MHFD Manual. The review of all planning submittals will be based on the criteria presented herein. Important basic information on the function and types of inlets includes:

- **Function of Inlets:** The primary purpose of storm drain inlets is to intercept excess surface runoff and convey it into a storm drainage system, thereby reducing or eliminating surface flooding. Roadway geometry often dictates the location of street inlets located along the curb and gutter. In general, inlets are placed at all low points (sumps), along continuous grade curb and gutter, median breaks, intersections, and crosswalks. The spacing of inlets along a continuous grade segment of roadway is governed by the allowable spread of flow and flow depth. See further details of allowable spread of flow in Chapter 7, Streets.

- **Types of Inlets:** There are three major types of inlets approved for use within Commerce City right-of-way: curb opening, grate, and combination (has both a grate and a curb opening) inlets. Inlets are further classified as being on a "continuous grade" or in a "sump." The term "continuous grade" refers to an inlet placed in curb and gutter such that the grade of the street has a continuous slope past the inlet and, therefore, water ponding does not occur at the inlet. The sump condition exists whenever an inlet is located at a low point resulting in ponding water.

8.2 Standard Inlets

The standard inlets permitted for use in Commerce City are provided in Table 8-1.

Table 8-1. Inlet Types

Inlet Type	Standard Detail	Permitted Use
Type R (Curb Opening)	CDOT M-604-12	All street types
Type C (Grated Inlet)	CDOT M-604-10	All streets with a roadside or median ditch
Type D (Grated Inlet)	CDOT M-604-11	Only outside paved roadways
Type 13 (Grated Inlet)	CDOT M-604-13	Alleys or drives with a valley gutter (private areas only)

The City may consider other inlet types such as the Denver No. 16 grated combination inlet or the Colorado Department of Transportation (CDOT) Type 13 rated combination inlet for retrofit projects if the applicant demonstrates that the City's standard inlet types

are unsuitable. The use of inlet types that are not listed in Table 8-1 will require a variance.

8.3 Inlet Design

Proper inlet design includes both the proper inlet hydraulic capacity and appropriate inlet placement. The sizes and types of inlets shall be designed based on the required hydraulic capacity of the inlet. The criteria and procedures in the Streets/Inlets/Storm Drains chapter of the MHFD Manual must be followed for inlet design in Commerce City, except as modified and supplemented herein. Additional information on hydraulic design and placement of inlets follows.

8.3.1 Hydraulic Design

Provided that the MHFD Manual criteria are met, a variety of approaches can be used to size inlets, including computer programs and charts. MHFD's Street Capacity and Inlet sizing software can be downloaded from MHFD's website and is appropriate for use with on-grade and sump inlet designs. Inlet capacity curves are provided below for convenience; however, designers are strongly encouraged to utilize MHFD's software for design.

8.3.2 Inlet Capacity Curves

Inlet capacity curves are presented in Figures 8-1 through 8-7 for Type R, Type 13, and Type C inlets. On-grade capacity curves in Figures 8-5, 8-6, and 8-7 only apply when street flow is at the **maximum allowable depth**. For lower gutter depths, the inlet interception rate will decrease. Type R, Type 13 Grated, and Type 13 Combination inlets may be used in either on-grade or sump conditions. Type C inlets may only be used in sump conditions.

The following assumptions were used for developing these curves using UD-Inlet:

1. Local depression at Type R inlets is 3 inches.

2. Local depression at No. 13 Grated and Combination inlets is 2 inches.

3. A clogging factor of 0.1 was applied to the curb openings (Type R and Type 13 Combination inlets).

4. A clogging factor of 0.7 was applied for single grate inlets (Type 13 Grated and Type 13 Combination inlet).

5. The length of a single unit for Type 13 Grated and Combination inlets was 2.98 feet and the width was 1.58 feet (according to CDOT design details).

6. All other values were the default in UD-Inlet.

7. The Type C chart was developed using orifice and weir equations with the following assumptions:

    a. The orifice coefficient is 0.67.

    b. The weir coefficient is 3.0.

    c. A clogging factor of 0.5 was used for the orifice for the Type C inlet.

    d. A clogging factor of 0.1 was used for the weir for the Type C inlet.

8.3.3 Inlet Location and Spacing

Inlets are required in the following locations:

- Sumps.
- Median breaks (e.g., where traffic turns across the median).
- Areas where street capacity (e.g., allowable design flow spread) would be exceeded without them.
- Upstream of pedestrian curb ramps with less than 1% slope on the curb return when a storm drain is available.

8.4 Design Considerations

1. In general, inlets should be located upstream of pedestrian curb ramps and spaced in a manner to prevent clogging. This is particularly critical for flat grades and sump conditions; approximately 20-foot spacing is recommended under these conditions.

2. Where significant ponding can occur such as in an underpass and in a sag-vertical curve, good engineering practice is to place flanking inlets on each side of the sag location inlet to relieve some or most of the flow burden on the inlet in sag. Flanking inlets are required in these sump conditions without overflow and in sump conditions requiring more than a triple inlet.

3. A minimum 2-foot apron must be used with valley inlets when no curb and gutter is present.

4. Inlets must be sized to accept the specified pipe sizes without knocking out any of the inlet corners.

5. All pipes entering or exiting inlets shall be cut flush with the inlet wall.

6. Other common-sense considerations regarding placement should also be taken into consideration such as placing inlets upstream rather than downstream of driveways.

7. An emergency overflow route must be provided in sump areas for new development. For other projects, the emergency overflow paths and depths must be addressed to prevent adverse impacts to properties and structures.
8. Grate inlets are not allowed at bus stops.

Figure 8-1. Allowable Inlet Capacity – Type R Inlet, Sump Conditions
(Note: See Section 8.3.2 for assumptions)

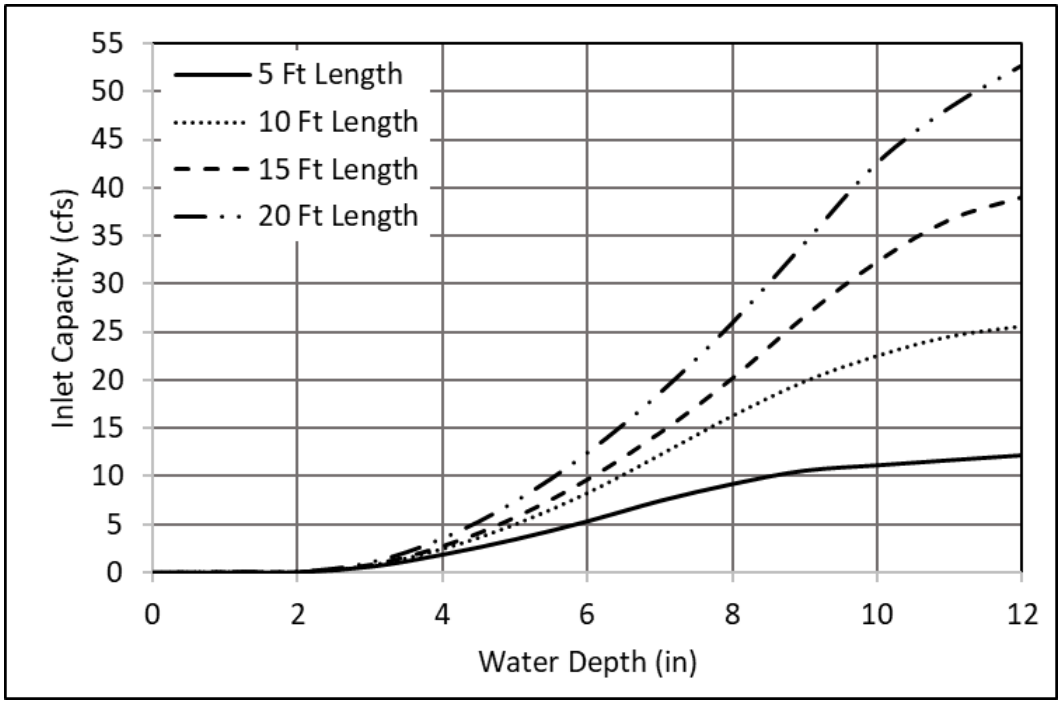


Figure 8-2. Allowable Inlet Capacity – Type 13 Grated Inlet, Sump Conditions
(Note: See Section 8.3.2 for assumptions)

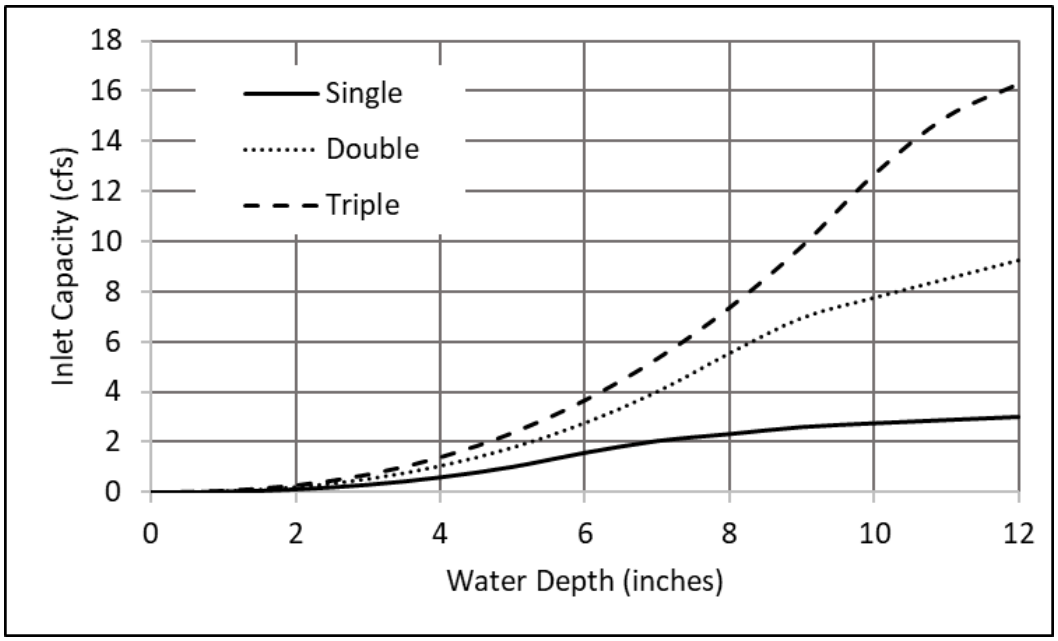


Figure 8-3. Allowable Inlet Capacity – Type 13 Combination Inlet, Sump Conditions
(Note: See Section 8.3.2 for assumptions)

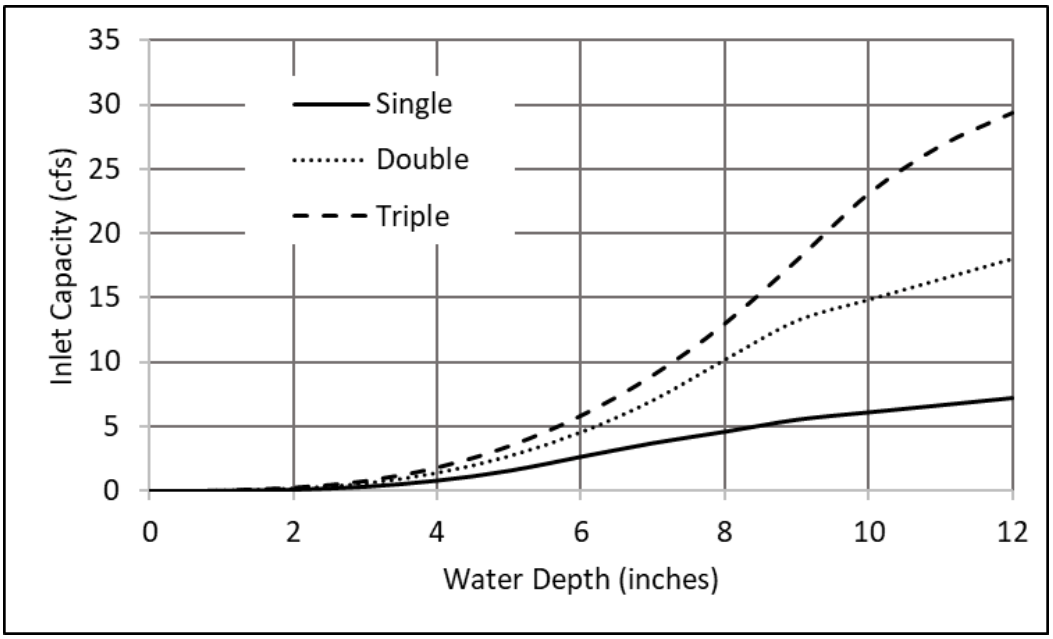


Figure 8-4. Allowable Inlet Capacity – Type C Inlet, Sump Conditions
(Note: See Section 8.3.2 for assumptions)

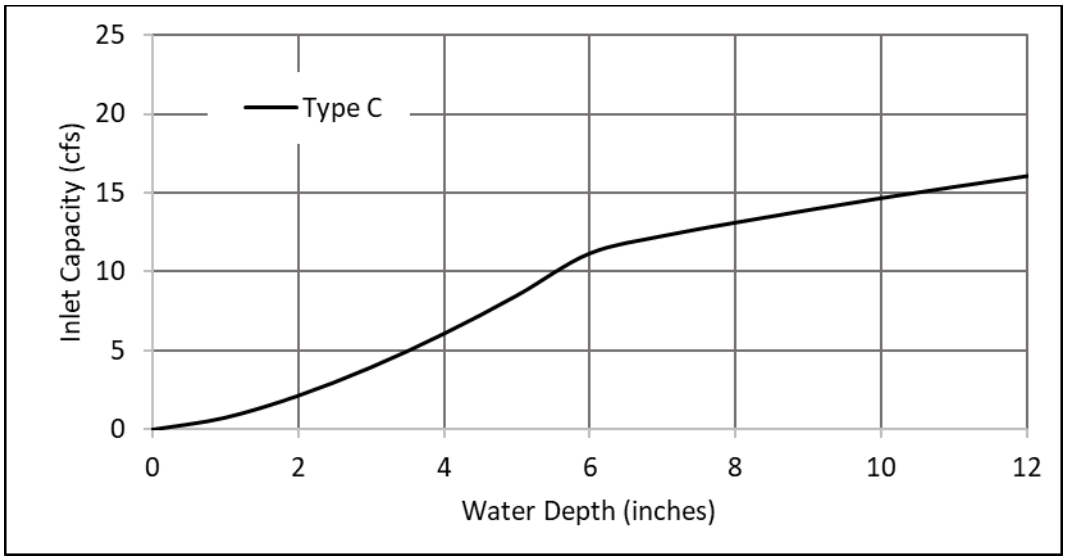


Figure 8-5. Allowable Inlet Capacity – Type R Inlet, On Grade Conditions
(Note: See Section 8.3.2 for assumptions)

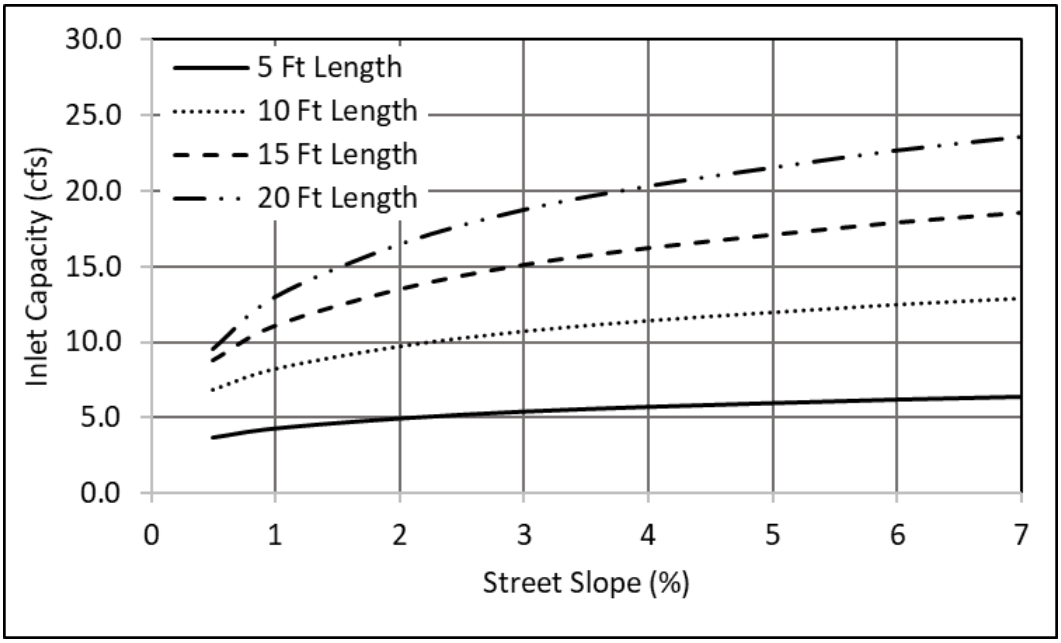


Figure 8-6. Allowable Inlet Capacity – Type 13 Grated Inlet, On Grade Conditions
(Note: See Section 8.3.2 for assumptions)

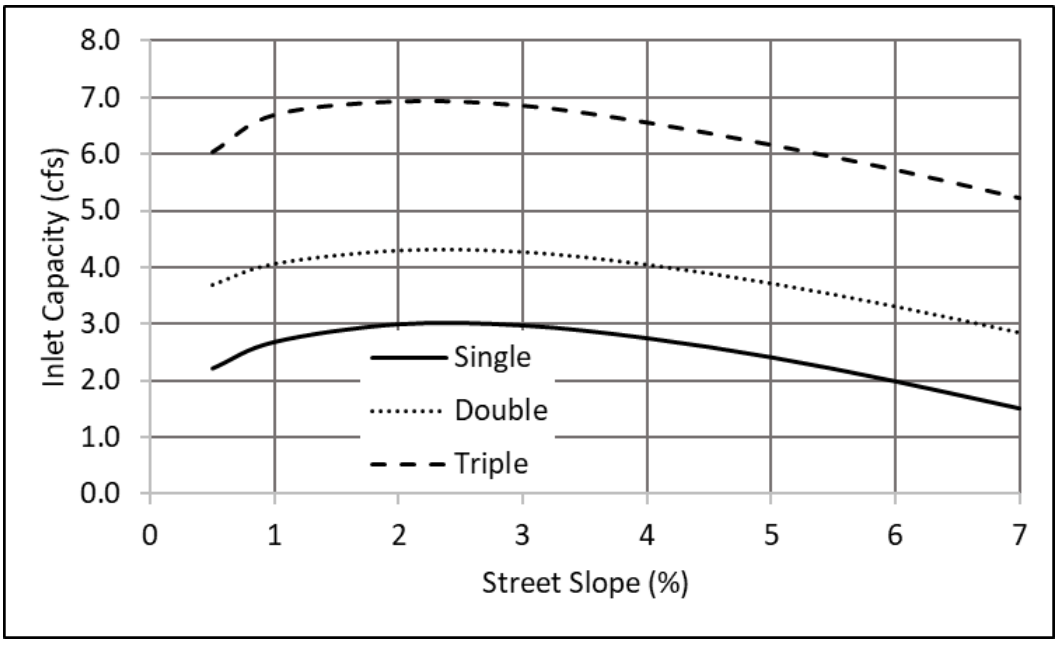
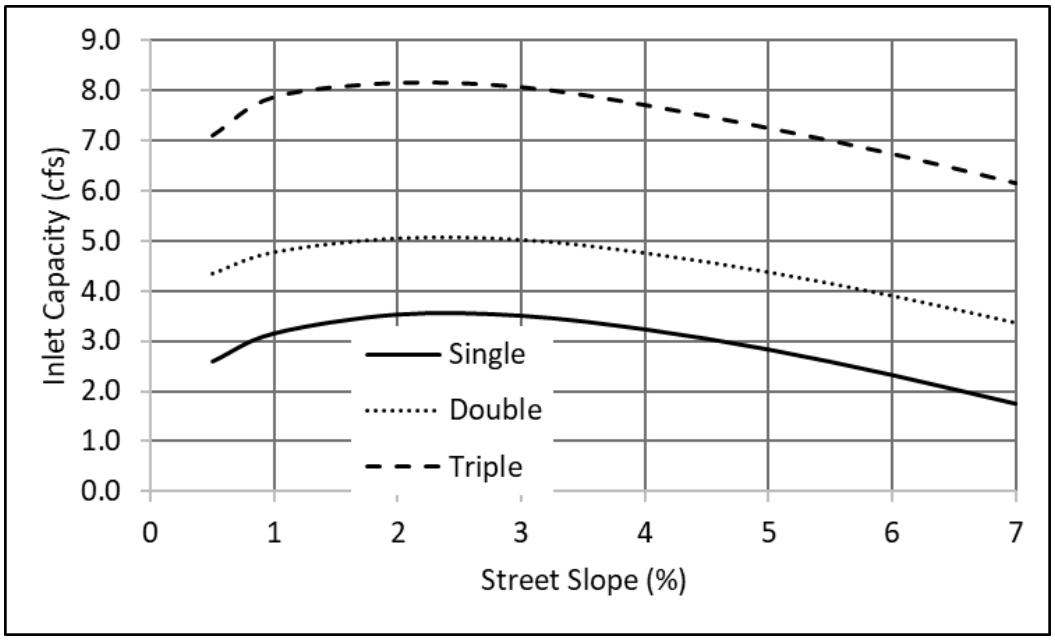


Figure 8-7. Allowable Inlet Capacity – Type 13 Combination Inlet, On Grade Conditions

(Note: See Section 8.3.2 for assumptions)



9.0 Storm Drains

9.1 Introduction

Storm drains are the portion of the urban drainage system that provide subsurface conveyance of flows to control the depth and spread of runoff in streets and other surface drainage systems. Except as modified herein, the design of storm drains must be in accordance with the Storm Drain Systems section of the Streets/Inlets/Storm Drains chapter of the MHFD Manual.

9.2 Design Storms for Sizing Storm Drain Systems

Two design storms must be considered for sizing storm drain systems, the minor (5-year) storm and the major (100-year) storm. In each case, storm drains must be sized to carry the portion of runoff that cannot be conveyed on the surface, as dictated by the available capacity in streets and swales during the minor and major storm events. When connecting to an existing storm sewer system, the Applicant must demonstrate that the proposed system will not exacerbate any existing stormwater problems and that adequate downstream capacity exists. Minimizing the peak discharge rates (i.e., over-detaining) may be required in these cases.

9.2.1 Minor Event Design Storm

At a minimum, storm drains must be sized to convey any minor storm runoff that exceeds the minor event capacity of the street or roadside swales (discussed in Chapter 7, Streets). Inlets are located at these points to intercept excess flow and route it to the storm drain. Storm drains must be designed to convey the minor storm flood peaks while flowing at most 80% of the full pipe capacity. Section 9.3 provides additional information on hydraulic design methods for the minor storm.

9.2.2 Major Event Design Storm

There are conditions when the storm drain system will be sized to convey flows greater than the minor storm runoff, including locations where:

- The street capacity for the major storm is exceeded, especially where the grade slopes down behind the curb and the major storm capacity is limited to the height of the curb.
- Regional storm drains are designed for the major storm.
- The storm drains must convey undetained flows to a regional detention basin.

If a storm drain is to be designed to carry major storm flows, the inlets to the storm drain must be designed accordingly. In pipes designed to convey up to the major storm, the hydraulic grade line (HGL) is allowed to rise above the top of the storm drain, but must be kept at least 1.0 foot below manhole lids, inlet grates and inlet curb openings. Section 9.3 provides additional information on hydraulic design methods for the major storm.

9.3 Hydraulic Design

Storm drains must be designed to convey the minor storm flood peaks while flowing at 80% of the full pipe capacity at most. To ensure that this objective is achieved, the hydraulic and energy grade lines must be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses must be calculated accounting for friction, expansion, contraction, bend, and junction losses following the methods in the Storm Drain Systems section of the Streets/Inlets/Storm Drains chapter of the MHFD Manual. Additionally, for convenience, a chart identifying the hydraulic properties of circular pipe is provided in Figure 9-1. This chart assumes that the friction coefficient and Manning's n do not vary with depth, which is a common design assumption. The UD-Sewer 2009 software program (downloadable from MHFD's website) or the EPA Stormwater Management Model (SWMM) may also be used to design storm drains.

The maximum velocity in all storm drains is 18 feet/second. The minimum velocity is 3 feet/second at half-full flow conditions.

The final EGL must be at or below the proposed ground surface for the design event. The HGL must not exceed the crown of the pipe for the minor storm. In cases where the conduit is designed to convey up to the full 100-year flow, the allowable HGL must be 1.0 foot below inlet elevations, or 1.0 foot below ground where no inlets are present.

9.4 Construction Materials

Storm drain construction materials must be ASTM C76 Class III reinforced concrete pipe (RCP) unless otherwise approved by the City Engineer.

9.5 Pipe Size

The minimum allowable pipe size for storm drains is dictated by ease of maintenance rather than hydraulics. The length of the pipe also affects the ability to maintain a storm drain. Table 9-1 presents the minimum pipe sizes for public storm drains.

Table 9-1. Minimum Size Criteria for Public Storm Drains

Type	Minimum Equivalent Pipe Diameter
Main Trunk	18 inches
Lateral from Inlet	15 inches

Outfall structures are considered main trunks; therefore, the minimum outfall diameter is 18 inches or equivalent.

9.6 Vertical and Horizontal Alignments

Table 9-2 provides the vertical alignment requirements for storm drains.

Table 9-2. Vertical Alignment Requirements for Storm Drains

Vertical Alignment of Storm Drain Relative to:	Minimum Vertical Clearance (above or below)	Comment
Cover	Minimum cover depends upon the pipe size, type and class, and the soil bedding condition.	The drain grade must be such that a minimum cover is maintained to withstand American Association of State Highway and Transportation Officials (AASHTO) HS-20 (or as designated by Commerce City) loading on the pipe.
Water Main	18 inches	Approval from South Adams County Water Department will be required for lesser clearances.
Sanitary	12 inches	Additionally, when a sanitary sewer main lies above a storm drain, or within 18 inches below, the sanitary sewer must have an impervious encasement or be constructed of approved sewer pipe with the nearest joint at least 10 feet from the centerline of the crossing.
Other	Varies	For vertical drops greater than 8 feet, special designs are required that address potential cavitation and energy dissipation. These situations will require special review. See *Design and Construction of Urban Stormwater Management Systems* (ASCE and WEF 1992) for guidelines for drop shaft structures. The invert of a pipe leaving a manhole should be at least 0.1 foot lower than the incoming pipe to ensure positive low flows through the manhole.

In most cases, storm drain alignment between drainage structures (inlets or manholes) must be straight, using manholes to accommodate changes in alignment. Storm drain horizontal alignment may be curvilinear for pipes with diameters of 48 inches or greater, but only when approved in writing by the Review Engineer. The applicant must demonstrate the need for a curvilinear alignment. The radius limitations for pulled-joint pipe are dependent on the pipe length and diameter and amount of opening permitted in the joint. The minimum parameters for radius-type pipe must be in accordance with the manufacturer's specifications.

Storm drains parallel to the street must not be placed under the tree lawn or the sidewalk.

9.7 Manholes/Cleanouts

Manholes are required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two or more drains. A manhole may be required at the beginning and the end of the curved section of storm drain. The maximum spacing between manholes is 500 feet for pipes with a vertical dimension of 42 inches and larger, and 400 feet for pipes with a vertical dimension of 15 to 36 inches. The required manhole size shall be as follows:

Table 9-3. Required Manhole Diameters

Sewer Diameter (inches)	Manhole Diameter (feet)
15 to 18	4
21 to 42	5
48 to 54	6
60 and larger	Appropriate manhole size from CDOT Standard Plan No. M-604-20

Larger manhole diameters or a junction structure may be required when large diameter pipe alignments are not straight through manholes or when more than one storm drain line goes through the manhole. A special structure is required for 42-inch or larger pipe when the angle of deflection is more than 45 degrees.

Cleanouts for maintenance access, instead of manholes, are allowed only for private, on-site storm drains 10 inches in diameter or smaller and must be the same size as the pipe to be cleaned. Spacing of cleanouts must conform to the requirements of the most current version of the International Plumbing Code.

9.8 Outlets

Proper design of storm drain outlets is necessary to minimize erosion at the outfall location and to protect public safety. Key guidance on these topics is presented in the following sections.

9.8.1 Conduit Outlet Protection

Adequate erosion protection must be provided at all storm drain outlets in accordance with Section 3 of the Hydraulic Structures chapter of the MHFD Manual, which provides criteria for riprap aprons, low tailwater stilling basins, concrete impact stilling basins, concrete baffle chutes, and grouted boulder outfalls.

9.8.2 Safety

Headwalls and wingwalls associated with storm drain outlets must be provided with guardrails, handrails, or fencing in conformance with Denver building codes and roadway design safety requirements. Handrails are required in all areas where the drop

from the headwall or wingwall exceeds 30 inches. The height of the handrail must be 42 inches for pedestrian walkways or open areas and 54 inches when bicycle or equestrian traffic will be near the storm drain outlet (AASHTO 2002).

9.9 Abandonment

Storm drains greater than 8 inches to be abandoned in place must be plugged with clean concrete and standard manufactured plugs or caps at both upstream and downstream ends of the abandoned section. If manholes are also abandoned in place or if the structure is to be removed completely, all storm drains must be plugged upstream and downstream of the removed structure following removal. Storm drains to be abandoned with an internal diameter of 8 inches and larger must be filled with sand, pumped grout mixtures, or flowable fill in order to minimize future subsidence attributable to the potential collapse of the abandoned facility. Storm drains with an internal diameter smaller than 8 inches must be plugged at entrance and exit ends with approved grout mixtures or concrete.

9.10 Design Considerations

All of the design criteria in this chapter must be followed. Several key considerations that the designer must take care to address include:

1. Design the EGL below the ground surface for the design event.

2. Design the HGL not to exceed the pipe’s crown for the minor storm.

3. Design the HGL not to exceed 1.0 foot below inlet elevations, or 1.0 foot below ground where no inlets are present when the conduit is designed to convey the major event.

4. Account for all losses in the EGL and HGL calculations including outlet, form, bend, manhole, and junction losses.

5. Provide adequate erosion protection at the outlet of all storm drains.

6. Provide cross sections for riprap protection.

7. Check for minimum pipe cover and clearance with utilities.

8. Check overflow under sump conditions.

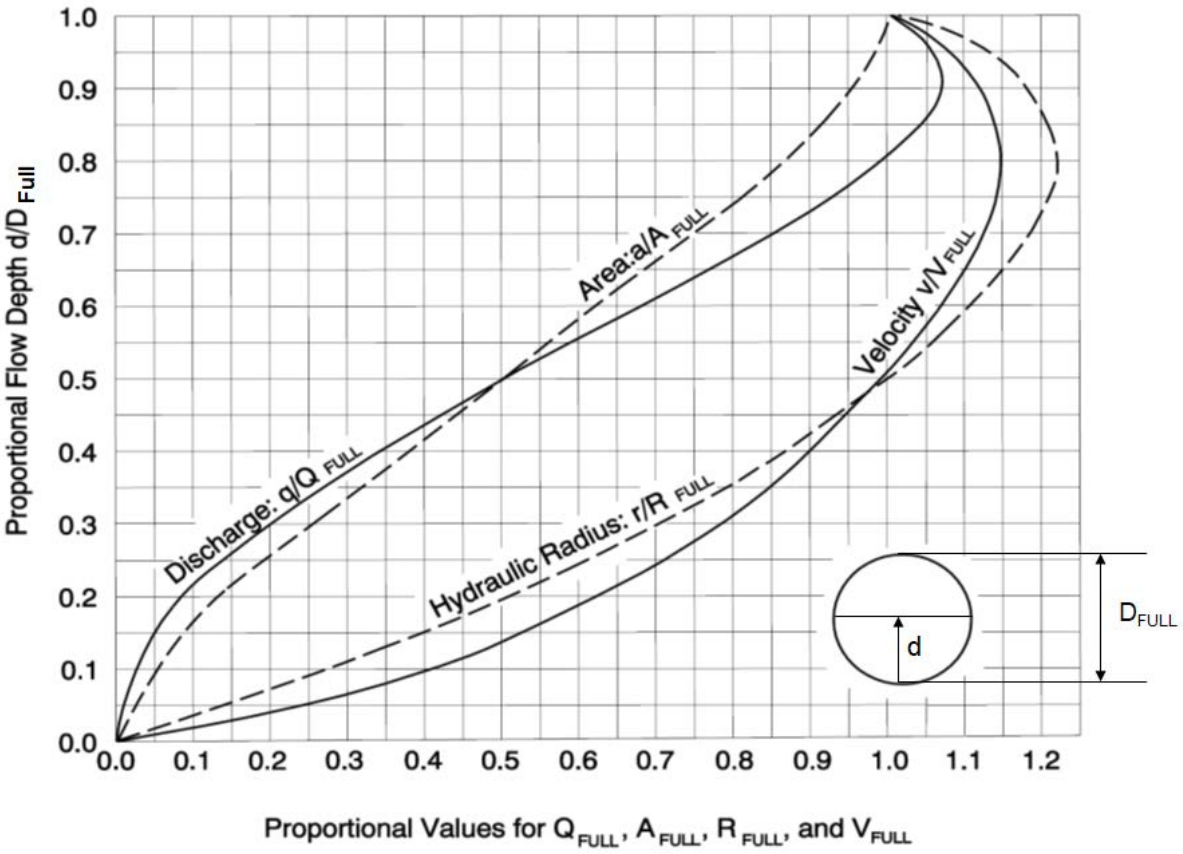
9. When a storm drain flows into a detention or water quality facility, design the invert of the inflow pipe to be higher than the anticipated water quality level in the pond.

10. Storm drain outfalls to major drainageways must be designed to meet MHFD Maintenance Eligibility Program requirements.

11. Construction of an outfall in a mapped floodplain requires a floodplain development permit.

12. Backflow prevention devices such as flap gates for storm drain outlets should only be considered as a last option.

Figure 9-1. Hydraulic Properties of Circular Pipe



Source: *Open Channel Hydraulics* (Chow 1959, reissued 1988); figure adapted from Oregon Department of Transportation Hydraulics Manual (2014).

10.0 Open Channels

10.1 Introduction

This chapter provides the minimum technical criteria for the hydraulic evaluation and design of open channels in Commerce City. In many instances, special design or evaluation techniques will be required. Design criteria in the Open Channels chapter of the MHFD Manual are hereby incorporated by reference. Except as modified herein, all open channel designs must be in accordance with the MHFD Manual.

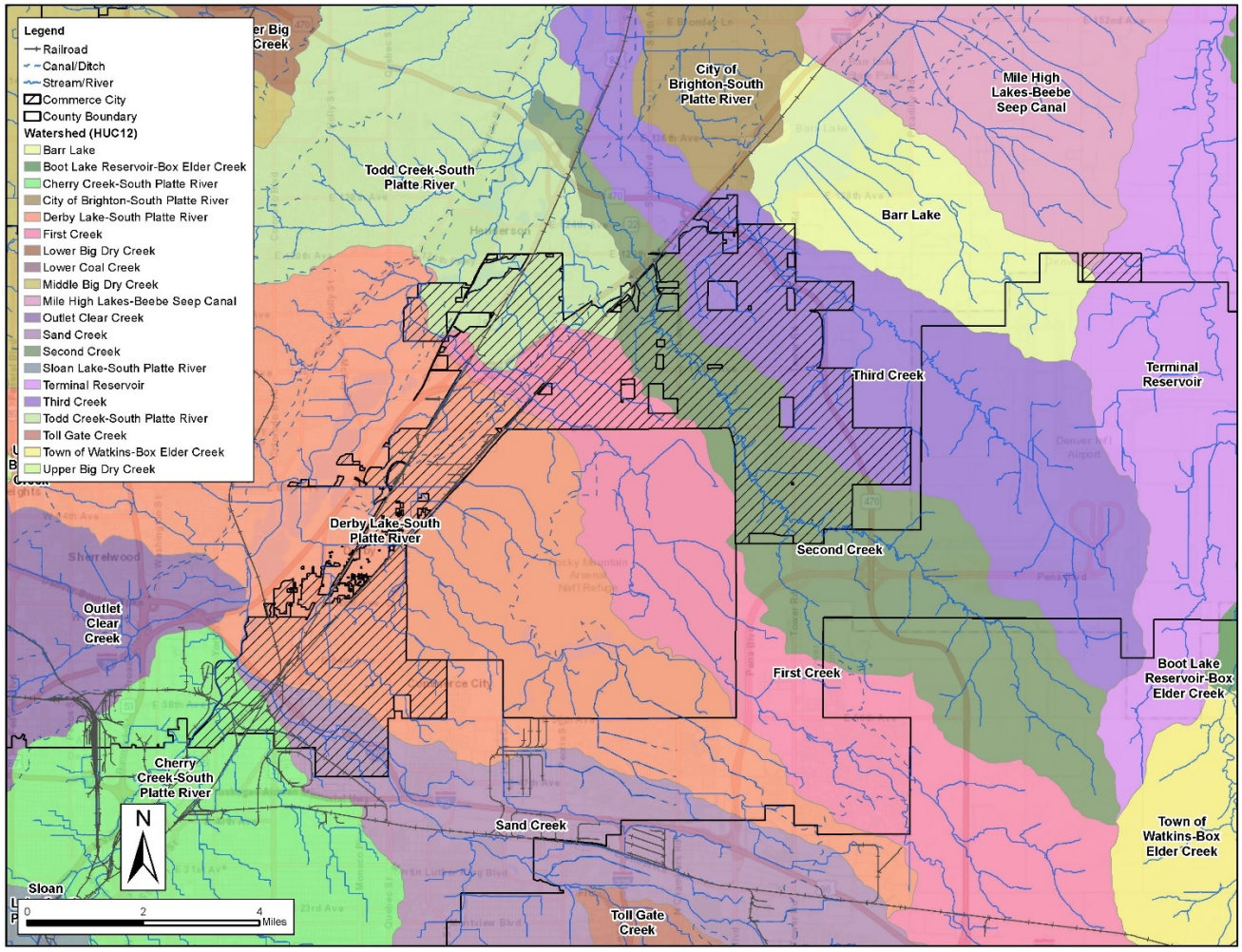
10.2 Major Drainageways

As previously discussed in Chapter 3, a major drainageway is defined as any drainage flow path with a tributary area of 130 acres or more. Major drainageways in Commerce City include portions of Sand Creek, Irondale Gulch, First Creek, Second Creek, Third Creek, and their tributaries. In addition, the South Platte River runs along portions of the City's western boundary. Figure 10-1 shows major drainageways in and near Commerce City. Not all major drainageway in Commerce City have well-defined flow paths. Many of the major drainageways in Commerce City have sandy beds and banks (Sand Creek, as an example) that are especially vulnerable to channel instability due to hydromodification/erosion. Unless design and construction of major drainageway improvements are performed with an understanding of geomorphology and sediment transport, areas of excessive aggradation or degradation are likely to develop.

A major objective of managing major drainageways in Commerce City is to provide outfalls for all major drainageways that allow positive drainage through the City and ultimately to the South Platte River. This is challenging due to many factors including barriers created by highways, railroads and ditches, the need for multi-jurisdictional cooperation, costs, and other factors. Nonetheless, for development in Commerce City to occur in a manner that protects public health, safety, and welfare, outfalls for major drainageways are a necessity. The City has worked with the MHFD to develop master plans for the major drainageways and several direct flow areas in the City that will help to achieve this important objective once implemented.

Whenever a development alters or improves a major drainageway, the developer(s) are responsible for making revisions to the floodplain maps at their own expense. All plans, details, calculations, and other requirements must be submitted through the City to FEMA according to FEMA's criteria. The City will notify the Colorado Water Conservation Board and the MHFD as required.

Figure 10-1. Major Drainageways in the Vicinity of Commerce City



10.3 Minor Drainageways

Minor drainageways convey flows from tributary areas less than 130 acres. The design principles in the MHFD Manual apply to both classifications of streams. Additionally, the MHFD Open Channels chapter provides design information for grass swales based on several standard cross-sections. Commerce City encourages the use of vegetated, open channel drainageways for minor drainage systems when feasible.

10.4 Natural Channel Design

The Open Channels chapter of the MHFD Manual emphasizes providing adequate space for the stream corridor and using naturalized channel design. The MHFD Manual provides guidance for preserving, protecting, and enhancing existing natural channels and for designing naturalized channels where new channels are to be constructed. Although much of Commerce City is urban in character, many of the streams that flow through the community can be enhanced through the natural channel design principles described in the MHFD Manual. While the use of closed-conduits may be necessary for crossing impediments to natural drainage such as roads, ditches, and railroads, in other areas natural channel design concepts should be evaluated and applied as appropriate. Application of the low-maintenance, high-functioning design concepts in the MHFD Manual will result in reduced lifecycle costs for drainageways in Commerce City.

10.5 Rock and Boulders

Sizing for riprap and boulders must follow the criteria in the Open Channels chapter of the MHFD Manual:

1. For mild slope conditions (generally subcritical flow conditions with slopes of less than 2%), Equation 8-11 in the MHFD Manual may be applied.

2. For steep slope conditions, generally 2 to 20%, apply the Colorado State University (CSU) equation, U.S. Army Corps of Engineers Steep Slope Riprap equation or the U.S. Department of Agriculture – Agricultural Research Service equations in the MHFD Manual, including the recommended concentration and scaling factors.

3. For steeper changes in grade such as drop structures and rundowns, refer to the Hydraulic Structures chapter of the MHFD Manual for criteria and guidance.

Whether in mild slope or steep slope conditions, consider a safety factor when specifying the size of riprap. Sizing methods presented in the MHFD Manual were developed under controlled laboratory conditions. Field installation of rock is much less precise compared to laboratory conditions. It is difficult to grade riprap flat across a channel bottom or in a manner that provides a uniform slope. Sometimes the riprap delivered from local quarries is slightly smaller than specified. Flow conditions in streams can be affected by a variety of elements including debris, sedimentation, vegetation, etc. and can result in flow concentrations. It is important to include a safety factor when using these equations because the variability associated with conditions in the field cannot be quantified.

10.6 Commerce City Design Criteria

The following criteria apply to natural channels and constructed naturalized channels within Commerce City:

1. **Master Plan Information**. If published MHFD or Commerce City outfall system or drainage master plans exist, channel designs should be completed with projected future condition hydrology and recommendations consistent with the intent of these plans; however, conformance to or variation from any existing master plans will be determined by the City's Review Engineer. Where master plans include outdated methodologies, MHFD and Commerce City will provide guidance as to the intent of channel improvements.

2. **Hydraulic Analysis**. A detailed hydraulic analysis of the design reach and any upstream or downstream area of influence must be conducted to inform the design following the guidance in the MHFD Manual. The analysis must be based on HEC-RAS for a suitable range of design events including the 2-year, 10-year and 100-year events, at a minimum. For major drainageways, the 50- and 500-year events must also be evaluated. In some cases, a two-dimensional hydraulic analysis may be appropriate for a project. If this is the case, the applicant must first consult the City to obtain approval for an alternative modeling approach using a two-dimensional model that the City can review using publicly available software.

3. **Regulatory Floodplain Analysis**. A regulatory floodplain analysis must be performed in conformance with Commerce City, MHFD, and FEMA floodplain permitting requirements, as approved by the Commerce City Floodplain Administrator.

4. **Filling of the Floodplain**. Filling of the floodplain to construct naturalized channels must be avoided because it generally increases erosion potential on the stream, reduces valuable channel and floodplain storage capacity, and tends to increase downstream runoff peaks. The City has adopted a zero-foot rise floodway, which means that encroachments into the 100-year floodplain are not allowed to cause an increase in the 100-year water surface elevations. Therefore, cut and fill must be carefully evaluated using a hydraulic model to achieve no rise and some export of material may be necessary.

5. **Freeboard**. A minimum of 18 inches of freeboard above the 100-year water surface to the top of bank or property lines (whichever is more restrictive) must be provided in major and minor drainageways, with 3 feet provided at bridges relative to the low chord of the bridge.

6. **Swales**. Design charts shown in Section 6 of the Open Channels chapter of the MHFD Manual may be used for 100-year design discharges up to 40 cfs.

7. **Synthetic Lining and other Proposed Materials**. Generally, stable channel conditions are to be achieved by applying the principles and materials described

in the MHFD Manual. The use of synthetic fabrics for lining of channels and other material differing from standard materials identified in the MHFD Manual (i.e., vegetation, rock, temporary coir, or biodegradable erosion control blanket) will be allowed only upon written approval of a variance from the City Engineer.

8. **Preservation of Natural Features**. Natural channel boundaries and alignments must be preserved, maintained, or enhanced in their natural condition to serve as landscape and visual amenities, to provide focal points for development projects, and to help define “edges” in and around communities. Vegetation groups, rock outcroppings, terrain form, soils, waterways, and bodies of water must be preserved to the extent practicable.

9. **Allowance for Future Vegetation**. Channel capacity must be provided to accommodate anticipated future growth of vegetation within the floodplain, as approved by the Review Engineer. Overstory canopy trees are allowed and encouraged within the floodplain outside of high hazard areas (e.g., outside of the floodway).

10. **Future Bridges**. Appropriate allowances for known future bridges or culverts, which can raise the water surface profile and cause the floodplain to be extended, must be included in the hydraulic and design analysis. The applicant must contact the City for information on future bridges and roads in undeveloped areas.

11. **Design Drawings**. The existing stream in the design reach and any proposed channel improvements must be clearly shown in plan, profile, section, and detail, as approved by the Review Engineer.

12. **Pre-submittal Meeting**. For any improvements or alterations to a major drainageway or plans to construct a naturalized channel, the applicant must meet with the City to discuss the concept and obtain the requirements for planning and design documentation.

13. **MHFD Maintenance Eligibility**. Per Colorado Revised Statues (CRS) §32-11-221(1), requirements for drainage facilities other than minor collection systems in the MHFD boundary must be approved by MHFD. All projects eligible for MHFD’s Maintenance Eligibility requirements and must satisfy the design, construction, and vegetation criteria and requirements in the most current version of MHFD’s Criteria Manual and Maintenance Eligibility Guidelines (downloadable from MHFD’s website).

14. **Environmental Permitting**. A variety of federal (e.g., 404 permit), state (e.g., dewatering, stormwater) and local permits are often required when constructing open channels. The applicant must obtain necessary permits.

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11.0 Hydraulic Structures

11.1 Introduction

The criteria to be used in the design of hydraulic structures must be in accordance with the Hydraulic Structures chapter of the MHFD Manual, unless modified herein. Hydraulic structures described in the MHFD Manual include grade control structures in open channels and outfalls and rundowns to convey tributary runoff into streams.

11.2 Commerce City Design Criteria

Design criteria applicable to hydraulic structures in Commerce City include the following:

1. **Hydraulic Analysis**. Grade control structures may be designed using the simplified design approach described in the MHFD Manual if the design criteria for using simplified design procedures are met. Otherwise, grade control structures must undergo the detailed hydraulic analysis approach described in the Manual.

2. **Grade Control Structures**. Grade control structures must be grouted stepped boulder or sculpted concrete unless otherwise approved. Ungrouted rock grade control structures may only be used if approved by the Review Engineer based on a detailed HEC-RAS hydraulic analysis and rock sizing evaluation. Existing grade control structures not meeting current MHFD criteria must be replaced with compliant grade control structures when the cost of maintenance or repair is greater than 50% of the value of the existing structure in order for these structures to meet MHFD Maintenance Eligibility Program requirements.

3. **Pipe Outfalls and Rundowns**. As described in the Hydraulic Structures chapter of the MHFD Manual, pipe outfalls are preferred over rundowns for conveying tributary runoff into open channels. Rundowns may only be used if approved by the Review Engineer. If rundowns are used, the applicable criteria described in the MHFD Manual must be met and riprap protection must be provided on the opposite bank to protect against any impinging flow.

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12.0 Culverts and Bridges

12.1 Introduction

A culvert is defined as a conduit for the conveyance of water under a roadway, railroad, canal, or other embankment. In addition to serving hydraulic functions, culverts also must carry overhead loads from traffic and other activities, thereby serving a structural function. Proper culvert design is essential because culverts often significantly influence upstream and downstream flood risks, floodplain management, and public safety.

Bridges are typically designed to cross a waterway with minimal disturbance to the flow. However, for practical and economic reasons, abutment encroachments and piers are often located within the waterway. Consequently, the bridge structure can cause adverse hydraulic effects and scour potential that must be evaluated and addressed as part of each design. The design of a bridge is very specific to site conditions and numerous factors must be considered.

The criteria presented in this chapter must be used in the design of culverts and bridges in Commerce City. The criteria, techniques, and design examples provided in the Culverts and Bridges chapter of the MHFD Manual are hereby incorporated by reference and not repeated herein, unless modified by Commerce City.

12.2 General Design and Hydraulic Evaluation

The MHFD Culverts and Bridges chapter provides detailed information on culvert hydraulics, culvert sizing and design, culvert inlets, and outlet protection. The MHFD Culverts and Bridges chapter also provides references for additional information, including the Federal Highway Administration's 2012 Hydraulic Design Series No. 5, *Hydraulic Design of Highway Culverts*.

The sizing of a culvert or bridge depends on several factors including the street designation (i.e., local, collector, arterial, or highway) and the nature of the waterway. Culverts and bridges should be designed to minimize impacts to waterways to the extent practical.

For culverts, the street classification, the allowable street overtopping depth (if any), and the allowable headwater depth are key design parameters. Overtopping is not allowed for any street designation at major drainageway crossings.

All new bridge structures must be designed to pass the 100-year flow with an allowance for freeboard between the 100-year water surface elevation and the low chord of the bridge. Hydraulic effects of the bridge must be evaluated to determine the effect of the structure on 100-year water surface elevations and sediment transport.

The hydraulic principles, criteria, roughness coefficients, entrance loss coefficients, culvert capacity charts, and other information provided in the Culverts and Bridges chapter of the MHFD Manual must be used in the hydraulic evaluation, sizing, and design of culverts, except as modified herein. The UD-Culvert spreadsheet

(downloadable from MHFD's website) may also be used in the hydraulic evaluation of culverts.

The criteria in this chapter are considered the minimum design standards and may need to be modified where other factors are considered more important. For example, the designer must consider flooding of adjacent structures or private property, excessive channel velocities, availability of alternate routes, and other factors pertinent to a specific site.

12.3 Culvert Sizing Criteria

For street crossings, the minimum culvert size is based on the allowable street overtopping for the various street classifications as set forth in Table 12-1 and allowable headwater depths as discussed in Section 12.6. Street overtopping is not allowed for the 10-year frequency or smaller storm. Other conditions may be present that will require a larger culvert size, particularly with regard to public safety concerns and upstream and downstream impacts. In some cases, the minimum criteria may result in some structures remaining in the 100-year floodplain, which may require an increase in culvert size to lower the floodplain elevation. Also, if only a small increase in culvert size is required to prevent overtopping, then the larger culvert is required.

Culverts discharging into minor and major drainageways must account for tailwater effects. This is especially important when culverts discharge in floodplains. If a floodplain is not established by FEMA or MHFD, the engineer should use the U.S. Geological Survey's StreamStats web-based tool to estimate the peak discharge for the design event and analyze tailwater depths based on topography and hydraulic analysis.

See the MHFD Manual for criteria and design procedures for culvert applications other than street crossings.

Table 12-1. Allowable Roadway Overtopping at Culvert Crossings

Street Classification	10-year Storm Event	100-year Storm Event
Local	No road overtopping allowed	Overtopping at crown governed by maximum depth of 12 inches at gutter flowline.[1]
Arterial and Collector	No road overtopping allowed	No overtopping at crown. Maximum depth of 12 inches at gutter flowline.[1] Ratio of maximum headwater (H_w) to culvert diameter (D) may not exceed 1.5 ($H_w/D \leq 1.5$)

[1] See Chapter 7, Streets, for further discussion regarding allowable flow depth in the street based on street classification.

12.3.1 Construction Material and Pipe Size

Within Commerce City, culverts must be constructed from ASTM C76 Class III reinforced concrete or better. Other materials for construction are subject to written approval by the City Engineer. The minimum pipe size for culverts within a public right of way is 18-inch-diameter culvert, and the same minimum pipe size applies to roadside ditch culverts for driveways.

12.3.2 Inlet and Outlet Configuration

Within Commerce City, all culverts must be designed with headwalls, wingwalls, and aprons, or with flared end sections at the inlet and outlet. Flared end sections are only allowed on pipes with diameters of 30 inches (or equivalent) or less. Refer to the MHFD Culverts and Bridges chapter for guidance on layout and configuration of culvert headwalls and wingwalls. Construction of headwalls and wingwalls must be in accordance with CDOT M Standards.

Outlet protection is required at culvert outfalls to minimize the potential for erosion immediately downstream of culverts. Outlet protection such as riprap armoring or concrete aprons helps to stabilize the transition from the culvert to the downstream channel. See the Culverts and Bridges and Hydraulic Structures chapters of the MHFD Manual for guidance and criteria on outlet protection.

For design of culvert inlets and outlets, the designer should consider compatibility with the upstream and downstream channels including geometry, hydraulics, and aesthetics.

12.3.3 Headwater Considerations

The maximum headwater (Hw) for the 100-year design flows must be no more than 1.5 times the culvert diameter (D), or 1.5 times the culvert rise dimension for shapes other than round. Also, the headwater depth may be limited by the street overtopping criteria in Table 12-1.

12.3.4 Structural Design

As a minimum, all culverts must be designed to withstand an HS-20 loading (unless designated differently by Commerce City) in accordance with the design procedures of the American Association of State Highway and Transportation Officials (AASHTO) in *Standard Specifications for Highway Bridges* and with the pipe manufacturer's recommendation.

12.3.5 Safety Grates

Consider using safety grates for any culverts and underground pipes that are accessible to the public. Follow the guidance and criteria in the MHFD Culverts and Bridges chapter to determine when safety grates are required and to design safety grates. Always evaluate effects on hydraulic forces and clogging potential as it relates both to public safety and hydraulic capacity.

12.3.6 Design Considerations

All of the design criteria in this chapter must be followed. Key factors to consider for design include:

1. No street overtopping is allowed for the 10-year storm.
2. Check minimum and maximum culvert velocities.
3. The minimum culvert size for crossing the public right of way is 18-inch diameter or equivalent.
4. The minimum culvert size for roadside ditches at driveways is 18-inch diameter or equivalent.
5. Headwalls and wingwalls must be provided for all culverts with a diameter larger than 30 inches.
6. Check maximum headwater for design conditions. The ratio of maximum headwater to culvert diameter, Hw/D, may not exceed 1.5. Street overtopping criteria in Table 12-1 must also be satisfied.
7. Check structural requirements and emergency overflow route.
8. Consider public safety including accessibility to the public, maximum velocities, guard rails, embankment, slopes, and other factors.

12.4 Bridge Sizing Criteria

The hydraulic design of a bridge is very specific to site conditions, and numerous factors must be considered. A partial list of these factors includes location and skew, structural type selection, water surface profiles and required freeboard, floodplain management and permitting, scour considerations, deck drainage, and environmental permitting. The consideration of these factors requires that every bridge project have a unique design. All new bridges must be designed to safely handle the major design storm event flows with the required freeboard. Replacement bridge structures should also be designed to the same standards; however, depending on the site conditions, adjustments to the criteria may be necessary.

12.4.1 Bridge Freeboard

A minimum of 3 feet of freeboard is required for bridges, measured from the 100-year stormwater surface elevation to the lowest elevation of the bridge low chord. The design engineer must consider the profile grade of the bridge and roadway, potential for debris accumulation, predicted sedimentation, maintenance requirements, and other site-specific conditions to determine whether additional freeboard should be provided for the crossing structures.

12.4.2 Hydraulic Analysis

Hydraulic analysis of the channel passing under the bridge must be of sufficient extent upstream and downstream to identify any conditions that might affect the hydraulic performance of the channel and structure. The channel cross section, including the low-flow channel, should be maintained through the bridge to the extent practical to minimize changes to the hydraulics of the channel. Generally, a rise of no more than 1 foot in the water surface of the channel through the bridge structure should occur. Appropriate sediment transport and scour analyses must also be completed to account for long-term changes in the channel bed or cross section.

Many acceptable manuals are available for use in bridge hydraulic studies and river stability analysis. Consult the Open Channels and Hydraulic Structures chapters of the MHFD Manual for basic criteria and information regarding other publications and resources. Additional references include the *CDOT Drainage Design Manual* (CDOT 2019) and FHWA publications including *Highways in the River Environment — Floodplains, Extreme Events, Risk, and Resilience, Hydraulic Engineering Circular No. 17* (FHWA 2016), *Evaluating Scour at Bridges* (FHWA 2012), and *Stream Stability at Highway Structures* (FHWA 2012).

12.4.3 Low Water Crossings and Pedestrian Bridges

Crossings for pedestrian use can vary greatly from small, low-use crossings to regional trail crossings. The crossings can have impacts on the floodplain, wetlands, and wildlife habitat. For these reasons, pedestrian and low-water crossing criteria are addressed on an individual basis, with criteria established following submittal of a request for the crossing. Consideration must be given to floodplain impacts, debris accumulation and passage, sediment transport, structural design, tethering of the structure or potential blockage of other conveyance structures, clearances to water levels and structural members, maintenance responsibility and cost, and construction and replacement cost of the structure.

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13.0 Detention (Storage)

13.1 Introduction

This chapter provides technical criteria for the planning and design of detention (storage) facilities in Commerce City. Design criteria in the Storage chapter of the MHFD Manual are hereby incorporated by reference. Except as modified herein, all detention facility designs must be in accordance with the MHFD Manual.

Detention of flood flows for all development and redevelopment projects is required in accordance with these criteria for the purposes of reducing urban drainage problems and the costs of drainage facilities. The main purpose of a detention facility is to store excess storm runoff associated with increased watershed imperviousness and release this excess runoff at a rate similar to the rate experienced from the watershed without development.

Full Spectrum Detention (FSD)

FSD is a storage-based approach to water quality, channel stability, flood control, and peak discharge attenuation. It is based on detaining the excess urban runoff volume (EURV) and releasing it over approximately 72 hours. The EURV is essentially the increase in runoff volume from undeveloped to urbanized conditions. The EURV includes the water quality capture volume (WQCV), which corresponds to the 80th percentile storm runoff event. FSD helps to offset some of the impacts that urbanization has on the downstream stream network.

Pumped detention basins are not allowed to serve as permanent water quantity or quality control measures for any development within Commerce City. This is because electromechanical systems can be unreliable, require frequent and costly maintenance, and may trigger requirements for water quality monitoring. However, temporary pumped detention basins are sometimes necessary during construction to hold water until a permanent, gravity outfall is available. Commerce City may approve such temporary pumped detention basin in a Development Agreement or other written agreement, as an interim solution, until a permanent outfall is built.

13.2 Full Spectrum Detention

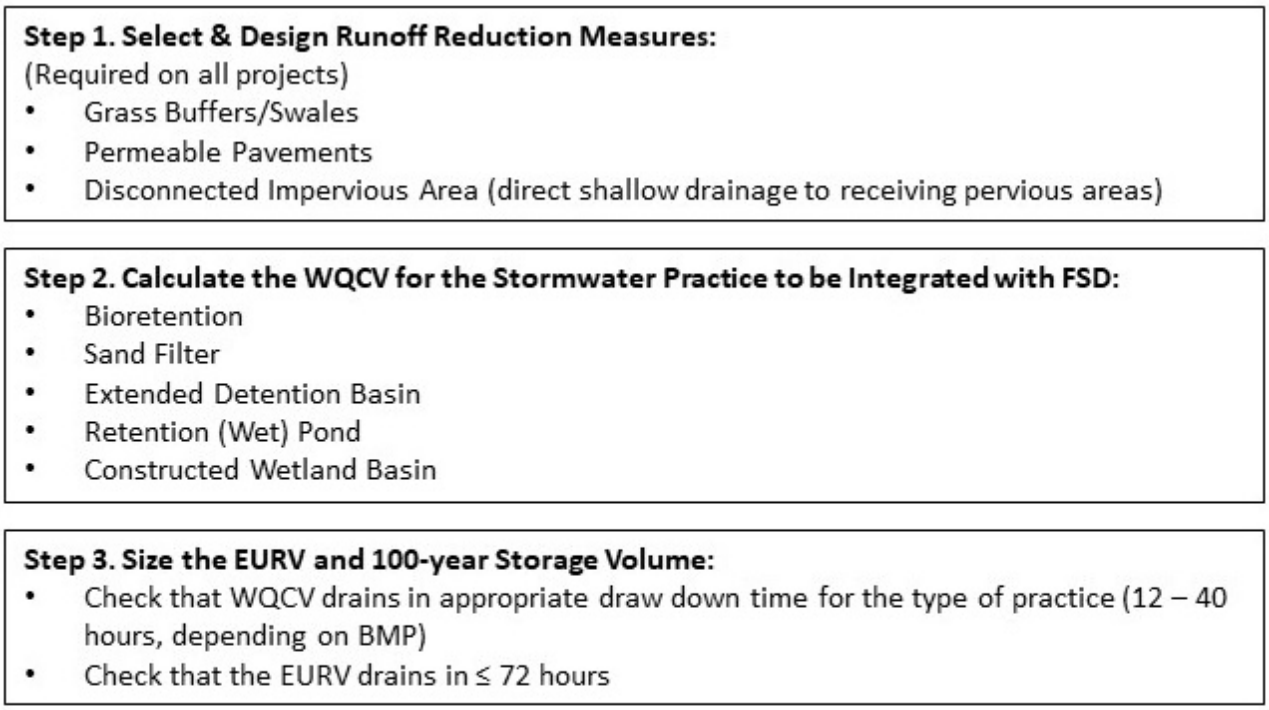
All detention facilities must be designed to provide Full Spectrum Detention (FSD) in accordance with the Storage chapter of the MHFD Manual. As such, three control volumes are integrated into the design: the water quality capture volume (WQCV), the excess urban runoff volume (EURV), and the 100-year event volume.

In Commerce City, the WQCV is considered to be a “nested” part of the EURV and 100-year event volume and does not need to be added to the EURV or overall 100-year storage volume. The 100-year event volume must be provided below the crest elevation of the emergency spillway, with peak discharges in excess of the storage capacity discharged via the spillway. The embankment height must be sufficient to pass emergency spillway flows with freeboard as described below.

13.3 Integration of Water Quality and Flood Control Detention

FSD integrates water quality and flood control detention through a process described in Figure 13-1. As described in the Storage chapter of the MHFD Manual, FSD may combine the three control volumes for WQCV, EURV, and 100-year detention into one facility or have separate facilities for any of the three volume components.

Figure 13-1. Steps in Integration of Full Spectrum Detention and Water Quality in Commerce City



Note: Stabilizing drainageways and providing source control measures are two additional steps in the MHFD's Four Step Process to protecting water quality. Drainageway stabilization is addressed in Chapter 10 Open Channels, and Source Controls are addressed in Chapter 14 Stormwater Quality.

Structural stormwater control measures (SCMs[1]) in Figure 13-1 that may be used to provide WQCV treatment include:

- Bioretention facilities
- Sand filters
- Extended detention basins
- Retention (wet) ponds
- Constructed wetland basins

Fact sheets for each of these types of SCMs are provided in Volume 3 of the MHFD Manual. Additional discussion of stormwater quality is provided in Chapter 14 of this Manual.

Water quality and flood control detention are required for all projects that disturb more than 5,000 square feet. For sites that fall below this threshold, runoff reduction measures must be implemented in accordance with the Runoff Reduction Fact Sheet in Volume 3 of the MHFD Manual to the maximum extent practicable. Single family, infill residential projects that disturb more than 5,000 square feet but create less than 5,000 square feet of new impervious area may be exempt from water quality and detention requirements.

For projects that create more than 5,000 square feet of disturbance but where impervious area can be managed through the use of grass buffers, swales, or other types of receiving pervious areas (RPAs), the applicant may request an exception to detention and/or water quality requirements from the Administrator. “Beat-the-peak” approaches based on timing of hydrographs from design storms to avoid detention will not be accepted by Commerce City as justification for a variance.

Commerce City requires integration of flood control detention and water quality treatment. The following references describe strategies to achieve this integration:

- Chapter 14 of this Manual
- Volume 2 of the MHFD Manual (Storage chapter)
- Volume 3 of the MHFD Manual

[1]Historically SCMs have been referred to as stormwater best management practices (BMPs). In this Manual, the acronym “SCM” is used since this is the current terminology to describe stormwater quality management practices in the City’s Phase II MS4 Permit.

13.4 Regional Detention Facilities

For Commerce City to consider regional detention facilities, the following criteria must be met:

1. A Commerce City-approved plan recommends the regional detention facility.

2. The regional detention facility is designed to accommodate the fully developed flows from the upstream watershed.

3. The regional detention facility is constructed or will be constructed in phases with the development; otherwise, temporary detention must be provided.

4. Legally-binding ownership and maintenance responsibilities by a public entity are clearly defined to ensure the proper function of the facility in perpetuity.

5. There is adequate conveyance of the fully developed flows from the site to the regional detention facility.

6. Design of the regional detention facility is completed in accordance with the MHFD Manual and the requirements in Colorado Revised Statues (CRS) §32-11-221(1) for drainage facilities. All regional facilities must be designed to meet the MHFD's Maintenance Eligibility requirements and must satisfy the design, construction, and vegetation criteria and requirements in the most current version of the MHFD Manual and Maintenance Eligibility Guidelines (downloadable from MHFD's website). The design must also consider the following criteria:

    a. For regional detention basins, designers should consider compatibility with surrounding land uses. For example, a detention basin in a residential or open space area could consider potential aesthetic and/or recreational uses, while a detention basin serving an industrial area would not likely include such considerations.

    b. The creation of jurisdictional dams is strongly discouraged. Depending on the size of the detention basin, it may not be feasible to avoid creation of a jurisdictional dam in some situations, and design should not be compromised simply to avoid creating a jurisdictional design. Nonetheless, when good design can avoid creating embankment heights that trigger state dam safety regulations, this is desirable.

    c. Regional detention basins must be located on existing publicly-owned lands whenever possible.

    d. If regional flood control detention facilities incorporate the regional WQCV for stormwater quality, developments upstream of the regional facility must provide onsite stormwater quality enhancement as identified in Chapter 14, Stormwater Quality.

13.5 Relationship to Adjacent Properties and Structures

Impacts to upstream and downstream properties relative to proposed detention facilities must be considered and minimized through appropriate facility design. Designs must take into account the location of structures near detention facilities and plan accordingly to reduce the likelihood of seepage into basements and structural damage by ensuring finished floor elevations or structures adjacent to ponds are 1.5 feet above the water surface elevation when the emergency spillway is conveying the maximum design flow or emergency flow. If a detention pond is planned adjacent to an irrigation canal, the developer/engineer is required to submit a seepage analysis to demonstrate that the development is not impacting seepage into or out of the canal or to inform the design of controls needed to mitigate potential issues.

13.6 Maintenance

All detention facilities must be designed with adequate maintenance access and in a manner that facilitates maintenance. All-weather, stable maintenance access must be provided for all detention facility elements requiring periodic maintenance. Grades should not exceed 10% for haul road surfaces and 20% for skid-loader and backhoe access surfaces. Stabilized access includes concrete, articulated concrete block, concrete grid pavement, or reinforced grass pavement. The recommended cross slope is 2%. Maintenance access also includes providing storage and staging areas for sediment and debris removal during maintenance activities. Commerce City requires all regional facilities be eligible for MHFD maintenance. Download the most current version of MHFD's Maintenance Eligibility Guidelines and contact MHFD early in the planning process to expedite their review.

An operations and maintenance plan is required for each detention facility. The minimum requirements for an operations and maintenance plan are listed in Chapter 3, Submittals.

13.7 Office of the State Engineer Coordination

13.7.1 Jurisdictional Dam Requirements

Any dam constructed for the purpose of storing water with a surface area, volume, or dam height as specified in CRS §37-87-105, as may be amended, requires the approval of the plans by the Office of the State Engineer (SEO). Those facilities subject to state statutes must be designed and constructed in accordance with the criteria of the state, in addition to the criteria in this Manual. To the extent that SEO criteria and requirements differ from the requirements in this Manual, the more restrictive requirements apply. Construction of jurisdictional dams for detention facilities is strongly discouraged due to the higher level of hazard posed by a jurisdictional dam. In some cases, depending on the size of the detention facility, creation of a jurisdictional dam may be unavoidable. In these cases, compliance with the Colorado Rules and Regulations for Dam Safety and Dam Construction (2 CCR 402-1) is required.

13.7.2 Drain Time Requirements

Detention facilities must undergo a notification process with the SEO in conformance with CRS §37-92-602(8), as may be amended, and present documentation that drain times conform with the requirements of this statute. Colorado water law requires that 97% of the 5-year or less event drain within 72 hours and that 99% of the 100-year event drain within 120 hours. Facilities that do not drain within these time periods require water rights, including plans for augmentation to replace evaporative losses and should be avoided in Commerce City. Augmentation plans are costly, both to acquire suitable water rights and to adjudicate and administer the plans.

13.8 Design Standards for Detention Facilities

The Storage chapter of the MHFD Manual provides figures illustrating typical combinations of water quality facilities such as extended dry detention basins (EDBs), sand filters, and other facilities with FSD. Individual components of an above-ground detention facility are discussed in the subsections below.

13.8.1 Grading Requirements

The bottom of the detention basin must slope toward the trickle channel. The minimum design slope of the pond bottom toward the trickle channel is 3%. Grading requirements for embankments must be in accordance with Table 13-1. All earthen embankments must be covered with a minimum of 6 inches of approved topsoil and revegetated with grass in accordance with the Revegetation chapter of the MHFD Manual. Groundwater inflow to detention facilities must be avoided. The bottom of the detention facility storage area must be at least 2 feet above the seasonal high groundwater elevation. In general, stormwater quality and detention facilities should be located outside of FEMA- and MHFD-designated 100-year floodplains so that they are not inundated by riverine flooding during a flood event. In some cases, it may not be feasible to locate these facilities outside of 100-year floodplain, and through a variance process, Commerce City may approve facilities within the 100-year floodplain so long as they are located outside of and above the 10-year floodplain level defined in the Flood Insurance Study or in a MHFD FHAD.

Table 13-1. Grading Criteria for Embankments

Embankment Height	Criteria (horizontal to vertical, H:V)
5 feet in height or less	No steeper than 4:1
Greater than 5 feet	Slopes must not be steeper than 3:1 (4:1 or milder preferred)

13.8.2 Retaining Walls

The use of retaining walls within detention basins is discouraged. However, if walls are unavoidable, low-height walls less than 30 inches high that are constructed of natural rock or landscape block are preferred. Plain-faced concrete walls are allowed in

industrial settings. Long-term maintenance access, safety, and aesthetics are important design considerations. Walls may not be continuous around a detention facility, but must allow access for maintenance equipment. Maintenance equipment must be able to safely reach the bottom of the facility, including the forebay and outlet structure, and have adequate space to operate and turn. If multiple retaining walls are used, a separation of at least 4 feet must be provided between tiered walls. Foundation walls of buildings may not be used as detention basin retaining walls. If accepted by Commerce City, a handrail may be required for any retaining walls exceeding a height of 30 inches (as measured from the ground line to the top of the wall). Detention basins with retaining walls should be located away from major pedestrian routes, and emergency egress routes from detention basins must be provided.

A registered professional engineer must perform a structural analysis of retaining walls that exceed 30 inches in height for the various loading conditions the wall(s) may encounter. The wall design and calculations must be stamped by a professional engineer and submitted to Commerce City for review. The structural design details and requirements for the retaining wall(s) must be included in the construction drawings.

13.8.3 Emergency Spillway and Freeboard

In designing the emergency spillway, the flow is the 100-year undetained flow from the contributing watershed for fully developed watershed conditions. This is in case the outlet is plugged and the pond is full during the peak rain event. For contributing drainage areas greater than or equal to 5 acres, the elevation of the top of the embankment must be a minimum of 1 foot above the water-surface elevation when the emergency spillway is conveying the maximum design or emergency flow. For contributing drainage areas of less than 5 acres, the elevation of the top of the embankment must be at least 6 inches above the water-surface elevation when the emergency spillway is conveying the maximum design or emergency flow when the outfall structure is in a 100% blocked condition.

Some situations may require more stringent emergency spillway criteria than presented in the Storage chapter of the MHFD Manual. When the storage facility falls under the jurisdiction of the SEO as a dam, the spillway's design storm is prescribed by the SEO (SEO 2020). Also, analysis of downstream hazards may indicate that the spillway design storm will need to be larger than the 100-year event.

13.8.4 Inlet and Forebay

Inlets and sediment forebays must be sized in accordance with the MHFD Manual. The intent of the forebay is to reduce loading of sediment and debris to the main body of a detention facility. Alternative designs may be considered with Commerce City's approval; however, a forebay or equivalent pre-treatment facility is required for all detention basins.

13.8.5 Trickle (Low Flow) Channel

All grassed-bottom detention basins must include a trickle channel designed according to the MHFD Manual. The MHFD Manual has options for concrete-bottom and soft-

bottom trickle channels. Commerce City's approval is required to use the soft-bottom trickle channel approach, and markers are required to provide a reference to the correct invert when removing accumulated sediment during maintenance.

13.8.6 Outlet Configuration

The MHFD Manual and website provide design guidance, design details, and examples for several detention facility outlet configurations. See the Outlet Structure Fact Sheet in Chapter 4 of Volume 3 of the MHFD Manual for criteria related to outlet structure design, including criteria for orifice plates, micropools, trash racks, and safety grates.

All detention facilities in Commerce City must incorporate the following:

1. All mounting hardware for the orifice plate and trash racks must be stainless steel.

2. Orifice plates must be stainless steel.

3. The WQCV and/or EURV orifice plate must have a neoprene gasket between the plate and outlet structure to prevent leakage.

4. The configuration of the orifice plate openings must be in accordance with the Outlet Structures Fact Sheet in Volume 3 of the MHFD Manual. In general, fewer large orifices are preferable to many small orifices to reduce the likelihood of plugging, while still meeting required drain times stipulated in the Chapter 4 of Volume 3 and in the Storage chapter of the MHFD Manual. The 100-year orifice control typically is located at the entrance to the outlet pipe. The MHFD-Detention workbook is a tool that can be used for sizing the openings of the orifice plate and other outlet hydraulic controls.

5. If orifices are 1 inches square or 1.25 inches in diameter or larger, fabricated bar grating with nominal openings of 1 by 4 inches is recommended in lieu of a well screen.

6. Outlets must incorporate micropools in conformance with the Outlet Structure Fact Sheet in Volume 3, and the well screen (or bar grating as appropriate) must extend to the bottom of the micropool.

7. All outlets must be designed to minimize unauthorized modifications that affect proper function. A sign with a minimum area of 1.5 square feet must be attached to the outlet or posted nearby (if unable to be posted to the outlet) with the following message:

WARNING
This is a Water Quality Treatment Facility.
Keep screen and grate clean.
Unauthorized modification of this outlet is a code violation.

13.8.7 Landscaping Requirements

Detention areas and embankments should be designed and constructed to blend with their surroundings, creating site amenities rather than eyesores. In open space or natural areas, techniques to be considered include creation of topographic changes that mimic natural conditions (including a variety of slope changes), using natural materials such as stone, blending with the textures and patterns of the surrounding landscape, and using materials that match the local environment. No plain-faced precast or cast-in-place concrete is allowed in residential and commercial areas; although these types of concrete may be allowed in industrial areas. Existing drainage patterns should be preserved whenever possible.

Vegetate all above-ground detention basins in accordance with the criteria in the Revegetation chapter of Volume 2 of the MHFD Manual. Landscaping improvements should enhance the aesthetics of the basin. When determining landscaping, long-term maintainability of the facility should be a high priority. The following is a list of guidelines (adapted from Douglas County Storm Drainage Criteria Manual, 2005) for basin landscaping:

1. In areas that will be viewed by the public, detention areas should be designed as natural-looking features that fit into the surrounding landscape and add to the overall character of an area. The shape of the detention basin should be as natural looking as practical, with terracing of the slopes and a bottom sloping toward the trickle channel. The tops and the toes of slopes should vary, and there should be an undulation in the shape and grading of the sides of the detention area. In industrial settings with restricted public access, a natural-looking appearance may be less important, and other factors such as ease of maintenance may be higher design priorities. In general, the landscaping and aesthetics of detention facilities should be designed for compatibility with adjacent and nearby land uses.

2. Slopes should be well vegetated to prevent erosion. The use of appropriate groundcovers and grasses at the tops of slopes help to soften the appearance of the detention area and can incorporate the detention area into the surrounding landscape. Appropriate plant material, such as wetland species or drought-tolerant species, should be planted in the detention area and on the slopes. Shrubs and trees should be offset from the top of the slope and placed so that they do not interfere with maintenance and so that tree roots will not cause structural issues. Native and perennial species should be used to the extent practical. Water rights or water service from the South Adams County Water and Sanitation District will be required for any irrigation of vegetation.

3. The use of wood mulch in and adjacent to detention facilities is discouraged because of its potential to be displaced and clog outlet structures. Mulch placed over filter fabric is particularly susceptible to displacement and should not be used on slopes greater than 6 (horizontal) to 1 (vertical) or below the 100-year water surface elevation. The use of rock mulch is discouraged because it is difficult to remove sediment from the rock.

Typically, runoff is conveyed to detention facilities in a storm drain pipe. When runoff is conveyed to the detention facility via a swale or when the storm drain pipe discharges higher up on the pond embankment, rundowns may be needed to minimize erosion at inflow points. When rock or concrete rundowns are used, they should be attractive and compatible with the overall design.

13.8.8 Multiple Use Considerations

Multiple uses of detention facilities are encouraged; however, it is critical to minimize conflicting uses. In some portions of Commerce City, including areas of residential development, multi-use facilities that provide benefits related to aesthetics, wildlife, and recreation are desirable. Park and detention facility conflicts may relate to the time required for the detention area to drain and dry out, safety in areas used for child play, mosquito-borne illness (e.g., West Nile virus) concerns, and protection and enhancement of wildlife. In other settings, such as industrial areas, multi-uses including aesthetics and recreation may not be compatible; although, other multi-uses such as combining stormwater management and parking through the use of permeable pavements may still be beneficial.

Considerations for multi-use facilities include:

- Compatibility of the facility design with constraints related to surrounding land uses, cultural and historical preservation requirements, or other protective constraints such as those related to aquatic or terrestrial wildlife habitat.
- Compatibility with recreational uses. The level of organized and informal activity in a park must be considered as well as passive versus active recreation objectives.
- Technical constraints and opportunities including soil characteristics, turf management, or terrain, and irrigation requirements.
- Potential for new natural areas and wildlife corridors.
- Size and configuration of the park. For example, a small neighborhood park under 5 acres would probably not be appropriate for a large detention facility.
- Maintenance and operations, funding resources, successful techniques for dealing with silt, debris, trash, etc. (These considerations should be reflected in the facility O&M plan.)
- The configuration and easements for underground utilities and their impact on the existing park land.
- Potential for total rehabilitation of existing sites to accommodate multi-purpose uses.
- Integration with other aspects of the open space system.

- Multi-use does not result in the any direct, active use of water impounded in or passing through the facility. For example, water may not be pumped out of the facility for irrigation purposes.

13.9 Design Standards for Parking Lot Detention

Parking lot detention is allowed in Commerce City only when designed and constructed using permeable pavements with void storage so that the runoff being detained is infiltrated to the subgrade and detained in void space, rather than on the surface of the parking lot.

13.9.1 Depth Limitation

Surface ponding in parking areas is allowed only to the extent that it is necessary to infiltrate runoff into a permeable pavement system for below-grade detention of the WQCV, EURV, and/or 100-year flood control volume. To limit the potential for surface ponding in permeable pavement parking lot detention areas, the ratio of impervious drainage area to the permeable pavement area must not exceed 3:1 (impervious drainage area to permeable pavement area). Higher ratios may be allowed on a case-by-case basis through a variance process if the applicant can demonstrate through hydrologic routing, accounting for reduced permeable pavement infiltration rates over time, that the temporary maximum ponding depth would not exceed 6 inches for the 100-year event.

13.9.2 Outlet

The outlet for parking lot detention is provided via the permeable pavement system and consists of infiltration into underlying soils and/or discharge via an underdrain system. When an underdrain is used for the outlet, the underdrain must be designed to drain the WQCV in 12 hours, the EURV in 72 hours, and the 100-year event at the specified release rate. For events that are larger than the 100-year design event, the designer must provide an overflow path that is clear of obstructions and will not impact structures.

13.9.3 Performance and Maintenance

The outlet for parking lot detention is provided via the permeable pavement system and consists of infiltration into underlying soils or discharge via an underdrain system. When an underdrain is used for the outlet, the underdrain must be designed to drain the WQCV in 12 hours, the EURV in 72 hours, and the 100-year event at the specified release rate. For events that are larger than the 100-year design event, the designer must provide an overflow path that is clear of obstructions and will not impact structures.

The City requires an inspection, operation, and maintenance plan for parking lot permeable pavement system detention sites. Additionally, the City will require a bond to ensure operation and maintenance at these sites.

13.9.4 Flood Hazard Warning

All parking lot detention areas must have multiple signs posted identifying the detention basin area. The signs must have a minimum area of 1.5 square feet and contain the following message:

WARNING
This area is a stormwater detention facility and is subject to periodic flooding.

Any suitable materials and geometry of the sign are permissible, subject to approval by the Department of Public Works.

13.10 Underground Water Quality and Detention Facilities

Underground water quality and detention facilities are prohibited in Commerce City for the following reasons:

- Underground water quality and detention facilities are not visible; therefore, these types of facilities tend to be “out-of-sight, out-of-mind.” As a result, these devices may not receive regular maintenance or performance evaluation.
- Maintenance access may be more complex, which can be a deterrent to maintenance. Additionally, confined space entry and special safety requirements may apply, depending on the installation.
- Anaerobic (absence of dissolved oxygen) conditions in bottom sediments are more likely to develop in underground devices. This condition can release pollutants that were bound to the sediment and cause bad odors.
- Vegetation within above-ground systems provides benefits beyond stormwater management, including the removal of air pollutants, mitigation of the urban heat island effect, and improvement of habitat.

Generally, there is sufficient land available in Commerce City to implement surface-based water quality and detention practices. Underground practices may be considered on a case-by-case basis if the applicant can demonstrate that reasonable surface-based alternatives are infeasible. The use of underground practices requires approval by the Commerce City Board of Adjustment. The following criteria must be met for consideration of underground practices by the Board of Adjustment:

1. The applicant has demonstrated that surface-based practices are infeasible. Analysis by the applicant must include analysis of alternative site layouts, consideration of reduced intensity of development, and sizing and conceptual design of surface-based practices to demonstrate that surface-based practices are not feasible given the ultimate use of the site and site characteristics.

2. The applicant has provided adequate assurances for long-term operation and maintenance of the facility, including arrangements for regular inspection and maintenance using appropriate equipment for the type of facility.

3. The design provides for access hatches or manholes for accessing the underground facility in areas where access will not be restricted by parked vehicles or other surface uses of the area.

4. The performance of the underground facility will be comparable to above-ground facilities in Volume 3 of the MHFD Manual.

The facility meets the criteria in the Volume 3 of the MHFD Manual for Underground SCMs.

13.11 Design Standards for Retention (Wet) Ponds

13.11.1 Allowable Use

See the Storage chapter and Retention Pond Fact Sheet of the MHFD Manual for allowable uses for retention ponds. Commerce City allows retention ponds to be used as a water quality practices, but water rights are required for such uses. Retention ponds used for water quality have a permanent pool that remains between storm events and a surcharge volume that fills and drains during periods of runoff. Retention of stormwater runoff is not an allowable flood control practice in Commerce City. Any existing retention ponds in Commerce City must be converted to detention (fill and drain) facilities as soon as an adequate outfall is available to receive flow releases from the facility, in order to avoid costly water rights acquisitions and adjudications. Colorado water law requires that 97% of the 5-year or less event must drain within 72 hours and that 99% of the 100-year event must drain within 120 hours. Existing retention facilities must be retrofit to meet these drain time criteria to comply with Colorado water law, or a water right must be obtained (CRS §37-92-602(8) Frequently Asked Questions, 2015). Development agreements may require a cash-in-lieu fees to be made to the City for future conversions of retentions pond to detention.

13.11.2 Design Standards for Retention Ponds

See the Retention Pond Fact Sheet in Volume 3 of the MHFD Manual for applicable design standards.

13.12 Summary of Key Design Considerations

All of the design criteria in this chapter must be followed. Several key considerations that the designer must take care to address include:

1. Grade earth slopes per Section 13.9.1.

2. Provide trickle channels in areas that are not permanently inundated.

3. Provide proper trash racks and micro-pools at all outlet structures.

4. Provide signage as needed.

5. Provide maintenance access to all structures (inlets, forebays, trickle channel, outlet and spillway).

6. Provide an emergency spillway and check the emergency overflow path.

7. Check finished floor elevations of any structures near the detention basin to verify adequate freeboard.

8. Design the invert of the inflow pipe to the detention basin to be higher than the WQCV level.

9. The bottom elevation the detention basin storage area must be at least 4 feet above the seasonal high groundwater. Groundwater inflow into detention systems is not allowed.

14.0 Stormwater Quality

14.1 Introduction

Commerce City requires permanent stormwater control measures (SCMs), formerly known as best management practices (BMPs), to be implemented on development and redevelopment projects to protect the City's streams, lakes, and wetlands. These requirements are also necessary for the City to comply with Colorado's water quality regulations and the City's Municipal Separate Storm Sewer System (MS4) discharge permit, as well as total maximum daily load (TMDL) requirements for the South Platte River. The City incorporates Volume 3 of the MHFD Manual as the basis for its design criteria.

Terminology

"Stormwater control measure" (SCM) refers to any best management practice (BMP) or other method used to prevent or reduce the discharge of pollutants to Waters of the State. SCMs include, but are not limited to, BMPs, green infrastructure (GI), green stormwater infrastructure (GSI), and low impact development (LID).

14.2 Applicability

All development and redevelopment projects in the City must implement stormwater control measures to enhance the water quality of storm runoff, as described in Table 14-1. If a proposed development or redevelopment is part of a larger common plan of development or sale, then requirements in Table 14-1 also apply. Table 14-1 contains two thresholds: a 1-acre threshold for the area of disturbance that arises from MS4 Permit requirements and a 5,000-square-foot threshold for area of disturbance, which is a Commerce City criterion. Proposed projects must comply with the more restrictive of these two thresholds when determining post-construction water quality requirements for a site. When post-construction SCMs are required, WQCV-based stormwater controls must be sized to provide the WQCV for the entire upgradient watershed, assuming future developed conditions.

Definition of Larger Common Plan of Development or Sale

The Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (Division) defines a "larger common plan of development or sale" as a part of the General Permit for Stormwater Discharges Associated with Construction Activities and in the General Phase II MS4 Permit. This term is defined as "a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules, but remain related. The Division has determined that "contiguous" means construction activities located in close proximity to each other (within ¼ mile). Construction activities are considered to be "related" if they share the same development plan, builder or contractor, equipment, storage areas, etc."

Table 14-1. Permanent Stormwater Quality Control Measure Requirements

Project Conditions	Runoff Reduction/ MDCIA[1]	Permanent Stormwater Quality Control Measure Requirements
Total Disturbance ≥ 1 acre	Required	Must satisfy one of the MS4 Permit design standards (for the area of disturbance).
Total Disturbance < 1 acre, and Total Disturbance Area ≥ 5,000 square feet	Required	Must satisfy one of the MS4 Permit treatment standards for new impervious area. For sites that have small amounts of additional impervious area, runoff reduction through the use of grass buffers, swales, and other types of RPAs may be used to satisfy this requirement.
Total Disturbance < 5,000 square feet	Required	Not required

[1]Minimized Directly Connected Impervious Area (MDCIA) must be implemented in a manner that does not cause adverse impacts to structures or adjacent property.

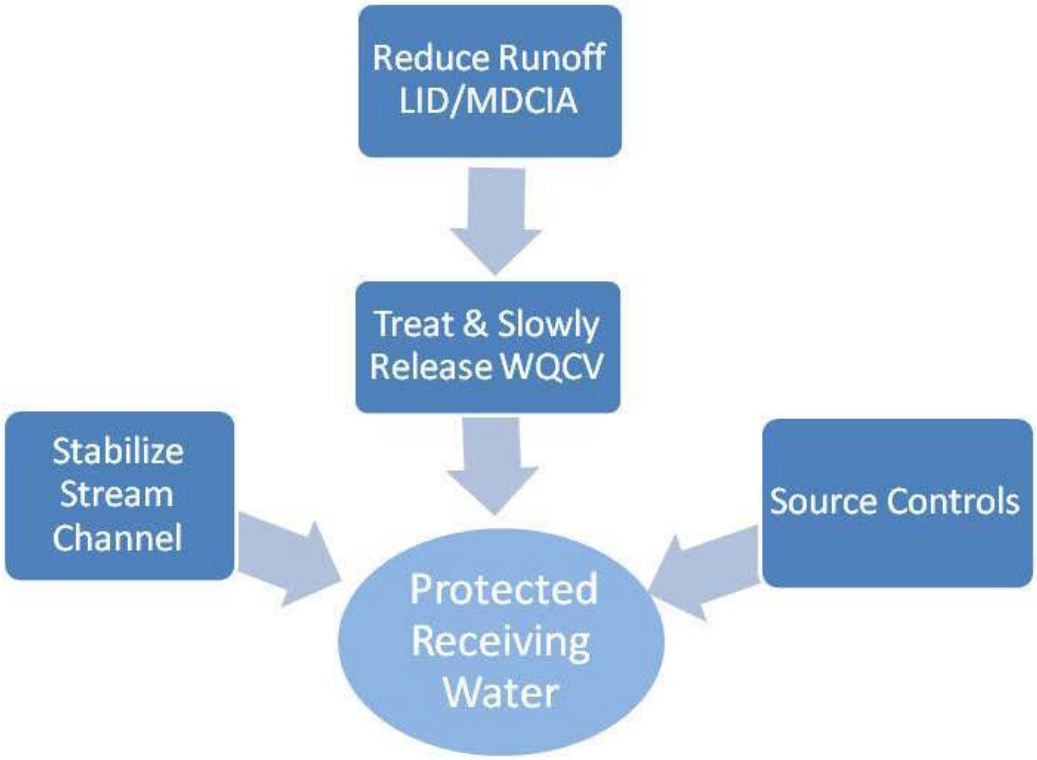
14.3 Design Approach

Stormwater quality management approaches in Commerce City are based on the "Four-Step Process" described in Volume 3 of the MHFD Manual (Figure 14-1). Additionally, Commerce City encourages integration of water quality and flood control in full spectrum detention facilities, as discussed in Chapter 13 Detention.

As described in Volume 3 of the MHFD Manual, effective stormwater management: 1) integrates pollutant source controls, 2) reduces runoff volumes through minimized directly connected impervious area (MDCIA), 3) treats the water quality capture volume (WQCV), and 4) incorporates stream stabilization. This chapter focuses on runoff reduction (MDCIA) and treatment of the WQCV.

Commerce City strongly encourages the use of practices that infiltrate runoff when soil properties, underlying groundwater conditions, and adjacent development characteristics are compatible with infiltration. In all cases, runoff reduction through minimization of directly connected impervious area is required to the extent practical. To successfully plan, design, and construct infiltration-based SCMs, data related to soil characteristics, infiltration rates, depth to groundwater, and other related information are needed. Commerce City incorporates the criteria in Chapter 4 of Volume 3 of the MHFD Manual for geotechnical investigations and data collection for infiltration-based stormwater control measures. See Section 14.3.3, below, for additional information.

Figure 14-1. MHFD's Four-Step Process for Stormwater Quality Management



To effectively implement MDCIA on a site, it must be considered early in the land development planning process. On some small sites, it may be possible to meet stormwater quality management requirements through the use of MDCIA alone. On larger sites, the size of WQCV facilities may be reduced through the implementation of MDCIA. The City adopts MHFD's method for quantifying volume reduction described in Volume 3 of the MHFD Manual. Volume 3 provides guidance on selecting permanent SCMs, considering factors such as watershed size, soils, depths to groundwater and bedrock, baseflows, watershed conditions, and targeted pollutants.

Conserving Existing Amenities

During the planning phase of development, identify portions of the site that provide stormwater quality benefits and should be protected or improved. Such areas may include mature trees, stream corridors, wetlands, and Hydrologic Soil Group (HSG) A and B soils with higher infiltration rates. Natural areas to be preserved must be protected from compaction during the construction phase. Consider temporary construction fence for this purpose. In areas where disturbance cannot practically be avoided, rototilling and soil amendments should be integrated to restore the infiltration capacity of areas that will be restored with vegetation.

14.3.1 Scale of Application

There are three general approaches to providing stormwater quality treatment in Commerce City: 1) onsite, 2) sub-regional, and 3) regional. Onsite facilities serve individual lots. Sub-regional facilities serve two or more lots with a total contributing drainage area of less than 130 acres. Regional facilities serve drainage areas between 130 acres up to 1 square mile and may be applicable for larger development and redevelopment projects. Regional facilities that provide stormwater quality treatment must comply with the regional detention facility requirements described in Chapter 13 Detention.

If regional or sub-regional facilities provide stormwater quality treatment, then the following conditions must be met:

1. **MDCIA Requirement:** Before discharging to a Water of the State, at least 20% of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10% of the upstream disconnected impervious area of the applicable development site. The receiving pervious area must consist of some combination of landscaped buffers, swales, or permeable pavement. Other sizing criteria may be more restrictive—this criterion applies only to disconnection of small onsite impervious areas via drainage as sheet flow to pervious, vegetated areas. (For example, more restrictive criteria apply to permeable pavement: a 10:1 run-on ratio would not be acceptable due to the need to reduce the potential for clogging and to avoid the need for frequent maintenance.)

2. **Stream Stabilization:** All surface conveyances leading to the regional or sub-regional water quality facility must be fully stabilized. Any new or existing outfalls leading to a regional drainageway must be designed, constructed, and stabilized in accordance with MHFD criteria and must be approved through the MHFD Maintenance Eligibility Program.

3. **Source Controls:** Where applicable in industrial areas or other developments that have the potential for significant source pollution, source control measures are required for the individual parcels upstream of the regional or sub-regional facility.

The contributing drainage area is an important consideration both at the site level and at the regional level. At the site level, there is a practical minimum size for certain SCMs, largely related to the ability to drain the WQCV over the required drain time. For example, it is technically possible to size the WQCV for an extended detention basin for a half-acre site; however, designing a functional outlet to release the WQCV over a 40-hour drain time is practically impossible due to the very small orifices that would be required. For this size watershed, a bioretention SCM would be more appropriate. At the other end of the spectrum, there must be a limit on the maximum drainage area for a regional facility to ensure adequate treatment of rainfall events that may produce runoff from only a portion of the area draining to the SCM. If the overall drainage area is too

large, events that produce runoff from only a portion of the contributing area will pass through the outlet (sized for the full drainage area) without adequate residence time in the SCM. As a practical limit, the maximum drainage area contributing to a regional water quality facility should be no larger than 1 square mile.

14.3.2 Design Criteria

Design of conveyance-based SCMs (e.g., grass buffers, swales) is based on flow rates for design events, as specified in Volume 3 of the MHFD Manual. Storage-based SCMs (e.g., extended detention basins, bioretention, sand filters) are based on storing and slowly releasing the WQCV unless Full Spectrum Detention designs are implemented to provide treatment of the Excess Urban Runoff Volume (EURV), as described in Chapter 13 Detention of this Manual and in Volume 2 of the MHFD Manual. The WQCV is calculated using methods in Volume 3. MHFD's UD-BMP spreadsheet can be used as a design aid for SCM selection and sizing, as well as to quantify runoff reduction achieved through disconnection of impervious area. The City requires treatment of the full WQCV unless the required treatment volume is reduced through the implementation of runoff reduction methods. Reductions in WQCV treatment volumes must be quantified using the Runoff Reduction Method described in Volume 3.

Volume 3 of the MHFD Manual provides design criteria for SCM types appropriate for use in Commerce City. The City adopts MHFD's design criteria for SCMs listed in Table 14-2. Additionally, the City may approve use of other SCM types with demonstrated performance on a case-by-case basis. The use of SCMs that are not included in the MHFD Manual requires a variance.

Table 14-2. Stormwater Control Measures (SCMs) Allowed in Commerce City

SCM Type[1,2]	Comment
Grass Buffers and Grass Swales	Can be used to disconnect impervious area and provide volume reduction. If used as a stand-alone practice, these must be designed to satisfy the volume reduction design standard in the MS4 Permit. They do not treat the WQCV and are usually part of a treatment train with other practices that provide the WQCV. They can also be used to provide pretreatment.
Bioretention	Can be designed for WQCV or EURV. Well suited for smaller sites, infill, and redevelopment. Not suited for sub-regional or regional applications unless a pretreatment forebay following EDB sizing criteria is provided and depth and area guidelines are strictly followed. Partial- and full-infiltration configurations are not suitable for sites where soil or groundwater contamination may exist or are known to exist.
Green Roof	Primarily provides volume reduction.
Extended Detention Basin	Not recommended for drainage areas with less than 2 impervious acres, and not allowed for sites with less than 1 impervious acre. Can be designed for WQCV or EURV.
Sand Filter	Most suitable for drainage areas less than 1 acre. Partial- and full-infiltration configurations are not suitable for sites where soil or groundwater contamination may exist or is known to exist. A variance is required to use underground sand filter design variations, such as below-ground vaults. Underground SCMs are considered practices of last resort, and surface-based SCMs are usually feasible in Commerce City. Additional requirements for underground facilities apply, as described in Chapter 13 Detention. Can be designed for WQCV or EURV.
Retention Pond (Wet Pond)	Water rights and space constraints may limit application in Commerce City. Only permitted for drainage areas greater than 1 acre. Can be designed for WQCV or EURV. Retention is allowed as a water quality practice when the WQCV is stored above the permanent pool. It is subject to satisfying requirements for water rights. Retention is prohibited as a flood control practice in Commerce City.
Constructed Wetland Pond	Water rights and space constraints may limit application in Commerce City. Only permitted for drainage areas greater than 1 acre. Can be designed for WQCV or EURV.
Permeable Pavement	Suitable for parking areas, alleys, and low-use areas without the potential for groundwater contamination. Enables use of SCM surface area for other purposes. Can be designed for WQCV and flood control.
Underground SCMs	The City prefers above-ground treatment approaches. Underground SCMs are considered practices of last resort and surface-based SCMs are usually feasible in Commerce City. May be used for pretreatment or approved on a case-by-case basis when no above-ground alternatives are feasible. A variance approved by the Board of Adjustment is required for underground SCMs.

[1]The City encourages the use of SCMs in sequence (treatment trains) and the use of forebays as part of SCM designs to facilitate maintenance.

[2]The City reserves the right to also accept SCMs detailed in future editions of the MHFD Manual when those SCMs meet the intent of these criteria.

14.3.3 Additional Requirements for Infiltration-Based Practices

Soils with good permeability, typically associated with HSGs A and B, provide opportunities for infiltration of runoff and are well-suited to infiltration-based SCMs such as bioretention, permeable pavement systems, sand filters, grass swales, and grass buffers, often without the need for an underdrain system. Even when soil permeability is low, these types of SCMs may be feasible if soils are amended to increase permeability or if an underdrain system is used. In some cases, however, soils restrict the use of infiltration-based SCMs. When soils with moderate to high swell potential are present, infiltration should be avoided to minimize damage to adjacent structures due to water-induced swelling. In some cases, these SCMs can still be used if an impermeable liner and underdrain system are included in the design.

Infiltration-based practices are generally not appropriate for sub-regional or regional water quality facilities, due to the large area and shallow depth requirements that should be strictly adhered to in all cases. If sub-regional or regional infiltration practices can meet these design requirements, additional pre-treatment must be provided to reduce sediment loading, which will otherwise reduce the effectiveness of the SCM over time due to clogging.

Infiltration-based practices are also not appropriate for sites where the potential for groundwater or soil contamination may exist or is known to exist, unless a no-infiltration configuration is utilized. It is incumbent upon the designer to ensure that the selected SCM does not result in additional contamination or the spread of existing contamination if a partial- or full-infiltration configuration is utilized. Potential resources for identifying known or suspected contamination are provided in Table 3-2 in the Submittals chapter. Figure 14-2 provides a flow chart for determining how to address areas of known contamination in post-construction stormwater control design.

In all cases, consultation with a geotechnical engineer is necessary for evaluating the suitability of soils for various infiltration-based SCMs and establishing minimum distances between infiltration SCMs and structures. See the Submittals chapter for geotechnical report requirements and Chapter 4 of Volume 3 for data collection and testing requirements for infiltration-based SCMs. Typical evaluations include evaluating Natural Resource Conservation Service (NRCS) mapping and soil properties, geotechnical investigations including boring on site and soil sampling and laboratory analysis to characterize soil properties, and in situ testing of infiltration rates of the soils beneath a proposed control measure using a double-ring infiltrometer (American Society for Testing and Materials [ASTM] D 3385) or other comparable methods identified in Volume 3 of the MHFD Manual.

14.3.4 Safety

SCMs must be designed and maintained in a manner that protects the safety of both the public and maintenance personnel. Design criteria in Volume 3 of the MHFD Manual incorporate safety considerations.

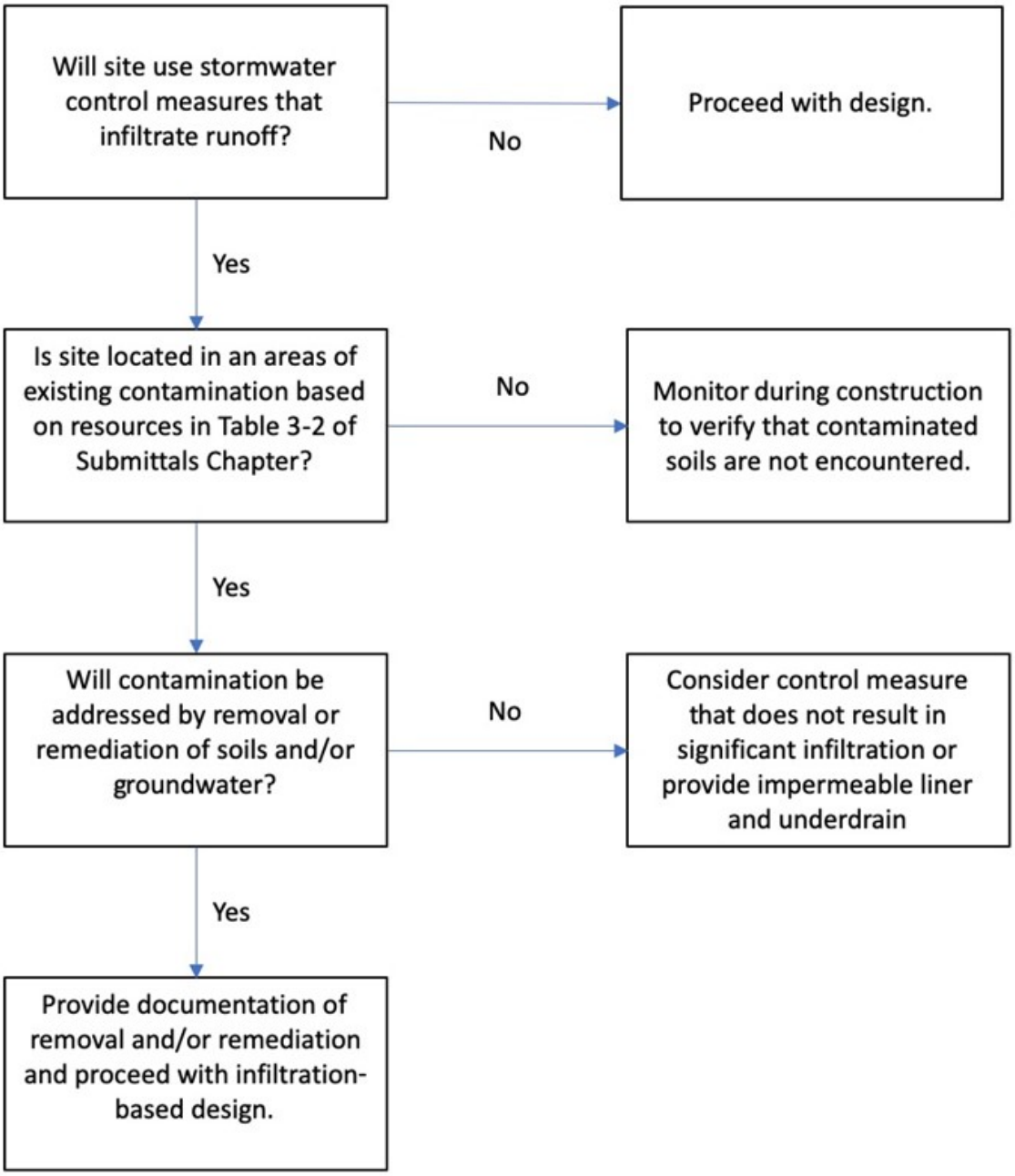
14.3.5 Aesthetics

SCMs should be designed to be aesthetically compatible with surrounding land use. Consultation with a landscape architect is recommended. Volume 3 of the MHFD Manual provides recommendations for aesthetically-pleasing designs that complement, rather than detract from, the development.

14.3.6 Maintenance

All SCMs must be designed with adequate maintenance and access provisions and in a manner that facilitates maintenance. The City requires that an Operation and Maintenance Plan be completed for all permanent SCMs. A copy of the Operation and Maintenance Plan is to be provided to both the City and to the owner of the facility or facilities to which it applies. Operations and Maintenance Plan contents are described in the Submittals chapter.

Figure 14-2. Flow Chart for Sites with Potential Contamination



14.4 Water Rights Reporting Requirements for Stormwater Facilities

CRS §37-92-602 (8) provides water rights-related legal protection for any regional or individual site stormwater detention and infiltration facility in Colorado, provided the facility meets these criteria:

1. It is owned or operated by a governmental entity or is subject to oversight by a governmental entity (e.g., required under an MS4 Permit).

2. It continuously releases or infiltrates at least 97% of all of the runoff from a rainfall event that is less than or equal to a 5-year storm within 72 hours after the end of the event.

3. It continuously releases or infiltrates as quickly as practicable, but in all cases releases or infiltrates at least 99% of the runoff within 120 hours after the end of events greater than a 5-year storm.

4. It operates passively and does not subject the stormwater runoff to any active treatment process (e.g., coagulation, flocculation, disinfection, etc.).

This statute specifies that runoff treated in stormwater detention and infiltration facilities must not be used for any other purpose by the owner/operator/overseer (or that entity's designees), must not be released for subsequent diversion or storage by the owner/operator/overseer (or that entity's designees) and must not be the basis for a water right or credit (MHFD 2016).

Under this statute, new stormwater detention and infiltration facilities must complete certain reporting requirements facilitated by an on-line mapping system for Stormwater Detention and Infiltration Facility Notification (https://maperture.digitaldataservices.com/gvh/?viewer=cswdif). This information must be filed prior to operation of the facility and include the following:

1. Location.

2. Approximate surface area at design volume.

3. Data that demonstrate that the facility has been designed to comply with the release rate requirements described above. (The MHFD-Detention workbook available at www.MHFD.org can be used to demonstrate compliance with release rates.)

Not all stormwater facilities are required to complete filing requirements, and certain types of facilities are not protected under this statute, as summarized in Table 14-3. Neither retention facilities nor constructed wetlands are protected under CRS §37-92-602 (8). These facilities expressly require a water right. Temporary construction and sedimentation basins should not be uploaded to the online portal unless they will be used as permanent detention basins. In such cases, the final detention configuration should be completed before uploading the record.

Table 14-3. Stormwater Facility Reporting Requirements under Senate Bill 15-212 (MHFD 2016)

SCM Type	Water Quality Only	Flood Control Included
Grass Buffers	Not Required	Not Required
Grass Swales	Not Required	Not Required
Bioretention (with or without underdrain)	Not Required	Required
Green Roof	Not Required	Not Required
Extended Detention Basin	Required	Required
Sand Filter	Not Required	Required
Permeable Pavement Systems	Not Required	Required
Media Filter Drain	Not Required	Not Required
Underground Detention Vaults	Required	Required
Constructed Wetland Pond	N/A, Subject to Water Rights	
Retention Pond	N/A, Subject to Water Rights	

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15.0 Construction Site Stormwater Management and Erosion Control

15.1 Introduction

Commerce City manages and implements a program to reduce or prevent the discharge of pollutants from construction activities to the storm drain system, receiving waters, and wetlands. Commerce City's program complies with its Colorado Discharge Permit System Municipal Separate Storm Sewer System (CDPS MS4) Permit requirements, the statewide CDPS General Permit for Stormwater Discharges Associated with Construction Activity (COR-400000), and the Commerce City Land Development Code.

This chapter identifies the triggers for a Grading Permit, requirements for Stormwater Management Plans (SWMPs), and the minimum technical criteria for stormwater management and SCMs at construction sites. This chapter hereby incorporates by reference Chapter 7 Construction BMPs in Volume 3 of the Urban Storm Drainage Criteria Manual (MHFD Manual) pertaining to the design and implementation of construction-related stormwater control measures (SCMs, also referred to as best management practices, BMPs).

Construction Site Stormwater Management Principles

1. Implement erosion and sediment control measures to reduce soil loss from all construction sites to the maximum extent practicable.
2. Manage construction sites to prevent discharges of chemicals, construction wastes, and other pollutants from construction sites.
3. Prevent damage to properties adjacent to construction sites arising from sediment, debris, chemical wastes, or other pollutants.
4. Protect Waters of the State and wetlands from damage caused by erosion, sedimentation, chemical wastes, or other pollutants arising from construction activity.

15.2 Commerce City's Construction Site Stormwater Management Policies

Commerce City's construction site stormwater management policies include:

1. All construction activities disturbing 5,000 square feet or more are required to address erosion, sediment control, and potential chemical water quality issues by submitting a SWMP to the Public Works Department (Public Works) for review and approval. The SWMP includes a SWMP narrative and a set of erosion and sediment control plans. For the SWMP narrative, Commerce City prefers to use the Adams County template. However, other formats will be acceptable if they contain the state minimum information requirements. The SWMP narrative shall be submitted as a standalone document. Minimum requirements for the erosion and sediment control plans can be found on the City's Engineering Construction

Standards and Specifications, Erosion & Sediment Control Details, and MHFD fact sheets.

2. All construction projects, whether required to obtain a Grading Permit or not, are subject to implementing SCMs at construction sites. Inspections and escalating enforcement actions by Public Works may occur from the beginning of site demolition or site grading until the site has achieved final stabilization and any required permits are closed. For sites not required to obtain a Grading Permit, Commerce City may initiate enforcement under its illicit discharge program, when necessary.

3. Structural and non-structural SCMs must be implemented in accordance with this chapter and the technical criteria in Volume 3 of the MHFD Manual. Additional or alternative practices may be approved by the Administrator on a case-by-case basis. Factors such as project type, size, duration, soil type, site slope, and proximity to Waters of the State[2] must be considered when selecting SCMs. Guidance for selection of SCMs for construction sites can be obtained from Volume 3 of the MHFD Manual.

15.3 Grading Permit

15.3.1 Permit Triggers

A construction site is defined by construction activities that involve ground surface disturbance and associated activities including, but not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. All of these areas must be included in calculating the construction site area, even if the area is located at a different part of the property from where the primary construction activity will take place or on a different piece of property.

Commerce City requires applicants to obtain a Grading Permit prior to earth disturbance activities at a project when *any* of the following criteria are present:

1. The construction site area disturbs 5,000 square feet or more; or

2. The construction site is under 5,000 square feet in area but meets one of the following criteria:

[2] Commerce City's Phase 2 MS4 Permit defines Waters of the State as "any and all surface and subsurface waters which are contained in or flow in or through this state, but not including waters in sewage systems, waters in treatment works of disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. This definition can include water courses that are usually dry. For the purposes of this permit, Waters of the State do not include subsurface waters."

3. The project site is part of a larger overall common plan of development or sale[3] and the overall development plan will ultimately disturb 5,000 square feet or more;

4. The project site has been identified by Commerce City as having a significant potential for erosion, based on site characteristics including but not limited to topography, soil type, or vegetation types (or lack thereof);

5. The project site is known to contain contaminated soils on site or has a pre-existing condition warranting special care during construction; or

6. The project site discharges runoff directly into Waters of the State.

In addition to a Grading Permit from Commerce City, construction projects that disturb 1 or more acre, or that are part of a 1-acre or larger development or sale plan, must also obtain coverage under the General Permit for Stormwater Discharges Associated with Construction Activities from the Colorado Department of Public Health and Environment (CDPHE Permit). In some cases, a Grading Permit may be required even when a CDPHE Permit is not. Projects requiring both a CDPHE Permit and a Commerce City Grading Permit must obtain and comply with permits from both entities. Where the Grading Permit and CDPHE Permit have conflicting requirements, the more stringent standard must be followed.

15.3.2 Grading Permit Application Submittal Requirements

A Grading Permit application, an erosion and sediment control plan, and the SWMP narrative must be submitted electronically to the City. Commerce City may request additional information or revisions before approval of the Grading Permit. Once the City Engineer has determined that the provided materials meet the requirements set forth in this chapter, the applicant must supply two full-size paper copies of the erosion and sediment control plans and SWMP narrative that contain the professional engineer's original wet stamp and signature. A copy of the approved grading permit and SWMP must be kept on the jobsite at all times during construction.

15.3.3 Guarantee

The applicant will be required to file a faithful performance bond, letter of credit, or other improvement security approved by the City in an amount of $3,000 per disturbed acre with a minimum of $5,000 prior to issuance of the Grading Permit to cover all costs of SCMs and revegetation for such period as specified by the City.

[3] "Common Plan of Development or Sale" means a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules but remain related. "Contiguous" means construction activities located in close proximity to each other (within ¼ mile). Construction activities are considered to be "related" if they share the same development plan, builder or contractor, equipment, storage areas, etc.

15.3.4 Permittee's Duty to Comply

The permittee is the primary responsible party for day-to-day compliance with the Grading Permit and SWMP. The Grading Permit is a legally-binding agreement between the permit holder and the City, subject to compliance inspection and enforcement. The permittee must comply with the terms and conditions of the Grading Permit, including implementation of the approved SWMP. Failure to comply with the Grading Permit will result in escalating enforcement actions by Commerce City such as verbal warnings, notices of violation, letters of non-compliance, stop work orders, and municipal summonses. These infractions are also subject to potential referral to the CDPHE Water Quality Control Division for further enforcement.

15.3.5 Transfer of Permit

When all or a portion of a permitted site is sold or otherwise transferred to a different entity or the responsibility of a permitted site is transferred to another entity, the new entity must apply to Public Works for a transfer of the existing Grading Permit or apply for a new permit. Construction activities cannot proceed until the appropriate entity has obtained coverage under a Grading Permit. The new permittee for a transferred permit must complete a Grading Permit Transfer Form, specifying the area to be transferred, the effective date of the transfer, and the contact names, addresses, phone numbers, and email addresses for the current and new permittee. The form must include the signature of the permittee transferring a portion or all of a permitted site and an affirmative, signed statement from the new permittee that the new permittee has reviewed, understands, and will comply with all Grading Permit and SWMP requirements.

15.3.6 Term, Expiration or Suspension of Permit

Commerce City's conditions related to permit term, expiration, or suspension include:

1. The Grading Permit remains active and in effect until the project is completed and final stabilization has been certified by the permittee and approved by Public Works. Final stabilization methods include installation of sod or other landscaping measures, hard surfacing (such as paving or concrete), or seeding that has achieved uniform coverage equal to 70% of the pre-construction vegetation density. Additionally, all temporary SCMs must be removed following final stabilization, an inactivation request must be submitted to Public Works, and the site must pass a final inspection from Public Works.

2. The Grading Permit expires if construction has not commenced within 180 days of the issuance of the Grading Permit. If construction stops for longer than 6 months, the contractor needs to schedule a new pre-construction meeting and renew the Grading Permit. The SWMP may be required to be resubmitted and re-approved by the City.

3. Failure to pay any required Grading Permit fees will result in the immediate suspension of the Grading Permit.

15.4 Requirements for Construction Site Stormwater Control Measures

The permittee must implement SCMs to minimize the discharge of pollutants from all potential pollutant sources during all phases of construction at the site. SCMs must be installed prior to commencement of activities that may contribute pollutants to stormwater discharges and must remain in place, as necessary, to control potential pollutants until final stabilization is achieved. SCMs must be selected, designed, installed, and maintained in accordance with good engineering, hydrologic, and pollution control practices. SCMs implemented at the site must be designed to prevent pollution or degradation of Waters of the State. The permittee must implement structural and/or nonstructural SCMs that effectively minimize erosion, sediment transport, and the release of other pollutants related to construction activity.

15.4.1 Control Measures for Erosion and Sediment Control

SCMs for erosion and sediment control may include, but are not limited to, wattles/sediment control logs, silt fences, earthen dikes, drainage swales, sediment traps, temporary slope drains, inlet protection, outlet protection, gabions, sediment basins, temporary revegetation, permanent revegetation, mulching, geotextiles, sod stabilization, surface roughening, maintaining existing vegetation, protection of trees, and preservation of mature vegetation. Design criteria for these and other practices are described in Volume 3 of the MHFD Manual. The following minimum erosion and sediment control measures are required:

1. **Vehicle Tracking Controls**: Vehicle tracking controls must be implemented to minimize vehicle tracking of sediment from disturbed areas to paved surfaces.

2. **Street Sweeping:** Paved surfaces adjacent to construction sites with the potential to convey flows offsite or into the MS4 must be swept by the close of each business day (and during the day as needed) when sediment and other materials are tracked or discharged onto them. Sweeping by hand or mechanical street sweepers is acceptable. Mechanical street sweepers using water while sweeping may be required to minimize dust. Washing off paved surfaces with water is prohibited.

3. **Sediment Controls:** Stormwater runoff from all disturbed areas and soil storage areas for which permanent or temporary stabilization is not implemented must flow to at least one SCM to minimize sediment in the discharge. This may be accomplished through filtering, settling, or straining. The SCM (or SCMs) must be selected, designed, installed, and adequately sized in accordance with good engineering, hydrologic, and pollution control practices. The SCM(s) must contain or filter flows to prevent the bypass of flows without treatment and must be appropriate for stormwater runoff from disturbed areas and for the expected flow rate, duration, and flow conditions (i.e., sheet or concentrated flow).

4. **Inlet Protection:** Inlet protection must be implemented on all existing or proposed storm drain inlets in the vicinity of the project site that may receive site

runoff. The type of inlet protection must be appropriate to the type of storm inlet (on grade, sump, grate, etc.) and the ground surface at the inlet (paved or pervious).

5. **Perimeter Controls:** Perimeter control measures must be installed along the edge of the construction site to filter and control surface runoff leaving the construction site. Design of perimeter controls must consider the area of disturbance draining to the SCM, the ground conditions (paved or pervious), and other site-specific factors. When in close proximity to receiving waters, redundant perimeter controls are advised due to the consequences of failure. Maintenance and repair of perimeter controls must occur as needed and as soon as practicable following discovery of the need for maintenance or repair.

6. **Sedimentation Basin Outlets:** Sedimentation basin outlets must withdraw water from or near the water surface of the basin, unless infeasible. If this is not feasible, it is incumbent on the applicant to demonstrate why drawing water from the surface or near the surface is infeasible.

7. **Vegetative Buffers:** Pre-existing vegetation or equivalent SCMs must be maintained for areas within 50 horizontal feet of receiving waters, unless infeasible.

8. **Soil Compaction:** Soil compaction must be minimized for areas where future permanent infiltration control measures are planned or where final stabilization will be achieved through vegetative cover. Where soil compaction cannot be avoided in these areas, decompaction may be required before final stabilization of the area.

9. **Topsoil Preservation:** Unless infeasible (or inappropriate due to contamination or poor quality), topsoil must be preserved for those areas of a site that will utilize vegetative final stabilization.[4] If topsoil cannot be stored and re-applied, import of topsoil or amendment of onsite soils may be required.

10. **Stockpiled Soil and Materials:** The following SCMs are required for stockpiles of soil, land clearing debris, or construction materials containing soil or sediment:

    a. Locate the stockpiles outside of any natural buffers and away from waterways and onsite drainage pathways.

    b. Protect stockpiles located within 100 feet of perimeter controls, inlets, or stormwater conveyances with additional controls. Examples of acceptable controls include compacted dirt berms, silt fence, and/or sediment control logs.

[4] See *Topsoil Management Guidance* accessible at mhfd.org for additional information on topsoil management.

c. Where practicable, provide cover or appropriate temporary stabilization to avoid direct contact of precipitation with the stockpile and to minimize potential for sediment discharge.

11. **Soil Exposure:** Minimize the amount of soil exposed and duration of exposure during construction activities, including the disturbance of steep slopes, through phasing and temporary stabilization practices.

15.4.2 Control Measures for Other Common Pollutants

In addition to erosion and sediment control, Commerce City requires control measures for other common pollutants including:

1. **Petroleum Products and Other Chemicals:** Bulk storage of 55 gallons or more of petroleum products and other liquid chemicals must have secondary containment or equivalent protection measures to contain spills and prevent spilled material from entering Waters of the State.

2. **Concrete Washout:** Discharges of concrete washout waste to the ground are allowed, provided that such discharges do not leave the site as surface runoff. A containment area must be designated for the washout of cement truck delivery chutes and masonry operations contained on site. This containment area must be designed so that all wash water is totally contained. Water discharged into the containment area is allowed to infiltrate, evaporate, or may be removed from the site to an appropriate facility for disposal. The permittee must ensure the washing activities do not contribute pollutants to stormwater runoff or receiving waters. Discharges that may reach groundwater must flow through soil that has buffering capacity prior to reaching groundwater. The concrete washout location must not be located in an area where shallow groundwater may be present and would result in buffering capacity not being adequate, such as near natural drainages, springs, or wetlands. Concrete washouts should be at least 5 feet above the seasonal high groundwater table on the site. Dried concrete waste must be removed and properly disposed.

15.4.3 Stabilization Requirements

The following temporary and permanent site stabilization requirements must be implemented for each site:

1. Temporary stabilization must be implemented for earth disturbing activities on any portion of the site where ground disturbing construction activity has permanently ceased, or temporarily ceased for more than 14 calendar days. Temporary stabilization methods may include, but are not limited to, surface roughening, tarps, soil tackifier, and hydroseeding. The permittee may exceed the 14-day schedule when either the function of the specific area of the site requires it to remain disturbed, or, physical characteristics of the terrain and climate prevent stabilization. The SWMP must document the constraints necessitating the alternative schedule, provide the alternate stabilization

schedule, and identify all locations where the alternative schedule is applicable on the site map.

2. Final stabilization must be implemented for all construction sites. Final stabilization is reached when all ground surface disturbing activities at the construction site are complete and either a uniform vegetative cover with an individual plant density of at least 70% of pre-disturbance levels is established, or equivalent permanent alternative stabilization methods are implemented. Vegetative cover provided by noxious weeds or other invasive plants does not satisfy final stabilization requirements, and if this occurs, weed management will be required until the type of vegetation called for in the SWMP is established at the required density. Commerce City may approve alternative final stabilization criteria for specific operations or projects.

3. Final stabilization must be designed and installed as a permanent condition. Final stabilization plans for obtaining vegetative cover or alternative stabilization methods must include the following at a minimum:

    a. Seed mix selection and application methods.

    b. Soil preparation and amendments.

    c. Soil stabilization methods (e.g., crimped straw, hydromulch, or rolled erosion control products).

    d. Appropriate sediment control measures as needed until final stabilization is achieved.

    e. Permanent pavement, hardscape, xeriscape, and stabilized driving surfaces.

    f. Other alternative stabilization practices as applicable.

4. All temporary SCMs must be removed from the construction site once final stabilization is achieved, unless otherwise approved by Commerce City.

15.4.4 Additional Site-specific Requirements

In addition to the minimum requirements identified above, Commerce City requires additional SCMs on sites meeting the following conditions:

1. **Potential for High Flow Conditions:** Sites that are located directly adjacent to Waters of the State or that have areas tributary to the site that may generate large volumes of runoff must be protected by SCMs that provide flow control and diversion. Acceptable SCMs include slope drains, temporary swales and channels, diversion dikes, coffer dams, sand bag barriers, and other comparable practices.

2. **Steep Slopes:** Sites that have slopes 3:1 (horizontal: vertical) or steeper must implement SCMs to prevent or minimize slope erosion. The use of one or more of the following SCMs or approved SCMs providing equivalent protection is required:

    a. Geotextiles and Matting: Fabric, jute matting, and other materials that provide a surface cover on slopes to minimize erosion from raindrop impact or sheet flow runoff. Geotextiles and matting must be properly installed and secured to the surface.

    b. Slope Roughening/Terracing: Slope roughening is similar to the agricultural erosion measure known as contour plowing where furrows are plowed along elevation contours. Care must be taken to prevent pedestrian or vehicular traffic across areas where this is used because even minimal traffic can destroy the SCM's effectiveness.

3. **On-site Drainageways:** Sites that are adjacent to drainageways, have a drainageway within the site, or are constructing a drainageway within the site must provide SCMs in accordance with the MHFD Manual for construction in waterways. Examples of SCMs include, but are not limited to:

    a. Instream Velocity Reduction/Sediment Entrapment SCMs: Check dams, sediment traps, or similar measures to reduce the velocity of flow and entrap sediment are required. Waters of the State must not be used as sediment collection facilities. SCMs must be used to control sediment from entering these areas.

    b. Temporary Stream Crossings: A temporary stream crossing is required where repeated crossing of a drainageway by construction equipment may be necessary. The MHFD Manual criteria for Temporary Stream Crossings must be followed. Temporary stream crossings must be limited to one per 2,000 linear feet of drainageway unless approved by the City.

    c. Minimizing Disturbance to Existing Drainageways: It is critical that construction disturbance within drainageways be minimized. Where construction within a drainageway is unavoidable, the applicant must delineate construction limits that restrict activities to the smallest area possible. Construction fence or other means of delineation must be indicated on the erosion and sediment control plans within the drainageway corridor to indicate the allowable limits of disturbance. Perimeter controls must be provided between any areas of disturbance and waterways.

    d. Stabilizing Disturbances to Existing Drainageways: Stabilization must be implemented as quickly as possible upon completion of earth-disturbing activities within the drainageway. All disturbed areas within drainageways must be revegetated with topsoil (at least 6 inches in depth), seeded and

mulched, and unless otherwise approved, protected with a rolled erosion control product (RECP) sized in accordance with criteria from the MHFD Manual. Additional plantings, such as willows or other riparian species should be considered to enhance channel stability, habitat, and aesthetics. Erosion control blankets are required for the disturbed channel bed and banks, and all slopes steeper than 4:1.

e. Permitting and Water Control Plan: Work adjacent to or within drainageways is often subject to floodplain permitting by Commerce City, short-term groundwater dewatering permitting by the CDPHE Water Quality Control Division, and/or Clean Water Act §404 permitting by the U.S. Army Corps of Engineers. In cases where a development construction project includes stream or conveyance channel crossings or improvements within active flowing water, the SWMP must include the preparation of a Water Control Plan to identify the phasing of work necessary to meet controls required to meet federal, state, and/or local regulations related to work in Waters of the State. The applicant must consult with Commerce City on requirements for a Water Control Plan based on site-specific conditions and anticipated hydrology.

4. **Contaminated Site:** The SWMP for sites where there is known contamination by solid waste or toxic, radioactive, or other hazardous material must implement any additional requirements identified in these plans:

    a. Construction Management Plan.

    b. Stockpile Protection and Site Stabilization.

    c. Groundwater Dewatering, Management, and/or Remediation Plan(s).

    d. Remediation Plan.

    e. Contaminated Materials Management Plan.

    f. Asbestos-Containing Materials/Asbestos-Contaminated Soils Management Plan approved by the CDPHE, in accordance with the Colorado solid waste regulations.

5. **Sensitive Areas:** In addition to protecting drainageways, other sensitive areas may exist on construction sites. These could include:

    a. Protected habitat for threatened or endangered species.

    b. Wetlands.

    c. Nesting bird habitat.

    d. Riparian corridors.

e. Mature cottonwood stands.

f. Steep slopes.

g. Potential stormwater infiltration areas.

h. Historic, cultural, or archeological resources.

i. Areas of unique or pristine vegetation, habitat, or landform.

A resource inventory should be conducted for the site, including any sensitive areas such as those listed above. The location, aerial extent, and type of resource, including stream floodplains, must be shown on the erosion and sediment control plans. Disturbance to sensitive resource areas must be avoided or minimized. Destroying or disturbing wetlands, nesting bird habitat, and protected habitat for threatened or endangered species is restricted; these restrictions must be addressed through the appropriate federal or state agency permitting processes.

An applicant can achieve many of the objectives of preserving critical resource areas by leaving open space areas undisturbed and excluded from clearing and grading operations. The technique of mapping out areas of the site that can be left undisturbed, termed “fingerprinting,” can reduce grading costs and contribute to the ultimate value of the development. The erosion and sediment control plans and SWMP must clearly show limits of construction and must call out construction fence or other means to protect resources that are to be preserved.

15.5 Maintenance and Corrective Actions

The permittee must ensure that all SCMs remain in effective operating condition and are protected from activities that would reduce their effectiveness. SCMs must be maintained in accordance with good engineering, hydrologic, and pollution control practices. Observations leading to the required maintenance of control measures can be made during a site inspection or during general observations of site conditions. The necessary repairs or modifications to a SCM requiring routine maintenance must be conducted to maintain the SCM in an effective operating condition.

The permittee must assess the adequacy of SCMs at the site and the need for changes to those SCMs necessary to ensure continued, effective performance. When an inadequate SCM is identified and a new or replacement SCMs become necessary, then corrective actions must be implemented and documented in the SWMP.

15.6 Stormwater Management Plan (SWMP) Requirements

The Grading Permit requires submittal of a SWMP to Public Works for approval prior to beginning construction activities. A SWMP must be developed for each construction site in accordance with good engineering, hydrologic, and pollution control practices. Public Works will evaluate whether the SWMP meets the requirements of this chapter, as well

as CDPHE requirements, when the area of disturbance is 1 acre or more. Once the submitted SWMP is approved by Public Works, it becomes an enforceable part of the Grading Permit. The SWMP must be implemented as written and updated, from commencement of construction activity until final stabilization is complete.

A copy of the SWMP must be kept onsite, either physically or electronically, when construction activities are occurring at the site unless the permittee specifies another location and obtains prior approval from Commerce City.

15.6.1 SWMP Narrative Content and Site Map(s)

For the SWMP narrative, Commerce City prefers to use the Adams County template. However, other formats will be acceptable if they contain the state minimum information requirements. Minimum requirements for the erosion and sediment control plans can be found on the City's Engineering Construction Standards and Specifications, Erosion and Sediment Control Details, and MHFD fact sheets. The SWMP, at a minimum, must include the following elements:

1. **Qualified Stormwater Manager:** The SWMP must list individual(s) by title and name who are designated as the site's qualified stormwater manager(s) responsible for implementing the SWMP in its entirety. This role may be filled by more than one individual.

2. **Spill Prevention and Response Plan:** The SWMP must have a spill prevention and response plan. The plan may incorporate by reference any part of a Spill Prevention Control and Countermeasure (SPCC) plan under §311 of the Clean Water Act or a Spill Prevention Plan required by a separate CDPS permit. The relevant sections of any referenced plans must be included as part of the SWMP.

3. **Materials Handling:** The SWMP must describe and locate all SCMs implemented on the site to minimize impacts from handling significant materials that could contribute pollutants to runoff. These handling procedures can include SCMs for pollutants and activities such as exposed storage of building materials, paints and solvents, landscape materials, fertilizers or chemicals, sanitary waste material, trash, and equipment maintenance or fueling procedures.

4. **Potential Sources of Pollution:** The SWMP must list all potential sources of pollution that may reasonably be expected to affect the quality of stormwater discharges associated with construction activity from the site. This must include, but is not limited to, the following pollutant sources:

    a. Disturbed and stored soils.

    b. Vehicle tracking of sediments.

    c. Management of contaminated soils.

    d. Loading and unloading operations.

e. Outdoor storage activities (erodible building materials, fertilizers, chemicals, etc.).

f. Bulk storage of materials.

g. Vehicle and equipment maintenance and fueling.

h. Significant dust or particulate generating processes (e.g., saw cutting material, including dust).

i. Routine maintenance activities involving fertilizers, pesticides, herbicides, detergents, fuels, solvents, oils, etc.

j. On-site waste management practices (waste piles, liquid wastes, dumpsters).

k. Concrete truck/equipment washing, including washing of the concrete truck chute and associated fixtures and equipment.

l. Dedicated asphalt, concrete batch plants, and masonry mixing stations.

m. Non-industrial waste sources such as worker trash and portable toilets.

n. Other areas or operations where spills can occur.

o. Other non-stormwater discharges including construction dewatering discharges not covered under the CDPS General Permit for Construction Dewatering Discharges and wash water that may contribute pollutants to the MS4.

5. **Implementation of SCMs:** The SWMP must include design specifications that contain information on the implementation of SCMs in accordance with good engineering hydrologic and pollution control practices. This information may include applicable drawings, dimensions, installation information, materials, implementation processes, SCM-specific inspection expectations, and maintenance requirements. A narrative description of non-structural SCMs must also be included in the SWMP.

   The SWMP must include a documented use agreement between the permittee and the owner or operator of any SCMs located outside of the permitted area that are utilized by the permittee's construction site for compliance with this permit but not under the direct control of the permittee. The permittee is responsible for ensuring that all control measures located outside of their permitted area that are being utilized by the permittee's construction site are properly maintained and in compliance with all terms and conditions of the permit. The SWMP must include all information required for and relevant to any SCMs located outside the permitted area, including location, installation specifications, design specifications, and maintenance requirements.

6. **Site Description:** The SWMP must include a site description which includes, at a minimum, the following:

    a. Nature of the construction activity at the site.

    b. Proposed schedule for the sequence for major construction activities and the planned implementation of control measures for each phase (e.g., clearing, grading, utilities, vertical, etc.).

    c. Estimates of the total acreage of the site, and the acreage expected to be disturbed by clearing, excavation, grading, or any other construction activities.

    d. Summary of any existing data used in the development of the construction site plans or SWMP that describe the soil or existing potential for soil erosion.

    e. Description of the percent of existing vegetative ground cover relative to the entire site and the method for determining the percentage.

    f. Description of any allowable non-stormwater discharges at the site, including those being discharged under CDPHE's low risk discharge guidance policy.

    g. Description of areas receiving discharge from the site. Including a description of the immediate source receiving the discharge. If the stormwater discharge is to an MS4, the name of the entity owning that system, the location of the storm sewer discharge, and the ultimate receiving water(s).

    h. Description of all stream crossings located within the construction site boundary.

7. **Erosion and Sediment Control Drawings:** Commerce City requires that the SWMP include one or more site maps (erosion and sediment control drawings) at one of the following scales: 1" = 20', 1" = 30', 1" = 40', 1" = 50' or 1" = 100'. The scale selected must be suitable for practical use and readability. Contour intervals of 1 to 2 feet are required for these plans depending on the topographic relief of the site. The site map(s) must include the following elements:

    a. Title block, including name and address of proposed project, submittal date, title of drawing, and sheet number.

    b. Existing and proposed right-of-way and easements.

    c. Drawing information, including north arrow indicator, section, township, range, drawing scale, and symbol legend.

d. Construction site boundaries – all areas outside of the limits of construction must be lightly shaded to clearly show area not to be disturbed.

e. Flow arrows that depict stormwater flow directions onsite and runoff direction.

f. Existing and proposed topography, including cross-sections showing both existing and proposed grades and clearly marked existing and proposed grading contours (legible with elevations) extending at least 100 feet beyond the project boundaries.

g. All areas of ground disturbance including areas of borrow and fill and including phased limits of grading and clearing.

h. Locations of areas used for storage of soil.

i. Locations of all waste accumulation areas, including areas for liquid, concrete, masonry, and asphalt.

j. Locations of dedicated asphalt, concrete batch plants and masonry mixing stations, including containment areas for chute washout.

k. Locations of fuel, lubricant, and chemical storage areas and equipment maintenance and fueling locations.

l. Locations of sanitary facilities.

m. Locations of contaminated areas.

n. Locations of construction entrances.

o. Locations of and phasing for all structural SCMs.

p. Locations of and phasing for all non-structural SCMs.

q. Locations of springs, streams, wetlands, and other State Waters, areas that require pre-existing vegetation be maintained within 50 feet of a receiving water, and other natural features within 100 feet of the site boundary must be shown.

r. Locations of all stream crossings located within the construction site boundary.

s. Location of existing and proposed structures on the site, with structures subject to demolition clearly identified.

t. Locations of all storm runoff discharge points at site boundaries or internal to site if a drainageway is located onsite.

u. Name of receiving water(s): if discharge is to an existing storm sewer system, this should be stated, along with the name of the ultimate receiving water(s).

v. All applicable Commerce City standard notes.

w. Installation details for all proposed construction SCMs.

x. Details for all proposed structural permanent stormwater quality control measures.

y. Professional engineer's stamp and signature.

8. **Final Stabilization and Long-term Stormwater Management:** The SWMP must describe the practices used to achieve final stabilization of all disturbed areas at the site and identify permanent stormwater controls (e.g., detention ponds, bioretention) that will be in place after construction operations are completed. Some post-construction water quality structural stormwater control measures, such as extended detention basins, may be used temporarily as construction SCMs when site conditions allow. A description of the procedures to be employed to convert an active construction SCM to a permanent water quality feature may also be required to ensure final design standards are met without any reduction in capacity or function resulting from the use of the SCM during construction. Infiltration-based post-construction control measures such as bioretention facilities are not suitable for use during the construction phase.

9. **Inspection Reports:** After construction begins, the onsite copy of the SWMP must include documented inspections. See Section 15.7.3.

10. **Permittee Certification:** Each SWMP will include a signed certification by each co-permittee as follows:

> "I am duly authorized to submit, on my own behalf as (insert name of co-permittee applicant) or as a duly authorized representative of (insert name of co-permittee applicant), this Stormwater Management Plan in connection with an application to the City of Commerce City Public Works Department for a Grading Permit for the Project named above as described herein. I understand that erosion control, sediment control and water quality enhancing measures beyond those described herein may be required in accordance with a finally approved Stormwater Management Plan that is adopted and incorporated into a Grading Permit for the Project named above as described herein. Further, I understand that, once approved by Commerce City's issuance of the requested Permit, my obligations to implement the approved Plan must continue until such time as the Plan is properly completed, modified or terminated."

15.6.2 Supporting Technical Information and Documents

When applicable to the project, copies of additional plans and/or technical materials must be available for review upon request at the time of Grading Permit application. Issuance of the Grading Permit may be delayed until Public Works has received and reviewed applicable requested plans and materials, which may include:

1. Drainage report
2. Soils/geotechnical studies
3. Environmental audits (for sites under environmental remediation)
4. Copies of applications for related Colorado Discharge Permit System (CDPS) Permits, including:
    a. Stormwater Discharges Associated with Construction Activity
    b. Construction Dewatering Discharges
    c. Remediation Activities Discharging to Surface Water or Groundwater
5. Air Pollution Emission Notification – Fugitive Dust or other Air Pollution Permits
6. Copies of correspondence with other governmental jurisdictions related to:
    a. Wetlands
    b. Floodplains
    c. Waterways
    d. Discharges to or from other jurisdictions
    e. Total Maximum Daily Load (TMDL) requirements specified by CDPHE
7. Copies of temporary access agreements with adjacent landowners, including:
    a. Use of land for material storage or lay down
    b. Stabilization and restoration of disturbed areas
    c. Acceptance of flow to or from adjacent sites

15.7 Responsibilities of Permittee

15.7.1 Maintain SWMP and Grading Permit Onsite

Permittees must keep an electronic or hard copy of the Grading Permit and SWMP on site at all times. The SWMP kept on the site should be the originally approved document and attachments or appendices with all revisions noted to match existing site conditions.

15.7.2 SWMP Modifications and Permit Amendments

Permittees are required to amend, adapt, and adjust their SWMP to accurately reflect phased construction changes and current conditions at site. Permittees must keep a record of SWMP changes made that includes the date and identification of the changes. The SWMP must be modified when any of the following occur:

1. A change in design, construction, operation, or maintenance of the site requiring implementation of new or revised control measures.

2. The SWMP proves ineffective in controlling pollutants in stormwater runoff in compliance with the permit conditions.

3. SCMs identified in the SWMP are no longer necessary and are removed.

4. Corrective actions are taken onsite that result in a change to the SWMP.

A notation must be included in the SWMP that identifies the date of the site change, the SCM(s) removed or modified, the location(s) of those SCM(s), and any changes to the SCM(s). The permittee must ensure the site changes are reflected in the SWMP.

SWMP modifications are categorized as major or minor modifications that have differing approval requirements:

1. **Major Modifications**: Major modifications are changes to the SWMP that remove or add area to the project, modify the final hydrology or drainage of the final design, replace the approved SWMP, or otherwise expand or contract the scope of the approved project. Major modifications to the SWMP proposed by the contractor/owner must be in writing (including revised plans) and submitted to Public Works at least 10 business days prior to the desired date of implementation. Public Works will re-approve the SWMP if the proposed modifications are acceptable.

2. **Minor Modifications:** Minor modifications are changes to the SWMP that do not increase the scope or change hydrology of the project but modify or improve specific SCMs in use at the site, indicate progression in phasing of the project, or specify relocation of previously approved SCMs within the project. Minor modifications can be made in the field by the permittee if the permittee can demonstrate that the modified SCMs are equivalent to, or better than, the originally approved SCMs. Minor modifications must be thoroughly documented in the permittee's SWMP narrative, drawings, and specifications. If Public Works

deems the minor field modification inadequate, the permittee must make specific modifications as directed. Minor modifications are expected and encouraged as part of standard practice for ongoing compliance with requirements for maintenance and operation of SCMs and SWMP implementation corresponding with evolving site conditions.

3. **Grading Permit Amendment:** Major and minor modifications to the SWMP become part of the Grading Permit upon Public Works' approval of the modifications.

15.7.3 Inspections

Construction site stormwater inspections include several different types of inspections by the Erosion and Sediment Control Inspector for Commerce City and mandatory Self-Monitoring Inspections by the permittee. Additional inspections by other regulatory authorities may also be conducted. Inspection requirements and responses include:

1. Permittees must contact Public Works, no less than three business days in advance of any site demolition, clearing, grubbing, grading, or excavation activity in order to schedule the preconstruction meeting and initial site inspection. The permittee must not commence any such activity until the site passes the initial inspection by Public Works.

2. Permittees must ensure Self-Monitoring Inspections of the SCMs occur at least once every 14 days and after every significant precipitation event or significant snow melt until such time as permanent non-erosive conditions are established or active disturbance at site is mitigated to the extent that Public Works approves a modified/extended inspection schedule. Reduced inspection frequencies may be approved if conditions specified for reduced inspection frequency in the CDPHE Construction Stormwater Discharge General Permit are met. Inspections must be conducted by a qualified stormwater professional.

3. The Erosion and Sediment Control Inspector for Commerce City will perform routine inspections at least once every 45 days beginning after the initial inspection and ending once the Final Inspection has been completed. The purpose of routine inspections is to evaluate all pollutant sources, evaluate discharge points to the MS4 or beyond the limits of the construction site to determine whether an illicit discharge has occurred, and to identify failure to implement control measures, inadequate control measures, and control measures requiring routine maintenance.

4. If the permittee's Self-Monitoring Inspections or an inspection by Public Works finds that SCMs in the initially-approved SWMP are not functioning as intended, the permittee must begin implementing additional or revised SCMs or other corrective actions immediately. Changes must be documented in the SWMP, with major modifications approved by Public Works.

5. The permittee must keep a record of all inspections. Inspection records must be kept with the SWMP and made available to Commerce City upon request. Uncontrolled releases of sediment or polluted stormwater or measurable quantities of sediment found off-site must be recorded with a brief explanation describing the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. Documentation of uncontrolled releases at site does not alleviate any state or federal requirements for reporting of discharges or upset conditions. Care should be taken to ensure compliance with all regulatory requirements at site.

15.8 Enforcement

The enforcement of an approved SWMP is typically driven by the inspection process. If inadequate control measures are identified by the permittee during a Self-Monitoring Inspection or the Erosion and Sediment Control Inspector during an inspection, the permittee must undertake corrective actions immediately after they become aware of the inadequacies, unless infeasible. If immediate corrective action is not possible, the permittee must document the reason why and an alternative schedule for completion of the corrective action in the SWMP. To document the completion of corrective actions in response to the Erosion and Sediment Control Inspector's Routine Inspection, the Erosion and Sediment Control Inspector will either conduct a follow-up Compliance Inspection or will require that the permittee perform an Operator Compliance Inspection to gather and report information that verifies the completion of corrective actions, such as photos and written documentation.

In cases where corrective actions are not completed as described above, or in certain other cases, the City may take more aggressive actions to get a site into compliance with the approved SWMP and Grading Permit. Table 15.1 summarizes some of these actions.

It is expected that under normal conditions, escalation of enforcement actions will proceed through a Verbal Warning, Notice of Violation, Letter of Noncompliance, and then a Stop Work Order. The City may impose additional requirements and conditions for re-issuance of the Grading Permit. A Municipal Summons may be issued for noncompliance with a Stop Work Order.

Table 15-1. Typical Enforcement Mechanisms

Enforcement Option	Description	Typical Applications
Verbal Warning	The ESC Inspector will inform the Qualified Stormwater Manager of items that require corrective action.	No immediate danger to public safety, property, or water resources. Items must be corrected immediately or an alternative schedule and justification by the contractor must be provided.
Notice of Violation	The ESC Inspector will document the items that were not corrected from the verbal warning. A copy of the inspection form will be provided to the Qualified Stormwater Manager.	No immediate danger to public safety, property, or water resources. Items must be corrected immediately or an alternative schedule and justification must be provided.
Letter of Noncompliance	This is a letter written to the permittee. It contains a description of the problem, the measures required to bring the site into compliance, and a timeframe for completion of those measures.	No immediate danger to public safety, property, or water resources. Items must be corrected immediately or an alternative schedule and justification must be provided. Compliance has not been achieved while working with the owner/representative or contractor. Used when the City wants to document ongoing problems and agreed upon follow-up.
Stop Work Order	This Order requires the permittee to stop all activity on the site except for the work necessary to bring the site into compliance with the approved SWMP. Depending on the compliance problem and the City's past experience with the individuals involved, the City may impose the Order on only a portion of the site.	Used when there is an immediate threat to public safety, property, or water resources or when the site has failed to comply with the Letter of Noncompliance.
Municipal Summons	Issuance of a summons to appear before a judge in Municipal Court.	Used when the site has failed to comply with the Erosion and Sediment Control Ordinance or the Stop Work Order.

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