

City of Pueblo
**Drainage Criteria
Manual**



April 2023

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Chapter 1.0 General Provisions

1.1 Enactment Authority

The City of Pueblo Stormwater Utility has amended the Storm Drainage Criteria and Policies dated June 9, 1997 and is superseding the manual with City of Pueblo Drainage Criteria Manual dated April, 2023. This amendment has been adopted by the City Council of the City of Pueblo by resolution in accordance with municipal code 16-12-3 (18).

1.2 Administrator

The "Stormwater Director" is responsible for administration and enforcement of the DCM, including review of all drainage reports, 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. The criteria described in this Manual are not intended to, nor should they be construed to, create any new rights, remedies, or benefits for any person, firm, corporation, or entity.

This Manual presents the policies and minimum technical criteria for the planning, analysis, design, and maintenance of storm drainage systems in the City and incorporates by reference the Mile High Flood District's (formerly the Urban Drainage and Flood Control District's) Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 (MHFD Manual) (UDFCD 2016). All Master Development Plans, Subdivisions, Re-subdivisions, Planned Unit Developments, Special Area Plans, or other proposed construction submitted for approval under the provisions of the current City of Pueblo Code of Ordinances, shall include adequate storm drainage provisions that meet or exceed the criteria in this Manual. All drainage design, analyses, and reports shall be prepared under the supervision of a professional engineer licensed in the State of Colorado.

1.4 Jurisdiction and Applicability

All of the policies and design criteria set forth in this Manual are adopted pursuant to the authority of the current City of Pueblo Code of Ordinances, as amended, and shall apply to all land within the current and subsequently annexed boundaries of the City (Figure 1-1), including all City-owned lands. This Manual applies to all storm drainage systems and facilities constructed in or on City Rights-of-Way (ROW), easements dedicated for drainage across public or private property, easements dedicated for public use, and to

all privately-owned and maintained stormwater conveyance, detention, retention, and water quality facilities.

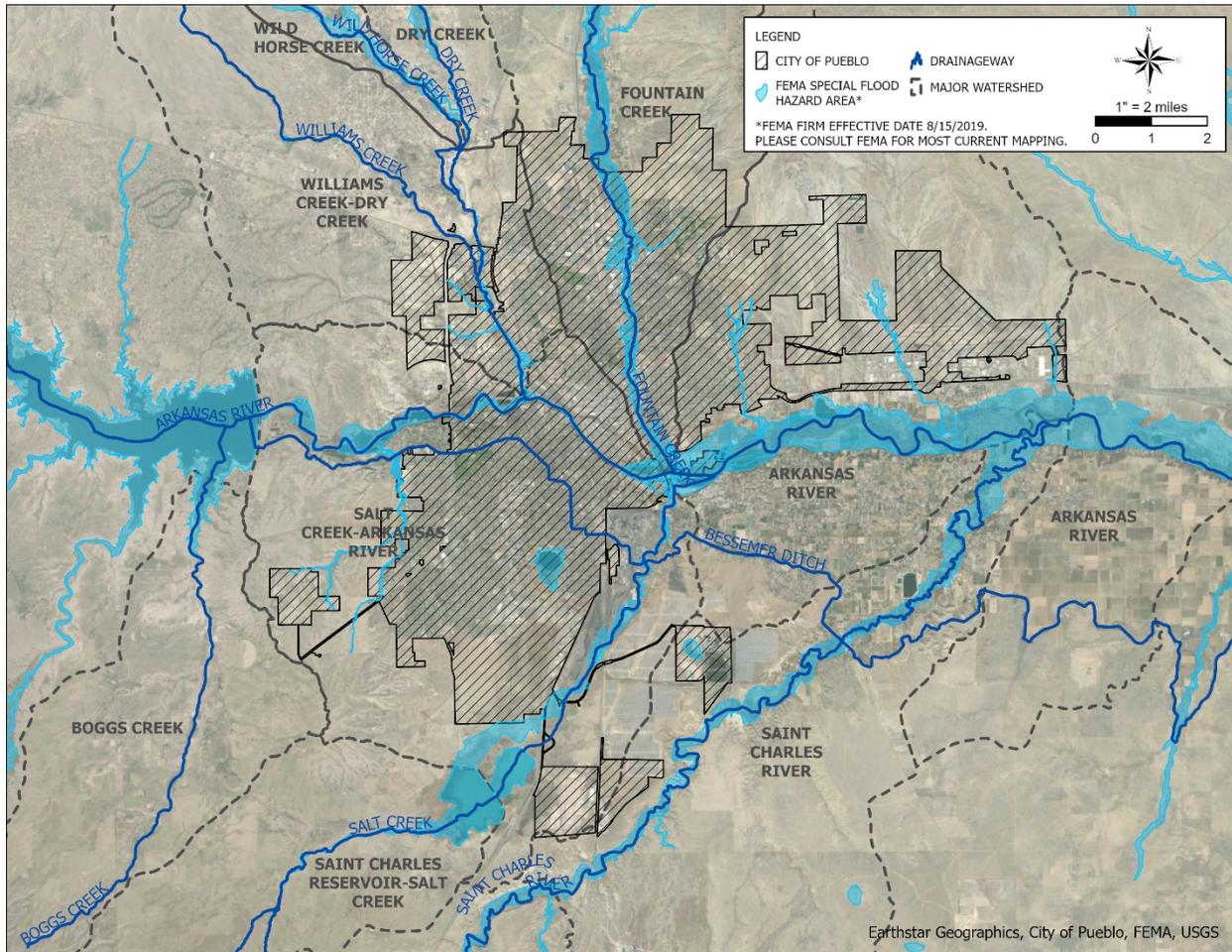


Figure 1-1. City of Pueblo Major Drainageways and Floodplains

This Manual applies to the administration of drainage, floodplain, and water quality provisions of the Pueblo Municipal 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 the City. Drainage and water quality treatment systems must be designed to address stormwater runoff from all disturbed portions of the development site, including all newly created impervious areas. When the Stormwater Director has determined that it is not practicable to capture runoff from portions of the site that will not drain towards a control measure, the applicant may request a variance (see Section 1.7), provided the stormwater is managed in a manner that is consistent with the City's Colorado Discharge Permit System (CDPS) General Permit COR090000 - Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4). In addition, areas within the City that are subject to the requirements of non-standard MS4

permits such as, for example, school districts, must comply with the criteria in this Manual as well as the requirements of the respective MS4 permit.

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, and 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 Stormwater Director, or their designees, review reports and construction plans required by this Manual. Where major drainageway improvements or floodplain delineation are involved, approval by the Floodplain Administrator, which may be the Stormwater Director or their designee, will be required, and administration of the subject area must be in accordance with Title XVII Chapter 9 of the Pueblo Code of Ordinances.

In cases where major drainageway improvements, outfalls to major drainageways, regional detention or water quality facilities, or floodplain modifications are proposed within the Fountain Creek watershed, the City will refer reports and construction plans required by this Manual to the Fountain Creek Watershed Flood Control and Greenway District (FCWFCGD). Per Colorado Revised Statute (CRS) §32-11.5-206(1), FCWFCGD approval will be required for the design and construction of the improvements.

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

The project owner or the owner's engineer is responsible for obtaining all applicable permits, including completing 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 project owner or owner's engineer is also responsible for submittals to irrigation companies on any development adjacent to canals that could impact the water quality, flow rate, or quantity of water delivered to those canals.

The City of Pueblo Stormwater Utility 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).

Long-term Operation and Maintenance Manuals are required for all major drainage improvements, as identified by the Stormwater Director. Operation and Maintenance Manuals 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 Stormwater Director, 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 the City, protect property, and minimize adverse impacts to the environment.
- Whenever a provision of this Manual and any other provisions of the Pueblo Code of Ordinances, law, 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 the City prior to the effective date of this Manual.
- The Stormwater Director has final authority to resolve any conflicting interpretations of this Manual.

1.7 Variances

Permittees may request variances from the requirements of this Drainage Criteria Manual within the context of these rules and regulations. The procedure for requesting variances is shown below (described in section 1.7.3). A variance cannot be granted that would create a condition of non-compliance with the City's MS4 permit. Any variance approved by the City will be documented using the City's Drainage Variance Form, including a description of the reasons for the approval and a finding that the variance does not create a condition of non-compliance with the City's MS4 permit.

1.7.1 Applicability

Variances are considered an extraordinary form of relief and are 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 the 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 Stormwater Director 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 the non-compliance is 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. Does not cause property damage to upstream or downstream properties;
 - d. Does not impose undue adverse environmental impacts;
 - e. Ensures access to the property and safe traffic flow will not be compromised; and
 - f. Does not cause undue negative impact to public safety, health, welfare, and environment.

The Stormwater Director may, at their discretion, utilize a third party (or third parties) to provide expertise or input when reviewing a variance application.

1.7.3 Submittal Requirements

Variance requests shall be submitted to the Stormwater Director in writing. 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 Stormwater Director or their designee.

1.7.4 Disposition of Variance

Upon receipt and review of a complete application for a variance, the Stormwater Director will review the application and provide a written disposition and findings 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. Alternatively, an appeal may be sought in accordance with Colorado Rules of Civil Procedure (CRCP) 106(a)(4).

1.8 Amendment of Manual

The policies and criteria contained in this Manual are basic guidelines that may be amended as deemed necessary or as required by law including amendments due to new technology or as more experience is gained in the use of this Manual. Amendments shall be adopted by Resolution. Final drainage reports or construction plans submitted to the City for approval prior to the effective date of any such Resolution shall be exempt from the requirements of any newly adopted amendment adopted by such Resolution.

1.9 Relationship to Other Standards

Included in this Manual are approved design methods, charts and tables, which when used will enable the City to perform its review in a more efficient and expeditious

manner. If the engineer prefers to use other methods, charts or tables, prior approval shall be obtained from the Stormwater Director or their designee before submittal. 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

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 possible that some nonconformities, defects, bugs, and errors with the software programs will be discovered as they become more widely used. The 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 the City will not be held liable for their use.

1.11 Permits and Other Requirements

The developer and/or landowner shall be required to obtain all permits required by federal, state, or local agencies in conjunction with work covered under this Manual and shall be required to comply with stormwater requirements which may be imposed directly by such agencies, or which may be indirectly necessitated in order for the City to comply with any permit which may be issued to the City.

1.12 Liability

The adoption of this Manual shall not create any duty to any person, firm, corporation, or other entity with regard to the application, enforcement or nonenforcement of this Manual. No persons, firm, corporation, or other entity shall have a private right of action, claim or civil liability remedy against the City, or its officers, employees, or agents, for any damage arising out of or in any way connected with the adoption, application, enforcement, or nonenforcement of this Manual. Nothing in this Manual shall be construed to create any liability under, or to waive any of the immunities, limitations on liability, or other provisions of, the Governmental Immunity Act, C.R.S. 24-10-101 et seq., or to waive any immunities or limitations on liability otherwise available to the City or its officers, employees, or agents.

Review and approval by the City of drainage improvements proposed in submittals does not relieve the engineer who designed such improvements from his or her professional responsibilities for the adequacy of the design of said improvements.

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Chapter 2.0 Stormwater Management Principles and Policies

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 the residents of the City of Pueblo (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 the City follows to manage drainage and summarizes policies followed for planning, design, operation and maintenance, irrigation facilities, flood control, and water quality. These principles form the underlying basis of the criteria established in this Manual.

2.2 Principles

The City follows well-established principles for urban stormwater management. These principles have been adopted from the 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 the 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 drainage infrastructure should account for the historical runoff from upstream sites, recognizing that runoff from future development must be detained at historic rates. Floodplain mapping will account for detention only from regional facilities.
 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. The City'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

Consistent with the principles of storm drainage planning described in Section 2.2, the City has developed specific policies that must be followed. These policies are divided into the following categories:

- Drainage planning (Section 2.3.1)
- Flood detention (storage) and stormwater quality facilities (Section 2.3.2)
- Drainage design (Section 2.3.3)
- Operation and maintenance of drainage facilities (Section 2.3.4)
- Storm drainage planning and irrigation facilities (Section 2.3.5)

2.3.1 Drainage Planning

1. All land development and redevelopment proposals must receive full site planning and engineering analyses. A drainage report and plan consistent with the submittal requirements in this Manual is required for all new development and redevelopment in the 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. The 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. The City supports and pursues a jurisdictionally unified approach to drainage to ensure an integrated comprehensive regional drainage plan.
5. In partnership with other local governments, the 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. The City defines a major drainageway as any drainage flow path with a tributary area of 130 acres or more.
8. Major drainageways must remain in open channels and must not be routed through a closed conduit, with the exception of transportation crossings.
9. The City considers stormwater runoff to be an integral part of the City's surface and groundwater resources and recognizes its potential for other uses.
10. The 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 transfers between drainage catchments must be addressed by the stormwater drainage design.
11. Historic major drainage pathways must be maintained, and *inter-watershed* 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 injury to water rights is caused.
 - d. No other regulatory requirement is violated.
12. Drainage improvements included in applicable regional drainage master plans, or as required by the City must be designed and constructed with all new development and redevelopment. Prior to implementing master plan recommendations based on modeling, the 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 City master drainage plan. Where no approved master drainage plan exists, the applicant must prepare and obtain approval for a master drainage plan for the affected area.
15. Retention ponds may be used to meet stormwater quality requirements when designed in accordance with City-approved criteria and when adequate water rights have been obtained. Retention ponds are not allowed for stormwater detention.
16. The City regulates and manages floodplains in accordance with floodplain requirements in the Pueblo Municipal Code and as described in Chapter 4, *Floodplains*, of this Manual.
17. The 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 the City before accepting discharges of groundwater to the storm drain system. Any detention system must be 2 feet or more above the seasonal high groundwater. Groundwater inflow into detention systems is not allowed.
19. The Policy of the City is to require that adequate measures be taken to prevent cross lot drainage.

2.3.2 Runoff Reduction, Flood Detention (Storage) and Stormwater Quality Facilities

1. Runoff reduction is required for all development and redevelopment projects with greater than 5,000 square feet and less than 1 acre of disturbance area to reduce the cumulative effect of increased runoff from multiple smaller sites and the urban drainage problems and increased costs of drainage facilities that can result. 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 these requirements at the discretion of the Stormwater Director.
2. To reduce urban drainage problems and the costs of drainage facilities, Full Spectrum Detention (FSD) is required for all development and redevelopment

projects that disturb 1 acre or more, with exceptions as described below. Requirements for drainage and stormwater quality for development and redevelopment projects are described further in this section and in Chapter 13, *Detention* and Chapter 14, *Stormwater Quality*.

Variances from FSD may be granted by the Stormwater Director under the following conditions:

- a. The project is immediately adjacent to a 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, *Detention*, 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 adjacent properties or right of way. At a minimum, a safe conveyance determination must meet the requirements for streets described in Chapter 7 and consider other site-specific factors.
- b. The 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 Stormwater Director 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 Chapter 14, *Stormwater Quality*, of this Manual.
5. All development and redevelopment projects must comply with the terms and conditions of the City of Pueblo's MS4 permit to minimize the discharge of pollutants to receiving waters to the maximum extent practicable through implementation of stormwater control measures (SCMs).

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 the City must implement SCMs to control erosion, sedimentation, and pollutant-laden stormwater discharges during construction activities in accordance with Chapter 15, *Construction Site Stormwater Management and Erosion Control*, of this Manual.
8. The 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 and the Pueblo Municipal Code.
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 Chapter 7, *Streets*.
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 accounting for the historical runoff from upstream sites, recognizing that runoff from future development must be detained at historic rates. Floodplain mapping will account for detention only from permanent regional detention facilities with a long-term operation and maintenance agreement in effect with the City.

6. Storm runoff must be determined by the Rational Method, Colorado Urban Hydrograph Procedure (CUHP), or CUHP used in combination with the Storm Water Management Model (SWMM), depending on the catchment size and complexity, as determined by the criteria provided in Chapter 6, *Runoff*.
7. Streets are an integral part of the urban drainage system and may be used for drainage in accordance with the limitations identified in Chapter 7, *Streets*, and Chapter 12, *Culverts and Bridges*, of this Manual. Streets must not be used for drainage in a manner that unduly restricts the primary purpose of streets, which is for transportation.
8. No interior building drains are allowed to directly tie into the City's storm drainage system per Pueblo Municipal Code. However, sump pumps are allowed to discharge via surface flow into the drainage system.
9. The design engineer shall perform construction observations at key stages of project construction. The engineer is responsible for confirming that the project is constructed in accordance with the design intent, as stated in Chapter 3, Section 3.4 *Construction Drawings and Specifications*.

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 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. Plat easement dedication statements shall provide that the City shall have the right, without the necessity at any time of procuring the consent or permission of anyone, to remove any building, fence, tree, street or other improvement or growth located upon such easement that may in any way endanger or interfere with the construction, reconstruction, maintenance, inspection or removal of all or any parts of the storm drainage facilities and to recover the costs thereof, plus an administrative charge of 15% from the owner(s) of the lots or parcels upon which the easements are located.
3. For detention and stormwater quality facilities, the City requires submittal of an Operation and Maintenance Manual.
4. The landowner is responsible for maintenance of storm drainage facilities unless the City has accepted responsibility for such maintenance, the storm drainage facilities are located within dedicated public easements or parcels accepted by

deed from the landowner to the City and no stormwater facility maintenance agreement with respect to the facilities has been executed.

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. In general, 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. In areas where historical runoff patterns drain into an irrigation ditch, management of runoff must be coordinated with the Stormwater Director.
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 the City.
 - e. The practice is determined to be in the 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, the 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.

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Chapter 3.0 Drainage Report and Construction Drawing Submittal Requirements

3.1 Introduction

This chapter describes requirements for Abbreviated Drainage Reports, Master Development Plan Drainage Reports, Preliminary Drainage Reports (PDRs), Final Drainage Reports (FDRs), and requirements for construction drawings and record (as-built) drawings.

Drainage report submittal requirements vary depending on the type of development occurring. Section 3.2 provides general guidelines for report submission. Section 3.3 includes a general description of the content required for each type of report. A detailed description of PDR and FDR requirements is provided in Section 3.4, and a checklist is provided on the City's website and should be completed prior to submission.

Incomplete reports will not be accepted for review. Submission of incomplete reports prolongs the review process and may result in significant delays to project approval.

All subdivisions, resubdivisions, Special Area Plans, planned unit developments (PUDs), commercial site plans or other development(s) (excluding "in-fill" single family residential lots) within the jurisdiction of the City of Pueblo (City) shall submit a PDR, an FDR, and as-built drawings in accordance with the requirements of this chapter. The drainage reports shall be submitted to the City for review by the Stormwater Utility Division.

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

3.2 General Submission Guidelines

All reports shall be submitted electronically through the current City submittal process. Spreadsheets, models and other input/output from technical analyses shall be included in the report and provided electronically in a format that City staff can review. The report shall include a narrative that presents the preliminary or final design submitted for review and shall be prepared by or under the supervision of a professional engineer who is licensed in Colorado. A redlined copy of the drainage report and/or a memo summarizing the comments will be provided to the applicant. The Drainage Report Checklist, completed and submitted by the applicant, will be used to determine the adequacy of the submittal.

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, may be required for some submittals. The applicant must address referral agency comments and obtain approvals when necessary.

All reports must be signed and stamped on the submittal cover sheet in accordance with Table 3-1. All drainage plans and required maps must be signed and stamped on each sheet.

Table 3-1. Drainage Submittal Requirements

Submittal ¹	Engineer Stamp Required?
Abbreviated Drainage Report	Yes
Master Development Plan Drainage Report	Yes
Preliminary Drainage Report	Yes
Final Drainage Report	Yes
Construction Drawings and Specifications	Yes

¹As-built drawings are required at completion of the project.

3.3 Drainage Report Types

3.3.1 Abbreviated Drainage Report

In the case of a resubdivision, where a complete drainage report has previously been approved by the City for the original subdivision, and the resubdivision does not significantly alter the concepts of the original drainage report, or in other cases where an abbreviated drainage report is determined to be appropriate by the City, the engineer may submit an abbreviated drainage report which conforms to the provisions of this Section.

An Abbreviated Drainage Report may be substituted in lieu of a full drainage report for development sites that meet all of the following qualifying criteria:

1. Prior approval must be obtained from Director of Stormwater or their designee.
2. The property is included in a previously approved drainage plan.
3. The development does not alter the existing drainage pattern.
4. The site currently discharges to an improved drainage channel or existing storm sewer system maintained by a municipal agency.
5. The adjacent surface drainage system will hydraulically accommodate post-development runoff.

The report shall generally follow the requirements of drainage report submittals and contain a cover letter by the engineer which describes the project and references the drainage report under which the project will be constructed. Any changes to the drainage design of the original subdivision shall be fully described and documented in accordance with all provisions of the drainage criteria contained in this manual.

If no design changes are to be made, the engineer shall so state. The City may require drainage design or analysis in addition to that given in the original drainage report if that report is deemed by the City to be incomplete. This may include requiring provisions for erosion control and flow arrows indicating lot drainage which had not been included in the original drainage report. The report shall include copies of the site map and revised drainage plan if applicable.

3.3.2 Master Development Plan Drainage Report

The drainage report for the Master Development Plan shall include, at a minimum, the following:

1. Maps

A map/maps showing the following information:

- A. Township, Range, Section, $\frac{1}{4}$ Section and general location
- B. The boundary of the master-planned area
- C. Existing and proposed zoning
- D. Existing topography with a maximum 10-foot contour interval
- E. Identification of all drainage basins tributary to the master-planned area
- F. All 100-year floodplains within or adjacent to the master-planned area
- G. Proposed street layout within the master-planned area
- H. Adjacent developments, master plans or subdivisions
- I. Drainage paths, with historic and developed flow rates identified at basin and sub-basin boundaries
- J. Natural drainage channels, man-made channels, bridges, culverts, storm sewers, detention ponds, and major erosion control features

2. Inflows from Upstream Basins

Discussion and analysis of the 100-year peak flows from all offsite tributary areas entering the master-planned area and the manner in which this drainage will be conveyed through the proposed development.

The design of drainage infrastructure should account for the historical runoff from upstream sites, recognizing that runoff from future development must be detained at historic rates. Floodplain mapping will account for detention only from regional facilities.

3. Downstream Impacts

Discussion and analysis of the 100-year peak flows leaving the master-planned area and their impact on downstream properties and drainage facilities. Include discussion of any proposed detention facilities. If downstream drainage improvements are required, provide preliminary cost estimates and a phasing plan.

4. Improvements within the Master-planned Area

Discussion of proposed drainage improvements within the master-planned area and preliminary cost estimates of those improvements. A discussion of planned phasing of the improvements should be included.

5. Water Quality Impact

Discussion of the general concept of stormwater quality management planning and water-quality objectives proposed in the master plan. Discussion of measures used to facilitate the general concept for some specific sites if applicable. For details regarding water quality, refer to USDCM Volume 3. This discussion will pertain to all residential development of 1 acre or greater in area, and all commercial and industrial development.

6. References

Include references to existing drainage studies for any tributary areas, if any.

3.3.3 Preliminary Drainage Report

The purpose of a Preliminary Drainage Report (PDR) 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. The report shall follow the requirements of drainage report submittals excluding hydraulic calculations.

3.3.4 Final Drainage Report

The purpose of the Final Drainage Report (FDR) is to update the concepts and to present the design details for the drainage facilities discussed in the PDR. Also, any change to the preliminary concept must be presented. The FDR shall follow the same format and organization as the PDR. The applicant shall provide a cover letter with the FDR that explains how comments from the City and comments from referral agencies have been addressed and how plans have changed as a result. In addition to the PDR items discussed above, the FDR shall include hydraulic calculations (refer to Section 3.4.2, Appendix A, Section B *Hydraulic Calculations*).

3.4 Requirements for Preliminary and Final Drainage Reports

3.4.1 Report Organization and Content

The drainage report shall be organized as follows:

1. Title Page

Include drainage report, subdivision or commercial site, address, engineer's name, owner's name, and date.

2. Cover Letter

The drainage report shall be transmitted with a cover letter prepared by the professional engineer responsible for the preparation of the report, describing the Project, noting any special conditions or problems encountered on the site, acknowledging that the drainage design and analyses were completed under his/her supervision in accordance with the City's Drainage Criteria Manual and that the design is in conformance with the City approved Master Plan for the drainage basin, if one exists, and presenting the final design for review. The cover letter shall identify any modification to the criteria that may be requested and shall be signed and stamped by the engineer.

3. Drainage Report Checklist

A completed Drainage Report Checklist, signed and stamped by the engineer, shall be included with the drainage report. Reports submitted with incomplete checklists will not be accepted for review. The Drainage Report Checklist may be found in Appendix B of this Manual or on the City's Stormwater Utility webpage.

4. Table of Contents

5. Purpose

Provide a general description of the project and its purpose.

6. General Location and Description

Include the city, county, and state. Discuss how the project site is bounded on each side. Identify the legal description (e.g., township, range, section, ¼ section, etc.). Provide names of surrounding developments. Identify the major drainageway in which the property resides (refer to the City's Stormwater Utility webpage for major drainage basins in the City). Identify existing drainage and water quality facilities.

Describe the property, including area (acres or square feet), ground cover (existing and proposed ground cover and vegetation), and characteristics of the major and minor drainageways, including topography and erosion characteristics.

Provide a general description of the project and proposed land use. Identify any existing major irrigation facilities, such as ditches or canals. Describe the history of flooding on the property, if any. Show and describe easements within and adjacent to the site. Identify all outfalls to major drainageways. 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, as per item 16, *Water Quality*, below.

7. Location Map

A map of sufficient detail to identify the project location including north arrow and major access roadways.

8. Existing Drainage Report/Master Plan

Discuss previous drainage studies for the site that influence or are influenced by the drainage design. Describe how previous studies are considered and affect the drainage for the site. Discuss the relationship to and implications of any adjacent drainage studies. Reference existing drainage reports and the Master Basin Planning Study found on the City's website.

9. Upstream Considerations

Upstream drainage patterns and their impact on the proposed development should be discussed. Identify locations and flow rates of drainage entering the site. Provide detailed hydrologic analysis using 100-year design storm criteria. The design of drainage infrastructure should account for the historical runoff from upstream sites, recognizing that runoff from future development must be detained at historic rates, unless a regional pond has already been constructed which accounts for the upstream developed condition. When dealing with large basins that lie partially outside of the city limits, confer with City staff prior to making runoff design assumptions. Floodplain mapping will account for detention only from regional facilities.

Stormwater detention will be required unless it has already been accounted for in an existing regional detention facility.

10. Downstream Considerations

Identify locations where flow leaves the site and the corresponding 100-year peak flow rates. Discuss drainage impacts on downstream facilities and properties. Discuss any downstream improvements that are to be made in

conjunction with the development. Provide detailed supportive hydrologic and hydraulic analyses.

11. Floodplain Discussion and FIRM

Reference any flood hazard delineation reports and Flood Insurance Rate Maps (FIRMs). FIRMs can be downloaded from the Federal Emergency Management Agency's (FEMA) Flood Map Service Center. Identify the applicable flood zone as indicated on the FEMA FIRM for the site. Indicate wetlands onsite or nearby.

12. Soils Discussion

Provide soil types and hydrologic soil group(s). 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, and should provide the measured groundwater elevation with bore logs provided in an Appendix.

13. Methods of Analysis

Hydrologic Criteria: Specify design rainfall and design storm recurrence intervals. Identify hydrologic soil groups of the site and of off-site drainage basins. Calculate imperviousness. Describe the runoff calculation method used. Identify the detention discharge and storage calculation method used. Discuss and justify other criteria or calculation methods used that are not presented in or referenced by the criteria in this Manual.

Hydraulic Criteria: Provide capacity analysis of existing and proposed drainage infrastructure. Perform floodplain analyses (if required) – describe methods used, regulatory requirements (Floodplain Development Permits, Conditional Letter of Map Revision, etc.), modifications to the floodplain, etc. Discuss any other drainage facility design criteria used that are not presented in this Manual.

14. Historic Conditions

Discuss historic (or existing) basin characteristics, including area, existing land use, imperviousness, overland and channelized slopes, and other physical parameters used for drainage calculations and analyses. Include general drainage concepts and existing drainage patterns of the property, runoff, and flow. Identify existing stormwater conveyance and storage facilities.

15. Proposed Conditions

Discuss characteristics for each proposed basin, including area, proposed land uses, imperviousness, overland and channelized slopes, and other physical

parameters used for drainage calculations and analyses. Include proposed drainage patterns of the property. Discuss impacts of development on basin characteristics. Discuss content of tables, charts, figures, and drawings presented in the report. Provide design flows shown at design points and detention storage volumes. Describe proposed stormwater conveyances, storage facilities, and outlet structures.

Describe stormwater control measures (SCMs), including physical measures as well as management practices, that will be part of the stormwater management design. Discuss the relationship to both upstream and downstream properties and the impact of the development's drainage on these properties.

Include general discussion of the vegetation plan, including seed mixes and plant types.

Discuss drainage impacts of site constraints such as streets, utilities, ditches, existing structures, and development of site plan. Discuss drainage problems encountered and proposed solutions.

List applicable regulations and permits, and discuss compliance with other local, state, and federal requirements.

Describe and justify any requested variances from the City's drainage criteria and/or any variations from approved master plans. Detailed justification must be provided for any variances requested. Include reference to the specific criterion that is the subject of 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. Documentation of approved variances from criteria shall be provided with the Final Drainage Report.

16. Water Quality

Describe how the project will satisfy Municipal Separate Storm Sewer System (MS4) permit construction phase requirements and discuss necessary permit coverage, as applicable. 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 Permit for Stormwater Discharges Associated with Construction Activities.

Describe how the project will satisfy MS4 post-construction requirements, if applicable, and which of the post-construction design standards in the MS4 permit that the project is intended to meet.

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 Environment, and provide documentation of remediation plans or other measures that will be used to avoid exposing runoff and infiltrated water to contamination.

Describe the control measures necessary to prevent the potential for illicit discharge from site activities and general concepts for erosion, sediment, and pollution prevention. Discuss compliance with other local, state, and federal requirements.

Table 3-2. Resources for Identification of Known or Suspected Contamination on Project Sites and within a 1-mile Radius¹

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, Brownfields 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).

¹These 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.

17. Maintenance

Discuss maintenance responsibilities of the drainage facilities and where the legally binding document showing the responsible party can be found (e.g., the Stormwater Facility Maintenance Agreement (SFMA) and/or Plat dedication statement, or if the City has agreed to take over maintenance). Identify

easements and tracts for drainage purposes, including conditions and limitations for use. If the owner is responsible for maintaining the drainage facilities, discuss the owner's obligations to the City per the SFMA and O&M Manual (e.g., annual reporting).

18. Conclusion

Discuss how the proposed drainage design is in compliance with the City's Drainage Criteria Manual, MS4 permit, and floodplain rules and regulations. Summarize any requested variances.

Summarize overall effectiveness of stormwater design concept to properly convey, store, and treat stormwater. Discuss compatibility of proposed development with approved master plans. Discuss drainage impacts of proposed development on upstream and downstream properties.

19. References

Reference all criteria, master plans, reports, or other technical information used in the development of the designs discussed in the drainage report.

3.4.2 Appendices

1. Appendix A – Hydrologic and Hydraulic Computations

A. Hydrologic Calculations

- i.* State assumptions for impervious percentages of upgradient and downgradient properties per City's planning department.
- ii.* For sites that receive off-site runoff, provide a diagram showing relationship/connectivity of basins, conveyance facilities, detention basins, and design points.
- iii.* 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.
- iv.* For each sub-basin and design point, document the peak discharge rates for the minor and major events.
- v.* Provide input and output listings for all models and spreadsheets used for hydrologic analysis and document rationale for input and assumptions.
- vi.* In cases where hydrograph-based analysis is used, provide representative minor and major event hydrographs at key design points.
- vii.* Provide detention area/volume capacity and outlet capacity calculations. Provide stage-area-storage-discharge tables for all water quality and detention facilities.

B. Hydraulic Calculations (Applicable to Part II of the Subdivision process)

- i.* Provide culvert capacity calculations, if applicable.

- ii. Provide street capacity and inlet calculations.
- iii. Include storm drain capacity calculations, including hydraulic and energy grade lines (HGLs and EGLs), if applicable.
- iv. Provide documentation of open channel design, low flow (trickle) channel design, stabilization, and grade control improvements. Provide water surface profiles for all open channels for the minor and major event.
- v. Describe energy dissipation at storm drain and culvert outlets and provide supporting calculations.
- vi. Document downstream/outfall system capacity to the major drainageway system.
- vii. Supporting calculations/information for spillway design is included.
- viii. Spillway design includes a determination of WSE during a 100% blocked outfall structure.
- ix. 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.
- x. Model input and output for hydraulic models used such as HEC-RAS, HY-8, and City workbooks (found on the City's Stormwater Utility webpage).
- xi. Description of hydrologic or hydraulic routing methods used and input parameters.

C. Water Quality

- i. Provide completed Pueblo worksheets for computation of the water quality capture volume (WQCV), excess urban runoff volume (EURV), detention storage volumes, release rates, and drain times.
- ii. Provide detailed documentation of design elements, including the outlet, inlets and forebays, facility bottom/low flow (trickle) channel, micropool, and other details.
- iii. Stormwater Detention and Infiltration Design Data (SDI) Worksheet (downloadable from the MHFD website as the *Compliance Design Data Workbook*), or acceptable alternative calculations for upload to the State Compliance Portal, demonstrating compliance with state law regarding maximum detention drain times. While much of the information in this workbook overlaps with the *Pueblo-Detention* workbook, the SDI Worksheet is in the correct format for the State Engineer's Office portal and its use is recommended for the purpose of demonstrating compliance with state law. *Pueblo-Detention* should still be used for other computations.

2. Appendix B – Standard Design Charts and Tables

3. Appendix C – Floodplain Maps

4. **Appendix D – Soils Map:** Provide soils map from Natural Resource Conservation Service (NRCS) and accompanying table with percentages of each soil type (not entire report).

5. Appendix E – Maps

- A. *Historic Drainage Map (should be legible when printed on 11" x 17"). Scale 1" = 10' to 1" = 100', as required to show sufficient detail.*
- B. *Proposed Drainage Plan (should be legible when printed on 11" x 17"). Scale 1" = 10' to 1" = 100', as required to show sufficient detail.*
- i. Title block
 - ii. Engineer's statement.
 - iii. Overall drainage basin boundary and sub-basin boundaries.
 - iv. Existing and proposed contours at 2 ft. maximum intervals. In terrain where slope exceeds 10%, maximum interval is 10 ft.
 - v. Property lines and easements with purposes noted.
 - vi. Streets and R.O.W. lines.
 - vii. Flow arrows.
 - viii. Accumulation of flows (cfs) at design points.
 - ix. Show paths chosen for computation of time of concentration.
 - x. Existing and proposed utilities, type, and size.
 - xi. Show *Design Point Summary Table* (minor and major flows), *Basin Summary Table* (minor and major flows), and *Pipe Routing Summary Table* (flows, sizes, material types, slopes, and total length).
 - xii. Impervious and pervious area table.
 - xiii. Existing and proposed storm sewers, inlets, and manholes. For storm sewers show size, slope, material, flow rate and flow arrows. For inlet show type and length. Show diameter of manholes.
 - xiv. Existing and proposed culverts. Show size, material, and flow rate. Show headwalls, wingwalls and riprap pad size and type. Delineate 100-year ponding limits.
 - xv. Existing and proposed open channels. Show typical cross sections with water surface elevations. Identify channel lining, slope, flow rate and velocity, and details of erosion control features and low flow (trickle) channel.
 - xvi. Existing and proposed detention ponds. Show grading plan, storage volumes for 10- and 100-year ponding elevations. Delineate 100-year ponding inundation limits. Show outlet structure, spillway, and low flow (trickle) channel details.
 - xvii. Existing natural channels within 150 feet of project. Delineate 100-year floodplain (and erosion buffer zone 25 feet from floodplain, if applicable). Show bridges, culverts, and erosion control features if any.
 - xviii. Drainage details (outlet structures, restrictor plates, orifice plate, spillway, riprap, etc.). Spillway plan should show 100-year WSE with 100% blocked outfall structure.
 - xix. Professional engineer's seal and signature on record copy.
- C. *Erosion and Sediment Control Plan or Stormwater Management Plan (should*

be legible when printed on 11" x 17"). Scale 1" = 10' to 1" = 100', as required to show sufficient detail.

3.4.3 Engineer's Statement

The drainage report shall be acknowledged by the engineer as follows:

"I hereby state that this (Preliminary/Final) Drainage Report for the (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Pueblo's Drainage Criteria Manual for the owners thereof. I understand that the City of Pueblo does not, and will not, assume liability for drainage facilities designed by others."

 Name

 Licensed Professional Engineer

 State of Colorado No. _____

 (Affix Seal)

3.4.4 Drawing Conventions

Table 3-3. Drawing Symbol Criteria and Hydrology Review

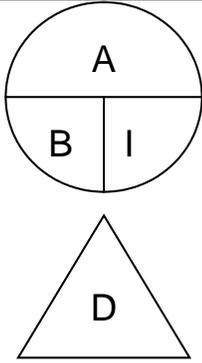
	A = Basin Designation B = Area in Acres I = % Imperviousness D = Design Point Designation			
Summary Runoff Table (to be placed on Drainage Plan)				
Design Point	Contributing Basin(s)	Contributing Area (acres)	5-Year Runoff (cfs)	100-Year Runoff (cfs)
X	XX	XX.XX	XX.X	XX.X

Table 3-4. Detention Basin Summary Table for Drainage 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			

3.5 Construction Drawings and Specifications

The information required for the plans shall be in accordance with sound engineering principles, this Manual, the City of Pueblo’s *Standard Construction Specifications and Standard Details*, 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 licensed 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 FDR, 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:

1. General Information Required for All Drainage Improvement Projects

- A. Cover sheet including:
 - i. Vicinity map.
 - ii. Professional engineer certification, seal, and signature on record copy.
 - iii. Title block which identifies the Project, the date, the firm that prepared the plans, the initials of the preparer and the professional engineer that is responsible for the design. Sheet index.
 - iv. Standard notes.
- B. Overall utility plan showing water, sanitary, and storm drain lines and facilities.

- C. Grading plan using the North American Vertical Datum of 1988 (NAVD88).
- D. Drainage plan using NAVD88.
- E. 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 roads. Include longitudinal and cross section slopes.
 - iv. Utilities adjacent to or crossing stormwater management facilities.
 - v. Drainage details (Outlet structures, restrictor plates, orifice plate, spillway, riprap, etc.)
 - vi. Any non-City standard details.
 - vii. Finished floor elevations of buildings adjacent to floodplains or open channels. If a building's finished floor elevation is not known, a note must be added to the plan that the finished floor elevation must be at least 1-foot above the 100-yr Water Surface Elevation.

2. Specific Design Feature Information

A. 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 (to be included on street construction plans). Plan and profile must be included on same sheet and shall be provided for laterals as well as mains. Include culvert inlet/outlet erosion control structures and design water surface profile.
- ii. All storm mains and laterals are required to be on their own independent centerline stationing at minimum 100' intervals.
- iii. There is no minimum length of laterals. However, laterals less than 5 feet in length will require flow fill adjacent to the pipe to compensate for difficulties with soil compaction.
- iv. Impervious area in square feet.
- v. *Pipe Summary Table* including size, type, and total length.
- vi. Major storm HGLs and EGLs if the facility is designed for events greater than the minor storm.
- vii. Pipe outlet protection shown on plan and profile views.
- viii. Utilities adjacent to or crossing storm drain or culvert alignment in plan and profile.
- ix. 1" = 10' scale, minimum, grading details for all pipe and culvert inlets and outlets.

B. Detention/storage facilities

- i. Detention basin grading, low flow (trickle) channel, inlet, outlet, and emergency overflow spillway locations.
- ii. Detention facility summary including volumes and release rates – provide on plans.
- iii. Forebay, micropool, low flow (trickle) channel (including longitudinal slope and cross section), and outlet construction details, including safety features, such as racks and openings.
- iv. Maintenance access to facility at inlets and outlet and access to facility to clean out accumulated sediment and pollutants.
- v. Design details for inlets and outlet, including hydraulic outlet control.
- vi. Revegetation specifications.
- vii. Finished floor elevations of all existing and proposed structures within the property.

C. 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 (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. Include typical cross-sections.
- iii. Side tributary channels and pipe outlets.

D. Permanent Stormwater Control Measures

- i. Control measures shall be shown on the grading plan.
- ii. Provide SCM volumes and release rates on plans.

E. Construction Erosion and Sediment Control Measures and Details

- i. Erosion and Sediment Control Plan (ESCP) or Stormwater Management Plan (SWMP), as applicable. See Chapter Chapter 15.0 *Construction Site Stormwater Management and Erosion Control*, Appendix C or D, or the City's Stormwater Utility webpage for guidance regarding the development of an ESCP or SWMP.

3.6 Record Drawings (As-Built Drawings) for Final Acceptance (Subdivisions) & Certificate of Occupancy (Commercial)

Record drawings for all drainage improvements are to be submitted to the City of Pueblo's Stormwater Utility Division for acceptance of a subdivision or for a Certificate of Occupancy. Submission shall include an electronic copy in pdf format including the engineer's statement, 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. "As-built" surveys must include a "red-line" design set that verifies the as-constructed project matches the intent of the original design drawings and which indicates any changes which were made to the original design drawings during construction. If the improvements for a project are constructed in phases, as-built drawings may be required at the completion of each phase. Acknowledgment 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
Licensed Professional Engineer or Land Surveyor
State of Colorado No. _____
(Affix Seal)

The City Engineer will compare the record drawing information with the construction drawings. Acceptance of a subdivision or a Certificate of Occupancy will only be issued 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 acknowledged and stamped by a professional engineer or land surveyor.

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Chapter 4.0 Floodplains

4.1 Introduction

The City of Pueblo (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, which is administered by the Federal Emergency Management Agency (FEMA). These regulations include adoption of a floodplain ordinance, designation of a floodplain administrator, and management of activities within the mapped regulatory floodplain through a floodplain permitting process.

Mapped regulatory floodplains within the City include major drainageways, such as Fountain Creek, and also include smaller channels that only flow intermittently, such as the Goodnight Arroyo (see **Photograph 4-1**).



Photograph 4-1. Fountain Creek (left photo) is a major drainage that runs through the City of Pueblo and is designated as a FEMA Special Flood Hazard Area (SFHA). Goodnight Arroyo (right photo) is a smaller channel with intermittent flow which is also located within the City of Pueblo and is mapped as a SFHA. These examples demonstrate the wide range in channel types that are mapped as regulatory floodplains by FEMA.

This chapter provides an overview of the City's Floodplain Rules and Regulations but is not intended to be a comprehensive presentation of the Code of Ordinances or its requirements. To the extent there are any inconsistencies in interpretation between this chapter and the Code of Ordinances, the interpretation based on the Code of Ordinances will prevail. For additional information, consult the City's Code of Ordinances, as may be amended from time to time, including Section 17-9-3 General Provisions, Section 17-9-4 Administration, and other sections referring to flooding or the 100-year floodplain.

4.2 Floodplain Mapping

4.2.1 Floodplains Designated by FEMA

FEMA's National Flood Hazard Layer provides the current effective floodplain mapping including the effects of Letters of Map Revision (LOMRs) or Letters of Map Revision Based on Fill (LOMR-F) since the effective date of the Flood Insurance Rate Map (FIRM) panels. Each of these panels delineates the area inundated by the 100-year flood, or the Special Flood Hazard Area (SFHA). The 100-year water surface elevation is called the base flood elevation, or BFE. A floodplain map should be obtained from the FEMA Map Service Center at www.fema.gov.

Regulatory Floodplain Terms

Special Flood Hazard Area (SFHA): The 100-year floodplain mapped by FEMA.

Base Flood Elevation (BFE): Water surface elevation of a flood having a 1% chance of occurrence, or a 100-year flood event.

Floodway: The portion of the floodplain that must remain undisturbed to avoid raising the BFE more than the regulatory limit (0.5 feet per Pueblo Code of Ordinances and state requirements).

Floodplain Fringe: The portion of the regulatory floodplain, or SFHA, not in the floodway.

Applicants should evaluate the floodplain map to determine the boundaries of the SFHA. If development will result in the alteration of a major drainageway, the developer is responsible for revising the floodplain maps at their expense. 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, including the application fees to FEMA, are the responsibility of the developer. All necessary documentation must be approved by the City and submitted to FEMA to process the CLOMRs and LOMRs.

4.2.2 Floodplains Not Mapped by FEMA

For all development within 150 feet of a natural channel that is not currently mapped by FEMA, but which is identified by the Floodplain Administrator as a major drainageway, the 100-year floodplain and erosion buffer zone shall be delineated. Erosion limit lines 25 feet beyond the 100-year floodplain are required for all natural channels and must be shown on the plat. Variances may be considered if channel stabilization measures are implemented. Additional requirements may be requested by the Floodplain Administrator in consideration of future conditions.

4.3 General Provisions

The City of Pueblo Code of Ordinances, Section 17-9-5, as may be amended from time to time, includes provisions for flood hazard reduction. See the most currently applicable Code of Ordinances for additional information.

4.3.1 Floodplain Compliance Required

All development proposals shall conform to the requirements of the City floodplain regulations and policies. In addition, all developments in the City located within mapped floodplains shall comply with the following 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 regulatory 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 a property that lies within the regulatory floodplain of any stream or drainage course.

For development in mapped floodplains, a Conditional Letter of Map Revision (CLOMR) must be issued by FEMA prior to the City issuing a building permit. "As-built" surveys, which include a "red-line" design set that verifies the as-constructed project matches the intent of the original design drawings and which indicates any changes which were made to the original design drawings during construction, must be submitted for construction in or near the regulatory floodplain prior to issuance of a Certificate of Occupancy.

4.3.2 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 1 foot above the base flood elevation.
2. With materials and utility equipment resistant to flood damage.
3. Using methods and practices that minimize flood damage.
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.

4.3.3 Structures

4.3.3.1 Residential Structures

Residential structures, if permitted, shall have the lowest floor (including the basement) elevated to 1 foot above the base flood elevation.

4.3.3.2 Nonresidential 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.
3. Be certified by a licensed 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.
4. For critical facilities (e.g., nursing homes, hospitals, fire stations, schools, above ground gasoline or propane storage or sales), no new, substantially improved, or additions 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. Note: a full list of critical facilities for purpose of floodplain regulations is provided in Section 17-9-5(h) of the Pueblo Code of Ordinances.

4.3.4 Floodways

Floodways are hazardous areas due to the depth and velocity of flood waters that carry debris, and which have significant erosion potential. Accordingly, all encroachments into floodways 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, as demonstrated and documented with a No-Rise Certification, as shown below. If so demonstrated, any new construction or substantial improvements must comply with the standards in the Code of Ordinances.

The following language may be used for a No-Rise Certification:

This is to certify that I am a licensed 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 [insert name of development] will not impact the 100-year flood elevations, floodway elevations, or floodway widths on [insert name of drainage that is the source of flooding] at published or unpublished cross-sections in the FEMA flood insurance study 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. Number and Stamp _____

4.3.5 Properties Removed from the Floodplain by Fill

If a Floodplain Development Permit is issued, 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 Administration

4.4.1 Floodplain Administrator

The Director of the Department of Stormwater Utility is the appointed Floodplain Administrator in the City and is responsible for reviewing and processing all Floodplain Development Permit applications and interpreting floodplain maps within the City. The Floodplain Administrator approves or denies Floodplain Development Permit applications based on state and local floodplain regulations. For a full list of the duties and responsibilities of the Floodplain Administrator, please see Section 17-9-4(b) of the Pueblo Code of Ordinances.

4.4.2 Floodplain Development Permits

A Floodplain Development Permit is required prior to commencement of any construction, development activity, or storage of materials within the regulatory floodplain. 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 or deny the application based on the approval criteria below.

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 Colorado Water Conservation Board (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 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 are 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 are 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 special conditions on approval of Floodplain Development Permits as described in the Code of Ordinances.

4.5 Allowable Uses

4.5.1 Allowable Uses within SFHAs

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 SFHAs subject to a Floodplain Development Permit. In addition, uses in the floodway shall only be permitted with a certification of no rise greater than 0.00 feet (see Section 4.3.4 of this chapter for details regarding a No-Rise Certification).

4.5.2 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 4.5.1 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 that remains unobstructed with a rise of no more than 0.5 feet.

4.5.3 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.

4.6 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.

4.7 Variances

The applicant may request variances from floodplain regulations described in this chapter and in the Code of Ordinances. 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 licensed 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 2010).

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.”

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

Chapter 5.0 Rainfall

5.1 Introduction

Design rainfall data to be used to complete hydrologic analyses described in the Runoff chapter of this Manual are presented in this section. This chapter provides:

- 1) point precipitation values for the City of Pueblo (City)
- 2) information on the Colorado Urban Hydrograph Procedure (CUHP) temporal storm distribution
- 3) an intensity-duration-frequency table for use with the Rational Method

All hydrological analyses within the City must use the rainfall data presented herein for calculating storm runoff. In some cases, the designer may need to consider events more extreme (less frequent) than the 100-year storm (e.g., for public safety, critical facilities).

The design storms and intensity-duration-frequency tables for the 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) (NOAA 2013) and information from the MHFD manual.

5.2 Rainfall Depth-Duration-Frequency Values

Based on mapping and data presented in the NOAA Atlas 14, variations in rainfall depths across the City are minimal, and rainfall characteristics for the City can be represented by a single rainfall zone.

Rainfall depth-duration-frequency data are needed for both the Rational Method and for the Colorado Urban Hydrograph Procedure (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 Pueblo Department of Public Works location, which is representative of rainfall Citywide. The values in this table are the default rainfall values used in the City's design workbooks and may be applied to any area within City limits.

Table 5-1. City of Pueblo Point Rainfall Depths

Return Period	Rainfall Depth (inches)							
	5-minute	10-minute	15-minute	30-minute	1-hour	2-hour	3-hour	6-hour
2-year	0.27	0.39	0.48	0.74	0.94	1.14	1.19	1.29
5-year	0.35	0.52	0.63	0.97	1.22	1.46	1.53	1.65
10-year	0.43	0.63	0.77	1.18	1.48	1.77	1.85	1.98
25-year	0.55	0.81	0.99	1.50	1.88	2.25	2.35	2.50
50-year	0.66	0.96	1.17	1.78	2.23	2.67	2.78	2.95
100-year	0.77	1.13	1.38	2.09	2.61	3.13	3.26	3.45
500-year	1.07	1.57	1.92	2.91	3.63	4.35	4.54	4.79
Date: September 2021		Reference: NOAA Atlas 14, Volume 8, Version 2, 2013. Data reported for the City of Pueblo Department of Public Works.						

The point rainfall depths in Table 5-1 must be distributed temporally in 5-minute increments for use with CUHP. Area adjustment of these point rainfall values is required based on watershed size when using CUHP.

CUHP automatically generates the rainfall hyetograph based on the specified 1-hour point precipitation value and calculates temporal adjustments to rainfall distribution for various storm events and watershed sizes in accordance with the *Rainfall* chapter of the MHFD Manual. Refer to the MHFD Manual for additional documentation of hyetographs for watersheds of varying sizes.

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.

Table 5-3 provides intensity-duration-frequency data, which is also for use with the Rational Method. If the computed value of the time of concentration falls between the values listed in Table 5-2 or 5-3, linear interpolation should be applied to find the depth or intensity associated with the calculated time of concentration. Figure 5-1 shows intensity-duration-frequency curves for rainfall in the City of Pueblo.

Table 5-2. Rainfall Depth-Duration-Frequency Values for Use with the Rational Method (for Watersheds of 90 Acres or Less)

Time (minutes)	Rainfall Depth (inches)					
	2-year	5-year	10-year	25-year	50-year	100-year
5	0.27	0.35	0.43	0.55	0.66	0.77
10	0.39	0.52	0.63	0.81	0.96	1.13
15	0.48	0.63	0.77	0.99	1.17	1.38
20	0.57	0.74	0.91	1.16	1.37	1.62
25	0.66	0.85	1.04	1.33	1.58	1.85
30	0.74	0.97	1.18	1.50	1.78	2.09
35	0.78	1.01	1.23	1.56	1.86	2.18
40	0.81	1.05	1.28	1.63	1.93	2.26
45	0.84	1.09	1.33	1.69	2.01	2.35
50	0.87	1.14	1.38	1.75	2.08	2.44
55	0.91	1.18	1.43	1.82	2.16	2.52
60	0.94	1.22	1.48	1.88	2.23	2.61

Table 5-3. Rainfall Intensity-Duration-Frequency Values for Use with the Rational Method (for Watersheds of 90 Acres or Less)

Time (minutes)	Rainfall Intensity (inches/hour)					
	2-year	5-year	10-year	25-year	50-year	100-year
5	3.22	4.22	5.16	6.62	7.87	9.24
10	2.35	3.09	3.78	4.85	5.77	6.78
15	1.92	2.51	3.07	3.94	4.68	5.52
20	1.70	2.22	2.72	3.47	4.12	4.85
25	1.57	2.05	2.50	3.19	3.78	4.45
30	1.49	1.94	2.36	3.00	3.56	4.18
35	1.33	1.73	2.11	2.68	3.18	3.73
40	1.21	1.58	1.92	2.44	2.90	3.40
45	1.12	1.46	1.77	2.25	2.67	3.13
50	1.05	1.36	1.66	2.10	2.50	2.92
55	0.99	1.29	1.56	1.98	2.35	2.75
60	0.94	1.22	1.48	1.88	2.23	2.61

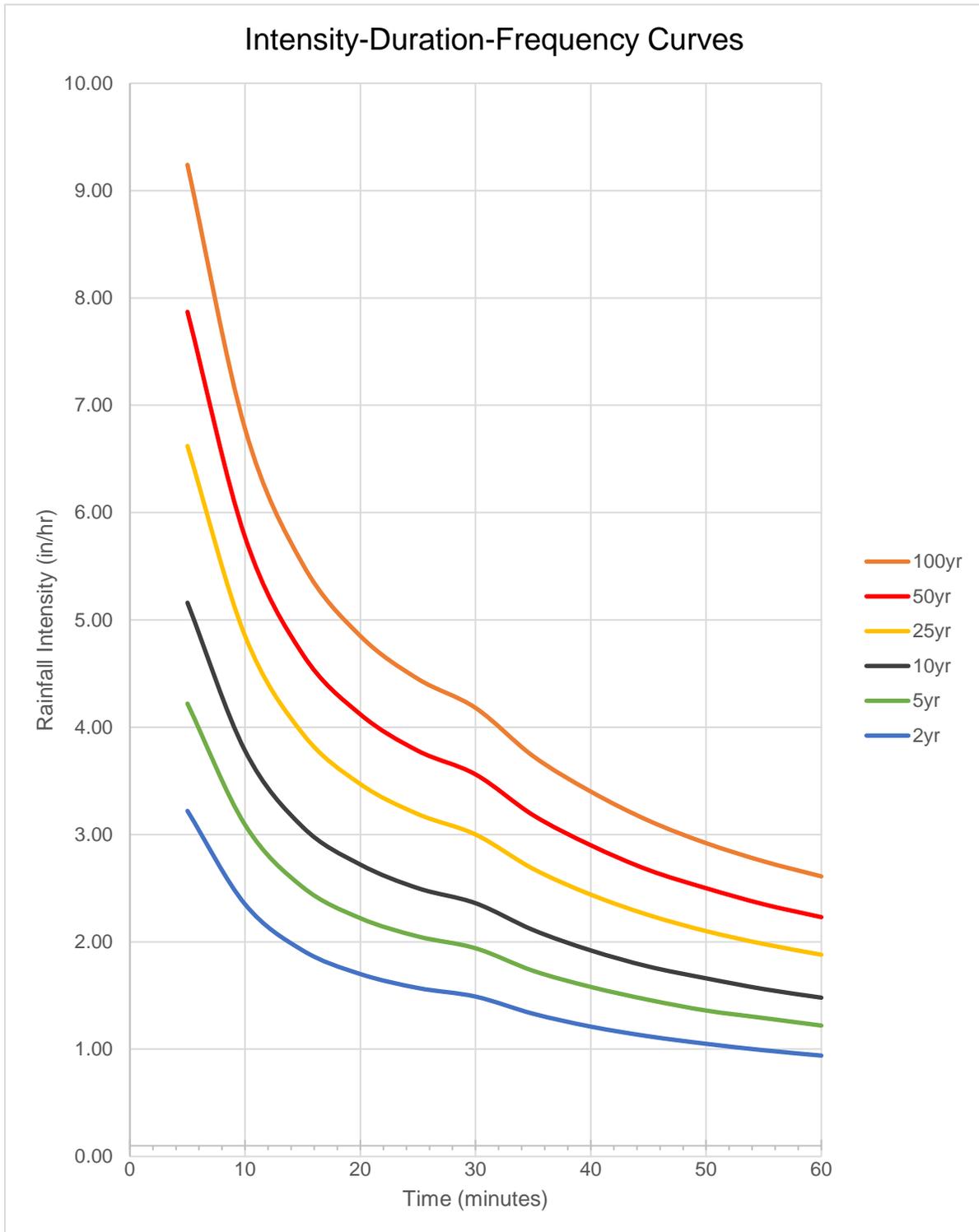


Figure 5-1. Rainfall Intensity-Duration-Frequency Curves for Use with the Rational Method (for Watersheds of 90 Acres or Less)

Chapter 6.0 Runoff

6.1 Introduction

Proper calculation of runoff is critical to planning and sizing of storm drainage facilities. Overestimates of runoff can result in higher cost facilities, while calculations that underestimate runoff can result in loss of life or damage to infrastructure, property, and natural resources.

This chapter identifies methods for determining the storm runoff design peak flow rates and volumes for preparation of storm drainage studies, plans, and facility designs for sites located in the City of Pueblo (City). Background information, equations, examples, and spreadsheets (e.g., *Pueblo-Rational* and CUHP) for these methods should be obtained from the *Runoff* chapter of the MHFD Manual, MHFD's website, and the City's Stormwater Utility website. The Stormwater Management Model (SWMM) for routing runoff also may be downloaded from the MHFD's website or from the Environmental Protection Agency (EPA) SWMM website.

6.2 Runoff Calculation Methods

Several methods for calculating runoff are acceptable for use in the City. These are:

- Rational Method
- Colorado Urban Hydrograph Procedure (CUHP)
- CUHP used in combination with the Storm Water Management Model (SWMM)

Descriptions of these runoff calculation methods are provided in Table 6-1. Criteria for determining which of these methods to use are also summarized in Table 6-1.

Criteria specified in this Manual must be followed for runoff calculations and storm drainage facility designs in the City unless otherwise stated in this manual. In some cases, the City may have detailed hydrologic studies or master drainage plans that may also be used.

Table 6-1. Runoff Calculation Methods Acceptable for Use in the City of Pueblo

Runoff Calculation Method	Application Criteria	Requirements for Use in City of Pueblo
Rational Method	Simple catchments less than 90 acres in size. Do not use when routing of hydrographs is required.	Use the City's <i>Pueblo-Rational</i> workbook 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 in <i>Rainfall</i> chapter for CUHP input.
SWMM	Routes and combines 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 the City has developed detailed hydrologic studies or master drainage plans appropriate for use in the study area.	Use values in published reports unless there is a compelling reason to modify published values.

6.2.1 Rational Method

As stated above, the Rational Method may be used for simple catchments smaller than 90 acres when routing of the hydrograph is not required. The MHFD Manual *Runoff* chapter provides details regarding assumptions and limitations under which the Rational Method may be applied and should be consulted prior to analysis. A customized version of the MHFD UD-Rational workbook with City rainfall data incorporated, the *Pueblo-Rational* spreadsheet, is available on the City's Stormwater Utility webpage. Use of the *Pueblo-Rational* spreadsheet is required by the City when the Rational Method is used to calculate runoff.

6.2.1.1 Rational Formula

The Rational Formula (Equation 6.1) relates peak runoff to the runoff coefficient (the ratio of runoff volume to rainfall volume), rainfall intensity, and the area contributing to runoff:

$$Q = CIA \quad \text{Equation 6.1}$$

Where:

Q = Peak rate of runoff (cfs)

C = Runoff coefficient

I = Average rainfall intensity (in/hr) for the duration equal to the time of concentration

A = Area contributing runoff (acres)

6.2.1.2 Time of Concentration

The time of concentration (TOC) is calculated as the travel time from the furthest point in the watershed to the design point. Both overland flow time and channelized flow time are included (Equation 6.2). The *Runoff* chapter of the MHFD Manual provides details for determining the TOC in urban and rural settings. A minimum TOC of 5 minutes should be used for urbanized, or developed, areas and 10 minutes for non-urban settings. The *Pueblo-Rational* spreadsheet is required for calculation of the TOC. At any design point, the pre-development TOC may not be shorter than the post-development TOC.

$$t_c = t_i + t_t \quad \text{Equation 6.2}$$

Where:

t_c = total time of concentration (minutes)

t_i = overland flow time (minutes)

t_t = channelized flow time (minutes)

6.2.1.3 Rainfall Intensity

Once the time of concentration has been calculated, the average rainfall intensity (in/hr) of a duration equal to the time of concentration at the specified storm event return frequency can be determined.

6.2.1.4 Runoff Coefficient

The runoff coefficient represents the expected ratio of runoff volume to rainfall volume for a storm event. The amount of runoff produced is controlled by several factors influencing infiltration in the watershed, including soil type and amount of impervious

surface cover. The *Runoff* chapter of the MHFD Manual includes guidance for estimating the percent of impervious surface of various land uses and equations for calculating the runoff coefficient for the different National Resource Conservation Service (NRCS) Soil Groups. The *Runoff* chapter of the MHFD manual provides tables with appropriate values for imperviousness and runoff coefficient parameters and may be referenced. A copy of these tables is included in Appendix A of this Manual.

6.3 Assumptions for Storm Flow Analysis

When determining design storm flows, the criteria and guidelines summarized in Table 6-2 (based on the MHFD Manual) must be followed to ensure that minimum design standards and uniform drainage approaches are maintained throughout the City.

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

Analysis Type	Requirements for Use in City of Pueblo
Onsite Analysis	<p>The design of onsite drainage infrastructure should account for the historical runoff from upstream sites, recognizing that runoff from future development must be detained at historic rates. Floodplain mapping will account for detention only from regional facilities.</p> <p>Calculate the time of concentration (TOC) using the <i>Pueblo-Rational</i> workbook for the first design point. At any design point, the pre-development TOC cannot be shorter than the post-development TOC.</p>
Offsite Analysis for the Minor Storm Event	<p>Onsite private detention facilities or regional detention facilities may be accounted for in the evaluation of the minor event runoff flow rate leaving the site for fully developed conditions.</p> <p>Inadvertent storage provided by road crossings, railroad embankments, and similar structures cannot be considered as detention.</p>
Offsite Analysis for the Major Storm Event	<p>Onsite private detention facilities or regional detention facilities may be accounted for in the evaluation of the major event runoff flow rate leaving the site for fully developed conditions. However, floodplain mapping will account for detention only from regional facilities.</p> <p>Inadvertent storage provided by road crossings, railroad embankments, and similar structures cannot be considered as detention.</p>

Chapter 7.0 Streets

7.1 Introduction

The criteria presented in this chapter are to 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, and Storm Drains* chapter of the MHFD Manual (Volume 1, Chapter 7) are incorporated into this Manual by reference and are not repeated herein. The City of Pueblo's Streets and Inlets Hydraulics Workbook, *Pueblo-Inlet*, is required to be used in the hydraulic evaluation of street flows and was used to prepare the figures presented in this chapter.

7.2 Function of Streets in the Drainage System

The primary function of urban streets is for safe and efficient traffic movement. Stormwater drainage and conveyance in streets must be consistent with this function and be designed to minimize the potential for street drainage to interfere with traffic, especially at intersections. When the drainage in the street exceeds allowable limits set forth in Section 7.3, a storm drain system (refer to Chapter 9) or an open channel (refer to Chapter 10) is required to convey the excess flows. Streets are also part of the major drainage system because they carry flows in excess of the minor storm, subject to the limitations described in Section 7.3.

7.3 Allowable Use of Streets for Storm Flows

Allowable use of streets for storm flows is summarized in Table 7-1 through Table 7-3. The minor storm referenced in these tables is the 5-year event and the major storm is the 100-year event.

Street classifications in the City include Local, Collector, and Arterial streets, as defined in the City's *Roadway Classification Design Standards and Policies* (City of Pueblo, 2004). Local roads provide access to and through residential areas or business campus areas with very low traffic generation. Collector roadways function to provide access to and through residential areas, provide runs between neighborhoods and form the outside edge of neighborhoods, and provide local commercial access of "main street" character, such as shopping and employment. Minor arterial streets provide for high-capacity roadways which connect neighborhoods, areas, and regional features with many points of access. Major arterial streets provide for continuous traffic movement connecting neighborhoods, areas, and regional features at higher speeds with limited access.

No curb overtopping during the minor storm is allowed for any street regardless of the street's 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, based on the hydraulic evaluation techniques in the *Streets, Inlets, and Storm Drains* chapter of the MHFD Manual.

Table 7-1. Allowable Use of Streets for Minor Storm Runoff (5-Year Event)

Street Classification	Maximum Street Encroachment
Local and Collector	No curb overtopping. Flow spread must leave at least one 10-ft 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 (100-Year Event)

Street Classification	Maximum Depth and Inundated Area
Local and Collector	Residential dwellings, public, commercial, and industrial buildings must be 12 inches or more 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 be 12 inches or more 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. The extent of flooding shall not extend beyond the street ROW.

Table 7-3. Allowable Cross-street Flow When Cross Pans Are Allowed¹

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.

¹Cross pans are not allowed to convey flow across arterial streets. Cross pans are allowed only at intersections controlled by stop signs on local and collector 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. As noted previously, the hydraulic calculations to be used are provided in the *Streets, Inlets, and Storm Drains* chapter of the MHFD Manual. These calculations use the hydrology developed in the

Rainfall and *Runoff* chapters (Chapters 5 and 6 of this Criteria Manual, respectively) and are subsequently to be used in calculations for inlets and storm drain sizing. The *Pueblo-Inlet* spreadsheet should be retrieved from the City’s website and used in the hydraulic analysis. Table 7-4 lists acceptable roughness coefficients to be used for asphalt and concrete streets in the City.

Table 7-4. Manning’s Roughness Coefficients for use in Hydraulic Calculations

Street and Gutter Material	Manning’s <i>n</i> to be Used in Hydraulic Calculations
Asphalt street with concrete gutter	0.016
Concrete street and gutter	0.013

7.4.1 Allowable Gutter Flow Depths and Spreads

Table 7-5 summarizes the allowable gutter flow depth and flow spread into the roadway for the minor storm event for various City roadway classifications. Table 7-6 provides the same information for the major storm.

Table 7-5. Minor Storm (5-Year Event) - Permitted Flow Spread and Depths

Street Type	Flowline to Flowline Street Width (ft)	Minor Event Criteria	Maximum Allowable Spread (ft)
Local	30	No curb overtopping/ one 10-foot lane free	10
	32		11
	36		13
Collector	36	No curb overtopping/ one 10-foot lane free	13
	44		17
	60		25
Arterial	67	No curb overtopping/ one 10-foot lane free each direction	23.5
	29.5 ¹		19.5
	30 ¹		20

¹Median present, street width based on ½ street

Table 7-6. Major Storm (100-Year Event) - Permitted Flow Spread and Depths

Street Type	Flowline to Flowline Street Width(ft)	Major Event Criteria	Maximum Allowable Spread (ft)
Local	30	Depth not to exceed 1 foot maximum at gutter flow line	15
	32		16
	36		18
Collector	36	Depth not to exceed 1 foot maximum at gutter flow line	18
	44		22
	60		30
Arterial	67	Depth not to exceed 1 foot maximum at gutter flow line/ not to exceed crown/ (whichever is more restrictive)	33.5
	29.5 ¹		29.5
	30 ¹		30

¹Median present, street width based on ½ street

Note: See Pueblo *Roadway Classification Design Standards and Policies* for typical street cross sections.

7.4.2 Allowable Street Capacity Curves

Figure 7-1 thru Figure 7-6 provide the allowable street capacity for the minor and major storm events based on the allowable spread and depths summarized in Tables 7-1, 7-2, 7-5 and 7-6. The *Pueblo-Inlet* workbook was used to generate the plots in Figure 7-1 through Figure 7-6 and complete 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 curves are provided strictly for guidance only; individual hydraulic calculations should be performed using the latest version of *Pueblo-Inlet* based on site-specific information. Other street cross slopes, alternate gutter dimensions, assumptions about capacity behind the curb, among other factors, will yield different results.
2. The reduction factor has been applied based on the *Streets, Inlets, and Storm Drains* chapter of the MHFD Manual (see Figure 7-7). The *Pueblo-Inlet* workbook automatically incorporates the reduction factor.
3. The allowable spread for the minor storm is provided in Table 7-5 for all street types.

4. The maximum allowable flow depth at the gutter flowline is 12 inches for the major event for local and collector streets.
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).
6. Gutter width is 2 feet, based on a standard gutter section.
7. Manning's n is 0.016.
8. Cross-slope is 2%.

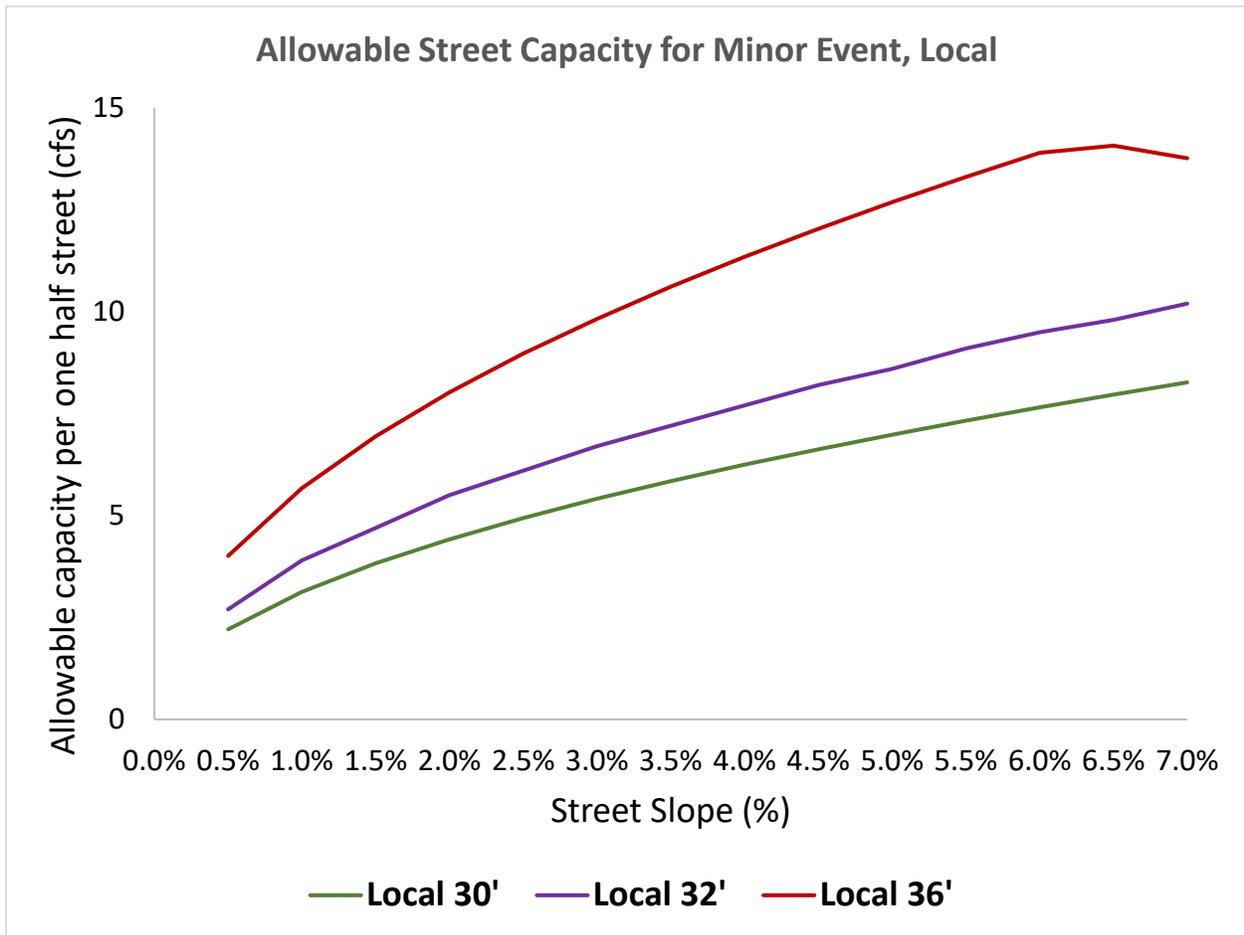


Figure 7-1. Allowable Street Capacity for Minor Event, Local Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)

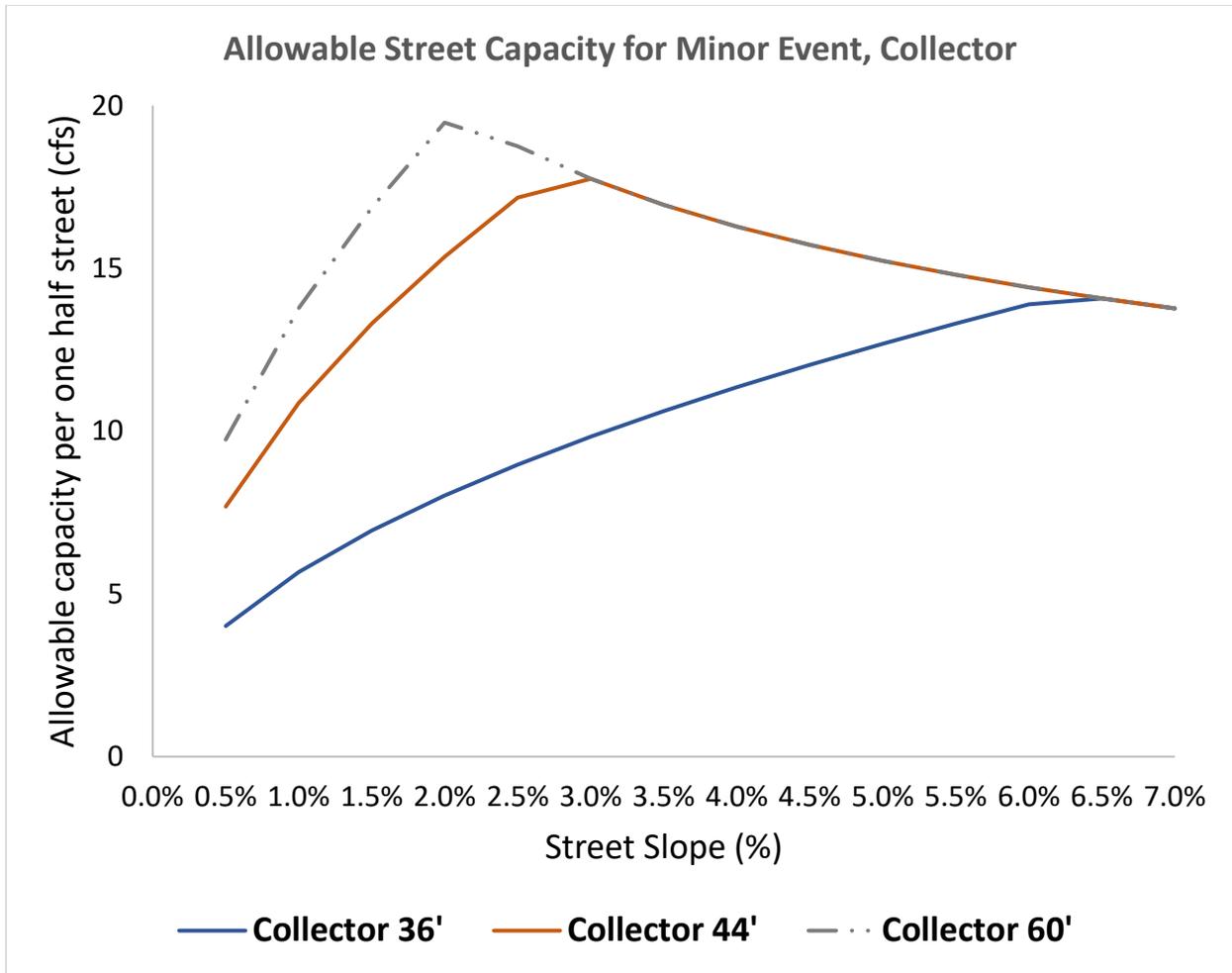
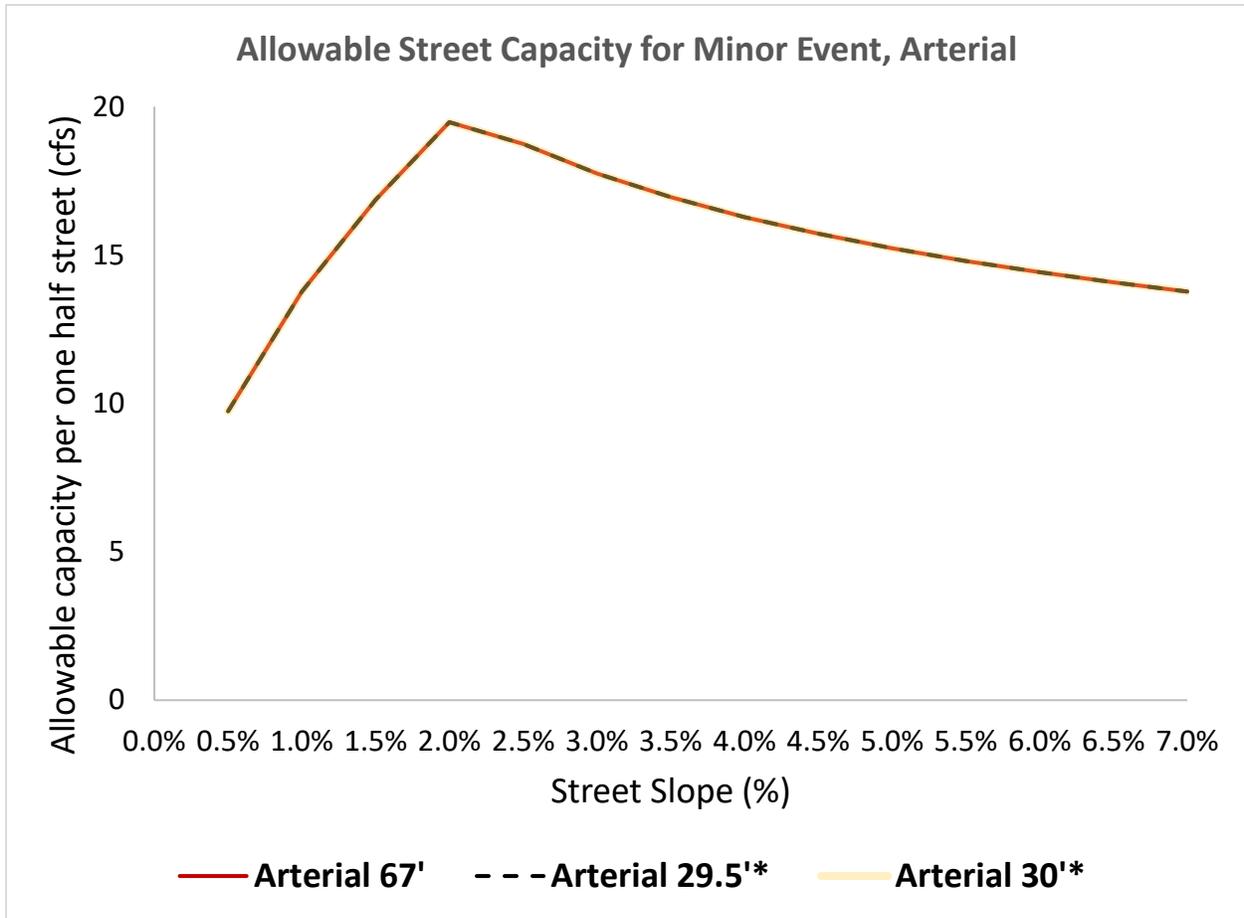


Figure 7-2. Allowable Street Capacity for Minor Event, Collector Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)



*Half of arterial street with median present.

Figure 7-3. Allowable Street Capacity for Minor Event, Arterial Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)

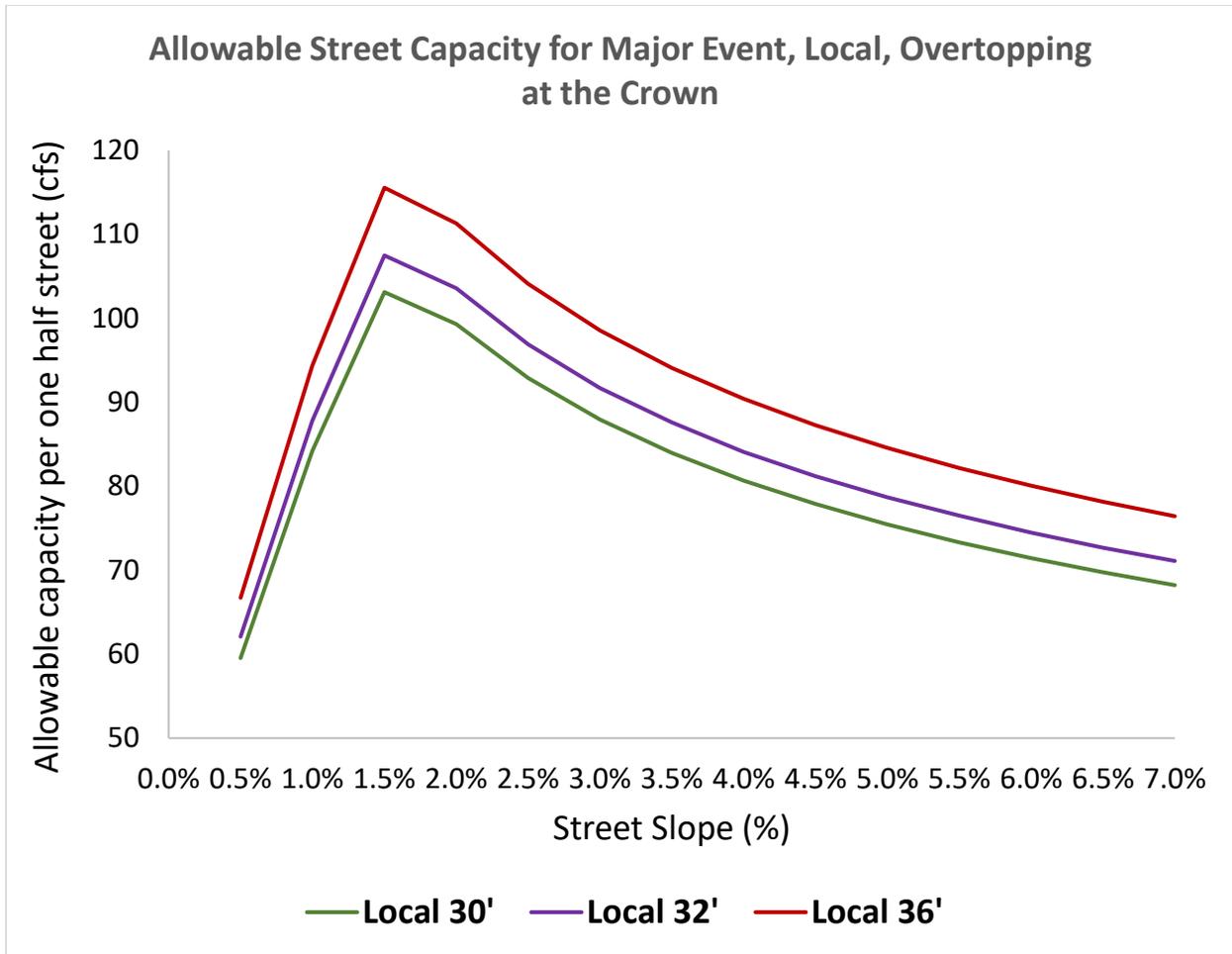


Figure 7-4. Allowable Street Capacity for Major Event, Local Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)

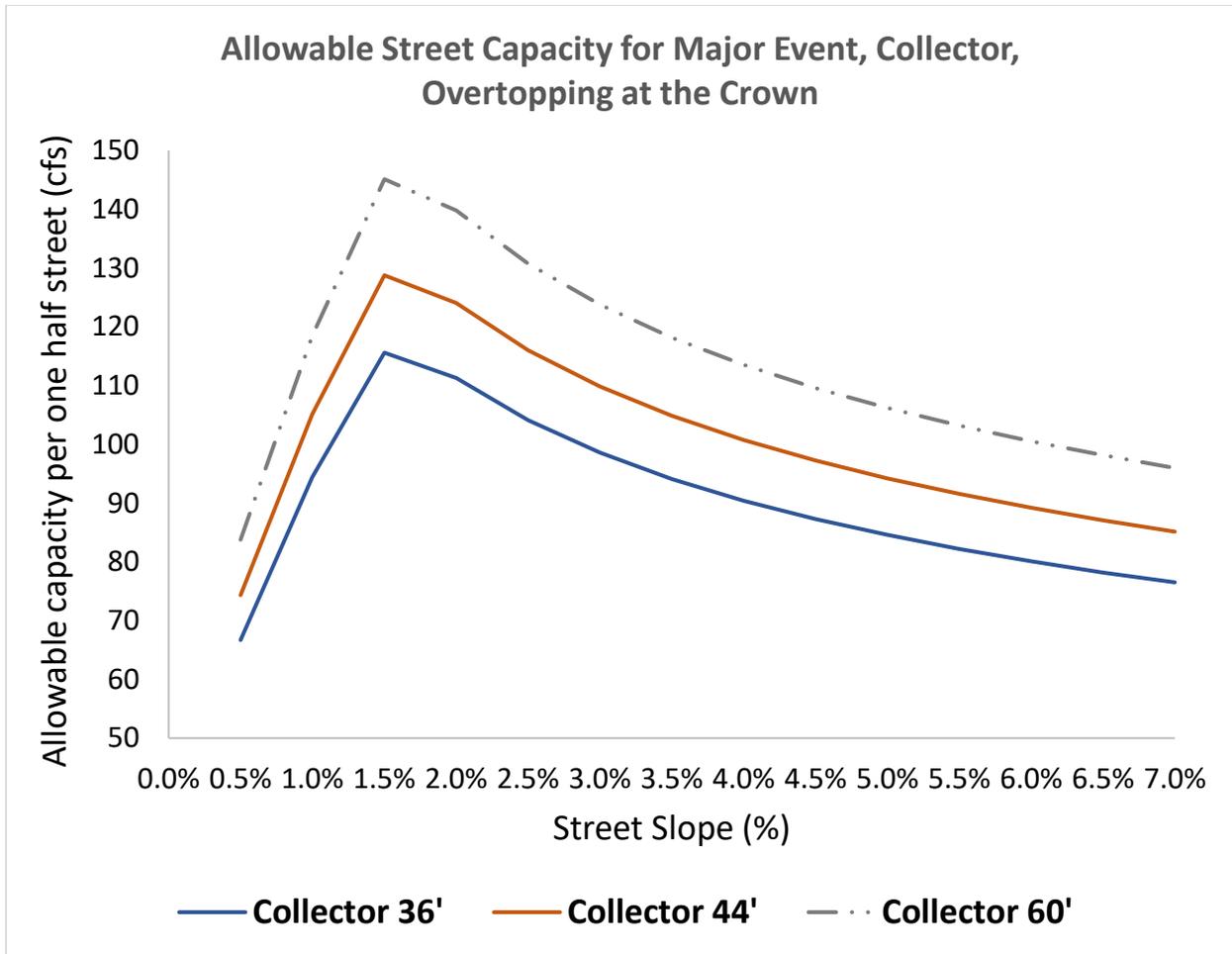
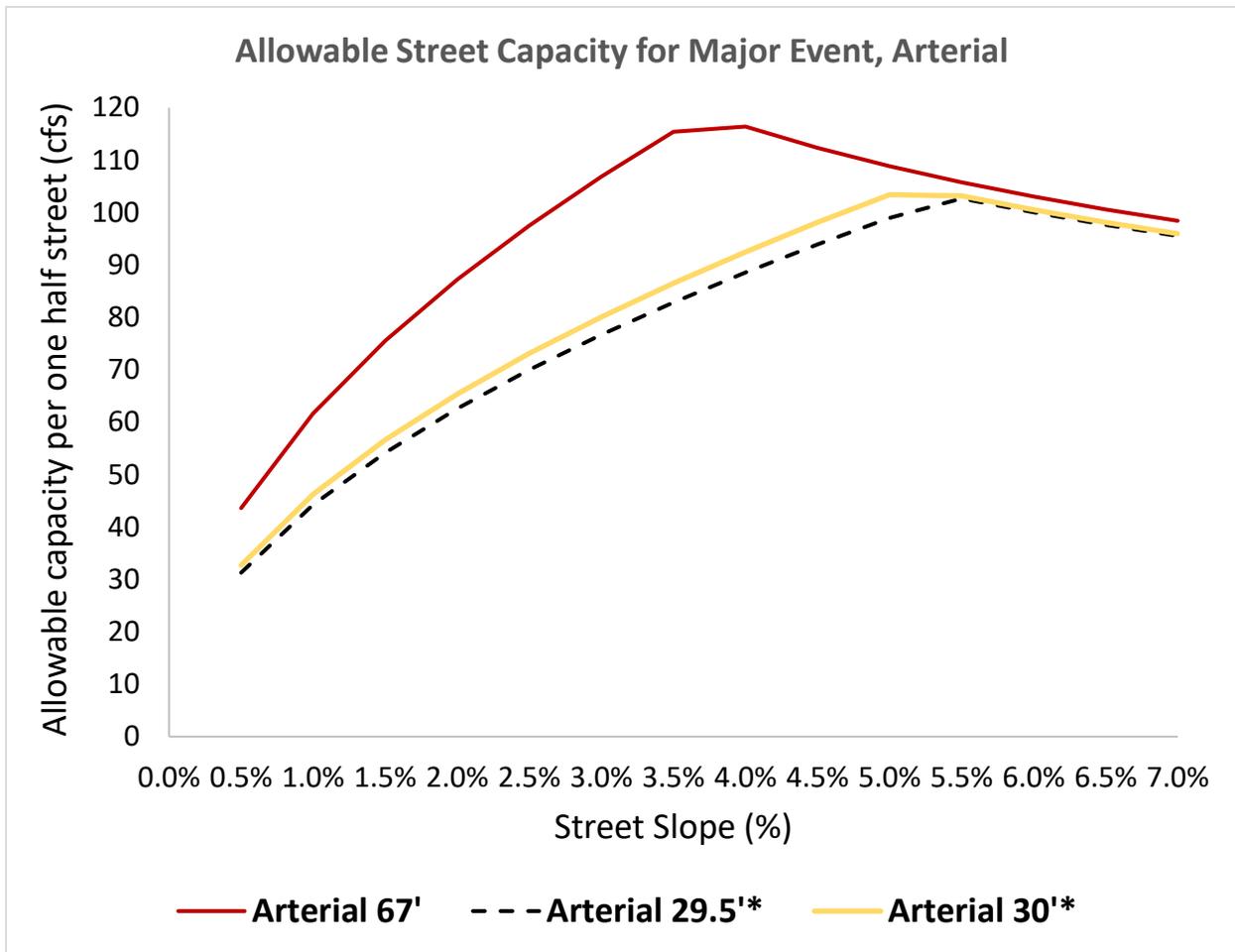


Figure 7-5. Allowable Street Capacity for Major Event, Collector Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)



*Half of arterial street with median present.

Figure 7-6. Allowable Street Capacity for Major Event, Arterial Streets

(Note: See Section 7.4.2 for assumptions used to generate curves)

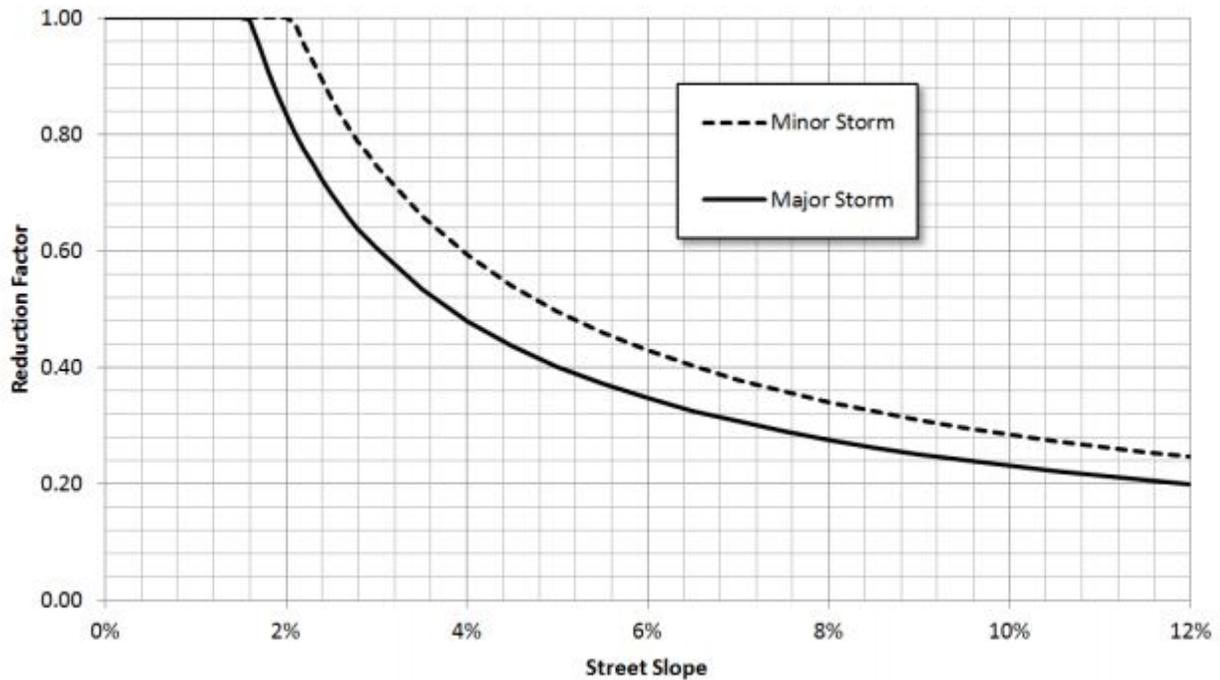


Figure 7-7. Reduction Factors for Gutter Flow

(Source: Guo 2000, per MHFD Manual)

Note: Gutters on steep slopes create elevated flow velocities that can impose a substantial force on pedestrians or vehicles. A reduction factor is applied only to a gutter depth of 6 inches or greater for the maximum gutter capacity based on the allowable flow depth in the gutter, per MHFD-Inlet workbook.

7.5 Design Considerations

All gutter and street drainage design must address the following representative considerations:

1. The primary function of urban streets is for public safety, including for pedestrians and safe traffic movement. Inlets should be placed upstream of intersections wherever practicable to intercept flow before it reaches the intersection. If an inlet is necessary at an intersection because of limited street capacity, it should be placed outside the curb radius whenever possible.
2. The maximum allowable street capacity for the minor event is provided in Table 7-5.
3. 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, and Storm Drains* chapter of the MHFD Manual (Figure 7-7 in this Manual). The *Pueblo-Inlet* workbook incorporates the reduction factor.

4. Nuisance flows must be carried by gutters or pans to an inlet. Nuisance flows are not allowed to impede pedestrian traffic in areas with high pedestrian use or cross a driving lane outside of a gutter or pan.
5. Cross pans are not allowed to cross arterial streets.
6. Cross pans are allowed only at intersections controlled by stop signs on collector and local streets.
7. Manholes in the cross pans are discouraged but will be considered on a case-by-case basis.
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 designer 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. Pavement overlays should be compatible with street drainage criteria.

Chapter 8.0 Inlets

8.1 Introduction

This chapter presents the criteria and methodology for design and evaluation of storm drain inlets located in the City of Pueblo (City). The criteria to be used in the design of storm drain inlets must be in accordance with the *Streets, Inlets and Storm Drains* chapter of the MHFD Manual (Volume 1, Chapter 7), unless modified herein. The review of all planning submittals will be based on the criteria presented in this chapter.

Important basic information on the function and types of inlets includes the following:

- **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, and prior to intersections. 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 the City's right-of-way: 1) curb opening (see Photograph 8-2), 2) grate, and 3) combination (an inlet with both a grate and a curb opening). Inlets are further classified as being on a "continuous grade" or in a "sump." The term "continuous grade" refers to an inlet placed in a 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. A sump condition exists where a low point results in ponded water and an inlet is located at the low point.



Photograph 8-2. Curb opening inlet in City of Pueblo.

8.2 Standard Inlets

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

Table 8-1. Inlet Types

Standard Inlet Types in City of Pueblo	
Inlet Type	Use Permitted
CDOT Type R Curb Opening	All street types
Slotted Inlet Parallel to Flow	Streets or open areas
CDOT Type D	Streets or open areas
CDOT Type C Grate	All streets with a roadside or median ditch
CDOT/Denver 13 Valley Grate	Alleys or drives with a valley gutter (private areas only)
Denver No. 16 Combination	All street types

The City may consider other inlet types 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, and Storm Drains* chapter of the MHFD Manual must be followed for inlet design in the City, except as modified and supplemented herein. Additional information on hydraulic design and placement of inlets is provided below.

8.3.1 Hydraulic Design

The MHFD's Street Capacity and Inlet sizing software has been customized for the City and can be downloaded from the City's Stormwater Utility webpage. The software is required for use with on-grade and sump inlet designs.

8.3.2 Inlet Location

Inlets are required in the following locations:

- Sumps.
- Areas where street capacity would be exceeded without them (e.g., where the allowable design flow spread would be exceeded).
- Upstream of pedestrian curb ramps with less than 1% slope on the curb return

where 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 and should also be placed at least 5 feet upstream of ADA ramps that are not at an intersection. This is particularly critical for flat grades and sump conditions; approximately 20-foot spacing is recommended under these conditions.
2. At locations that are prone to ponding, such as an underpass with a sag-vertical curve, good engineering practice involves placing flanking inlets on each side of the sag location inlet to relieve some or most of the flow burden on the inlet located 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.
9. Unless cross pans have been approved at an intersection, inlets shall also be placed at the upstream side of each intersection in such a manner that the downstream end of the inlet is located not less than ten (10) feet upstream from the point of tangency of the curb radius.
10. The length of an inlet shall not exceed 20 feet, unless approved by the Stormwater Director, and no more than one inlet shall be allowed to be placed adjacent to any residential lot, unless approved by the City.
11. Inlets shall be spaced so as not to interfere with driveway access that meets City roadway standards.
12. The minimum inlet pipe size shall be 15" diameter.

13. Inlets should be placed upstream of intersections to intercept flow before it reaches the intersection. Avoid placement of inlets in the curb return radii to minimize inlet damage from large vehicles.
14. Any redevelopment or upgrades must be brought up to current standards. If existing conditions, such as utility conflicts, do not allow this, then a variance may be applied for.

Chapter 9.0 Storm Drains

9.1 Introduction

Within an urban drainage system, storm drains provide subsurface conveyance of flows to control the depth and spread of runoff in streets and other surface drainage systems. The design of storm drains within the City of Pueblo (City) must be in accordance with the Storm Drain Systems section of the *Streets, Inlets, and Storm Drains* chapter of the MHFD Manual (Volume 1, Chapter 7), except as modified herein.



Photograph 9-3. Manhole covers for the storm drain system in the City of Pueblo alert the public to “No Dumping” because of the system’s discharge into receiving streams.

9.2 Design Storms for Sizing Storm Drain Systems

Two design storms must be considered for sizing storm drain systems: 1) the minor (5-year) storm, and 2) 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 drain system, the applicant must demonstrate that the proposed system will not exacerbate any existing stormwater problems identified by the City. Minimizing peak discharge rates may be required at the discretion of the Stormwater Director.

9.2.1 Minor Event Design Storm

Storm drains must be sized, at a minimum, to convey any minor storm runoff that exceeds the minor event capacity of the street or roadside swales as discussed in Chapter 7, *Streets*. Inlets are located at these critical points to intercept excess flow and route it to the storm drain. To avoid surcharging, storm drains must be designed to convey the minor storm flood peaks while flowing at a maximum of 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 pipe or culvert 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 most, at 80% of the full pipe capacity. To ensure that this objective is achieved, the hydraulic and energy grade lines must be calculated by accounting for pipe 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, and 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 (at end of chapter). This chart assumes that the friction coefficient and Manning's roughness coefficient ("n" value) do not vary with depth, which is a common design assumption for storm drains. The EPA Stormwater Management Model (SWMM) may also be used to design storm drains.

The maximum velocity in all storm drains is 15 feet/second. Storm drains must be designed with a minimum slope of 0.5% that generates a minimum velocity of 3 feet/second at half-full flow conditions.

The final Energy Grade Line (EGL) must be at or below the proposed ground surface for the design event. Flow must not exceed the 80% full capacity 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 Hydraulic Grade Line (HGL) must be 1.0 foot below inlet elevations, or 1.0 foot below ground where no inlets are present.

9.4 Construction Materials

Acceptable storm drain construction materials to be used for all public infrastructure include ASTM C76 Class III reinforced concrete pipe (RCP). High Performance (HP) Storm Polypropylene Pipe manufactured by Advanced Drainage System, Inc. (or approved equal), has also been approved for use in the City's right-of-way and under pavement for City-approved projects. Approved HP Storm Polypropylene Pipe diameters range in size from 15" to 60". Other materials may be considered on a case-by-case basis for private development projects that will not be publicly maintained. Storm drains which are subject to vehicular traffic shall be designed to support all dead loads plus live loads as specified in the City's *Standard Construction Specifications and Standard Details*.

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. Sidewalk chases are separate outfalls and are not subject to these requirements but must demonstrate sufficient hydraulic capacity. Variances may be considered and must be submitted to the Stormwater Director.

9.6 Vertical and Horizontal Alignments

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

Table 9-2. Vertical Clearance Requirements for Storm Drains

Vertical Alignment of Storm Drain Relative to:	Minimum Vertical Clearance (above or below) ¹	Comment
Cover	Minimum cover depends upon the pipe size, type and class, and the soil bedding condition.	A minimum cover of 3 feet must be maintained, except at the pipe terminus, unless otherwise approved by the City. The pipe must not extend into the street subgrade. 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 loading on the pipe (or as designated by the City of Pueblo).
Water Main	18 inches	Approval from the City will be required for lesser clearances.
Sanitary Sewer Main	18 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.

¹Vertical clearance must extend from outside of pipe to outside of pipe.

Table 9-3 provides vertical drop requirements for storm drains.

Table 9-3. Vertical Drop Requirements for Storm Drains

Vertical Alignment of Storm Drain Relative to:	Minimum Vertical Drop (above or below)	Comment
Manholes	0.1 – 0.3 ft depending on the horizontal deflection angle at manhole	The invert of a pipe leaving a manhole should be at least 0.1 feet lower than the incoming pipe for straight runs, 0.2 feet for 0-to-45-degree angles, and 0.3 feet for 45-to-90-degree angles to ensure positive low flows through the manhole.
Drop Shaft Structures	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 <i>Design and Construction of Urban Stormwater Management Systems</i> (WEF and ASCE 1992) for guidelines for drop shaft structures.

Horizontal alignment requirements for storm drains are summarized in Table 9-4. Storm drains parallel to the street must not be placed under the tree lawn (i.e., parking strip) or the sidewalk.

Table 9-4. Horizontal Alignment Requirements for Storm Drains

Horizontal Alignment of Storm Drain Relative to:	Minimum Horizontal Clearance (above or below)	Comment
Water Main or Sanitary Sewer	10 feet	The minimum horizontal clearance between a storm sewer and either a water main or sanitary sewer is 10 feet from outside of pipe to outside of pipe, unless otherwise approved by the City of Pueblo.

In most cases, the 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 when documentation from the pipe manufacturer allowing a curvilinear alignment is provided. 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.

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 diameter of less than 42 inches. The required manhole size shall be in accordance with values in Table 9-5:

Table 9-5. Required Manhole Diameters

Storm Drain Diameter (inches)	Manhole Diameter (feet)
15 to 18	4
>18 to <42	5
42 to 54	6
Larger than 54	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.

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 or handrails in conformance with City building codes and roadway design safety requirements. Guardrails are required in all areas where the drop from the headwall or wingwall exceeds 30 inches. The height of the guardrail 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.

In addition, storm drain inlets in locations where unauthorized entry is likely such as near schools, parks and residential areas, shall be provided with grates, only on the inlet side, that meet specifications described in the *Culverts and Bridges* chapter of the MHFD Manual (Volume 2, Chapter 11).



Photograph 9-4. Riprap protection at storm drain outlet

9.9 Abandonment

Storm drains greater than 8 inches to be abandoned in place, including manholes, must be plugged with clean concrete and standard manufactured plugs or caps at both the upstream and downstream ends of the abandoned section. Flow fill in abandoned pipes may be required by the Stormwater Director if the road or other area prone to problems is susceptible to settlement.

9.10 Easements

Easements are required around all storm drains receiving public water and not in City right-of-way and must be executed with form DPW 110, which can be found on the City's Stormwater Utility webpage. Subdivision easements can be shown on the plat, in

which case a DPW 110 will not be needed. The City requires the following equation be used in the calculation of easement widths:

For a single line storm drain, the easement width shall be:

$$W = B_c + 2H + 3$$

Where W = Required easement width (feet)
 B_c = Outside span of pipe (feet)
 H = Depth from top of pipe to final surface elevation (feet)

W shall be rounded to the next 5-foot increment with a minimum width of 20 feet. The storm drain shall be placed at the center of the easement. Access to easements shall remain open with no fences, unless otherwise approved.

The easement width for multiple line storm drains shall be calculated as a special case and must be approved by the City.

9.11 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. Storm drains must convey the minor storm flood peaks while flowing, at most, 80% of full pipe capacity.
2. EGLS and HGLs
 - a. The EGL must be below the ground surface for the design event.
 - b. The HGL must not be higher than 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.
 - c. Account for all losses in the EGL and HGL calculations including outlet, form, bend, manhole, and junction losses.
3. Provide adequate erosion protection at the outlet of all storm drains.
4. Provide cross section details for riprap protection.
5. Check for minimum pipe cover and clearance with utilities.
6. Check overflow under sump conditions.
7. 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. Exceptions to this requirement must be approved by the Stormwater Director.

8. Construction of an outfall in a mapped floodplain requires a floodplain development permit.
9. Backflow prevention devices such as check valves for storm drain outlets should only be considered as a last option.

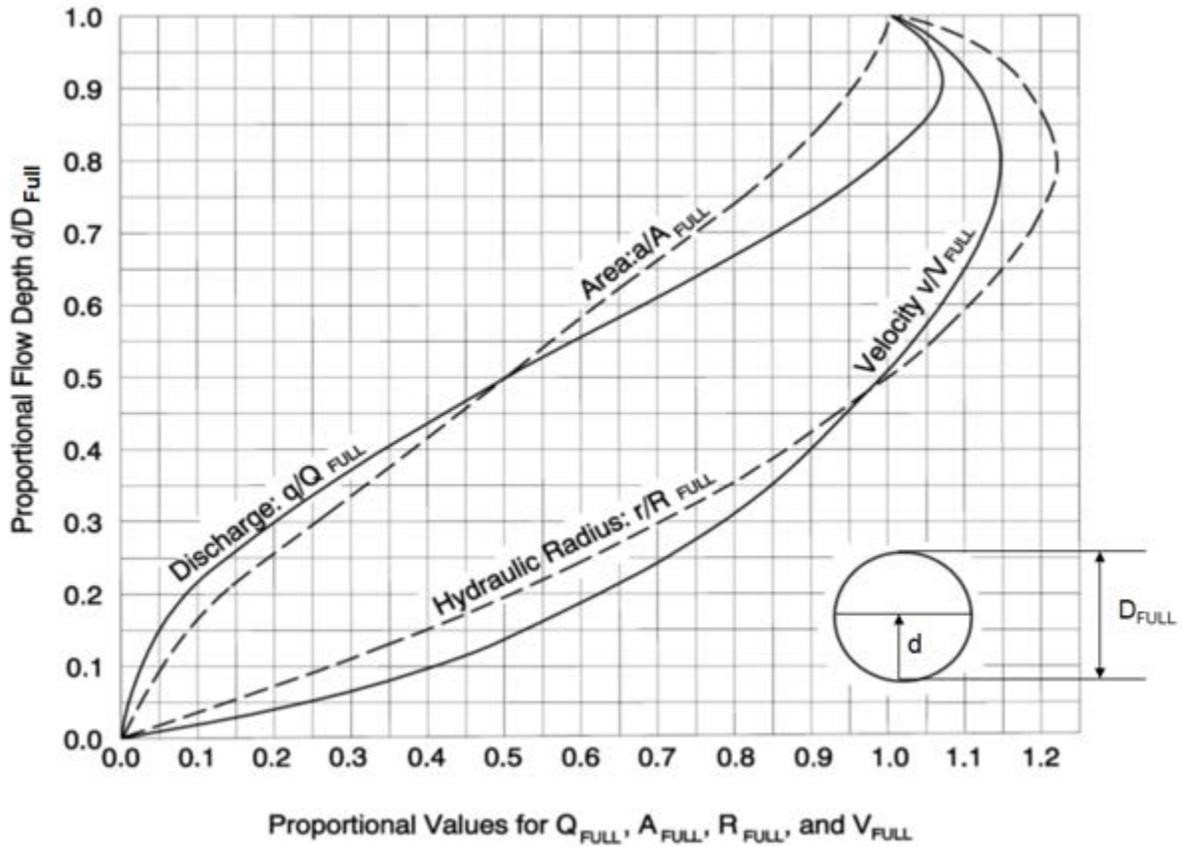


Figure 9-1. Hydraulic Properties of Circular Pipe

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

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Chapter 10.0 Open Channels

10.1 Introduction

Numerous benefits exist with incorporating open channels into urban drainage systems wherever possible, whether they are small swales conveying intermittent runoff, or naturalized channels with perennial flow. In addition to flow conveyance, natural and naturalized constructed channels provide additional benefits not found in piped systems, such as flood attenuation, water quality enhancement, ease of maintenance, riparian and aquatic habitat, as well as community value through recreational opportunities and natural areas.

The City of Pueblo (City) encourages the use of open channels wherever practicable. This chapter provides the minimum technical criteria for the hydraulic evaluation and design of open channels located in the 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

A major drainageway is defined as any drainage flow path with a tributary area of 130 acres or more. Major drainageways in the City include portions of Fountain Creek, Dry Creek, Salt Creek, and their tributaries. In addition, the Arkansas River runs through the heart of the City. A map of the major drainage basins in the City may be found on the City's website.

Major drainageways exist in the City with sandy beds and banks, such as Fountain Creek, as an example, that are especially vulnerable to channel instability because of urbanization and associated hydromodification and erosion. Excessive aggradation or degradation are likely to develop unless design and construction of major drainageway improvements are performed with an understanding of geomorphology and sediment transport.

A primary objective of managing flow in major drainageways in the City is to provide outfalls that have positive drainage through the City and ultimately to the Arkansas River. This is challenging in some locations due to factors that include barriers created by highways, railroads and ditches and the cost to address those obstacles. Nonetheless, for development in the City to occur in a manner that protects public health, safety, and welfare, outfalls for major drainageways are a necessity.

Urbanization and Hydromodification

The increase in impervious surface that accompanies urbanization typically leads to increases in flow peaks and volumes, increased duration of flow events, and decreases in sediment loads. Accordingly, channel erosion and impaired water quality often result when watersheds are urbanized.

10.2.1 Natural Channel Design and Preservation

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 the 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 the City.

8 Principles for Stream Restoration or Naturalized Channel Construction

1. Understand existing stream and watershed conditions
2. Apply fluvial geomorphology principles to manage sediment balance
3. Establish effective cross-sectional shape
4. Maintain natural planform geometry
5. Develop grade control strategy to manage longitudinal slope
6. Address bank stability
7. Enhance streambank and floodplain vegetation
8. Evaluate stream hydraulics over a range of flows

Source: Mile High Flood District Manual, *Open Channels* Chapter

10.2.2 Development Near Existing Channels

Whenever a development alters or improves a major drainageway, the developer(s) are responsible for making revisions to the floodplain mapping at their own expense. A minimum freeboard of 1 foot above the 100-year Water Surface Elevation (WSEL) is to be maintained for the lowest floor (including basement) of all non-critical structures in the channel vicinity. In drainages where the 100-year design flow does not exceed 10 cfs, 6 inches of freeboard is allowed when the channel is not adjacent to insurable structures. In cases where modifications are planned for a drainageway that is mapped by FEMA as having a regulatory floodplain, the developer must schedule a meeting with the City to determine whether a Conditional Letter of Map Revision (CLOMR) will be necessary prior to channel improvements being made.

In addition to the regulatory floodplain requirements, the respective developer responsible for the channel modifications is also responsible for obtaining a 404 permit, as applicable. Filling within the floodplain is generally to be avoided.

10.3 Minor Drainageways

Minor drainageways convey flows from tributary areas less than 130 acres. The minor drainage network provides important functions of flow attenuation and infiltration and should be preserved to the extent practicable. Most channels will need to be improved due to changed upstream conditions. 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. The City encourages the use of vegetated, open channel drainageways for minor drainage systems when feasible.

10.4 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. Evaluating channel and floodplain hydraulics is a key component of any stream project, providing valuable insight into flow properties such as water surface elevation, depth, velocity, shear stress, and Froude Number. Hydraulic design criteria are provided in the *Open Channels* Chapter of the MHFD Manual.

Understanding these flow properties is necessary to assess risks associated with structure flooding and channel erosion and can help guide the design of stream capacity and stabilization improvements. Methods for preliminary channel analysis and hydraulic modeling are described in this section.

10.4.1 Preliminary Channel Analysis

When a preliminary hydraulic analysis is desired for initial conceptual discussions with the City, Manning's equation may be used rather than the detailed analysis provided by modeling software. Assumptions of uniform, steady, and open-flow conditions are required to use Manning. These conditions are mostly theoretical and rarely exist in actuality. Flow computations under these assumptions are approximations only.

10.4.2 HEC-RAS Modeling

The Hydrologic Engineering Center's River Analysis System (HEC-RAS) from the U.S. Army Corps of Engineers (USACE) is the most commonly used software for open channel hydraulic modeling. HEC-RAS is a non-proprietary software and may be downloaded free of charge from the USACE website.

HEC-RAS models must use parameters described in the MHFD chapter on open channels or those documented in the software program. The HEC-RAS Hydraulic Reference Manual is a valuable resource for modeling techniques and parameter selection (USACE, Version 6.0, May 2021 or later, accessible from USACE's website). Justification must be provided for values used that are not consistent with the MHFD Manual and/or the HEC-RAS Hydraulic Reference Manual.

Hydraulic analysis using HEC-RAS is required for the design of major drainageways (i.e., drainages with a tributary area of 130 acres or more) or other drainages with a mapped FEMA floodplain. The use of Manning's Equation is allowed for the hydraulic analysis of minor drainageways (i.e., drainages with a tributary area of less than 130 acres) unless otherwise directed by the Stormwater Director.

10.5 Rock and Boulders

10.5.1 Sizing

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 of the variability associated with conditions in the field which cannot be quantified.

10.5.2 Specifications

Types of channel armoring approved by the City include soil riprap, void-filled riprap, and boulders. Chapter 8 *Open Channels* of the MHFD Manual provides detailed specifications for each.

10.6 Naturalized Channels Design Criteria

Detailed design parameters for naturalized channels are provided in the *Open Channels* Chapter of the MHFD Manual. The following criteria apply to natural channels and constructed naturalized channels within the City:

1. **Design Flows.** Open channels which are used for urban drainage must be

capable of conveying runoff from all tributary areas using the 100-year design storm criteria. Runoff from drainage catchments within the city limits shall be calculated based upon existing zoning maps, assuming fully developed conditions. Runoff from lands outside the city limits shall be based upon existing development and land use, however, sufficient right of way or easement shall be provided to allow for future channel improvements assuming tributary lands outside of the city limits are fully developed.

2. **Master Plan Information.** If 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, the City will provide guidance on the intent of channel improvements.
3. **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.
4. **Regulatory Floodplain Analysis.** A regulatory floodplain analysis must be performed in conformance with City and FEMA floodplain permitting requirements, as approved by the City Floodplain Administrator. Please see Chapter 4 of this Manual, *Floodplains*, for a more extensive description of regulatory floodplain considerations.

Where a natural drainage channel is adjacent to, or within a proposed development, the 100-year floodplain of the channel shall be determined and delineated on the subdivision plat.

The 100-year floodplain shall be established by an engineering analysis which takes into account physical properties of the channel and energy losses along the channel. Appropriate allowances for future bridges or culverts which can raise the water surface profiles and cause the floodplain to be extended shall be included in the analysis. Design flows shall be in accordance with Section 10.6, Item 1. The 100-year water surface profile shall be determined and shown on the drainage plan. Complete documentation shall be included in the drainage report.

5. **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. Within the floodplain, encroachments into areas mapped as floodways are not allowed to cause an increase in the 100-year water surface elevation. Therefore, cut and fill must be carefully evaluated using a hydraulic model to achieve no rise and some export of material may be necessary.

6. **Erosion Buffer Zone.** An erosion buffer zone must be established and delineated on the subdivision plat extending 25 feet beyond the 100-year floodplain for all natural or naturalized channels. Development occurring less than 25 feet from the 100-year floodplain requires a more detailed analysis of channel erosion and floodplain impacts by a professional engineer with specific training and experience in these subjects. Where these analyses are required, a resume of the engineer's training and experience shall be included with the drainage report. Any exception to this requirement must be approved by the Stormwater Director or their designee through the variance process.
7. **Roughness Factors.** Please refer to Appendix A and the *Open Channels* Chapter of the MHFD Manual for guidance regarding recommended roughness factors (Manning's "n" values) for use in hydraulic analyses.
8. **Grade Control Structures.** Where necessary, grade control structures as described in the *Hydraulic Structures* Chapter of the MHFD Manual shall be constructed at regular intervals to decrease the thalweg slope and to control erosion. If used, complete documentation shall be included in the drainage report.
9. **Freeboard.** The minimum freeboard shall be 1 foot above the computed 100-year water surface elevation to the lowest floor (including basement). Freeboard must be provided in major and minor drainageways and shall not be obtained by the construction of levees.

Freeboard shall not be less than that calculated as follows:

$$H_{FB} = 1.0 + V^2/2g$$

Where H_{FB} = freeboard height (feet)

V = average channel velocity (ft/s)

g = acceleration of gravity = 32.2 ft/sec²

In addition to the freeboard calculated above, additional freeboard must be provided at bends to account for super-elevation of the water surface.

An approximation of superelevation, h (ft), at a channel bend with velocity V (ft/s), centerline radius of curvature r_c (ft), and top width of channel, T_w (ft), can be obtained from the following equation:

$$h = V^2 T_w / g r_c$$

The freeboard shall be measured above the superelevation water surface.

Exceptions to the freeboard criteria described above include bridges, which are required to have 3 feet of freeboard relative to the low chord of the bridge or channels with flows less than 10 cfs which require 6 inches of freeboard when not adjacent to insurable structures.

10. **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.
11. **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 Director of Stormwater.
12. **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.
13. **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).
14. **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.
15. **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.
16. **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.
17. **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.

Modification of channels within the normal high-water line may require a U.S. Army Corps of Engineers Section 404 permit. It is the responsibility of the engineer to obtain a 404 permit if required.

18. **Revegetation.** It is important to implement a revegetation plan following any land disturbance activity in or near a drainageway. Vegetation provides stability to channel bed and banks and creates a healthy riparian environment. The *Revegetation* chapter of the MHFD manual provides resources for designing and implementing a revegetation plan. The Pueblo County Colorado State University Extension office website contains links to several documents pertaining to native plants and is another excellent resource for revegetation guidance in the City.

10.7 Maintenance and Easements

All open channels must be designed with adequate maintenance and access provisions and in a manner that facilitates maintenance. The City requires that an Operation and Maintenance (O&M) Manual and Stormwater Facility Maintenance Agreement (SFMA) be completed for all open channels and swales. A copy of the O&M Manual and SFMA are to be provided to both the City and to the owner of the facility or facilities to which they apply. The most up to date forms can be found on the City's Stormwater Utility webpage, along with guidance documents for the preparation of an O&M Manual and SFMA. All drainage reports which include open channel or swale designs must include a Maintenance and Inspection report form to be used by the owner in performing scheduled and post-storm maintenance and inspections. Maintenance and Inspection checklists may be accessed on the Stormwater Utility webpage. Maintenance is the responsibility of the property owner, unless otherwise specified by the Stormwater Director.

Easements are required around all open channels and swales and must be executed with form DPW 110, which can be found on the City's Stormwater Utility webpage. Easements must be wide enough to accommodate flow from the 100-year event, required freeboard, associated facilities, and, if necessary, a 12-foot-wide maintenance access road adjacent to the channel. The required SFMA shall provide for an access easement from the facility to the public right-of-way. Acceptable alternatives will be considered if adequate facility maintenance can be provided. Subdivision easements can be shown on the plat, in which case a DPW 110 will not be needed. However, an SFMA is still required.

Chapter 11.0 Hydraulic Structures

11.1 Introduction

The criteria used for the design of hydraulic structures within the City of Pueblo (City) must be in accordance with the *Hydraulic Structures* chapter of the MHFD Manual (Volume 2, Chapter 9), 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 City of Pueblo Design Criteria

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

1. **Grade Control Structures - Hydraulic Analysis.** The hydraulic analysis of grade control structures may use the simplified design approach for drop structures described in the *Hydraulic Structures* chapter of the MHFD Manual if the criteria for using simplified design procedures are met. Otherwise, the design of grade control structures must use the detailed hydraulic analysis approach described in the MHFD Manual.
2. **Grade Control Structures – Physical Characteristics.** Designers are encouraged to use smaller grade control structures where practicable, such as rock riffles, rather than larger structures that must be heavily engineered to withstand the hydraulic forces to which they are exposed.

Grade control structures must be constructed from grouted stepped boulders or sculpted concrete unless otherwise approved. The net drop height should be limited to five feet or less to avoid excessive kinetic energy and to avoid the construction of overly large structures.

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. Vertical grade control structures (see Photograph 11-5), while discouraged, should not exceed 3 feet to reduce the risk of injury from falling, as well as to reduce the potential for creating dangerous hydraulic conditions.

Existing grade control structures not meeting current 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.



Photograph 11-5. A series of rock riffles is generally a preferred approach for achieving grade control in a channel as opposed to a vertical structure such as the one shown in this photo. Where used, vertical grade control structures should have a drop of less than 3 feet.

- 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 extending to protect the opposite bank must be provided for protection against erosion.

Chapter 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 conveying water, culverts also must carry overhead loads from traffic and other activities, and thereby must satisfy critical structural requirements. 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 relatively 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 for each design. The design of a bridge is 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 City of Pueblo (City). The criteria, techniques, and design examples provided in the *Culverts and Bridges* chapter of the MHFD Manual (Volume 2, Chapter 11), are hereby incorporated by reference and are not repeated herein, unless modified by the City.

12.2 General Design and Hydraulic Evaluation

Detailed information on culvert hydraulics, culvert sizing and design, culvert inlets, and outlet protection is provided in the *Culverts and Bridges* chapter of the MHFD Manual. The MHFD Culverts and Bridges chapter also provides references for additional useful information, including the Federal Highway Administration's 2012 Hydraulic Design Series No. 5, *Hydraulic Design of Highway Culverts* (FHWA 2012).

The sizing of a culvert or bridge depends on several factors including the roadway classification (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 roadway classification, the allowable roadway overtopping depth (if any), and the allowable headwater depth are key design parameters. Overtopping is not allowed for any roadway classification at major drainageway crossings for the 10-year event.

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 City strongly recommends the use of the MHFD-Culvert spreadsheet in the hydraulic evaluation of culverts.

The criteria in this chapter are considered to be 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 Criteria

For street crossings, the minimum culvert size is based on the allowable roadway overtopping for the various roadway classifications as set forth in Table 12-1 and allowable headwater depths as discussed in Section 12.3.4. Street overtopping is not allowed for the 10-year frequency or smaller storm.

Table 12-1. Allowable Roadway Overtopping at Culvert Crossings

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

¹ Refer to Chapter 7, *Streets*, for further discussion regarding allowable flow depth in the street based on street classification.

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 installed beneath local and collector streets shall be designed for runoff from the 10-year design storm. Culverts installed beneath arterial streets shall be designed for runoff from the 100-year design storm.

Culverts installed beneath State Highways shall be designed in accordance with criteria established by the Colorado Department of Transportation.

All culvert designs shall include an analysis that determines whether inlet or outlet control conditions govern.

Ponding above culvert entrances will not be allowed if such ponding will cause property or roadway damage. The limits of ponding area for the 100-year design storm runoff shall be shown on the drainage plan, and drainage easements shall be established to restrict development from within this ponding area.

Culverts discharging into local 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, 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.

12.3.1 Construction Material and Pipe Size

Within City of Pueblo, culverts must be constructed from ASTM C76 Class III reinforced concrete or better. Other materials for construction, including High Performance (HP) Storm Polypropylene Pipe, are subject to written approval by the Stormwater Director. The minimum pipe size for circular culverts within a public right of way is 18 inches, and the same minimum pipe size applies to roadside ditch culverts for driveways. The minimum size for arch culverts is 13.5" x 22", and the minimum size for elliptical pipe is 14" x 23".

12.3.2 Multiple Pipe Culverts

Where multiple-pipe culvert installations have been approved by the City, the spacing between pipes shall be equal to one-half ($\frac{1}{2}$) of the outside pipe diameter or three feet, whichever is less.

12.3.3 Inlet and Outlet Configuration

Within City of Pueblo, all culverts must be designed with headwalls, wingwalls, and aprons, or with flared end sections at the inlet and outlet. Flared end sections are not recommended on pipes with diameters greater than 36 inches where a combination headwall/wingwall configuration may be advantageous. 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. Both must be located a sufficient distance from the edge of the shoulder to allow for a maximum slope of 3 horizontal to 1 vertical to the back of the structure.

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.



Photo 12-1. A twin-barrel culvert with flared-end sections is shown with a grouted rock headwall.

12.3.4 Headwater Considerations

The maximum headwater (H_w) for the 100-year design flows for Arterial streets 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.

12.3.5 Structural Design

As a minimum, all culverts must be designed to withstand an HS-20 loading (unless designated differently by City of Pueblo) in accordance with the design procedures of the American Association of State Highway and Transportation Officials (AASHTO) in *Standard Specifications for Highway Bridges* (AASHTO 2002) and with the pipe manufacturer's recommendation.

For large structures or where groundwater is a problem, the design shall include necessary provisions to resist hydrostatic uplift forces that could result in failure of the structure.

12.3.6 Safety Grates

Consider using safety grates on the inlets of culverts and underground pipes that are accessible to the public. Guidance and criteria in the MHFD *Culverts and Bridges* chapter (Volume 2, Chapter 11) specify when safety grates are required and the respective design criteria. Effects on hydraulic forces, clogging potential, and the effects

of clogging should always be evaluated as they relate to both public safety and hydraulic capacity. Safety grates should not be installed on outlets.

12.3.7 Culvert Design Considerations

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

1. No street overtopping is allowed at culvert crossings for the 10-year storm event.
2. Check minimum and maximum culvert velocities. The minimum flow velocity in a culvert shall be 3 ft/sec using estimated flows from the 5-year design storm. The maximum flow velocity at the outlet should be limited to the maximum channel velocities provided in the *Open Channels* chapter of the MHFD Manual. Where discharge velocities exceed this criterion, an approved energy dissipating structure must be constructed at the outlet.
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, H_w/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 Criteria

The hydraulic design of a bridge is 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 necessitates every bridge project having a unique design. All new bridges must be designed to safely convey 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.



Picture 12-2. Bridge on Union Avenue crossing Pueblo's Historic Arkansas Riverwalk.

12.4.1 Bridge Freeboard

A minimum of 3 feet of freeboard is required for bridges, measured from the 100-year water 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 0.5 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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Chapter 13.0 Detention

13.1 Introduction

This chapter provides technical criteria for the planning and design of detention (storage) facilities. Design criteria in the *Storage* chapter of the MHFD Manual (Volume 2, Chapter 12) are hereby incorporated by reference. Except as modified herein, all detention facility designs within the City of Pueblo (City) must be in accordance with the MHFD Manual.

The main purpose of a detention facility is to store excess storm runoff associated with increased watershed imperviousness and to release the excess runoff at a rate similar to the rate generated by the watershed without development, for a range of storm events described further below.

Detention of flood flows is required for all development and redevelopment projects that add more than 5,000 square feet of impervious area. The purpose of the requirement is to reduce urban drainage problems as well as reduce the costs of maintaining drainage facilities. All redevelopment projects that are already impervious may be required to detain as required by the Stormwater Director if the area is deemed to be a flood area.

For sites less than 1 acre, the City strongly recommends the use of sand filters or bioretention facilities. Extended detention basins are not recommended for smaller sites as the smaller diameter orifice plate openings plug easily.

Pumped detention basins are not allowed to serve as permanent water quantity or quality control measures for any development within the 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 store water until a permanent, gravity outfall is available. The City may approve such temporary pumped detention basins as an interim solution during construction until a permanent outfall is built. Such special design considerations must be reviewed and approved by the Stormwater Director or their designee.

Full Spectrum Detention (FSD)

FSD is a storage-based approach to managing stormwater runoff which provides benefits 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 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 offset some of the impacts that urbanization has on the downstream drainage network.

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: 1) the water quality capture volume (WQCV), 2) the excess urban runoff volume (EURV), and 3) the 100-year event volume.

In the City, the WQCV is considered to be a “nested” part of the EURV and the 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 of the detention facility, 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 in Section 13.8.5 below.

13.3 Integration of Water Quality and Flood Control Detention

FSD integrates water quality and flood control detention through a process shown 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. Major Steps for Integrating Full Spectrum Detention and Water Quality into Storage Facilities in the City of Pueblo

Step 3. Size the EURV and 100-year Storage Volume:

- Check that WQCV drains in appropriate draw down time for the type of practice (12 – 40 hours, depending on BMP)
- Check that the EURV drains in less than or equal to 72 hours

Step 2. Calculate the WQCV for the Measure to be Integrated with FSD:

- Bioretention
- Sand Filter
- Extended Detention Basin
- Retention (Wet) Pond
- Constructed Wetland Basin

**Step 1. Select & Design Runoff Reduction Measures:
(Required on all projects)**

- Grass Buffers/Swales
- Unconnected Impervious Area (direct shallow drainage to receiving pervious areas)

Note: Stabilizing drainageways and providing source control measures are two additional steps in the MHFD’s Four Step Process for 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 (SCMs¹) listed in Figure 13-1 that may be used to provide WQCV treatment include the following:

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 measures is provided in Chapter 14 of this Manual.

Water quality and flood control detention are required for all projects that disturb more than 1 acre. Detention measures must also be implemented for sites that fall below this threshold, but which involve an increase in impervious area of at least 5,000 square feet. The City strongly recommends the use of bioretention facilities and sand filters in sites less than 1 acre.

Stormwater management approaches that involve avoiding detention requirements based on timing of hydrographs from design storms (e.g., discharging from the pond to beat the peak flow rate in the channel) will not be accepted by the City as justification for a variance.

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

- Chapter 14 of this Manual (*Stormwater Quality*)
- *Storage* chapter of the MHFD Manual (Volume 2, Chapter 12)
- *Stormwater Quality* volume of the MHFD Manual (Volume 3)

13.4 Regional Detention Facilities

Regional Detention Facility Criteria:

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

¹Historically 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 used to describe stormwater quality management practices in the City’s Phase II MS4 Permit.

2. The regional detention facility is constructed or will be constructed in phases with the development; otherwise, temporary detention must be provided.
3. Legally binding ownership and maintenance responsibilities by a public entity are clearly defined to ensure the proper function of the facility in perpetuity.
4. There is adequate conveyance of the fully developed flows from the site to the regional detention facility.
5. Design of the regional detention facility is completed in accordance with the MHFD Manual and the requirements in Colorado Revised Statutes (CRS) §32-11-221(1) for drainage facilities. All regional facilities must satisfy the design, construction, and vegetation criteria in the most current version of the MHFD Manual. 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 should 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, it is desirable when good design can avoid creating embankment heights that trigger state dam safety regulations for jurisdictional dams.
 - c. Regional detention basins must be located on existing publicly owned lands wherever possible.
 - d. Regional flood control detention facilities must incorporate the regional WQCV for stormwater quality regardless of whether developments upstream of the regional facility 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 by the design of appropriate facilities. 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 of structures adjacent to ponds are 1.0 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 and, if necessary, to

inform the design of control measures, as needed, to mitigate the potential effects of the development related to seepage.

13.6 Maintenance and Easements

All detention facilities that require periodic maintenance must be designed to allow for all-weather, stable maintenance access. Slopes for haul road surfaces should not exceed 10%. Skid-loader and backhoe access surface slopes should not exceed 20%. Stabilized access includes concrete, articulated concrete block, concrete grid pavement, reinforced grass pavement, or geogrid designed to support the weight of maintenance vehicles. The recommended cross slope is 2%. Maintenance access also includes providing storage and staging areas for sediment and debris removal during maintenance activities.

To ensure proper maintenance of control measures is being performed, the City requires that an Operations and Maintenance (O&M) Manual and Stormwater Facility Maintenance Agreement (SFMA) be completed for all detention facilities. A copy of the O&M Manual and SFMA are to be provided to both the City and to the owner of the facility or facilities to which they apply. The most up to date forms can be found on the City's Stormwater Utility webpage, along with guidance documents for the preparation of an O&M Manual and SFMA. All drainage reports which include detention pond designs must include a maintenance and inspection report form to be used by the owner in performing scheduled and post-storm maintenance and inspections. Maintenance and Inspection checklists for each stormwater detention facility may be accessed on the Stormwater Utility webpage. Maintenance is the responsibility of the property owner, unless otherwise specified by the Stormwater Director.

Easements are required around all detention facilities to ensure adequate long-term operation and maintenance and must be executed with form DPW 110, which can be found on the City's Stormwater Utility webpage. The City requires that easements for detention facilities be wide enough to contain storage, freeboard and associated facilities. Easements shall also be provided for potential emergency spillway discharge, to the receiving drainage easement or right-of-way. Acceptable alternatives will be considered if adequate facility maintenance can be provided. Subdivision easements can be shown on the plat, in which case a DPW 110 will not be needed. However, an SFMA is still required.

If the owner fails to maintain the control measures, the SFMA gives the City the right to access the drainage easement via public ROW, abutting private roadway, and/or private driveway to perform the needed maintenance. In special cases, the City will agree to take over maintenance, in which case, 12 ft wide vehicular maintenance access must be provided as follows: 1) from public ROW or public property to the detention facility, 2) around the perimeter of detention facility, and 3) to the bottom of the detention facility.

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 Colorado 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.

The responsibility for filing plans and specifications with the SEO shall rest with the developer or engineer and, accordingly, adequate time must be allowed for the review process by the SEO to take place. City approval of the detention facility is contingent upon approval by the State Engineer.

Certification that the dam was constructed in accordance with approved plans and specifications shall be provided to the City by a qualified geotechnical engineer upon completion of construction. The cost of this certification shall be borne by the developer.

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. Refer to Table 14-2 in the *Stormwater Quality* chapter of this Manual for guidance on stormwater facility reporting requirements. Colorado water law requires that 97% of the 5-year or smaller 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 the 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 Storage Volume

Detention basins should be sized to accommodate the 100-year storage volume and provide a release rate that does not exceed the 100-year historic flow. Acceptable methods for sizing detention facilities in the City include the *Pueblo-Detention* workbook (recommended), as well as hydrograph routing using CUHP and SWMM.

Inflows to the detention facility shall be calculated assuming fully developed conditions in the tributary basin.

13.8.2 Grading Requirements

Grading requirements for stormwater detention facilities located in the City of Pueblo must be in accordance with Table 13-1. All slopes must be 4:1 or milder. The use of retaining walls for detention facilities is generally not preferred by the City due to safety and maintenance concerns.

Table 13-1. Grading Criteria for Detention Facilities

Slope Description	Criteria
Earthen embankment slopes	No steeper than 4 (horizontal):1 (vertical)
Bottom slope of detention facilities	No less than 2%, toward the low flow (trickle) channel

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 graded to be at least 2 feet above the observed high groundwater elevation.

13.8.3 Detention Pond Location Relative to Floodplains

Wherever possible, stormwater quality and detention facilities should be located outside of FEMA-designated 100-year floodplains, so 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 the 100-year floodplain, and through a variance process, the City may consider approval of a facility within the 100-year floodplain provided that it is located outside of and above the 10-year floodplain level defined in the Flood Insurance Study or based on a separate analysis accepted by the Stormwater Director.

13.8.4 Retaining Walls

While the use of retaining walls for detention facilities is not encouraged, the City recognizes they are sometimes necessary, particularly in higher density urban areas. In general, however, their use is not preferred due to safety and maintenance concerns and their use is discouraged. 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 or when used for outlet structures. Long-term maintenance access, safety, and aesthetics are important design considerations.

Walls may not be continuous around a detention facility to 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 the City, a railing will be required for any retaining walls exceeding a height of 30 inches (as measured from the ground surface 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 licensed professional engineer must perform a structural analysis of retaining walls that exceed 48 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 the City for review. The structural design details and requirements for the retaining wall(s) must be included in the construction drawings.

13.8.5 Emergency Spillway and Freeboard

The design flow for the emergency spillway of detention facilities is the 100-year undetained flow from the contributing watershed for fully developed watershed conditions. This criterion is to address a scenario with a plugged outlet structure and a full pond during the 100-year runoff event. 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 100-year flow with the outfall structure in a 100% blocked condition. For ponds with a depth of three feet or less, the required freeboard is 0.5 foot above the water-surface elevation when the emergency spillway is conveying the 100-year flow with the outfall structure in a 100% blocked condition. Parking lot detention requirements differ, as explained in Section 13.8.12.

The engineer shall analyze the emergency flow path of the spillway back to the natural drainageway. Documentation of the spillway design, dam protection and emergency flow path analysis shall be included in the Drainage Report.

Some conditions may require more stringent emergency spillway criteria than presented in the *Storage* chapter of the MHFD Manual. When a storage facility's size dictates that it be subject to the requirements of the SEO as a jurisdictional 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.

13.8.6 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. A forebay or equivalent pre-treatment facility is required for all detention basins. Riprap is not considered to be pre-treatment. Alternative designs may be considered with the City's approval.

13.8.7 Low Flow (Trickle) Channel

All grassed-bottom detention basins must include a low flow (trickle) channel designed according to the *Extended Detention Basin Fact Sheet* in Volume 3 of the MHFD Manual. The MHFD Manual has options for concrete-bottom and vegetated low flow channels. Vegetated low flow channels can provide enhanced water quality benefits and may be considered when site conditions are appropriate, with approval of the Stormwater Director.

13.8.8 Outlet Configuration

The MHFD Manual and website provide design guidance, design details, and examples for several detention facility outlet configurations. See the *Outlet Structures 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 the City must incorporate the following:

1. The 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 the required drain times stipulated in the *Storage* chapter (Chapter 9, Volume 2) and in the Treatment BMPs chapter (Chapter 4, Volume 2) of the MHFD Manual. The 100-year orifice control typically is located at the entrance to the outlet pipe. The *Pueblo-Detention* workbook can be used for sizing the openings of the orifice plate and other outlet hydraulic controls.
5. If orifices are 1 inch 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 Structures* Fact Sheet in Volume 3, and the well screen (or bar grating as appropriate) must extend to the bottom of the micropool.

13.8.9 Landscaping Requirements

Detention areas and embankments should be designed and constructed to blend with their surroundings to create 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, with the exception of outlet structures, though these types of concrete may be allowed in industrial areas. Existing drainage patterns should be preserved whenever possible.

Above-ground detention basins should be vegetated in accordance with the criteria in the *Revegetation* chapter (Chapter 13, Volume 2) of the MHFD Manual. When determining landscaping, enhancement of the basin aesthetics and long-term maintainability of the facility should be high priorities. The following is a list of guidelines for basin landscaping (adapted from the Douglas County Storm Drainage Criteria Manual, 2008):

1. In areas that will be viewed by the public, detention facilities should be designed to fit into the surrounding landscape and should add to the overall character of an area. The shape of a detention basin should be as natural looking as practical, with terracing of the slopes and a bottom that slopes toward the low flow (trickle) channel. The tops and the toes of slopes should vary, and undulation in the shape and grading of the sides of the detention area is encouraged. In industrial settings with restricted public access, a natural-looking appearance is typically less important, and other factors such as ease of maintenance may be a higher design priority. 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 helps 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 they do not interfere with maintenance and so that tree roots will not cause structural problems. Native and perennial species should be used to the extent practical.
3. The use of wood mulch in and adjacent to detention facilities is discouraged because of the potential for mulch 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 in areas located 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 in cases where the storm drain pipe discharges higher up on the pond embankment, rundowns may be needed to minimize erosion at inflow points. Where rock or concrete rundowns are used, they should be compatible with the overall design, including the aesthetics of the facility.



Photo 13-1. A neighborhood detention basin blends into the surrounding landscape and functions as an attractive open space area and community amenity.

13.8.10 Multiple Use Considerations

Utilizing detention facilities for multiple uses is encouraged; however, it is critical to minimize conflicting uses. In some portions of the City, including areas of residential development, multi-use facilities that provide benefits related to aesthetics, wildlife, and recreation are desirable. However, detention facilities conflicts with recreation uses may result from the time required for a detention area to drain and dry out, safety in areas used for children's recreation, mosquito-borne illness concerns (e.g., West Nile virus), and protection and enhancement of wildlife. In other settings, such as industrial areas, detention facilities may not be compatible with objectives such as recreation, though other multi-uses such as combining stormwater management with parking may still be beneficial.

Considerations for multi-use detention facilities include the following:

- 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 including the proposed level of organized recreation activities versus informal or passive recreation in a park.
- Technical constraints and opportunities including terrain, soil characteristics, turf management, and irrigation requirements.
- Compatibility of a park with the planned scale of a detention facility. For example, proposing to use a small neighborhood park (under 5 acres) would likely not be appropriate for a large detention facility.
- The configuration and easements for underground utilities and their impact on the existing park land.
- The potential for total rehabilitation of existing sites to accommodate multi-purpose uses.
- Integration with other aspects of the open space system, including the potential for new natural areas and wildlife corridors.
- Recognition that a multi-use detention facility does not allow for any direct, active use of the water impounded in or passing through the facility. For example, water may not be pumped out of the detention facility may not be used for irrigation purposes.
- Consideration of maintenance and operations, including successful techniques for dealing with silt, debris and trash, and the funding resources for maintenance. These considerations should be reflected in the facility Operation and Maintenance (O&M) manual.

13.8.11 Roadway Embankment Protection

In cases where a detention pond uses a roadway embankment to contain stormwater, the embankment shall be protected from catastrophic failure due to overtopping. Overtopping can occur when the pond outlets become obstructed or when an event with a return frequency greater than 100-years occurs. Protection of the embankment from failure caused by erosion at the emergency overflow may be provided in the form of a buried heavy riprap layer (such as Type H riprap with a d50 of 18 inches) on the downstream face of the embankment or a separate emergency spillway with a minimum capacity of twice the maximum release rate for the 100-year storm. Structures shall not be permitted in the path of the emergency spillway or overflow. The invert of the emergency spillway should be set equal to or above the 100-year water surface elevation.

13.8.12 Parking Lot Detention

Parking lot detention is allowed in the City with a maximum depth of 12 inches and freeboard of 6 inches for the 100-year design storm. All parking lot detention areas must have signs posted identifying the detention basin area. The signs must have a minimum area of 1.5 square feet with the following message:

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

Multiple options for suitable materials, geometry, and number of signs are permissible, subject to approval by the Stormwater Director or their designee.

13.9 Underground Water Quality and Detention Facilities

Underground water quality and detention facilities are prohibited in the City, unless approved through the variance process, 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, underground facilities are prone to not receiving regular maintenance or performance evaluations.
- Maintenance access may be more complex, which can be a deterrent to performing routine maintenance. Additionally, confined space entry and special safety requirements may apply, depending on the installation.
- Anaerobic conditions in bottom sediments (i.e., an absence of dissolved oxygen) are more likely to develop in underground devices. This condition can release pollutants bound to the sediment and result in bad odors.
- Vegetation within above-ground systems provides benefits in addition to stormwater management, including the reduction of urban heat, improvement of habitat for wildlife and vegetation, and removal of air pollutants.

Generally, sufficient land exists in the 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 not feasible. The use of underground practices requires a variance request and approval by the Stormwater Director. The following criteria must be met for consideration of underground practices:

1. The applicant has demonstrated that surface-based practices are not feasible. Analysis by the applicant must include an evaluation of alternative site layouts, consideration of reduced density of development, and sizing and conceptual design of surface-based practices to demonstrate that surface-based water

quality and detention 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 underground storage facility, including arrangements for regular inspection and maintenance using appropriate equipment for the type of underground facility being proposed.
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 and will meet the criteria for underground SCMs described in Volume 3 of the MHFD Manual.

13.10 Design Standards for Retention (Wet) Ponds

13.10.1 Allowable Use

Refer to the *Storage* chapter and *Retention Pond* Fact Sheet of the MHFD Manual for allowable uses for retention ponds. The City allows retention ponds to be used as a water quality practice, but water rights are required for ponds used for this purpose. Retention ponds used to achieve water quality requirements 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 the City of Pueblo.

The City may require any existing retention ponds be converted to detention (fill and drain) facilities as soon as an adequate outfall is available to receive flow releases from the facility. This requirement is necessary 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 retrofitted to achieve these drain time criteria to comply with Colorado water law; otherwise, a water right must be obtained (CRS §37-92-602(8) Frequently Asked Questions, 2015).

13.10.2 Design Standards for Retention Ponds

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

13.11 Summary of Key Design Considerations

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

1. Slope grading (Section 13.8.2).

2. The bottom elevation of the detention basin storage area must be at least 2 feet above the observed high groundwater elevation. Groundwater inflow into detention systems is not allowed (Section 13.8.2).
3. Finished floor elevations and freeboard of structures located near detention basins (Section 13.5).
4. Emergency spillway and emergency overflow path (Section 13.8.5).
5. Maintenance access to structures such as inlets, forebays, low flow (trickle) channel, outlet and spillway (Section 13.6).
6. Low flow (trickle) channels (Section 13.8.7).
7. Trash racks and micro-pools at all outlet structures (Section 13.8.8).
8. Signage (Section 13.8.8 and 13.8.12).

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Chapter 14.0 Stormwater Quality

14.1 Introduction

The City of Pueblo (City) requires permanent stormwater control measures (SCMs), formerly referred to as best management practices (BMPs), to be implemented at development and redevelopment projects. The purpose of SCMs is to reduce erosion and the transport of sediment and other stormwater pollutants in order to improve the water quality in 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 Wildhorse Creek.

Stormwater Control Measure 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).

Additional information regarding the current water quality condition of stream segments in the City of Pueblo may be accessed through the Colorado Department of Public Health and Environment (CDPHE) (<https://cdphe.colorado.gov/clean-water-gis-maps>) or the Environmental Protection Agency (EPA) (<https://mywaterway.epa.gov/>). The City incorporates Volume 3 of the MHFD Manual as the basis for its stormwater quality design criteria.

14.2 MS4 Permit

14.2.1 Areas Included in MS4 Permit

Development sites with one acre or more of land disturbance and located within the MS4 permit boundary are subject to Post-Construction Stormwater Management in New Development and Redevelopment Control Measure Requirements as outlined in General Permit No. COR090000. The current MS4 boundary in Pueblo County may be found on the Colorado Department of Public Health and Environment (CDPHE) website (see Stormwater Utility webpage for link). Current base design standards include the following parameters. Specific standards may be found in the City's current MS4 permit.

- Water Quality Capture Volume (WQCV) Standard: Requires treatment or infiltration of the WQCV.
- Pollutant Removal Standard: Requires treatment to reduce the mean concentration of Total Suspended Solids (TSS).
- Runoff Reduction Standard: Requires infiltration, evaporation, or evapotranspiration of a specified percentage of the WQCV.

At a minimum, new and redevelopment sites are required to meet one of the base design standards. The user should refer to the current MS4 general permit prior to the implementation of stormwater control measures to ensure the proposed design will meet the current standard. A link to the current MS4 permit may be found on the CDPHE website or the City’s Stormwater Utility webpage.

14.2.2 Non-Standard MS4 Permits

Certain public entities, such as the airport, school districts, and universities, require a non-standard MS4 permit for their stormwater discharges. Any non-standard MS4 permittee sharing a border with the City is required to have a Memorandum of Understanding (MOU) with the City. Facilities with a non-standard MS4 permit must coordinate with the Colorado Department of Public Health and Environment.

14.2.3 Areas Outside MS4 Permit

Development and redevelopment occurring in areas located outside the MS4 permit boundary are required to utilize runoff reduction practices as much as practicable. This includes disconnecting impervious areas and directing runoff to an RPA (Receiving Pervious Area).

14.3 Applicability

All development and redevelopment projects in the City must implement SCMs to enhance the quality of stormwater runoff. A description of permanent SCM requirements is provided in Table 14-1. For construction-phase stormwater quality measures, refer to Chapter 15, *Construction Site Stormwater Management and Erosion Control*.

Table 14-1. Permanent Stormwater Quality Control Measure Requirements

Project Conditions	Runoff Reduction ¹	Permanent Stormwater Quality Control Measure Requirements ²
Total Impervious Area < 5,000 sq. ft.	Encouraged, but not required	Encouraged, but not required.
Total Impervious Area ≥ 5,000 sq. ft. and Disturbance < 1 acre	Required	Minimize the amount of directly connected impervious area to the extent practicable. ³
Total Disturbance ≥ 1 acre	Required	Must satisfy one of the MS4 permit design standards (for the area of disturbance).

¹Runoff reduction through disconnection of impervious areas to receiving pervious areas is required for all projects to the maximum extent practicable. This must be done in a way that does not cause adverse impacts to adjacent structures or property.

²Detention requirements for flood control are addressed in Chapter 13, *Detention*.

³Directly connected impervious area is impervious area that drains to a storm drain system or stream without flowing over surfaces that would allow for infiltration. It is recognized that for redevelopment of infill sites, minimizing directly connected impervious area may not be practical in some cases.

If a proposed development or redevelopment is part of a larger common plan of development or sale, then requirements in Table 14-1 apply based on the size of disturbance of the larger common plan, as defined below. When post-construction SCMs are required, stormwater controls based on the WQCV 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 “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.

14.4 Design Approach

Stormwater quality management in the City is based on the “Four-Step Process” to minimize the adverse impacts of urbanization on stormwater, as described in Volume 3 of the MHFD Manual and illustrated in Figure 14-1. The Four Step Process for effective stormwater management involves the following:

- 1) Runoff reduction
- 2) Treatment of the WQCV
- 3) Stream stabilization
- 4) Pollutant source controls

Additionally, the City encourages integration of water quality and flood control in Full Spectrum Detention facilities, as discussed in Chapter 13 *Detention*.

This chapter focuses on the first two steps of the Four-Step Process, specifically:

- 1) Runoff reduction (i.e., disconnection of impervious areas to drain to pervious areas).
- 2) Treatment of the WQCV.

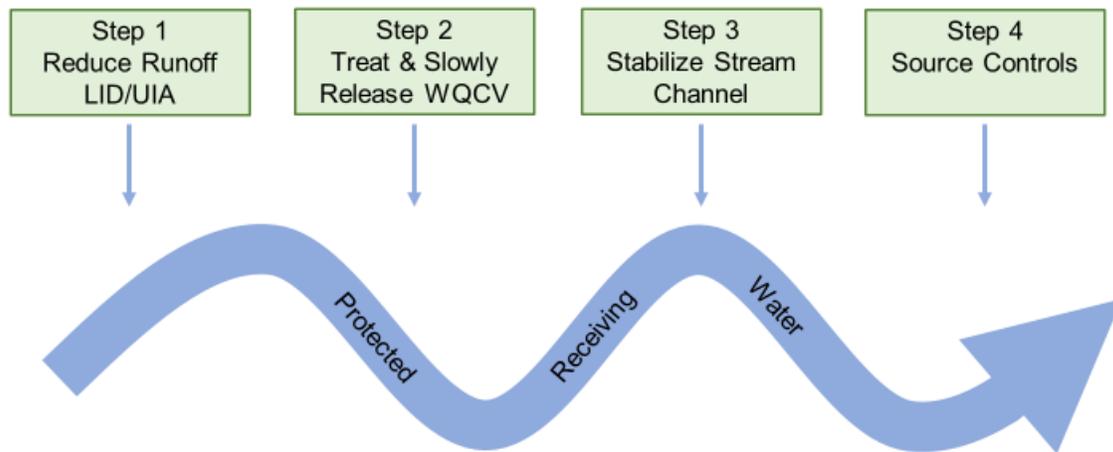


Figure 14-1. MHFD’s Four-Step Process for Stormwater Quality Management

With respect to Step 1, runoff reduction, the 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 disconnection of directly connected impervious area is required to the maximum extent practicable.

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. The 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 14.4.3, below, for additional information on this subject.

To effectively implement runoff reduction practices on a site, it must be considered early in the land development planning process. On some small sites, it may be possible to achieve stormwater quality management requirements solely by draining disconnected impervious areas to receiving pervious areas to infiltrate the WQCV. On larger sites, though the implementation of runoff reduction practices may not fully satisfy the stormwater quality management requirements, the runoff reduction may be used to reduce the size of WQCV facilities.

The City adopts the MHFD’s method for quantifying runoff 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 therefore 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. Temporary construction fence can be an effective measure for this purpose. In areas where disturbance cannot practically be avoided, rototilling and soil amendments should be integrated to improve the infiltration capacity of areas that will be restored with vegetation.

14.4.1 Scale of Application

There are three general approaches for providing stormwater quality treatment in the City:

1. Onsite facilities – used to serve individual lots.
2. Sub-regional facilities – used to serve two or more lots with a total contributing drainage area of less than 130 acres.
3. Regional facilities – used to serve drainage areas between 130 acres up to one square mile and which may be applicable for larger development and redevelopment projects. (Note: regional facilities that provide stormwater quality treatment must comply with the regional detention facility requirements described in Chapter 13 *Detention*).

If sub-regional or regional facilities provide stormwater quality treatment, then the following conditions must be met consistent with the City's MS4 permit:

1. **Runoff Reduction Requirement:** Before discharging to a water of the state, at least 20% of the upstream impervious area of the applicable development site must be disconnected from the storm drainage system; the impervious area must 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 or swales. This criterion applies only to disconnection of small onsite impervious areas via drainage as sheet flow to pervious, vegetated areas—other sizing criteria may be more restrictive.
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.

Waters of the State

The City's Phase II 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."

The contributing drainage area is an important consideration both at the site scale and at the regional scale. At the site scale, there is a practical minimum size for certain SCMs, which is largely related to the ability to drain the WQCV over the required drain time. For example, in most situations, extended detention basins are not recommended for sites with less than 1 acre of imperviousness. While it is technically possible to size the WQCV for an extended detention basin for a half-acre site, designing a functional outlet to release the WQCV over a 40-hour drain time is very difficult due to the small orifices that would be required. For a half-acre watershed, a bioretention SCM is typically 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 one square mile.

14.4.2 Design Criteria

Design of SCMs in the City must follow the procedures in Volume 3 of the MHFD Manual. All the types of SCMs included in Volume 3 are applicable in the City. The City will consider other types of SCMs, not included in Volume 3, on a case-by-case basis.

14.4.3 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 (e.g., HSG C), 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 for infiltration-based SCMs 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 used. Potential resources for identifying known or suspected contamination are provided in Table 3-3 in Chapter 3, *Submittals*. Figure 14-2, below, 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. As stated in the Submittals chapter, provide infiltration test results, and reference or append any geotechnical studies performed. See Chapter 4 of Volume 3 of the MHFD Manual 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.

14.4.4 Safety

SCMs must be designed and maintained in a manner that protects the safety of both the public and maintenance personnel. Refer to Volume 3 of the MHFD Manual for safety requirements and considerations.

14.4.5 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.

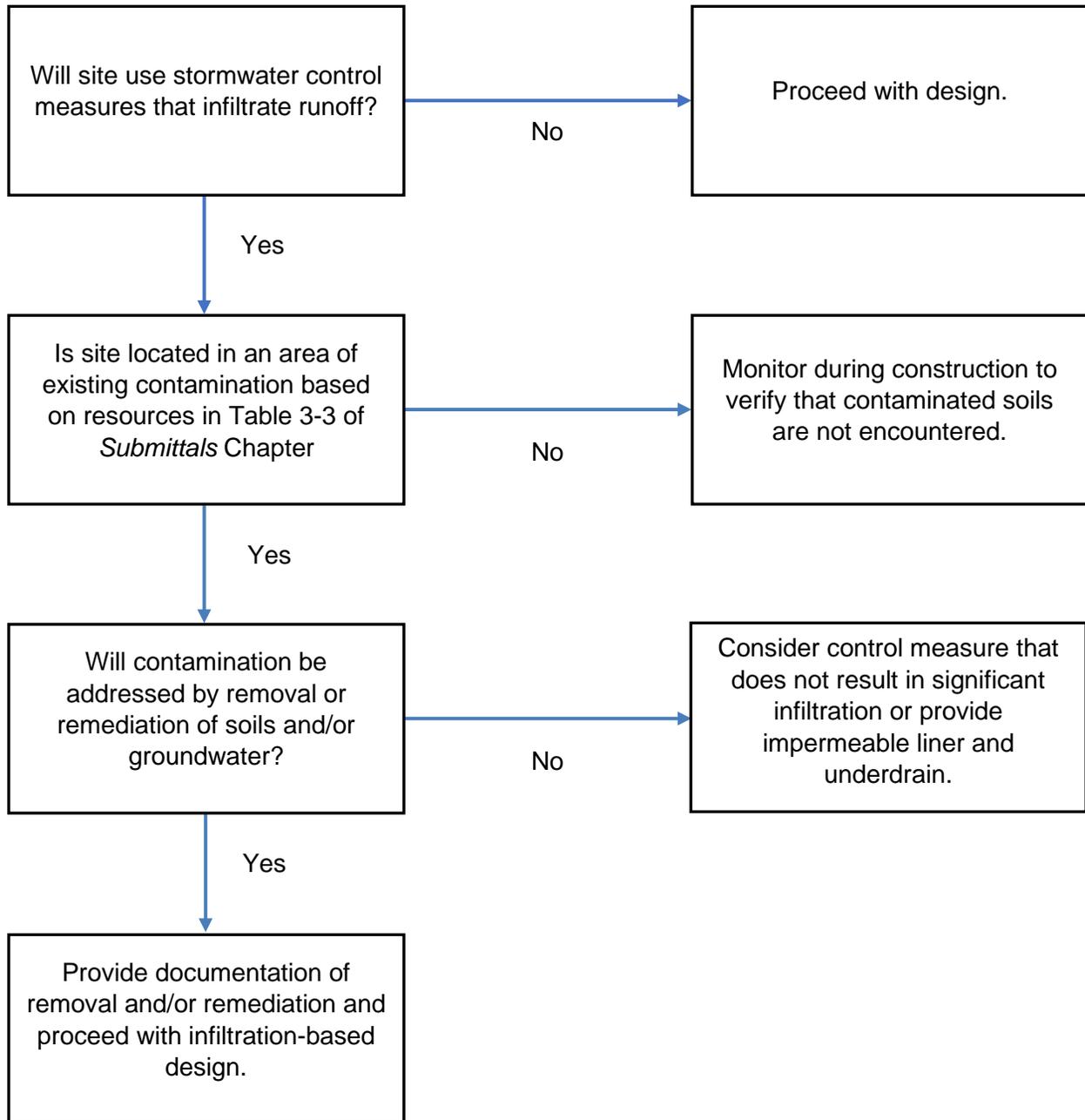


Figure 14-2. Flow Chart for Sites with Potential Contamination

14.4.6 Maintenance and Easements

The City requires a Stormwater Facility Maintenance Agreement (SFMA) for all water quality facilities to ensure proper maintenance of control measures is being performed. 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 (O&M) Manual and SFMA be completed for all permanent SCMs. A copy of the O&M Manual and SFMA are to be provided to both the City and to the owner of the facility or facilities to which they apply. The most up to date forms can be found on

the City's Stormwater Utility webpage, along with guidance documents for the preparation of an O&M Manual and SFMA. All drainage reports which include water quality facility designs must include a Maintenance and Inspection report form to be used by the owner in performing scheduled and post-storm maintenance and inspections. Maintenance and Inspection checklists for each water quality facility may be accessed on the Stormwater Utility webpage. Maintenance is the responsibility of the property owner, unless otherwise specified by the Stormwater Director.

Easements are required around all water quality facilities by the City's MS4 permit to ensure adequate long-term operation and maintenance and must be executed with form DPW 110, which can be found on the City's Stormwater Utility webpage. The City requires that easements be wide enough to contain storage, associated facilities, and a 12-foot-wide maintenance access road around the perimeter and to the nearest public right-of-way. Acceptable alternatives will be considered if adequate facility maintenance can be provided. Subdivision easements can be shown on the plat, in which case a DPW 110 will not be needed. However, an SFMA is still required.

If the owner fails to maintain the control measures, the SFMA gives the City the right to access the drainage easement via public ROW, abutting private roadway, and/or private driveway to perform the needed maintenance. In special cases, the City will agree to take over maintenance, in which case, 12 ft wide vehicular maintenance access must be provided as follows: 1) from public ROW or public property to the detention facility, 2) around the perimeter of detention facility, and 3) to the bottom of the detention facility.

14.5 Water Rights 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 the following 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 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.).
5. If it is in the Fountain Creek (tributary to the Arkansas River) watershed it must be required by or operated in compliance with an MS4 permit.

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, which may be accessed from the City’s Stormwater Utility webpage. This information must be filed prior to operation of the facility and include the following:

1. Location.
2. Approximate surface area at the design volume.
3. Data that demonstrate the facility has been designed to comply with the release rate requirements described above. The Stormwater Detention and Infiltration Design Data (SDI) Worksheet (downloadable from the MHFD website as the *Compliance Design Data Workbook*), or acceptable alternative calculations for upload to the State Compliance Portal, demonstrating compliance with state law regarding maximum detention drain times must be submitted to the state. While much of the information in this workbook overlaps with the *Pueblo-Detention* workbook, the SDI Worksheet is in the correct format for the State Engineer’s Office portal and its use is recommended for the purpose of demonstrating compliance with state law. *Pueblo-Detention* should still be used for other computations.

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 14-2.

Table 14-2. 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	N/A
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	

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.

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Chapter 15.0 Construction Site Stormwater Management and Erosion Control

15.1 Introduction

The City of Pueblo (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. The City's program complies with its Colorado Discharge Permit System (CDPS) Municipal Separate Storm Sewer System (MS4) permit requirements and the City of Pueblo Municipal Code.

This chapter identifies the triggers for an Erosion and Sediment Control Plan (ESCP) or Stormwater Management Plan (SWMP) and describes the minimum technical criteria for stormwater management and Stormwater Control Measures (SCMs), also referred to as Best Management Practices (BMPs), to control erosion and sediment transport at construction sites. This chapter incorporates by reference Chapter 7, *Construction Best Managements Practices* (BMPs), in Volume 3 of the Urban Storm Drainage Criteria Manual (MHFD Manual) pertaining to the design and implementation of construction related SCMs.

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 City of Pueblo's Construction Site Stormwater Management Policies

The City's construction site stormwater management policies include the following:

1. All construction activities² disturbing at least 1,000 square feet are required to address erosion, sediment, and potential chemical water quality issues by

² The City's MS4 permit defines construction activities as "ground surface disturbing and associated activities (land disturbance), which include, but are 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."

submitting an ESCP or SWMP to the City and the Stormwater Utility Division for review, unless proven to be exempt under *Exclusions* in the City's MS4 permit. If an exemption is to be made, a letter must be submitted stating which applicable exclusion the construction activity falls under. Construction activities with one acre or more of land disturbance are required to obtain coverage under the CDPS General Permit for Stormwater Discharges Associated with Construction Activities, COR400000. Submittal of a SWMP must be included in the application for coverage and must also be submitted to the City's Stormwater Utility for review. Instructions for completing an ESCP or SWMP may be found on the City's Stormwater Utility webpage. Instructions for SWMPs can also be found on the CDPHE website, and developers should refer to the current COR400000 permit to ensure state requirements are met. Additional guidance for best management practices for construction site stormwater management can be found in the *Construction BMPs* chapter of Volume 3 of the MHFD Manual.

2. All construction projects are subject to implementing SCMs at construction sites. Inspections and escalating enforcement actions by the Stormwater Utility may occur from the beginning of site demolition or site grading until the site has achieved final stabilization and any required permits are closed. The City may initiate enforcement under its illicit discharge program if 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 Stormwater Director on a case-by-case basis. Factors such as project type, size, duration, soil type, site slope, and proximity to waters of the state³ 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 Construction Activity Requirements

15.3.1 Plan Triggers

For all construction activities disturbing at least 1,000 square feet, the City requires the submittal of an Erosion and Sediment Control Plan (ESCP) or Stormwater Management Plan (SWMP) depending on the area of land disturbance (Table 15-1). As a requirement for coverage under the state's Stormwater Construction Permit, the SWMP must also be submitted to the state. It is the developer's responsibility to submit the SWMP to both the City and the state. Guidance documents for the preparation of each plan are available on the City's Stormwater Utility webpage. The State's current Stormwater

³The City's Phase II 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."

Construction Permit requirements should be referenced on the CDPHE website in preparation of the SWMP to ensure all current requirements are met.

15.3.1.1 Erosion and Sediment Control Plan (ESCP) Triggers

This section outlines the conditions under which an ESCP is required to be completed and submitted to the City.

1. The construction site results in land disturbance of at least 1,000 square feet, but less than 1 acre.
2. The construction site is under 1,000 square feet but meets one of the following conditions:
 - a. The project site has been identified by the 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).
 - b. The project site is known to contain contaminated soils on site or has a pre-existing condition warranting special care during construction.
 - c. The project site discharges runoff directly into waters of the state.

15.3.1.2 Stormwater Management Plan (SWMP) Triggers

This section outlines the conditions under which a SWMP is required to be completed and submitted to the City.

1. Construction activities that result in land disturbance of 1 acre or greater or are part of a larger common plan of development⁴ disturbing 1 acre or greater.

⁴ “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.

Table 15-1. Requirements for Erosion and Sediment Control for Construction Activities

Project Conditions	Erosion Sediment Control	Erosion Sediment Control Measure Requirements
Total Disturbance < 1000 square feet	Not required	SCMs should be implemented as needed to prevent illicit discharges
Total Disturbance > 1,000 square feet and < 1 acre	Required	Erosion Sediment Control Plan (ESCP)
Total Disturbance ≥ 1 acre	Required	Stormwater Management Plan (SWMP)

15.3.2 Requirements for Construction Site Stormwater Control Measures

All construction sites must implement SCMs to minimize the discharge of pollutants from all potential pollutant sources during all phases of construction at the site. No clearing, grading, excavation, filling, or other land disturbing activities shall be permitted until the City approves the ESCP or SWMP. After the plan is approved, 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.

These conservation measures shall apply to all on-site features, as well as to the protection of individual lots. During all phases of construction, it shall be the responsibility of those who initiate such land disturbing activities to maintain all erosion control features in a functional manner. 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 developer must implement structural and/or nonstructural SCMs that effectively minimize erosion, sediment transport, and the release of other pollutants related to construction activity.

15.3.2.1 Erosion and Sediment Control

SCMs for erosion and sediment control may involve a variety of options, which include but are not limited to the following: 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 which is discharged into storm sewer inlets 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(s) 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).



Photo 15-1. Examples of sediment control and inlet protection during construction activities

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, such as a grass swale).
5. **Perimeter Controls:** Perimeter control measures must be installed along the

edge of the construction site to filter and control surface runoff leaving the 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. Where in close proximity to receiving waters, redundant perimeter controls are advised because of 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 cannot be accomplished, it is incumbent on the applicant to demonstrate why drawing water from the surface or near the surface is not feasible.
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.⁵ 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 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.
 - c. Where practicable, provide cover or appropriate temporary stabilization to avoid direct contact of precipitation with the stockpile and to minimize the potential for sediment discharge.

⁵ See *Topsoil Management Guidance* accessible at mhfd.org for additional information on topsoil management.

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.

15.3.2.2 *Other Common Pollutants*

In addition to erosion and sediment control, the 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. If site conditions do not allow for discharge of concrete washout water to the ground, then containment for the concrete washout water must be used.

15.3.2.3 *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 the climate prevent stabilization. The ESCP or SWMP must document the constraints necessitating the alternative schedule, provide the alternate

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

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 ESCP or SWMP is established at the required density. The 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. The Pueblo County Colorado State University (CSU) Extension office serves as a resource for native planting guides.
 - 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 the City.

15.3.2.4 Site Specific Requirements

In addition to the minimum requirements identified above, the 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, sandbag 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 criteria in the MHFD Manual for construction in waterways. Examples of SCMs in waterways 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. 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 the City, short-term groundwater dewatering permitting by the CDPHE Water Quality Control Division, and/or Clean Water Act Section 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 ESCP or 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 the City on requirements for a Water Control Plan based on site-specific conditions and anticipated hydrology.
4. **Contaminated Site:** The ESCP or 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 other applicable plans for the City or CDPHE.
 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, spatial 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 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 ESCP or SWMP must clearly show limits of construction and must call out construction fence or other means to protect resources that are to be preserved.

Information regarding acceptable SCMs and proper installation can be found in Volume 3 of the MHFD Manual, the CDOT *Erosion Control & Stormwater Quality Guide*, and any City of Pueblo approved details on the Stormwater Utility webpage.

15.3.3 Maintenance and Corrective Actions

The developer 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 an SCM requiring routine maintenance must be conducted to maintain the SCM in an effective operating condition.

The developer 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 SCM becomes necessary, then corrective actions must be implemented and documented in the ESCP or SWMP.

15.4 Erosion and Sediment Control Plan (ESCP) Requirements

The City requires an Erosion and Sediment Control Plan (ESCP) be developed for all construction sites disturbing at least 1,000 square feet but less than 1 acre. Guidance for the development of the ESCP can be found in Appendix C and on the City’s Stormwater Utility webpage. The ESCP must be submitted to the City prior to commencement of land disturbing activities. Once the submitted ESCP is accepted by the Stormwater Utility, it becomes an enforceable part of the Construction Permit. The ESCP

Construction sites greater than 1,000 square feet and less than 1 acre are required to submit an **Erosion and Sediment Control Plan (ESCP)**.

Construction sites 1 acre or more, or less than 1 acre and part of a larger common plan of development 1 acre or more, are required to submit a **Stormwater Management Plan (SWMP)** to the City and obtain a Construction Stormwater Discharge Permit from CDPHE.

must be implemented as written and updated during the project, from commencement of construction activity until final stabilization is complete.

A copy of the ESCP 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 the City.

15.5 Stormwater Management Plan (SWMP) Requirements

Each construction site with an area of disturbance of 1 acre or more and/or which is part of a larger common plan of development that disturbs 1 acre or more requires the development of a SWMP in accordance with good engineering, hydrologic, and pollution control practices. Guidance for the development of the SWMP may be found in Appendix D, on the City's Stormwater Utility webpage, or the CDPHE website under the Construction Stormwater Discharge permit, COR400000. The SWMP must be submitted to the Stormwater Utility Division prior to beginning construction activities. The Stormwater Utility will evaluate whether the SWMP meets the requirements of the City's MS4 permit and this chapter. **Acceptance by the City does not imply the SWMP has met all the State's Construction Stormwater Permit application requirements, and the developer is responsible for submitting the SWMP to the State as well as the City.** Once the submitted SWMP is accepted by the Stormwater Utility, it becomes an enforceable part of the Construction Permit. The SWMP must be implemented as written and updated during the project, 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 the City.

15.6 Responsibilities of Permittee

15.6.1 Maintain Erosion and Sediment Control Plan or Stormwater Management Plan Onsite

Permittees must keep an electronic or hard copy of the ESCP or SWMP on site at all times. The ESCP or SWMP kept on the site should be the originally approved document and attachments or appendices with all revisions noted to match existing site conditions.

15.6.2 Erosion and Sediment Control Plan or Stormwater Management Plan Modifications and Permit Amendments

Permittees are required to amend, adapt, and adjust their ESCP or SWMP to accurately reflect phased construction changes and current conditions at the site. Permittees must keep a record of ESCP or SWMP changes made that includes the date and identification of the changes. The ESCP or 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 ESCP or SWMP proves ineffective in controlling pollutants in stormwater runoff in compliance with the permit conditions.
3. SCMs identified in the ESCP or SWMP are no longer necessary and are removed.
4. Corrective actions are taken onsite that result in a change to the ESCP or SWMP.

A notation must be included in the ESCP or 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 ESCP or SWMP.

ESCP or SWMP modifications are categorized as major or minor modifications that have differing approval requirements:

1. **Major Modifications:** Major modifications are changes to the ESCP or SWMP that remove or add area to the project, modify the final hydrology or drainage of the final design, replace the approved ESCP or SWMP, or otherwise expand or contract the scope of the approved project. Major modifications to the ESCP or SWMP proposed by the contractor/owner must be in writing (including revised plans) and submitted to the Stormwater Utility at least 10 business days prior to the desired date of implementation. The Stormwater Utility will re-approve the ESCP or SWMP if the proposed modifications are acceptable.
2. **Minor Modifications:** Minor modifications are changes to the ESCP or SWMP that do not increase the scope or change the 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 ESCP or SWMP narrative, drawings, and specifications. If the City's Stormwater Inspector 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 ESCP or SWMP implementation corresponding with evolving site conditions.

15.6.3 Inspections

Construction site stormwater inspections include several different types of inspections by the City's Stormwater Inspector and mandatory Self-Monitoring Inspections by the

permittee. Additional inspections by other regulatory authorities may also be conducted. Inspection requirements and responses include the following:

1. Permittees must contact the City Stormwater Utility, 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 the City Stormwater Utility.
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 the City Stormwater Utility 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 City Stormwater Inspector 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 the City Stormwater Utility finds that SCMs in the initially approved ESCP or 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 ESCP or SWMP, with major modifications approved by the City Stormwater Utility.
5. The permittee must keep a record of all inspections, which must be kept with the ESCP or SWMP and made available to the 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 the 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.

15.7 Enforcement

The enforcement of an approved ESCP or SWMP is typically driven by the inspection process. If inadequate control measures are identified by the permittee during a Self-Monitoring Inspection or the City’s Stormwater 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 ESCP or SWMP. The City’s Stormwater Inspector will require documentation of the completed corrective actions in response to the inadequacies of the ESCP or SWMP.

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 ESCP or SWMP. Table 15-2 summarizes some of these actions.

It is expected that under normal conditions, escalation of enforcement actions will proceed through a Written Warning, Notice of Violation, and finally a Municipal Summons.

Table 15-2. Typical Enforcement Mechanisms

Enforcement Option	Description	Typical Applications
Written Warning	The City Stormwater Inspector (CSI) will inform the permittee, responsible party, or agent for, of items that require corrective action.	No immediate danger to public safety, property, or water resources. Items must be corrected immediately, not to exceed 48 hours.
Notice of Violation	The CSI will document the items that were not corrected from the Written Warning. A Notice of Violation will be sent via first class and certified mail to the permittee, responsible party, or agent for.	No immediate danger to public safety, property, or water resources. Items must be corrected immediately, not to exceed 48 hours.
Municipal Summons	The CSI will issue a Municipal Summons after failure to comply with the Notice of Violation or for an illicit discharge that causes an immediate danger to public safety, property, or water resources.	Immediate danger to public safety, property, or water resources or when no adequate corrective action has been taken following the Written Warning and Notice of Violation.

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Chapter 16.0 References

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Appendices

Appendix A.

Guidance for Parameters Used in Calculations

Table A. Recommended percentage imperviousness values (from MHFD Manual)

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only):	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

The following tables, text, and figures of runoff coefficients and equations based on NRCS soil groups have been excerpted from the MHFD Manual *Runoff* chapter (Chapter 6):

Table 6-4. Runoff coefficient equations based on NRCS soil group and storm return period

NRCS Soil Group	Storm Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
A	$C_A = 0.84i^{1.302}$	$C_A = 0.86i^{1.276}$	$C_A = 0.87i^{1.232}$	$C_A = 0.88i^{1.124}$	$C_A = 0.85i+0.025$	$C_A = 0.78i+0.110$	$C_A = 0.65i+0.254$
B	$C_B = 0.84i^{1.169}$	$C_B = 0.86i^{1.088}$	$C_B = 0.81i+0.057$	$C_B = 0.63i+0.249$	$C_B = 0.56i+0.328$	$C_B = 0.47i+0.426$	$C_B = 0.37i+0.536$
C/D	$C_{C/D} = 0.83i^{1.122}$	$C_{C/D} = 0.82i+0.035$	$C_{C/D} = 0.74i+0.132$	$C_{C/D} = 0.56i+0.319$	$C_{C/D} = 0.49i+0.393$	$C_{C/D} = 0.41i+0.484$	$C_{C/D} = 0.32i+0.588$

Where:

i = % imperviousness (expressed as a decimal)

C_A = Runoff coefficient for Natural Resources Conservation Service (NRCS) HSG A soils

C_B = Runoff coefficient for NRCS HSG B soils

$C_{C/D}$ = Runoff coefficient for NRCS HSG C and D soils.

The values for various catchment imperviousness and storm return periods are presented graphically in Figures 6-1 through 6-3, and are tabulated in Table 6-5. These coefficients were developed for the Denver region to work in conjunction with the time of concentration recommendations in Section 2.4. Use of these coefficients and this procedure outside of the semi-arid climate found in the Denver region may not be valid. The UD-Rational Excel workbook performs all the needed calculations to find the runoff coefficient given the soil type and imperviousness and the reader may want to take advantage of this macro-enabled Excel workbook that is available for download from the UDFCD's website www.udfcd.org.

See Examples 7.1 and 7.2 that illustrate the Rational Method.

Table 6-5. Runoff coefficients, c

Total or Effective % Impervious	NRCS Hydrologic Soil Group A						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.01	0.01	0.04	0.13	0.27
5%	0.02	0.02	0.02	0.03	0.07	0.15	0.29
10%	0.04	0.05	0.05	0.07	0.11	0.19	0.32
15%	0.07	0.08	0.08	0.1	0.15	0.23	0.35
20%	0.1	0.11	0.12	0.14	0.2	0.27	0.38
25%	0.14	0.15	0.16	0.19	0.24	0.3	0.42
30%	0.18	0.19	0.2	0.23	0.28	0.34	0.45
35%	0.21	0.23	0.24	0.27	0.32	0.38	0.48
40%	0.25	0.27	0.28	0.32	0.37	0.42	0.51
45%	0.3	0.31	0.33	0.36	0.41	0.46	0.54
50%	0.34	0.36	0.37	0.41	0.45	0.5	0.58
55%	0.39	0.4	0.42	0.45	0.49	0.54	0.61
60%	0.43	0.45	0.47	0.5	0.54	0.58	0.64
65%	0.48	0.5	0.51	0.54	0.58	0.62	0.67
70%	0.53	0.55	0.56	0.59	0.62	0.65	0.71
75%	0.58	0.6	0.61	0.64	0.66	0.69	0.74
80%	0.63	0.65	0.66	0.69	0.71	0.73	0.77
85%	0.68	0.7	0.71	0.74	0.75	0.77	0.8
90%	0.73	0.75	0.77	0.79	0.79	0.81	0.84
95%	0.79	0.81	0.82	0.83	0.84	0.85	0.87
100%	0.84	0.86	0.87	0.88	0.88	0.89	0.9
Total or Effective % Impervious	NRCS Hydrologic Soil Group B						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.01	0.07	0.26	0.34	0.44	0.54
5%	0.03	0.03	0.1	0.28	0.36	0.45	0.55
10%	0.06	0.07	0.14	0.31	0.38	0.47	0.57
15%	0.09	0.11	0.18	0.34	0.41	0.5	0.59
20%	0.13	0.15	0.22	0.38	0.44	0.52	0.61
25%	0.17	0.19	0.26	0.41	0.47	0.54	0.63
30%	0.2	0.23	0.3	0.44	0.49	0.57	0.65
35%	0.24	0.27	0.34	0.47	0.52	0.59	0.66
40%	0.29	0.32	0.38	0.5	0.55	0.61	0.68
45%	0.33	0.36	0.42	0.53	0.58	0.64	0.7
50%	0.37	0.4	0.46	0.56	0.61	0.66	0.72
55%	0.42	0.45	0.5	0.6	0.63	0.68	0.74
60%	0.46	0.49	0.54	0.63	0.66	0.71	0.76
65%	0.5	0.54	0.58	0.66	0.69	0.73	0.77
70%	0.55	0.58	0.62	0.69	0.72	0.75	0.79
75%	0.6	0.63	0.66	0.72	0.75	0.78	0.81
80%	0.64	0.67	0.7	0.75	0.77	0.8	0.83
85%	0.69	0.72	0.74	0.78	0.8	0.82	0.85
90%	0.74	0.76	0.78	0.81	0.83	0.84	0.87
95%	0.79	0.81	0.82	0.85	0.86	0.87	0.88
100%	0.84	0.86	0.86	0.88	0.89	0.89	0.9

Table 6-5. Runoff coefficients, c (continued)

Total or Effective % Impervious	NRCS Hydrologic Soil Group C						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2%	0.01	0.05	0.15	0.33	0.40	0.49	0.59
5%	0.03	0.08	0.17	0.35	0.42	0.5	0.6
10%	0.06	0.12	0.21	0.37	0.44	0.52	0.62
15%	0.1	0.16	0.24	0.4	0.47	0.55	0.64
20%	0.14	0.2	0.28	0.43	0.49	0.57	0.65
25%	0.18	0.24	0.32	0.46	0.52	0.59	0.67
30%	0.22	0.28	0.35	0.49	0.54	0.61	0.68
35%	0.26	0.32	0.39	0.51	0.57	0.63	0.7
40%	0.3	0.36	0.43	0.54	0.59	0.65	0.71
45%	0.34	0.4	0.46	0.57	0.62	0.67	0.73
50%	0.38	0.44	0.5	0.6	0.64	0.69	0.75
55%	0.43	0.48	0.54	0.63	0.66	0.71	0.76
60%	0.47	0.52	0.57	0.65	0.69	0.73	0.78
65%	0.51	0.56	0.61	0.68	0.71	0.75	0.79
70%	0.56	0.61	0.65	0.71	0.74	0.77	0.81
75%	0.6	0.65	0.68	0.74	0.76	0.79	0.82
80%	0.65	0.69	0.72	0.77	0.79	0.81	0.84
85%	0.7	0.73	0.76	0.79	0.81	0.83	0.86
90%	0.74	0.77	0.79	0.82	0.84	0.85	0.87
95%	0.79	0.81	0.83	0.85	0.86	0.87	0.89
100%	0.83	0.85	0.87	0.88	0.89	0.89	0.9

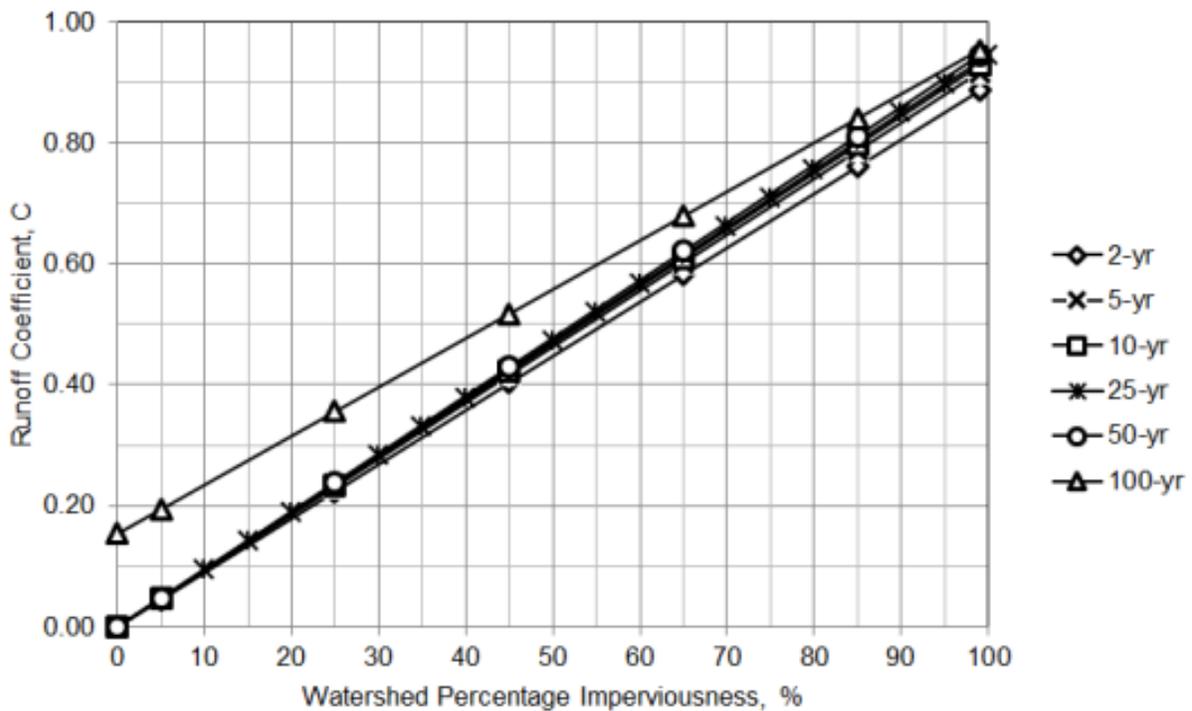


Figure 6-1. Runoff coefficient vs. watershed imperviousness NRCS HSG A

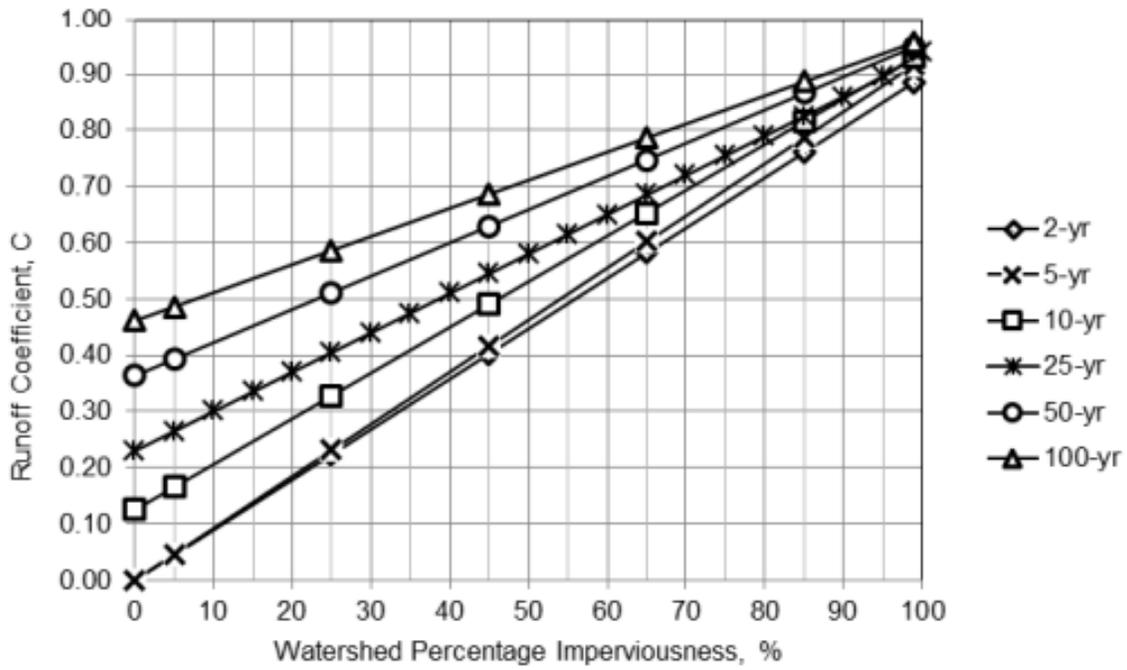
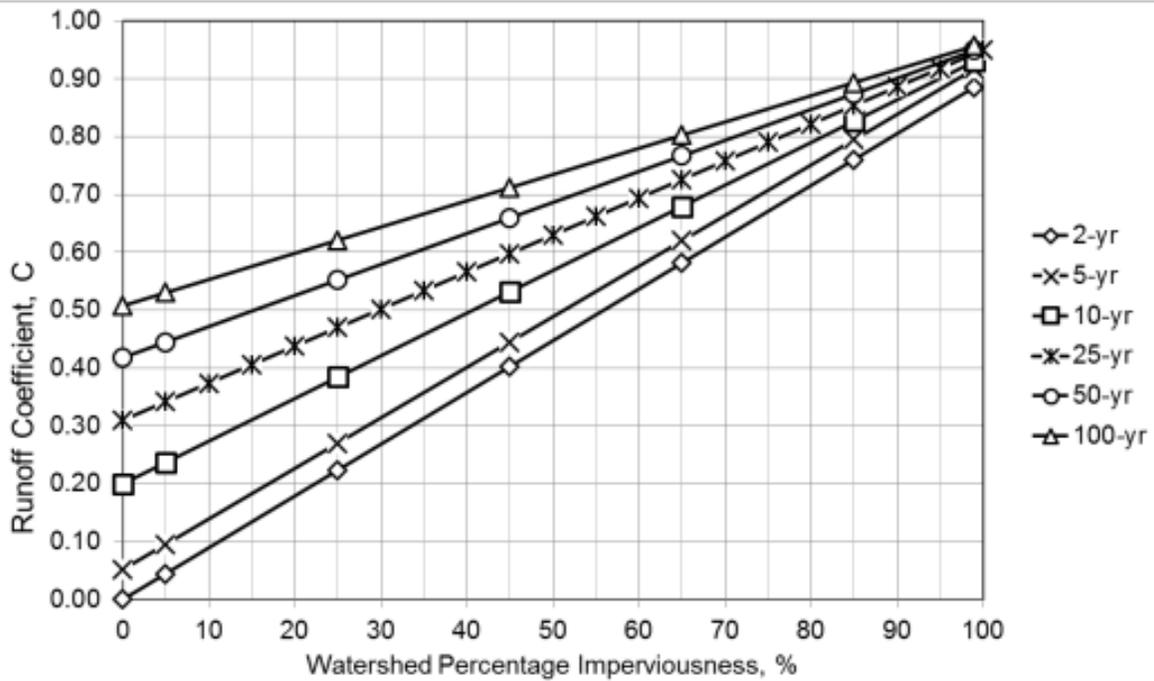


Figure 6-2. Runoff coefficient vs. watershed imperviousness NRCS HSG B



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Appendix B.

Drainage Report Checklist



City of Pueblo
 211 E. "D" Street
 Pueblo, CO 81003
 Phone (719) 553-2899
 stormwater@pueblo.us

DRAINAGE REPORT CHECKLIST

INCOMPLETE SUBMITTALS PROLONG THE REVIEW PROCESS	
Drainage Report Submittal Checklist and Review Sheet	
Applies to Part I & II Subdivision Plans and Commercial Site Plans	
Project Location:	
Owner Name:	
Owner Email:	
Owner Phone:	
Owner Address:	
Engineer Name:	
Engineer Email:	
Engineer Phone:	
Engineer Address:	
Date Submitted:	
Submitted by (firm):	
Contact:	Phone:

Review Requirements (All reports will be rejected if missing these requirements)

Complete	Review Requirements
	Cover letter prepared by the professional engineer responsible for the preparation of the report.
	P.E. Certification: Signed and sealed certification statement indicating that the engineer of record has completely reviewed this drainage report.
	The drainage report and plan follow the formatting set forth in this checklist and the City of Pueblo Drainage Criteria Manual (DCM).
	The design follows the criteria set forth by the City of Pueblo's DCM.
	The design meets the City of Pueblo's MS4 permit



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DRAINAGE REPORT CHECKLIST

Report Requirements

Complete	N/A	Report Requirements
		1. Title Page
		2. Cover Letter
		3. Drainage Report Checklist
		4. Table of Contents
		5. Introduction
		6. General Location and Description
		7. General Location Map
		8. Existing Drainage Reports/Master Plans
		9. Upstream Considerations
		10. Downstream Considerations
		11. Floodplain Discussion and FIRM
		12. Soils Discussion
		13. Methods of Analysis
		14. Historic Conditions
		15. Proposed conditions
		16. Water Quality
		17. Maintenance
		18. Conclusions
		19. References

Appendices

Complete	N/A	Appendices
		1. Appendix A – Hydrologic and Hydraulic Computations
		A. Hydrologic Calculations
		B. Hydraulic Computations (<i>Applicable to Part II of the Subdivision process</i>)
		C. Water Quality
		2. Appendix B – Standard Design Charts and Tables
		3. Appendix C – Floodplain Maps
		4. Appendix D – Soils
		A. SCS Soils Map (not entire report)
		B. Geotechnical study (if performed), including groundwater elevations
		5. Appendix E – Maps/Plans
		A. Historic Drainage Map



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DRAINAGE REPORT CHECKLIST

Complete	N/A	Appendices
		<p>B. Drainage Plan</p> <p>The Drainage Plan shall be a stand-alone document. The information shown on the checklist must be shown on the Drainage Plan. Other plan submittals (e.g., separate utility plan, separate grading plan, etc.) will not be accepted for review.</p>
		i. Title block.
		ii. Engineer's statement.
		iii. Overall drainage basin boundary and sub-basin boundaries.
		iv. Existing and proposed contours at 2 ft. maximum intervals. In terrain where slopes exceed 10%, maximum interval is 10 ft.
		v. Property lines and easements with purposes noted.
		vi. Streets and R.O.W. lines.
		vii. Flow arrows
		viii. Accumulation of flows (cfs) at design points.
		ix. Show paths chosen for computation of time of concentration.
		x. Existing and proposed utilities, type, and size.
		xi. Show <i>Design Point Summary Table</i> (minor and major flows), <i>Basin Summary Table</i> (minor and major flows), and <i>Pipe Routing Summary Table</i> (flows, sizes, material types, slopes, and total length).
		xii. Impervious and pervious area table.
		xiii. Existing and proposed storm sewers, inlets, and manholes. For storm sewers show size, slope, material, flow rate and flow arrows. For inlet show type and length. Show diameter of manholes.
		xiv. Existing and proposed culverts. Show size, material, and flow rate. Show headwalls, wingwalls and riprap pad size and type. Delineate 100-year ponding limits.
		xv. Existing and proposed open channels. Show typical cross sections with water surface elevations. Identify channel lining, slope, flow rate and velocity, and details of erosion control features and trickle channel.
		xvi. Existing and proposed detention ponds. Show grading, storage volumes for the WQCV, EURV and 100-year ponding elevations. Show outlet structure, spillway, trickle channel, forebay and micropool details.
		xvii. Existing natural channels within 150 feet of project. Delineate 100-year floodplain (or erosion buffer zone if applicable. Show bridges, culverts, and erosion control features if any.
		xviii. Drainage details (outlet structures, restrictor plates, orifice plate, spillway, riprap, etc.).
		xix. Professional Engineer's seal and signature on record copy.



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DRAINAGE REPORT CHECKLIST

Complete	N/A	Appendices
		C. Erosion Sediment Control Plan (ESCP) or Stormwater Management Plan (SWMP)

I. Signatures

I hereby certify that this _____ (Preliminary/Final) Drainage Report for the _____ (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Pueblo's Drainage Criteria Manual for the owners thereof. I understand that the City of Pueblo does not, and will not, assume liability for drainage facilities designed by others.

Name

Licensed Professional Engineer

State of Colorado No. _____

(Affix Seal)

Submittal Rejected by _____ Date _____

Submittal Accepted by _____ Date _____

Appendix C.

Erosion and Sediment Control Plan Guidance

Guidance for the Development of an Erosion and Sediment Control Plan (ESCP) in the City of Pueblo

Erosion and Sediment Control Plan (ESCP) Requirements

The City of Pueblo (City) requires an Erosion and Sediment Control Plan (ESCP) be developed for all construction sites disturbing at least 1,000 square feet but less than 1 acre. The ESCP must be submitted to the City prior to commencement of land disturbing activities. Once the submitted ESCP is accepted by the Stormwater Utility, it becomes an enforceable part of the Construction Permit. The ESCP must be implemented as written and updated during the project, from commencement of construction activity until final stabilization is complete.

Construction sites greater than 1,000 square feet and less than 1 acre are required to submit an **Erosion and Sediment Control Plan (ESCP)**.

Construction sites 1 acre or more, or less than 1 acre and part of a larger common plan of development 1 acre or more, are required to submit a **Stormwater Management Plan (SWMP)** to the City and obtain a Construction Stormwater Discharge Permit from CDPHE.

A copy of the ESCP 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 the City.

General Requirements

The ESCP shall consist of acceptable erosion control practices and sediment control facilities in conjunction with an appropriate implementation schedule in order to accomplish adequate control. Adequate erosion control measures shall be constructed prior to land disturbing activities such that no adverse effects of site alteration will impact surrounding properties. Particular attention shall be given to concentrated flows of water, either to prevent their occurrence or to provide appropriate conveyance devised to prevent erosion. Sediment control devices shall be required at all points where sediment laden water might leave the site.

The plan must include permanent structures for conveying storm runoff, final site stabilization, and temporary sediment control features including sediment basins and stabilization of the sites where temporary features have been removed. Any erosion control measures to be implemented outside of the property line of the site will generally not be approved unless the plan is accompanied by an appropriate legal easement of the area in which such work is to be done.

Information regarding acceptable BMPs and proper installation can be found in Volume 3 of the MHFD Manual, the CDOT Erosion Control & Stormwater Quality Guide, and City of Pueblo approved details.

Erosion and Sediment Control Plan (for 1000 sq ft to 1 acre)

The City requires an ESCP at one of the following scales: 1" = 20', 1" = 30', 1" = 40', or 1" = 50'. The scale selected must be suitable for practical use and readability. The ESCP 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, drawing scale, and symbol legend.
- d. Property boundary.
- e. Flow arrows that depict stormwater flow directions onsite and runoff direction.
- f. Control Measures addressing the following:
 - 1) Land disturbance and storage of soils.
 - 2) Vehicle tracking.
 - 3) Loading and unloading operations.
 - 4) Outdoor storage of construction site materials, building materials, fertilizers, and chemicals.
 - 5) Bulk storage of materials.
 - 6) Vehicle and equipment maintenance and fueling.
 - 7) Significant dust or particulate generating processes.
 - 8) Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, and oils.
 - 9) Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment.
 - 10) Dedicated asphalt and concrete batch plants.
 - 11) Other areas or operations where spills can occur.
 - 12) Other non-stormwater discharges including construction dewatering not covered under the Construction Dewatering Discharges general permit and wash water that may contribute pollutants to the MS4.

- g. Locations for all structural SCMs.
- h. Locations of all non-structural SCMs.
- i. Location of existing and proposed structures on the site, with structures subject to demolition clearly identified.
- j. All applicable City standard notes.
 - i. Prior to any construction, including site grading and excavation, an approved 'Erosion and Sediment Control Plan' shall be posted on-site and all required BMPs installed.
 - ii. General contractor shall maintain and update the 'Erosion and Sediment Control Plan' as construction dictates. Current and correct plan shall always remain on-site and be readily accessible to the City Stormwater Inspector.
 - iii. General contractor or his representative shall inspect, at a minimum, the site every 2 weeks and within 24 hours of any precipitation or snowmelt event that causes surface erosion. (i.e., that results in stormwater running across the ground).
 - iv. General contractor/owner is fully responsible to maintain all required BMPs to prevent erosion and sediment from leaving the construction site.
 - v. Failure to comply with minimum requirements is a violation of City Ordinances.
 - vi. No cross-lot drainage permitted. Stormwater shall be directed to the nearest public Right-of-Way (streets & alleys), dedicated drainage easements, and/or City of Pueblo stormwater conveyance system.
- k. Installation and implementation specifications or a reference to the document.

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Appendix D.

Stormwater Management Plan Guidance

Guidance for the Development of a Stormwater Management Plan (SWMP) in the City of Pueblo

Stormwater Management Plan (SWMP) Requirements

Each construction site with an area of disturbance of 1 acre or more and/or which is part of a common plan of development that disturbs 1 acre or more requires the development of a SWMP in accordance with good engineering, hydrologic, and pollution control practices and must be submitted to the Stormwater Utility Division prior to beginning construction activities. The Stormwater Department will evaluate whether the SWMP meets the requirements of the City's MS4 permit and the City's DCM. Once the submitted SWMP is approved by the Stormwater Utility, it becomes an enforceable part of the Construction Permit. The SWMP must be implemented as written and updated during the project, from commencement of construction activity until final stabilization is complete.

Construction sites greater than 1,000 square feet and less than 1 acre are required to submit an **Erosion and Sediment Control Plan (ESCP)**.

Construction sites 1 acre or more, or less than 1 acre and part of a larger common plan of development greater than 1 acre, are required to submit a **Stormwater Management Plan** to the City and obtain a Construction Stormwater Discharge Permit from CDPHE.

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 the City.

SWMP Narrative Content and Site Map(s)

A complete description of SWMP requirements may be accessed on the CDPHE website. It is the responsibility of the applicant to ensure the content of the submitted SWMP meets current requirements of the State's Stormwater Construction Permit. The SWMP, at a minimum, must include the elements listed below (note: refer to the CDPHE website for the most current permit requirements):

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 Section 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 (for SWMP):** The 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', or 1" = 50'. The scale selected must be suitable for practical use and readability. 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. Contour intervals of 1 to 2 feet are required for these plans depending on the topographic relief of the site.
 - 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. Locations where alternative temporary stabilization schedules apply.
 - t. Location of existing and proposed structures on the site, with structures subject to demolition clearly identified.
 - u. Locations of all storm runoff discharge points at site boundaries or internal to site if a drainageway is located onsite.
 - v. 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).
 - w. All applicable City standard notes.
 - x. Installation details for all proposed construction SCMs.
 - y. Details for all proposed structural permanent stormwater quality control measures.
 - z. 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 15.5.3 of the *Construction Site Stormwater Management and Erosion Control* chapter of the DCM.
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. 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 for the Project named above as described herein. Further, I understand that, once approved by the City of Pueblo'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."

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 by the City and may include the following:

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

