



CITY OF LITTLETON
**STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA
MANUAL**

Version 7

JANUARY 5, 2022

Public Works Department
Engineering Division
2255 W. Berry Ave
Littleton, CO 80120
303-795-3865

Previous: 10/1986, 9/2002, 6/2003, 7/2003, 2/2009, 6/2012, 10/2012, 12/2018, 7/2019

MASTER OUTLINE

Cover Memorandum

Chapters

1. General Provisions
2. Drainage Planning Submittal Requirements
3. Drainage Policy
4. Floodplain Regulations
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6. Runoff
7. Open Channels
8. Storm Sewers
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MEMORANDUM

TO: All Users of City of Littleton Storm Drainage Design and Technical Criteria Manual

FROM: Carolyn Roan, Water Resource Manager

SUBJECT: Drainage Design and Technical Criteria Manual Update

DATE: January 5, 2022

Revisions have been completed to the Littleton Storm Drainage Design and Technical Criteria Manual. Please discard previous versions of the manual and use the electronic version now available online on the City of Littleton Public Works Department website: <https://www.littletongov.org/city-services/city-departments/public-works/sewer-and-storm-drainage>

There are changes to numerous chapters, so the entire manual is to be replaced. Hard copies will no longer be provided.

These revisions become **effective** on the date of this memorandum. Any new submittal received by the City of Littleton on or after this date must conform to these revisions.

Amendments and revisions

This CRITERIA has been prepared on the basis of current technology, regulations, and procedures in the Denver Metropolitan Area and State of Colorado for storm drainage design. Due to the dynamic nature of urban storm drainage, amendments and revisions will be required from time to time as experience is gained in use of this CRITERIA, and applicable regulations and state of practice change. Such revisions will be made to the version available online on the Public Works Department website.

Users of this CRITERIA are encouraged to submit comments or suggestions. These can be sent to:

Water Resource Manager
City of Littleton Public Works Department/Engineering Division
2255 West Berry Ave
Littleton CO 80120
303-795-3863

Thank you and feel free to contact the Public Works Department/Engineering Division with any questions.



CHAPTER 1 - GENERAL PROVISIONS

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1.1 SHORT TITLE

These regulations together with all future amendments shall be known as the *City of Littleton Storm Drainage Design and Technical Criteria Manual* (hereafter called Criteria).

1.2 APPLICABILITY

These Criteria shall apply to all land within the corporate limits of the City of Littleton, including any public lands, facilities constructed on City rights-of-way, easements dedicated for public use, and to all privately owned and maintained drainage facilities, including but not limited to detention ponds, storm sewers, inlets, manholes, culverts, swales and channels.

1.3 PURPOSE AND INTENT

It is the purpose of these Criteria to promote the public health, safety, and general welfare and to minimize public and private losses due to flooding within the City by adopting policies, procedures, standards, and criteria for storm drainage and stormwater quality protection. Presented in these Criteria are minimum standards for analysis and design of storm drainage facilities. All subdivisions, re-subdivisions, exemptions from platting, building and grading permits for commercial and industrial uses, or any other proposed construction submitted for approval under the provisions of the Littleton Storm Drainage Ordinance, Municipal Code Title 7, Chapter 7, shall include adequate storm drainage system analysis and appropriate drainage system design. Such analysis and design shall meet or exceed the criteria set forth herein. Municipal Code 7-7 contains information regarding non-stormwater discharges to the city's drainage system.

Alternatives to the provisions of these Criteria may be suggested by the applicant. The applicant shall have the burden of showing that alternatives are equal or better.

These Criteria were prepared in strict accordance with the guidance and direction provided by the Mile High Flood District's (hereafter called MHFD) *Urban Storm Drainage Criteria Manual* (hereafter called Manual). Policies and technical criteria not specifically addressed in these Criteria shall follow the provisions of the Manual.

Drainage facilities in place or under construction at the time of Criteria adoption shall be accepted without regard to the provisions of these Criteria.

1.4 ENACTMENT AUTHORITY

These regulations are adopted pursuant to Municipal Code Title 7, Chapter 7, and Title 10.

1.5 AMENDMENT AND REVISIONS

These policies and Criteria may be amended as new technology or state of practice is developed and/or if experience gained in the use of these Criteria indicates a need for a revision. Amendments and revisions to these Criteria will be made by the City of Littleton's Director of Public Works Department (hereafter called Director) when necessary to accomplish the goal of reasonable public protection from surface water runoff and quality. Criteria revisions are effective from their posted

date on the city's website unless otherwise noted, for all submittals on or after that date.

The City's approval of drainage reports and drainage facilities shall be valid for 2-years. Documents with approvals more than 2-years old may require revision prior to development to comply with Criteria in effect at that time. Amendments will be applicable to all drainage reports submitted after the effective date of an amendment. Final drainage reports are exempt from an amendment provided they are submitted for approval within 60-days after the effective date of an amendment.

1.6 ENFORCEMENT RESPONSIBILITY

It shall be the duty of the Director to enforce the provisions of these Criteria.

1.7 REVIEW AND APPROVAL

The City will review all drainage submittals for general compliance with these Criteria. An approval by the City does not relieve the owner, engineer, or designer from responsibility of ensuring that the design is sound, without error, and that calculations, plans, specifications, construction, and record drawings comply with the Criteria.

The MHFD may be requested to review reports and construction plans required by these Criteria. Where major drainageway improvements or a revised flood plain delineation are involved, MHFD approval may be required. It is the City's intent to maximize eligibility for MHFD maintenance of drainage facilities, which requires approval of plans by the MHFD.

Adequate time must be allocated in development planning to permit a complete review by the City. The intent of these Criteria is to more clearly define the City's requirements and reduce the time and effort required to develop an acceptable drainage design.

1.8 INTERPRETATION

In the interpretation and application of the provisions of the Criteria, the following shall govern:

1.8.1 Minimum Standards:

In its interpretation and application, these Criteria shall be regarded as the minimum requirements.

1.8.2 Higher Standards:

Whenever a provision of these Criteria and any other provisions of the Regulations or any provision in any law, ordinance, resolution, rule, or regulation of any kind, contain any restriction covering any of the same subject matter, whichever restrictions are more restrictive or impose higher standards of requirements shall govern.



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1.8.3 Flexibility

Some development that occurs within the City of Littleton is referred to as “in-fill development”. Where such conditions exist, the City recognizes the need for more site-specific application and interpretation of these Criteria. The Director may grant variances from minimum standards to allow private and public improvements, which are compatible with surrounding in-place improvements, and consistent with the intent of municipal code. The burden of responsibility shall be on the applicant to show that these Criteria present an unreasonable hardship caused by pre-existing conditions when requesting a variance.

1.8.4 Abrogation:

These Criteria shall not abrogate or annul any permits or approved drainage reports, construction plans, easements, or covenants issued before the effective date of these Criteria.

1.9 OTHER STANDARDS

Technical criteria presented in these Criteria are consistent with those of the MHFD, which are presented in the current version of *Urban Storm Drainage Criteria Manual* (hereafter called Manual). These Criteria provide specific policies, procedures, and standards applicable to development in the City of Littleton. The Manual provides the basis and purpose for these Criteria and more detailed criteria for analysis and design of stormwater and water quality facilities, and is, therefore, an integral reference to these Criteria.

The applicant is also referred to the most recent version of the Colorado Department of Transportation (CDOT) *Standard M&S Plans* for additional design details referenced by these Criteria, but not covered in these Criteria or the Manual.

The applicant is also responsible for complying with other appropriate local, state, and federal requirements.

1.10 VARIANCE

A variance from any portion of the technical provisions of these Criteria may be granted by the Director or designee. All requests for variances from technical provisions shall be submitted in writing (normally a letter with the drainage report, see Chapter 2.0 - *Drainage Planning and Submittal Requirements*), shall state the provision for which the variance is requested, and shall provide evidence, data, or other information in support of the request. The Director or designee will review and rule on the request and provide findings in writing.

1.11 ABBREVIATIONS

BMP	Best Management Practice
CITY	City of Littleton
CCR	Colorado Code of Regulations
CDOT	Colorado Department of Transportation
CMP	Corrugated Metal Pipe

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CPMA	Corrugate Metal Pipe Arch
CRS	Colorado Revised Statutes
CSP	Corrugated Steel Pipe
CWCB	Colorado Water Conservation Board
DRCOG	Denver Regional Council of Governments
DWWM	Denver Wastewater Management
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHAD	Flood Hazard Area Delineation
FIA	Flood Insurance Administration
FIS	Flood Insurance Study
FIRM	Flood Insurance Rate Map
HERCP	Horizontal Elliptical Reinforced Concrete Pipe
MP	Master Plan
MHFD	Mile High Flood District
NRCS	National Resource Conservation Service (formerly SCS)
NRCP	Non-Reinforced Concrete Pipe
OSP	Outfall Systems Plan
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
SCS	Soil Conservation Service
SPP	Structural Plate Pipe
SPPA	Structural Plate Pipe Arch
SWMP	Stormwater Management Plan (in accordance with Chapter 13)
UDFCD	Urban Drainage and Flood Control District (now known as Mile High Flood District (MHFD))
USDCM	Urban Storm Drainage Criteria Manual
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

1.12 DEFINITIONS

As-Built Drawings: Drawings showing lines, grades, and elevations of constructed facilities.

Basin: As in “drainage basin”. The area of land that drains to and contributes storm runoff to a downstream design point of interest.

Best Management Practices (BMP): Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "state surface waters". BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. The term BMP is used interchangeably with the term “control measure”, and can include other

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methods such as the installation, operation, and maintenance of structural controls and treatment devices.

CCR: Colorado Code of Regulations

Channel: A perceptible natural or artificial watercourse, with a definite bed and banks to confine and conduct continuous or intermittent water flows.

Code: City of Littleton Municipal Code.

Common Plan of Development or Sale: 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).

Conceptual or Final Drainage Report: Description of preliminary analysis and design required by Section 2.3 or 2.4 of these Criteria.

Construction Activity: Applicable construction activities include the land disturbing activity and all activities and materials associated with the construction site and located at, or contiguous to, the land disturbing activities. Refers to 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. Construction does not include routine maintenance to maintain the original line and grade, hydraulic capacity, or original purpose of the facility. Repaving activities where underlying and/or surrounding soil is cleared, graded, or excavated as part of the repaving operation are considered construction activities. Construction activity is from initial ground breaking to final stabilization regardless of ownership of the construction activities. The WQCD has determined that “contiguous” means construction activities located in close proximity to each other (within ¼ mile).

Construction Dewatering: Discharge of groundwater, surface water, and stormwater that has mixed with the groundwater and/or surface water (i.e. commingled stormwater runoff) that has come into contact with applicable construction activities.

Control Measure: Any best management practice or other method used to prevent or reduce the discharge of pollutants to waters of the state. Control measures include but are not limited to best management practices. Control measures can include other methods such as the installation, operation, and maintenance of structure controls and treatment devices.

Criteria: The City of Littleton Storm Drainage Design and Technical Criteria

CRS: Colorado Revised Statutes

Detention: The process by which stormwater runoff is contained and slowly released at allowable

flow rates.

Director: Director of the City of Littleton Public Works Department or a designee.

Discharge: The discharge of pollutants as defined in section 25-8-103(3) C.R.S. Discharges do not include land application or discharges to the ground.

Easement: Authorization by a property owner for use by another party or parties of all or any portion of his/her land for a specified purpose.

Engineer: A professional experienced in storm drainage and flood control work and licensed to practice engineering in the State of Colorado.

Excess Urban Runoff Volume (EURV): The runoff volume that results from approximately a 10% chance rainfall event. This volume includes the WQCV.

Exclusion: A removal of the applicability of the terms or conditions in this chapter from applying to the given conditions.

Exemption: An exemption, waiver, or variance of the requirements for permanent control measures.

Final Drainage Report: Description of final analysis and design required by Section 2.4.1 of these Criteria.

Final Stabilization: The condition reached when all ground surface disturbing activities at the site have been completed, and for all areas of ground surface disturbing activities a uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed.

Flood: A general and temporary condition of partial or complete inundation of normally dry land areas from; (a) the overflow of inland waters; and/or (b) the unusual and rapid accumulation or runoff of surface waters from any source.

Flood Hazard Study: A report submitted with an application for development within a floodplain, in accordance with provisions of the Floodplain Regulations.

Floodplain Regulations: Title 10, Chapter 6 of the City Code.

Floodproofing: Any combination of additions, changes or adjustments which are intended to reduce or eliminate the risk of flood damage to property, utilities, structures and their contents.

Full Spectrum Detention: Design method used by the Mile High Flood District for sizing of detention ponds and their outlet structures.

Good Engineering, Hydrologic and Pollution Control Practices: Methods, procedures, and practices that: a) Are based on basic scientific fact(s), b) Reflect best industry practices and standards, c) Are appropriate for the conditions and pollutant sources, and d) Provide appropriate solutions to meet the associated permit requirements, including practice based and numeric effluent limits.

Green Infrastructure: Generally refers to control measures that use vegetation, soils, and natural processes or mimic natural processes to manage stormwater.

Historic: Natural conditions that existed prior to man's occupation or disturbance of the land.

Impervious Area: Developed areas with covering or pavement that prevents the land's natural ability to absorb and infiltrate typical precipitation and irrigation events. Impervious areas include, but are not limited to; roof tops, walkways, patios, driveways, parking lots, impervious storage areas, impervious concrete and asphalt, and any other continuous watertight pavement or covering.

Inadequate Control Measure: Any control measure that is not designed, implemented, or operating in accordance with the requirements of the Criteria. See also Control Measure Requiring Routine Maintenance

In-fill development: Land to be developed that is completely or mostly surrounded by existing development.

Land Disturbing Activity: Any activity that results in a change in the existing land surface (both vegetative and non-vegetative). Land disturbing activities 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. Compaction that is associated with stabilization of structures and road construction shall also be considered a land disturbing activity.

Lowest Adjacent Grade: The lowest ground elevation abutting a structure.

Manual: The Urban Storm Drainage Criteria Manual (Three Volumes), Current Version.

Master Drainage Plan (MDP): A watershed drainage plan that includes multiple properties.

Major Drainageway: A stormwater conveyance facility, such as a channel or conduit, which receives storm runoff from a tributary generally 130-acres or more.

Major Drainageway Plan: A plan for major drainageway stormwater conveyance facilities prepared under the jurisdiction of MHFD. Technical criteria for major drainageways are more restrictive than for minor drainageways.

Minor Drainageway: A stormwater conveyance facility, such as a channel or conduit, which receives storm runoff from a tributary less than 130-acres.

Minimization of Directly Connected Impervious Area: Impervious areas that are deliberately designed to be distributed and disconnected with smaller surface areas separated by zones of pervious surface, in order that stormwater runoff is less concentrated and infiltrates into the ground before entering a creek, storm sewer, or other drainage feature.

Minimize: For purposes of implementing control measures of this chapter, means reduce and/or eliminate to the extent achievable using control measures that are technologically available and economically practicable and achievable in light of best industry practices.

MS4: Municipal separate storm sewer system. A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by the city of Littleton, designed and/or used for collecting and/or conveying stormwater.

New Development: Land disturbing activities; structural development including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision for a site that does not meet the definition of redevelopment.

Non-Structural Control Measures: Includes control measures that are not structural control measures, and include, but are not limited to, control measures that prevent or reduce pollutants being introduced to water or that prevent or reduce the generation of runoff or illicit discharges.

Offsite Runoff: Storm runoff that originates outside of the boundary of the development in question and is tributary to the development.

Offsite Detention: Detention for offsite runoff, including water quality volume, which has been sized based on area and imperviousness of land tributary to the development in question.

Onsite Runoff: Runoff generated by land within the boundary of the development in question.

Onsite Detention: Detention storage for onsite runoff, including water quality volume, which has been sized based on the area and imperviousness of the development (i.e.: onsite area only).

Open Area: An area of ground that is not occupied by other features such as parking lots, roadways, or buildings, where a detention pond might be located.

100-Year Event: The runoff that results from a rainfall event with a 1% annual chance of occurrence or exceedance. This volume includes the WQCV and EURV.

Operator: The person or entity who is responsible for the overall operation of the facility or activity from which the associated discharge originates.

Outfall Systems Plan: A plan prepared under supervision of the MHFD for a stormwater conveyance facility, typically a conduit but can be an open channel, which receives storm runoff from a tributary

area generally less than 130-acres.

Pipe Memoranda: Standards and specifications for storm sewer pipe material presented in Storm Sewer Pipe Material Technical Memorandum (WWE 1987, Reference 40) and Update to Storm Sewer Pipe Material Technical Memorandum (B&M 19982008, Reference 41).

Pollutant: Dredged spoil, dirt, slurry, solid waste, incinerator residue, sewage, sewage sludge, garbage, trash, chemical waste, biological nutrient, biological material, radioactive material, heat, wrecked or discarded equipment, rock, sand, or any industrial, municipal or agricultural waste. See 5 CCR 1002-61.2(76).

Pre-Application Meeting: A required meeting, discussion, or conference between the applicant and the City staff to discuss requirements for storm drainage, water quality, and other facilities.

Pre-Planning Process: Process for review of proposed land-use changes prior to submittal of preliminary reports and construction plans. City staff meet weekly to discuss requirements and comments are forwarded to the applicant. Comments are based on written material submitted by the applicant.

Record Drawings: Drawings documenting final, as-constructed information for a storm drainage facility, as specified by paragraph 2.5 of these Criteria. Also referred to as “as-builts”.

Regional Detention: A stormwater detention facility that is publicly owned and maintained which serves all properties within the tributary watershed.

Redevelopment: Includes a site that is already substantially developed and has 35% or more of existing hard surface coverage, the creation or addition of hard surfaces; the expansion of a building footprint or addition or replacement of a structure; structural development including construction, installation or expansion of a building or other structure; replacement of hard surface that is not part of a routine maintenance activity; and land disturbing activities.

Roadway: Roads and bridges that are improved designed or ordinarily used for vehicular travel and contiguous areas improved, designed or ordinarily used for pedestrian or bicycle traffic, drainage for the roadway, and/or parking along the roadway. Areas primarily used for parking or access to parking are not included.

Significant Materials: Includes, but not limited to: raw materials; fuels; materials such as metallic products; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to re-released with stormwater discharges.

Site: A parcel, property, or portion of either. Includes common plan of ownership or contiguous development where multiple separate and distinct construction activities may be taking place at

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different times on different schedules but remain related. “Contiguous” means construction activities located in close proximity to each other (within ¼ mile).

State: The State of Colorado.

Stormwater: Stormwater runoff, snow melt runoff, and surface runoff and drainage. See 5 CCR 1002-61.2(103).

Structural Control Measures: Includes control measures that are comprised of facilities and structures that remove pollutants from water or retain, reuse, or provide for infiltration or evaporation of water.

Swale: An open, relatively small grass-lined channel that conveys storm runoff peak flows that are less than 50-cfs.

Variance: A written grant of relief from the technical requirements of these Criteria by the Director.

Waters of the State of Colorado: Any and all surface waters and subsurface waters which are contained in or flow in or through this state, but does not include 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.

Water Quality Capture Volume (WQCV): The runoff volume from a rainstorm or from the initial portion of a rainstorm, typically approximately ½ inch, which is thought to contain a higher percentage of pollutants. Also referred to as “first flush runoff”.

CHAPTER 2 - DRAINAGE PLANNING SUBMITTAL REQUIREMENTS

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2.1 REVIEW PROCESS

All residential, commercial or industrial subdivisions, re-subdivision, exemption from platting, building permits for individual commercial and industrial sites, or other development within the jurisdiction of these Criteria shall submit drainage reports, construction drawings/specifications, and record drawing information for review and approval in accordance with the requirements of this Chapter.

The City will typically review reports and plans and provide written or oral review comments and/or approval within twenty (20) working days of the submittal (see Figure-201). The City will make every effort to effect a complete review and comment within the review period indicated in Figure-201. However, the City cannot approve reports or plans by default. In addition, the City cannot guarantee the time for review. Subsequent re-submittal reviews may also require a minimum of 20 working days to review.

Applicants or their designated representative are required to attend a pre-application conference to review processing steps for the subdivision regulations. The applicant shall consult with the Director or representative for general information regarding subdivision regulations, required procedures, possible drainage problems and variances, and specific submittal requirements. The requirement to submit both a conceptual and final report will be determined at the pre-application conference.

2.2 SUBMITTAL REQUIREMENTS

A conceptual and final drainage report are required for all development, except as determined at the pre-application conference (such as whether a drainage letter will suffice, or if a drainage conformance letter applies) A drainage conformance letter can be used in lieu of a drainage report when the site's drainage is already accommodated by a regional drainage report and associated detention and water quality features. Provided in Table 2C are a summary of the City's planning process as it relates to drainage report submittal requirements. The number of report copies to be submitted will be determined at the pre-application conference. One copy will be returned to the applicant or his representative with comments.

All submitted reports should be clearly and cleanly reproduced. Photostatic copies of charts, tables, nomographs, calculations, or any other referenced material should be legible. Washed out, blurred or unreadable portions of the report are unacceptable and could warrant re-submittal of the report. The submittal shall include a declaration of the type of report submitted (i.e., Conceptual or Final).

Table 2D will be used to determine the adequacy of the submittal. Incomplete or absent information may result in the report being rejected for review. Revision dates must be included on all re-submittals.

All development and redevelopment must provide grading and stormwater management plans (Chapter 13), onsite detention (Chapter 14), and storm water quality enhancement (Chapter 15), unless otherwise modified at the pre-application conference.

The Conceptual Drainage Report shall only contain general information regarding the proposed drainage facilities for the development. For instance, only identify that a channel or storm sewer is proposed for conveyance, and not the size, slope, velocity or other more detailed information. Also, it is only required to identify the location and type of detention (i.e.: drainage and water quality), and not the volumes or release rates. Grading and stormwater management plans are not required at the conceptual level, except as necessary to identify general drainage design.

The Final Drainage Report shall provide details of proposed drainage facilities, including grading, stormwater management, detention and water quality enhancement, and is to be submitted along with construction documents (see Section 2.4.3). Any exemptions or variances sought are to be included in the report. Construction documents shall include a copy of the grading and stormwater management plans.

Any variance being requested from the storm drainage design criteria must be in the form of a separate letter, to be signed by the owner and city engineer. An example is available from the Engineering Division.

2.3 CONCEPTUAL DRAINAGE REPORT

The purpose of the Conceptual Drainage Report is to:

- Identify drainage conditions prior to proposed development, including designated floodplain boundaries (see Figure 202 and city's website/floodplain information).
- Identify existing and potential drainage problems, which may occur on-site or off-site because of the development.
- Identify proposed solutions to drainage problems, including location of detention storage and water quality requirements, in sufficient detail to verify their feasibility.

Text shall be typed on 8-1/2" x 11" paper. Text, tables, figures, charts, calculations, and appendices shall be bound to form a formal report. Drawings shall not be larger than 24" x 36" and included in a pocket attached with the report. The report shall include a cover letter presenting the conceptual design for review and shall be prepared by or supervised by an engineer licensed in Colorado.

2.3.1 Conceptual Report Contents

The *Conceptual Drainage Report* shall be prepared in accordance with the outline provided as part of the checklist in Table 2D (see Section 2.6). The checklist must be completed by the applicant and included with the drainage report. The checklist will be used by the City to determine the completeness of the report. The City will determine if information provided is lacking or incomplete and whether additional information must be submitted prior to further review. It is understood that information in the *Conceptual Drainage Report* is subject to change.

2.3.2 Conceptual Report Drawing Contents

A. **General Location Map:** A 8-1/2" x 11" map shall be provided in sufficient detail at a scale not larger than 1" = 1,000' and included with the report. The map shall identify:

1. Drainage flows entering and leaving the development and general drainage patterns within the development.
2. Path of all drainage from the upper end of any off-site basins to the defined major drainageways (see Figure-202 and Drainage Policy).
3. Major construction (i.e., development, irrigation ditches, existing detention facilities, culverts, and storm sewers) along the entire path of drainage.
4. All major basins. Topographic contours are optional.

B. **Floodplain Information:** A copy of Figure-202 showing the location of the subject property shall be included with the report. All major drainageways shall have the floodplain defined and shown on the report drawings. See the city's website for information on floodplain delineations.

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

1. Existing and (if available) proposed contours at 5-foot maximum intervals. The contours shall extend a minimum of 100-feet beyond the property lines or further, if required by the City.
2. All existing drainage facilities.
3. Approximate flooding limits based on available information.
4. Conceptual major drainage facilities including detention basins, storm sewers, swales, riprap, and outlet structures in the detail consistent with the proposed development plan.
5. Major drainage boundaries and sub-boundaries.
6. Any off-site feature influencing development.
7. Proposed flow directions and, if available, proposed contours.
8. Legend to define map symbols.

9. Title block in lower right corner.

2.4 FINAL DRAINAGE REPORT

The purpose of the *Final Drainage Report* is to:

- Identify drainage conditions prior to proposed development, including flood plain boundaries.
- Identify existing and potential drainage problems, which may occur on-site or off-site because of the development.
- Investigate or refine conceptual solutions to drainage problems, including detention storage and water quality requirements, in sufficient detail to verify their feasibility.
- Present design details for drainage facilities discussed in the Conceptual Drainage Report.
- Identify measures to control erosion during construction activities and when development is completed.

Text shall be typed on 8-1/2" x 11" paper. Text, tables, figures, charts, calculations, and appendices shall be bound to form a formal report. Drawings shall be 24" x 36" and included in a pocket attached with the report. The report, including the erosion control plan, shall include a cover letter presenting final design for review and shall be prepared by or supervised by an engineer licensed in Colorado. The cover sheet of the report shall contain the following certifications:

"I hereby certify that this *Final Drainage Report* (plan) for the design of (name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of *City of Littleton Storm Drainage Design and Technical Criteria* for the owners thereof. I understand that the City of Littleton does not and will not assume liability for drainage facilities designed by others."

Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

□ (Name of Developer) hereby certifies that the drainage facilities for (Name of Development) shall be constructed according to the design presented in this report. I understand that the City of Littleton does not and will not assume liability for the drainage facilities designed and/or certified by my engineer. I understand that the City of Littleton reviews drainage plans but cannot, on behalf of (Name of Development), guarantee that final drainage design review will absolve (Name of Developer) and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the Final Plat and/or Final Development Plan does not imply approval of my engineer's drainage design.

Name of Developer

Authorized Signature

Date

2.4.1 Final Report Contents

The *Final Drainage Report* shall be prepared in accordance with the outline provided as part of the checklist in Table 2D (see Section 2.6) as well as contents listed in individual chapters such as Chapter 14 and 15. The checklist must be completed by the applicant and included with the drainage report. The checklist will be used by the City to determine the completeness of the report. The City will determine if information provided is lacking or incomplete and whether additional information must be submitted.

2.4.2 Final Report Drawing Contents

- A. **General Location Map:** An 8-1/2" x 11" map shall be provided in sufficient detail at a scale not larger than 1" = 1,000' and included with the report. The map shall identify:
1. Drainage flows entering and leaving the development and general drainage patterns.
 2. Path of all drainage from the upper end of any off-site basins to the defined major drainageways (see Figure-202 and Drainage Policy).
 3. Major construction (i.e., development, irrigation ditches, existing detention facilities, culverts, and storm sewers) along the entire path of drainage.
 4. All major basins. Topographic contours are optional.
- B. **Floodplain Information:** A copy of Figure-202 showing the location of the subject property shall be included with the report. All major drainageways (see Section 3.2.5) shall have the floodplain defined and shown on the report drawings.
- C. **Final Drainage Plan:** Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on a 24" x 36" drawing shall be included. The plan shall show the following:
1. Existing and proposed contours at 2-foot maximum intervals. The contours shall extend a minimum of 100-feet beyond the property lines or further if required by the City.
 2. Property lines and easements with purposes noted.
 3. Streets, indicating ROW width, flowline width, curb type, sidewalk, and approximate slopes.

4. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, cross-pans, drainageways, gutter flow directions, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.
5. Overall drainage area boundary and drainage sub-area boundaries.
6. Proposed type of street flow (i.e., vertical or combination curb and gutter), roadside ditches, gutter slope, and flow directions, and cross-pans.
7. Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances, including riprap protection.
8. Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.
9. Routing and accumulation and flows at various critical points for the initial storm runoff listed on the drawing using the format shown in Table-2B.
10. Volumes and release rates for detention storage facilities and information on outlet works.
11. Location and elevations of all existing floodplains affecting the property.
12. Location and (if known) elevations of all existing and proposed utilities affected by or affecting the drainage design.
13. Routing of off-site drainage flow through the development.
14. Definition of flow path leaving the development through the downstream properties ending at a major drainageway.
15. Legend to define map symbols (see Table-2B for symbol criteria).
16. Title block in lower right hand corner.

2.4.3 Construction Plans

The Final Construction Plans and Final Drainage Report must be submitted for approval to the Director with sufficient review and time for corrections, prior to the consideration of the plat before the City Council. Before final subdivision plats and site plans can be submitted to City Council for approval, the following are required:

1. Drainage reports and/or construction plans must be approved by the Director without conditions,

2. All required drainage, maintenance or other easements and licenses with the City must be approved by the Director and the City Attorney, and the appropriate title insurance provided, and
3. Drainage, maintenance or other easements and other agency approvals must be fully executed and copies provided to the City.

Approval of the Final Construction Plans and Final Drainage Report are required prior to issuance of a grading or building permit.

Construction plans shall be prepared in accordance with sound engineering principles, these Criteria 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. The approved Final Drainage Plan shall be included as part of the construction documents for all facilities affected by the drainage plan. Construction plans shall be signed by a registered professional engineer as being in accordance with the City approved drainage report, drawings, and Criteria. Requirements for construction plans are outlined in the checklist in Table 2E and contents listed in Chapters 14 and 15.

2.4.4 Grading and Erosion Control Plan/Stormwater Management Plan

A stormwater management plan (SWMP) consists of a map and narrative showing contours, flow directions and best management practices to control potential erosion and sedimentation during and after construction. In addition, the SWMP includes the city's standard notes (Chapter 13) and details for BMPs (or references to other standard details). Narratives can be separate documents or included as notes on the SWMP plan sheets. Additional requirements for construction may be required as part of a separate Colorado CDPHE permit, which is responsibility of the contractor. The map of the required BMP features, standard details, and standard notes, and any pertinent stormwater management information must be included in the construction plan set. Portions or all of the SWMP are also included with the *Final Drainage Report*, the required narrative and calculations are described in Table 2D as part of Chapter IV - *Stormwater Management Plan*. If a SWMP will be submitted without a drainage report (small sites), preparation of the SWMP by an engineer may be waived, but shall be accompanied by a certification of the owner, along with inclusion of *Standards Notes for Stormwater Management Plans* (see Chapter 13 for a copy of these requirements).

The SWMP shall be a separate drawing in the construction plan set and may be included with the drainage plan described above, provided all information is clear and legible. The SWMP shall be prepared in accordance with Table 2F and meet the requirements as shown in Chapter 13 of these Criteria.

2.5 RECORD DRAWINGS AND ACCEPTANCES

Record drawings for all improvements are to be submitted to the City. Drawings shall be submitted in electronic format and paper prints. Drawings shall include appropriate seals and signatures in accordance with current state law, with the request for Probationary Acceptance of public improvements or prior to requesting a Certificate of Occupancy for

commercial, industrial or multi-family residential building sites.

Storm drainage as-built drawings shall verify the following:

Pipes: pipe material, diameter, inverts at upstream and downstream ends, length, slope based on recorded length and inverts. Location if more than 2' off of design.

Manholes, inlets: size, type, cover type, invert elevation, grate or rim elevation, location if shifted 2' or more from design

Culverts: pipe material, diameter, inverts at upstream and downstream ends, length, slope based on recorded length and inverts. Location if more than 2' deviation from design.

Underdrains: pipe material, size, cleanout locations, depth of bury, slope

Detention/water quality facilities: volume(s) – WQCV, EURV, 100-yr and/or other design event, design water surface elevations – WQCV, EURV, 100-yr or other, top surface area, pond bottom and spillway elevations, emergency spillway elevations, inlet and outlet elevations, spot elevations sufficient to determine volume; engineer and surveyor statements (see below)

Detention/water quality structures: deviations from design dimensions, invert elevations of bottom of structure, and orifice(s), weirs, outlet pipe, top grate, and other pertinent elevations for function of facility.

Porous landscape detention/sand filters/biofilters/swales: length, width, typical section if deviated from design, inverts sufficient to identify longitudinal slope, location if deviated more than 2' from design, volumes above filter medium and design water surface elevations, thickness of filter media, size/material and slope of underdrains.

Vaults: same as detention/water quality structures and volume within structure (if applicable), manufacturer name and model (if applicable)

Certification of the record drawings is required as follows:

1. Registered Land Surveyor: A registered land surveyor in the state of Colorado shall certify the as-built elevations of detention and water quality facilities, and surface areas at the design depths, outlet structure sizes and elevations, storm sewer sizes and invert elevations at inlets, manholes, and discharge location, and representative open channel cross-sections, and dimensions of all the drainage structures.
2. Registered Professional Engineer: The responsible design engineer shall compute the as-built volumes of detention and water quality facilities and state that

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 construction drawings.

A revised Standard Detention and Infiltration (SDI) design spreadsheet file shall be provided with the as-builts, as applicable, that reflects the as-built condition (see Chapter 14 and 15)

The Director will compare the certified record drawing information with the construction drawings to ensure that:

1. The record drawing information demonstrates that the construction is in compliance with the design intent.
2. The record drawings are certified by both a registered land surveyor and a professional engineer licensed in Colorado.

2.5.1 Probationary Acceptance

All public storm drainage facilities shall be guaranteed by the developer to the City for a minimum one-year warranty period (with the exception of sewers over 20' deep which shall require a two-year warranty period or other special cases). The procedure for obtaining Probationary Acceptance (starting the warranty period) and Final Acceptance is contained in the City's *Engineering Requirements for Subdivisions*.

During the Probationary period, the City will perform routine maintenance of the public drainage facilities. The developer is responsible for any workmanship defects and for removal and clean-up of construction debris, dirt and mud in the system.

2.5.2 Acceptances

1. For newly constructed public drainage improvements, the City may consent to a reduction of the improvements guarantee provided by the developer when the drainage improvements are granted Probationary Acceptance.
2. For new commercial, industrial and residential building sites, the drainage portion of the Certificate of Occupancy shall be accepted when the Record Drawings are determined by the City to comply with the above criteria.

2.6 CHECKLIST

To aid the designer and reviewer, a summary of the required certifications and approvals is presented below.

ITEM	CERTIFICATION REQUIRED	CITY APPROVAL REQUIRED
Conceptual Drainage Report	Engineer	No
Final Drainage Report	Engineer and Developer	Yes
Construction Drawings	Engineer	Yes

Construction cost BMPs

Record Drawings

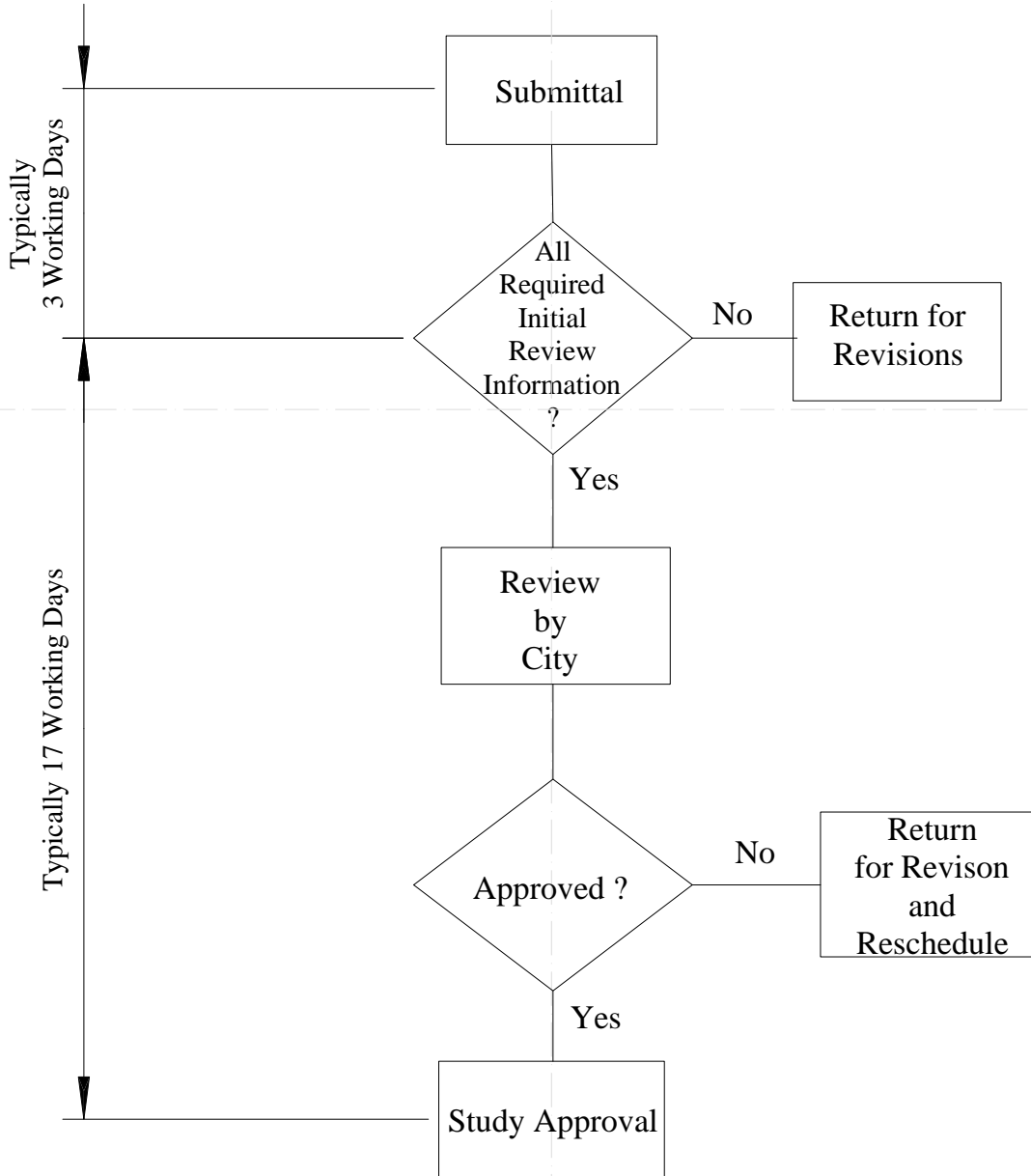
Engineer/Surveyor

Yes

A checklist for Conceptual and Final drainage reports, for construction plans, and for grading and stormwater management plans (SWMP) are provided in Tables 2D, 2E and 2F. These checklists contain recommended report outline and contents for all drainage reports, and contents for construction plans. A copy of the completed checklist shall be bound with the conceptual and final drainage report.

Applicant is to identify with a “✓” if information is provided with the appropriate submittal. If applicant believes information is not required, indicate with “n/a”. City will review the submittal to determine if information is required and whether information must be submitted. Due to the nature of a conceptual report, not all information listed in the outline/checklist may be required for a conceptual drainage report, such as those items listed with an asterisk (*). If the applicant is uncertain if information is required, the applicant is encouraged to contact the City.

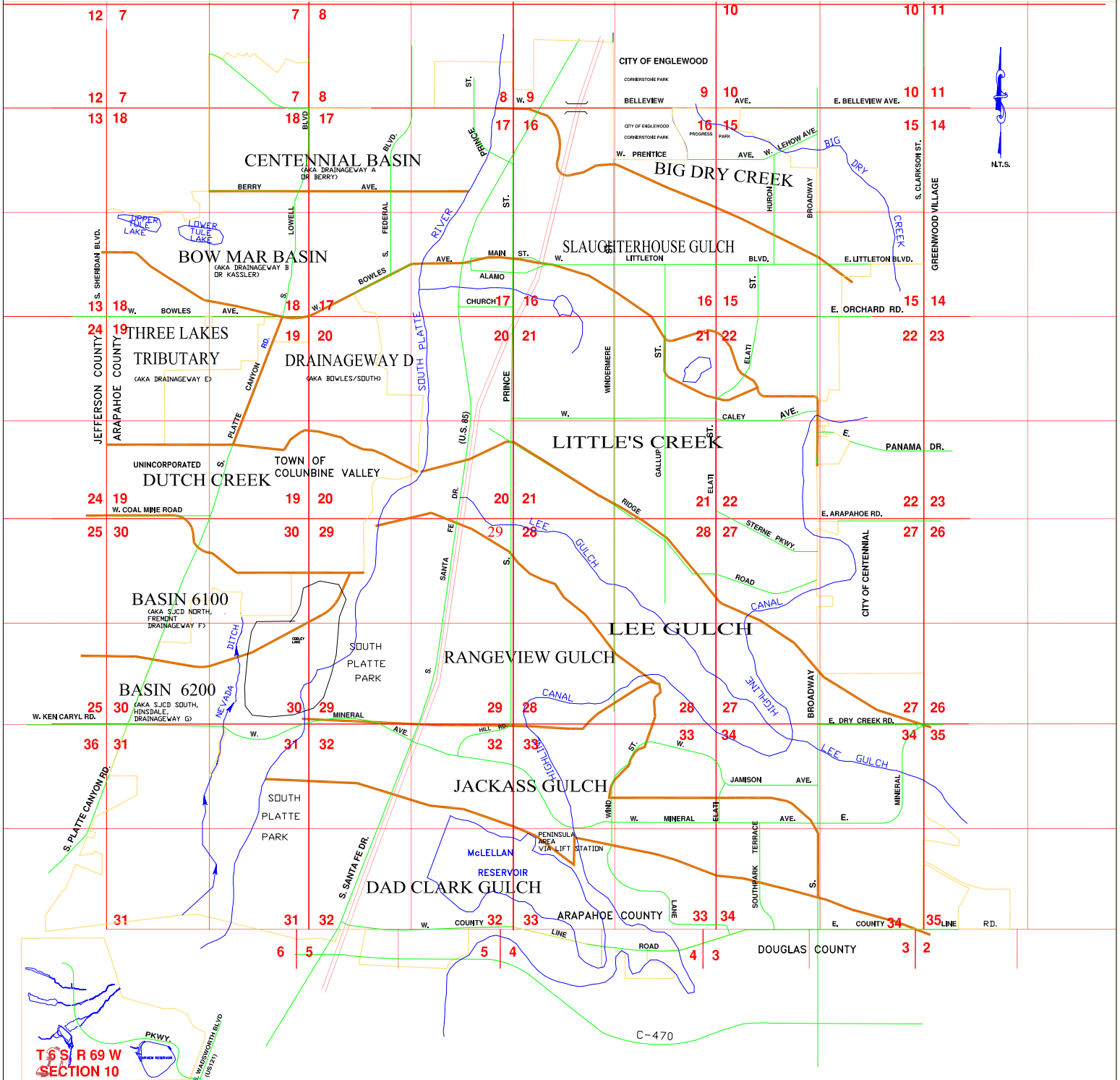
SUBMITTAL AND REVIEW FLOW CHART



NOTE: Review time increases if any "NO" is received and the submittal is returned for revisions.

CITY OF LITTLETON MAJOR DRAINAGEWAYS

T 5 S , R 68 W



T 5 S, R 69 W
SECTION 10

DATE: JULY 2019
REV:

STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

FIGURE 202

DRAWING SYMBOL CRITERIA AND HYDROLOGY REVIEW TABLE



A = BASIN DESIGNATION

B = AREAS IN ACRES

C = COMPOSITE RUNOFF COEFFICIENTS



D = DESIGN POINT DESIGNATION

SUMMARY RUNOFF TABLE

(to be placed on drainage plan)

DESIGN POINT	CONTRIBUTING AREA (ACRES)	RUNOFF PEAK	
		Minor Storm * (CFS)	Major Storm 100 yr (CFS)
XX	XX .XX	XX.X	XX.X

*5-year storm for design of minor drainage system (streets, storm sewer, culverts) and 10 year storm for detention design.

CITY OF LITTLETON PLANNING PROCESS
 AS RELATED TO DRAINAGE
 SUBMITTAL REQUIREMENTS

REZONING AND PLATTING APPLICATIONS

CASE I: Site being considered for rezoning will be platted in one filing

<u>Planning Stage</u>	<u>Required Drainage Submittal</u>
Rezoning	Conceptual Drainage Report
Preliminary Plat	Conceptual Drainage
Final Plat	Report Final Drainage Report

CASE II: Site being considered for rezoning will be platted in more than one filing

<u>Planning Stage</u>	<u>Required Drainage Submittal</u>
Rezoning	Conceptual Drainage Report to serve as total Site or Master Drainage Plan in order to centralize drainage improvements (i.e.: detention facilities, channels, storm sewer, etc.) to the greatest extent possible.

Prior to approval of any Preliminary Plats by the Planning Commission	Conceptual Drainage Report for the total rezoned site or basin to further define and expand upon the Master Drainage Plan prepared at rezoning.
---	---

Narrative evaluating compliance with the Master Drainage Plan Report as related to the specific filing in question. Major modifications, discrepancies or oversights identified in the Plan as compared to the Rezoning application may require the Conceptual Drainage Report be amended.

Final Plat	Final Drainage Report for specific filing
------------	---

BUILDING PERMITS FOR MULTI-FAMILY
 RESIDENTIAL, COMMERCIAL AND
 INDUSTRIAL SITES

A Conceptual Drainage Report is required with conceptual site plan submittal.
 A Final Drainage Report with final construction plans is required with final site plan submittal.

NOTE: The drainage submittal requirements as outlined in this Table are general guidelines and do not represent all circumstances under which specific drainage submittals may be required. Prior to submittal, the applicant shall consult with the Director for submittal requirements regarding applications or processes not addressed in this Table.

Table 2D

City of Littleton Storm Drainage Design and Criteria Manual
DRAINAGE REPORT CHECKLIST

Instructions: Applicant to check item if provided. If not applicable, indicate with "N/A"

City will determine if N/A is in fact required

Outline may vary from this format depending on the project, but content should still be present in the report

Items with asterisk (*) are not required for conceptual reports.

TITLE PAGE

- A. Type of report; conceptual, preliminary or final
- B. Project Name
- C. City Project Number
- * D. Professional Engineer seal and signature

INTRODUCTION

- A. Background
 - 1. Identify project and purpose
 - * 2. Identify previous city reviews and dates
- B. Project location
 - 1. Township/Range/Section
 - 2. Address or nearest cross streets, subdivision name, city and state
 - 3. Reference to a location map
- C. Property description
 - 1. Identify area (total site area, project area, disturbed area, existing & proposed impervious area), ownership, and land use/zoning
 - 2. Describe existing ground cover, vegetation, soils, topography and slopes/aspect
 - 3. Describe existing general drainage patterns
 - 4. Describe existing irrigation facilities
 - 5. Identify existing drainage or irrigation tracts, easements, etc.
- D. Previous investigations/reports
 - 1. Previous Drainage Reports
 - 2. Major Drainageway Planning study, outfall study, flood hazard area delineation study, floodplains, flood insurance study

DRAINAGE SYSTEM

- A. Existing drainage conditions
 - 1. Describe existing drainage basins and flow directions; provide a map with 1' contours extending minimum 100' beyond property/project limits, showing basin delineations and flow arrows
 - 2. Describe existing drainage features; ditches, channels, ponds, storm sewer, culverts, floodplains; show on the map
 - 3. Describe location of project in relation to existing major drainageways and floodplains and drainage master plans; show on the map
 - 4. Describe concentration of flows and magnitude at key design points; show on the map
 - 5. Describe offsite drainage area coming into the project area; identify location(s) on the map
- B. Proposed drainage system
 - 1. Describe proposed drainage pattern and drainage basins; show on a map with existing and proposed contours
 - 2. Describe how proposed project meets elements of Drainage Master Plan, if applicable
 - 3. Describe whether the project is a state MS4 site (over 1 acre of disturbance), and whether it meets a state exemption for permanent water quality, and how (with engineering justification)
 - 4. Describe how offsite flows are handled
 - 5. Describe proposed drainage elements (channels, inlets, culverts, storm sewers, ponds, etc.) at key design points to handle proposed flow values; show on a map
 - 6. Describe detention and water quality requirements and how they are met, particularly if a state MS4 site; detention/WQ feature volumes, release rates of flow, etc.; show locations on a map
 - * 7. Describe maintenance responsibility and maintenance activities/frequency (Operation and Maintenance Plan, see manual)
 - * 8. Identify proposed drainage easements; show on the map
 - * 9. Describe temporary erosion and sediment controls and pollution control during construction (Stormwater Management Plan narrative, SEE CHAPTER 13)

ANALYSIS AND CRITERIA

- 1. Identify and verify design in accordance with latest version of City Storm Drainage and Technical Criteria Manual
- 2. Identify any other drainage design criteria used
- 3. Identify development constraints on the project per a MHFD master plan or other development master plan, if applicable
- 4. Identify other constraints from streets, utilities, existing structures, other developments, etc.
- 5. Identify criteria used for hydrology and hydraulic design calculations if not following city standards
- 6. Identify design storms used for various drainage elements, method for designing drainage infrastructure, such as standard spreadsheets or computer software
- 7. Identify any variances from City storm criteria that are requested and provide justification

CONCLUSION

- 1. Describe compliance with City storm criteria and MHFD major drainage master plans, or variances requested
- 2. Describe design's effectiveness in controlling surface runoff
- 3. Describe how design meets requirements of floodplain regulations, if applicable

REFERENCES

- 1. Reference source documents for criteria, soils information, major drainage master plans or FHADs, FEMA documents, etc.

APPENDIX

- 1. Completed copy of this Drainage Report checklist
- 2. Location Map of Project
- 3. Soils Information
- 4. Calculations of runoff coefficient and assumptions
- 5. Calculations of existing and proposed flows leaving the site
- * 6. Calculations for sizing storm sewer, inlets, channels, ditches, street flow spread, etc.
- * 7. Calculations for riprap sizing and limits
- 8. Calculations for required water quality and detention volumes
- * 9. Water quality/detention pond feature design, orifice design, etc.
- * 10. Stormwater Detention and Infiltration (SDI) worksheet output, if applicable (for all detention ponds or Extended Detention Basin water quality facilities)
- 11. Existing and Proposed Drainage Maps
- * 12. Drainage design construction plans
- 13. Excerpts from applicable floodplain map, FHAD, Master Plan and/or FIS report
- 14. Other requirements as noted in Manual

OTHER REQUIRED CERTIFICATION STATEMENTS (see chapters of manual)

- 1. Engineer Cost Estimate for Stormwater Management Plan implementation and maintenance (for surety)

Checklist prepared by _____
(Name of Preparer)

Table 2E

City of Littleton Storm Drainage Design and Criteria Manual
DRAINAGE CONSTRUCTION DOCUMENTS CHECKLIST

*Instructions: Applicant to check item if provided. If not applicable, indicate with "N/A"
City will determine if N/A is in fact required*

PLAN VIEW

- A. Scale Bar, North Arrow, Title Block
- B. Legend of all linework and symbols for all existing and proposed features
- C. Project Name and City Project Number
- D. Existing Features:
 - 1. Contours at 1' intervals, based on NAVD88 datum. Index (5') contours labeled
Contours to extend at least 50' beyond property or project area.
 - 2. Location and elevation of benchmarks
 - 3. Easements, ROW and Property Lines
 - 4. Street Names
 - 5. Major and minor channels and floodplains
 - 6. Existing utilities and drainage infrastructure
- E. Proposed Features:
 - 1. Contours at 1' intervals, based on NAVD88 datum. Index (5') contours labeled, flow arrows, critical spot elevations
Contours to extend at least 50' beyond property or project area.
 - 2. Benchmark and Control Point locations and information
 - 3. Easements, ROW and Property Lines
 - 4. Street Names
 - 5. Proposed structures / Finished Floor Elevations
 - 6. Channels and ditches
 - 7. Proposed Storm drainage infrastructure and other utilities (storm sewer, culverts, inlets, etc.)
 - 8. Underdrains and/or other drainage features
 - 9. Detention and water quality features:
 - a. Each feature has plan view at 1"=50' or larger with 1-foot contours
 - b. Each structure (inlet and outlet)
 - c. Trickle channel, forebay, etc.
 - d. Emergency spillway and protection
 - e. Erosion protection information and limits
 - f. Design water surface area/limits
 - g. Operation and Maintenance Plan notes and callouts (separate plan)
 - 10. General and/or standard notes as applicable to the drainage feature construction, including references to standard details

PROFILE VIEW

- A. Storm sewer profiles with invert and crown, design discharge value, HGL and EGL; slopes, pipe size, and material labels, proposed grade
- B. Manhole, inlet, and outlet locations with inverts, location and and rim/grate elevation labels
- C. Utilities above and below storm sewers (or in conflict), and clearances (min)
- D. Roadway crossings, row, easements or other labels
- E. Outlet information; type of outlet, riprap thickness, extent of wingwalls/headwalls, etc.
- F. Channel invert profile with existing and proposed grade, location stationing, utilities, and riprap
in channel structures location labeled with top/bottom elevations, in channel culvert size, material, extents and inverts
- G. Detention/WQ pond profile with existing and proposed grades, all structures, design water surface elevation/volume callouts
- H. Scale ; grids for horizontal and vertical

SECTION VIEW:

- A. Street typical section with 100-year street depth
- B. Channel cross sections every 100' showing existing and proposed topography
- C. Channel typical section with bottom width, top width, side slopes, erosion protection, etc.
- D. Detention/WQ features:
 - 1. pond cross section with existing and proposed grade, all structures, design water surface elevations/volume callouts
- E. Trench detail, or reference to standard detail

STRUCTURAL DETAILS

- A. Detention/WQ features:
 - 1. Concrete sections to show thickness, rebar, etc.
 - 2. Details of orifices, weirs, restrictor plates, etc.
 - 3. Water surface elevations and release rates of design events
- B. inlet, manhole, and grate details, or references to standard details

STANDARD NOTES:

- 1. No building, structure, or fill will be placed in the detention/WQ facilities and no changes or alterations to detention/WQ facilities are permitted without approval of the City Engineer.
- 2. Maintenance and operation of the detention/WQ facilities is the responsibility of the property owner. If owner fails in this responsibility, the City has the right to enter, perform maintenance, and be reimbursed for costs. Maintenance and Operation of the facilities shall follow the filed Operations and Maintenance plan.
- 3. Detention and WQ volumes, features and drainage basins shall be verified. As-built drawings shall be prepared by a Professional Engineer registered in Colorado prior to certificate of occupancy.
- 4. Permission to reproduce these plans is hereby given to the City for its purposes associated with plan review, approval, permitting, inspection and construction of the work.

PROFESSIONAL ENGINEER SEAL AND SIGNATURE (COLORADO)

OTHER REQUIRED CERTIFICATION STATEMENTS (see chapters of manual)

Table 2F

City of Littleton Storm Drainage Design and Criteria Manual

STORMWATER MANAGEMENT PLAN CHECKLIST

*Instructions: Applicant to check item if provided. If not applicable, indicate with N/A
City will determine if N/A is in fact required*

PLAN SHEET(S)

	A. Scale Bar, North Arrow, Title Block, Vicinity Map
	B. Legend of linework, symbols, and labels used for various BMPs/Control Measures
	C. Project Name and City Project Number
	D. EXISTING contour lines at 1' interval extending 100' beyond property or project limits, with index contours labeled.
	E. PROPOSED contour lines at 1' interval, extending 100' beyond property or project limits, with index contours labeled.
	F. Approval Block (see manual)
	G. Easements, existing and proposed
	H. Existing water bodies, irrigation ditches, channels, or floodplains
	I. Existing sensitive areas, such as wetlands
	J. Existing and proposed buildings, fences, walls, large trees and other physical features
	K. Existing and proposed drainage features; storm sewer, inlets, channels, ponds, etc.
	L. Layout of proposed BMPs/control measures with labels matching the legend and details
	1. Initial, Interim, and Final phase plan sheets should be produced to correspond with anticipated construction sequencing
	M. Proposed drainage flow arrows
	N. Identification of slopes 3:1 and steeper
	O. Sidewalks, roads, and other areas to remain impervious
	P. Locations of stockpiles, vehicular access points to the site, haul routes, fueling stations,
	Q. Area summary table including:
	1. Total Site Area
	2. Project Area (if different from total site area)
	3. Disturbed Area
	4. Existing and Proposed Impervious Areas
	5. Cut/Fill Quantities

DETAILS

	Reference to CDOT or Mile High Flood District standard details for BMPS/Control Measures
	Include any other BMP/Control Measure details or deviations from standards

STANDARD NOTES

	City Standard Notes (see Chapter 13)
	Other notes required to explain all pollution prevention measures as required by state permit (if applicable, and not contained in other narratives)

APPENDIX

	1. Calculations of existing and proposed flows leaving the site
	2. Soils information
	3. runoff coefficient calculations and assumptions
	4. excerpts from applicable floodplain map, FHAD, Master Plan and/or FIS report
	5. Location map of project
	6. Drainage maps of existing and proposed conditions
*	7. Calculations for sizing of storm sewer, channels, ditches
*	8. Drainage design construction plans
	9. Water quality and detention calculations
*	10. Water quality/detention pond feature design/orifice design, etc.
	11. Stormwater Detention and Infiltration (SDI) worksheet output, if applicable.
*	12. Riprap sizing and limits calculations
	13. Other requirements as noted in manual

OTHER REQUIRED CERTIFICATION STATEMENTS (see chapters of manual)



CHAPTER 3 - DRAINAGE POLICY

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3.1 INTRODUCTION

Presented in this chapter are the City of Littleton drainage policies. These policies are based on drainage principles and criteria discussed in the Mile High Flood District *Urban Storm Drainage Criteria Manual* (Manual). Policy statements are presented in *italic* text. To facilitate enforcement of these policies and interpretation for special circumstances (see Section 1.6 and 1.8), the Director may refer to information presented in the Manual for guidance.

3.2 BASIC PRINCIPLES

Urban Sub-System: City policy considers stormwater drainage a sub-system of the overall urban system and requires planning for all developments to include the allocation of adequate space for stormwater and water quality facilities.

1. Multi-Purpose Resource: City policy considers storm runoff a multi-purpose resource with the potential for practical uses and encourages multi-purpose uses.
2. Water Rights: City policy recognizes possible effects of drainage and water quality facilities on water rights. When planning and designing drainage and water quality facilities, existing water rights must be protected.
3. Jurisdictional Boundaries: City policy is to pursue a unified approach to stormwater and water quality to achieve an integrated plan.
4. Major Drainageway: City policy defines a major drainageway as any drainage flow path with a tributary area of 130-acres or more.

3.3 REGIONAL AND LOCAL PLANNING

3.3.1 Basin Transfer

City policy discourages inter-basin transfer of storm drainage runoff and encourages drainage facilities that maintain existing drainage paths within the basin. However, the transfer of drainage from basin to basin is a viable alternative in certain instances and will be reviewed on a case-by-case basis.

3.3.2 Master Planning

In recognition that drainage boundaries are non-jurisdictional, the City has participated in regional watershed planning studies for major drainageways and outfall drainage systems. Studies completed in Littleton are identified by Mile High Flood District on the mapping section of their website. These studies may identify:

- Peak rates for design of future stormwater facilities based on future development conditions within the watershed. Peak runoff rates are available for flood frequencies from 2-year to 100-year.
- Locations and sizes of recommended stormwater improvements, such as storm

sewers, channels, culverts, and detention facilities. Some listed studies also provide recommendations for stormwater quality protection.

- Requirements for regional or on-site detention for all new development.
- Special conditions that may be imposed on existing and future development to meet stormwater and water quality goals for the watershed.

For the purposes of these Criteria, drainage facilities are categorized on a regional level as either a “major drainageway”, an “outfall system”, or a “minor drainage system”. Major drainageways are typically open channels or large storm sewers/street conveyance systems with drainage area over 130 acres, often with delineated floodplains. Outfall systems are typically tributary watersheds to the major drainageway, that may lack proper channel or storm sewer conveyance. Master plans of public improvements to alleviate flooding or erosion risks are defined in Major Drainageway Planning Studies and Outfall System Plans by the Urban Drainage and Flood Control District (now known as Mile High Flood District).

City policy requires integration of new development plans with adopted major drainageway and outfall system plans, which identify site requirements for private development and public improvements.

Major Drainageways or Outfall Systems design shall not account for the peak reduction effects of upstream on-site, privately-maintained, detention facilities.

If the development encroaches into the defined floodplain of, or is directly tributary to, a major drainageway, then the developer will be required to construct improvements as described in the planning report(s) for the major drainageway.

If a master-planned outfall system, as defined in approved outfall system reports, traverses the development, the developer is required to design and construct that portion of the outfall system within the development, in accordance with the Manual and these Criteria.

The development shall dedicate rights-of-way and easements for master planned drainage facilities, floodplain areas, and outfall system facilities including adequate space for operation and maintenance.

3.3.3 Areas with Significant Drainage Problems

Presently, there are areas in the City with significant drainage problems. Any new development or redevelopment in these areas may compound these drainage problems and, therefore, additional measures or analysis may be required to further mitigate impacts from development.

3.3.4 Local Drainage Planning

The minor drainage system consists of the conveyance features that direct storm runoff to the major drainageway flow path or the outfall; including curb and gutter, inlets and storm sewers, culverts,

bridges, swales, ditches, channels, detention areas, and other drainage facilities within a development. This minor drainage system is designed for two design events called the Minor and Major storms. Design and construction shall include connection of the minor drainage system to the major drainageway system or outfall system. Design and construction of the minor drainage system shall be as defined by the chapters of this Criteria and the Final Drainage Report and plan (section 2.4 of these Criteria).

City policy requires that all developments plan for, design, and construct drainage facilities to convey storm runoff from both the minor and major storm events.

3.3.4.1 Minor Storm

The minor storm is defined as that with a 5-year recurrence interval. The minor storm drainage system at a development site shall be designed to convey the runoff from the minor storm.

3.3.4.2 Major Storm

The major storm is defined as that with a 100-year recurrence interval. The major storm shall be analyzed at a development site to ensure adequate and safe conveyance of major storm runoff subject to the constraints outlined in this Criteria.

3.3.5 Floodplain Management

City policy requires that floodplains be left in their natural state, when possible, and be protected from degradation or adverse impacts on their natural state. Any development within a floodplain shall be in accordance with adopted Floodplain Regulations in Title 10, Chapter 7 of the City Code.

Improvements to existing structures in the floodplain that pre-date floodplain mapping are encouraged and may be required in certain circumstances, pursuant to Littleton Municipal Code Title 10, Chapter 7, the National Flood Insurance Program regulations, and Floodplain Regulations of the State of Colorado.

3.3.6 Storm Runoff Detention

City policy requires storm runoff discharges from development and re-development to occur in a quantity and manner similar to pre-developed conditions. The City may also require that discharges from new development not exceed capacity of existing downstream facilities. To reduce the magnitude and downstream impacts of developed runoff peaks, the City requires on-site detention for all development and re-development projects for projects over 5000 square feet in size, and exceeding 70% imperviousness (smaller sites) or over 10,000 SF impervious area. Impervious area or percentage can be effectively reduced with minimizing directly connected impervious areas and implementing other pervious buffers before runoff leaves a site into adjacent impervious streets, gutters, storm sewer etc. Details are presented in Chapters 14 and 15.

3.3.7 Storm Water Quality

City policy requires all construction activity resulting in disturbance equal to or exceeding 5,000 square feet of surface area exposing dirt to develop a stormwater management plan depicting temporary erosion and sediment control measures. Smaller site disturbances may be required to implement erosion and sediment control measures as described in individual permit requirements. Additional requirements are contained in Chapter 13.

City policy requires all new development and redevelopment projects with impervious area equal to or exceeding 10,000 square feet or equal or exceeding 70% imperviousness (smaller sites), to construct permanent water quality control measures to control the discharge of pollutants to the City's municipal stormwater system. Impervious area or percentage can be effectively reduced with minimizing directly connected impervious areas and implementing other pervious buffers before runoff leaves a site into adjacent impervious streets, gutters, storm sewer etc. Details are contained in Chapter 15.

3.3.8 Operations and Maintenance

City policy requires that all storm drainage facilities are operated and maintained for proper function, pursuant to Littleton Municipal Code Title 7, Chapter 7 – Littleton Storm Drainage Ordinance. Furthermore, City policy requires that all onsite detention and permanent water quality facilities shall have an Operation and Maintenance plan. This plan shall describe the purpose and function of the facility and its parts, and the inspection and maintenance schedule for various tasks required to ensure the facility operates as designed and as intended. Maintenance access to detention and water quality facilities shall be designed pursuant to the criteria in the Manual.

City policy requires that maintenance access for vehicles to all storm drainage facilities be provided in a dedicated easement or a tract, to assure continuous operational capability of the system.

- Privately owned facilities shall be located in an *easement or tract designated for drainage and maintenance access, with language as approved by the city*. The property owner shall be responsible for the maintenance of all private drainage facilities including inlets, pipes, culverts, channels, ditches, hydraulic structures, and detention basins located in the tracts.
- Should the property owner fail to adequately maintain said facilities, the City shall have the right to enter said *easement or tract* for the purposes of operations and maintenance. All such maintenance costs will be assessed to the property owner.
- Publicly owned facilities shall be located in dedicated easements to the city, *with language approved by the city*.
- To provide adequate area for maintenance of drainage facilities, drainage easements or tracts shall be exclusive of other utilities or uses, unless otherwise approved by the



Director.

- Obstructions within drainage easements that may have adverse impacts on maintenance activities are prohibited. Obstructions include, but are not limited to, fences, trees, large shrubs, large boulders, retaining walls, buildings, sign posts with concrete bases, utility poles. Any obstructions placed in an easement or tract are subject to immediate removal by the city without replacement, or cost reimbursement to the property owner.
- Drainage easements shall be shown on the Final Plat and Final Site Development Plan, with language approved by the city, and state maintenance requirements and that the City has the right of access as described above.

Minimum required dimensions of easement and tracts are outlined in the table below.

<i>Drainage Facility</i>	<i>Easement or Tract Width (feet)</i>
Storm Sewer	20 feet minimum, or based on installation depth and diameter or width of pipe, in accordance with Figure 801, whichever is greater.
Open Channels	
(a) Swales with Q_{100} less than 50-cfs	15 feet minimum, which includes 6-inches of vertical freeboard
(b) Minor or major channels with Q_{100} greater than 50-cfs	50 feet minimum, or 10' beyond width at design discharge with 12" of vertical freeboard, whichever is greater.
Detention Pond, Water Quality pond/facility	10 feet minimum surrounding the perimeter of the required surface area of the design volume and freeboard, embankment, service spillway, emergency spillway and other associated facilities.

3.4 GENERAL DESIGN CRITERIA

3.4.1 Drainage Criteria

City policy requires that all storm drainage facilities be planned and designed in accordance with these Criteria. Construction of any drainage facility not initiated within a two-year period from time of construction plan approval will be re-evaluated and subject to re-approval by the City if Criteria or policies change as determined by the Director.

3.4.2 Storm Runoff

City policy allows storm runoff to be determined by either the Rational Method or the Colorado Urban Hydrograph Procedure (CUHP), within the limitations as set forth in these Criteria and the Manual. For basins larger than 90 acres, the peak flows and volumes shall be determined by the CUHP.

3.4.3 Streets

City policy allows the use of streets for drainage with the depth and spread limitations described in Chapter 10 and 11 of these criteria.

Cross street flow is permitted in streets other than Arterials, subject to limitations set forth in Chapter 10 of these Criteria.

Overflow of the street gutter or crown at culverts and bridges, is permitted only in limited circumstances subject to limitations set forth in Chapter 11 of these Criteria.

3.4.4 Aesthetic Requirements

City policy requires that drainage channels, culvert inlet and outlet areas, and stormwater detention ponds be landscaped as specified in these Criteria.

3.5 IRRIGATION FACILITIES

3.5.1 Drainageway Interaction

City policy requires site drainage analysis and design to not account for interception of surface flows by an upstream irrigation ditch within the drainage basin.

3.5.2 Irrigation Ditches

City policy requires that:

1. Storm runoff shall be directed downstream into the historic or natural drainageway or basin which existed prior to ditch construction. Storm runoff discharges into a canal or ditch are

prohibited, except as required for water rights or as approved by the Director. See Chapter Section 15.4.6 for more specific information regarding the Highline Canal specifically.

2. New development and redevelopment plans shall include the design of appropriate structures to separate storm runoff from ditch flows, subject to the condition noted above, whenever irrigation ditches cross existing drainageways or master planned drainage improvements in the developing area. See 15.4.6 for more information.

3.5.3 Irrigation Reservoirs

City policy:

1. Restricts development to areas outside of the reservoir's high water line created by the design flood for the emergency spillway.
2. Restrict future development to areas outside of the high water line created by the breach of a dam (excepting high hazard classified dams, which have passed inspection by the state engineer's office in accordance with CRS 37-87-105 et seq.).
3. Restrict development to areas outside existing or potential future emergency spillway paths, beginning at the dam and proceeding to the point where the flood water returns to the natural drainage course

3.6 COMPUTER PROGRAMS

The City will accept hydrologic and hydraulic calculations for drainage reports performed using computer software subject to the following conditions:

1. Use of computer software supported by the Mile High Flood District are encouraged. Hard copies of input and output files shall be submitted with the drainage report. Electronic copies may be required.
2. Calculations performed using other computer software will be evaluated on a case-by-case basis. Engineer is encouraged to contact the Director regarding the use of specific software prior to submitting a drainage report. In addition to a copy of all input and output files, the engineer may be requested to provide a calibration run which demonstrates that results are acceptable to the City.

CHAPTER 4 – FLOODPLAIN REGULATIONS AND FLOODPLAIN DEVELOPMENT PERMIT PROCEDURES

4.1 INTRODUCTION

The regulation of floodplains is necessary to preserve and promote the general public health, welfare, and economic wellbeing of the city. The general purposes of floodplain regulations are summarized as follows:

1. To reduce the hazard of floods to life and property.
2. To protect and preserve hydraulic characteristics of water courses used for conveyance of flood waters, and
3. To protect the public from extraordinary financial expenditures for flood control and relief.

To help achieve these goals, the city of Littleton is a participating community in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS). By being a NFIP community, the city is required to adopt floodplain regulations, and all residents and business owners in the city are eligible to purchase NFIP flood insurance, whether the property is within or outside a designated floodplain. It must be noted that flood risk still exists for properties outside of designated floodplains. As part of the CRS program, Littleton residents and business owners qualify for discounted insurance premiums.

More information about floodplains in Littleton can be found at the Public Works website “Flood Information”; <https://www.littletongov.org/city-services/city-departments/public-works/flood-information>. Links to floodplain mapping for both local and FEMA floodplains can be found at that website, in addition to the City’s zoning map and mapping by Mile High Flood District. A map of floodplains as of December 2021 is included at the end of this chapter.

4.2 FLOODPLAIN CODE

The City of Littleton’s floodplain regulations are included in Municipal Code Title 10 Articles 7-1 and 7-2.

It is the proposed development applicant/engineer’s responsibility to review and comply with the most current floodplain regulations as provided in the Code. The city’s floodplain regulations are a compilation of requirements from the following sources:

1. Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP) regulations as contained in Code of Federal Regulations (CFR): 44 CFR Parts 59, 60, 65, and 70.

2. State of Colorado Department of Natural Resources, Colorado Water Conservation Board, Rules and Regulations for Regulatory Floodplains in Colorado, November 2021.
3. Local/city floodplain regulations which may be more stringent than (1) or (2) above, as permitted by 44 CFR, 60.1 (d), and as such, take precedence.

FEMA-delineated floodplains and local floodplains defined in Mile High Flood District Flood Hazard Area Delineation (FHAD) studies, are generally regulated the same way in the City of Littleton. However, local floodplains are not subject to FEMA Conditional Letters of Map Revision or Letters of Map Revision. Changes to local floodplain delineations will require a similar approval and adoption process handled locally by the city floodplain administrator, Colorado Water Conservation Board, and Mile High Flood District (fka UDFCD).

4.3 FLOODPLAIN OVERLAY DISTRICT

The floodplains in the city are delineated on the City's Zoning Map as the Floodplain Overlay District (FP-O). These areas depict the zones of additional building restrictions as described in Title 10, Articles 7-1 and 7-2 of the Municipal Code. This overlay district is also described in other sections of Title 10. The overlay district encompasses both FEMA and non-FEMA floodplain areas. Floodplains in the city of Littleton can also be viewed using address-lookup tools available within the "Flood Information" portion of the city's Public Works Department website, or the Mile High Flood District website.

4.4 FLOODPLAIN DEVELOPMENT PERMIT

4.4.1 General Information

Applications for any construction or development in a floodplain shall require a Floodplain Development Permit (FPD), regardless of the extent or nature of the work, unless a variance request is submitted and granted by the Administrator (variances may be subject to public hearing before the Planning Commission).

Underground utility projects that do not change the ground surface, either due to boring, drilling, or restoring the ground surface, do not require a FPD permit or modeling, but applicable permit approval will be conditional upon restoring ground elevations to existing conditions.

All other projects that change the ground surface (such as paving, etc) but do restore the original *elevations* are subject to the FPD permit, but will not require modeling, and will also have permit approval conditional upon restoring ground elevations to existing. Post project as-built survey may be required as a condition of the FPD permit.

The FPD permit process is to ensure that the project is in compliance with the floodplain regulations and the National Flood Insurance Program, as well as applicable State floodplain regulations. Permit application forms are available from the city's website (Permit Center/Applications), and are submitted together with attachments (details are below). The permit applications shall be reviewed by the City's Floodplain Administrator (administrator). The policies below are intended to clarify and supplement the information contained in the floodplain code.

Note: Some floodplains in the city are not depicted on FEMA Flood Insurance Rate Maps. In addition, a local study may have been adopted in the city as "best available information", with a revised floodplain and/or floodway that is not yet effective by FEMA. It is important to verify with the floodplain administrator in the Public Works/Engineering Division which floodplain or floodway delineation, or regulatory elevations, apply to any given project.

4.4.2 Review

There are two main considerations with floodplain projects that the floodplain administrator will evaluate as part of the permit review:

- 1) Need for hydraulic study: potential impact to floodway, floodplain water surface elevations and velocities, and surrounding properties, and whether hydraulic analysis and study are required to demonstrate the extent and amount of impact.
- 2) Proposed construction restrictions: If a project includes new structures, substantial improvements to existing structures, additions to existing structures, outbuildings, fill, fences, etc. These requirements are outlined in Title 10, Articles 7-1 and 7-2 for various types of construction.

All hydraulic studies or no-rise certification letters must be certified by a Professional Engineer licensed in the State of Colorado.

4.4.3 Submittals

4.4.3.1 Floodplain Development Permit applications

Applications shall include a Floodplain Development Permit application form and attachments as required. At a minimum, attachments shall include the following:

1. A narrative describing the project including:
 - Existing zoning for the property;
 - Existing [adjacent](#) development surrounding the property;
 - The proposed use of the property or purpose of the project;

- The name of the [watercourse](#) and source of all floodplain data;
 - Source and vertical datum for topographic survey;
 - General specifications for building construction including, but not limited to, material types, [floodproofing](#) measures, and water and sanitation facilities.
2. A site plan, certified by a registered Colorado professional engineer competent in open [channel](#) hydraulics. Such plan shall be prepared at a scale of one inch equals one hundred feet (1" = 100'), or larger, and shall include the following as applicable to the project:
- Existing zone district boundaries;
 - Location of floodplain and [floodway](#) limits with [base flood elevations](#);
 - Location of the centerline of the watercourse or storm sewer, labeled with the watercourse name;
 - Legal description of the property;
 - Layout of existing features and proposed project features;
 - Elevations of the site and immediately surrounding area, in relation to mean sea level, with existing and proposed project contours, and statement of vertical datum used;
 - Layout extents of proposed [structures](#), with the elevation of the [lowest floor](#) of these structures;
 - Location and elevations of all excavation and fill;
 - Locations and names of adjacent streets;
 - Location and elevations of water supply, sanitary facilities, and other [utilities](#).
3. If the project is changing elevations of the ground within the floodplain, then a typical floodplain cross section showing the existing ground elevations of the existing channel and [adjoining](#) floodplain, the proposed ground of the same, the cross sectional area to be occupied by the proposed development, and the base flood elevation.
4. If the channel or invert elevation of the floodpath is being altered, then a longitudinal profile showing the existing and proposed ground elevation of the bottom of the watercourse, e.g., invert of the channel of a stream, or the ground located at the centerline of the floodplain, and showing the existing and proposed base flood elevations.
5. If the project involves construction of a building within the floodplain, then drawings of the building and surrounding site grading will be required that adequately demonstrate compliance with structural requirements as outlined in Articles 7-1 and 7-2.
6. If required (see below sections), a hydraulic analysis performed by a registered engineer in Colorado, competent in open channel hydraulics, demonstrating the nature of the impacts of the project, or a [No-Rise Certification](#) from a registered engineer in Colorado.

Depending on the nature of the proposed project and potential impacts to the floodplain these additional elements may be required with the permit application:

1. Comments on the proposed floodplain development from affected agencies, as applicable including, but not limited to, the following:
 - City Engineer, [Community](#) Development, and Police;
 - South Metro Fire Department;
 - U.S. Army Corps of Engineers;
 - [Mile High Flood District](#);
 - Colorado Department of Transportation;
 - Parks and Recreation District;
 - [Colorado Water Conservation Board](#); and
 - Adjacent jurisdictions
2. If deemed necessary, the administrator may require that an applicant furnish additional information necessary to determine impacts, if any, of the proposed development on adjacent properties. (Revised 6-12-1992; amd. Ord. 19, Series of 2012; Ord. 15, Series of 2016)
3. If the project is determined to require a [FEMA CLOMR](#) or [LOMR](#), (or equivalent process for local floodplains) then additional information may be required.

4.4.3.2 Certificates

1. No-rise certification

A letter sealed and signed by a professional engineer in Colorado that a proposed project will not cause an increase (a “rise”) in 1% annual chance floodplain elevations. The letter must include engineering reasoning for why the project does not create a rise, or be supported by a hydraulic analysis that demonstrates this. A template example of a no rise certification is available on the FEMA website, but otherwise there is not a city form for this. The letter is addressed to the floodplain administrator.

2. Post-construction certifications

After construction of a project that had specific floodplain requirements, a letter sealed and signed by a professional engineer in Colorado stating that the construction has met all such requirements. This certification often requires an as-built survey or elevation certificate (below) to support such statements. There is not currently an approved template/format for this letter. The letter is addressed to the floodplain administrator.

3. Elevation Certificate

For structures constructed, substantially improved or substantial damage reconstructed within the floodplain will require a FEMA Elevation Certificate completed and certified by a Professional Land Surveyor in Colorado. An EC is required during construction after placement of the foundation to ensure compliance before the remainder of the structure is built. A post construction EC is required after full construction is completed. The FEMA Elevation Certificate (latest edition) is available online:

<https://www.fema.gov/glossary/elevation-certificate>

4. Certificate of Compliance

This letter or memo is issued by the Floodplain Administrator, after review of post-construction certifications from a project's engineer. This certificate verifies that the project is built in compliance with floodplain regulations. A copy is given to the Building Department to support their issuance of Certificate of Occupancy.

4.4.3.3 Floodplain Variance

Requests for a variance from a Floodplain Development Permit, any of its supporting documentation (such as hydraulic analysis), or any of the requirements of the floodplain code itself (Articles 7-1 and 7-2) can be made in writing to the floodplain administrator. This can be in letter format (the city does not currently have a template).

A variance will be considered only with adequate technical justification that there is insufficient flood risk associated with a project, or there are particular hardships associated with the permit. These do not have to be certified by a PE in Colorado, unless there is engineering or survey content of the variance request that must be supported by a PLS or PE. Requests for Floodplain Variance are subject to public hearing before the Planning Commission. In addition, within FEMA floodplains, any variances from FEMA NFIP regulations are required to be sent to FEMA. As such, the floodplain administrator is likely to request input from the regional FEMA office during the process of reviewing the variance request and decision whether to recommend issuance of a variance before the Planning Commission.

4.5 PROJECT CATEGORIES/CASES

Projects within floodplains generally fall into one of the categories below, which dictates the information that must accompany the floodplain development permit application as attachments. Definitions of terms are at the end of this chapter. A map of floodplains as of December 2021 is included at the end of this chapter. To search specific properties, please see the city's floodplain information website (link in Section 4.1).

1. FEMA Floodplains

- a) In the floodplain but outside of the Floodway
- b) In the Floodway
- c) In the floodplain when no Floodway defined
- d) Immediately adjacent the floodplain edge

2. Non-FEMA/Local Floodplains (FHAD or other approved study)

- a) In the floodplain but outside of the floodway (if studied and tabulated in the FHAD study, or shown on the FHAD map or other study)
- b) In the floodway (if studied as indicated above)
- c) In the floodplain when no floodway studied.
- d) Immediately adjacent to the floodplain edge

4.5.1 All FEMA PROJECTS Cases 1(a-d)

Upon discretion of the administrator, hydraulic analysis and/or a CLOMR may be required for projects or encroachments as determined necessary to better define the floodway limits or 1% chance water surface elevations, depending on the surrounding land use, insurable structures, and potential impacts.

As-built survey and statement of compliance from a licensed Colorado professional engineer will be required after construction in order for a Certificate of Compliance to be issued. Only after certificate of compliance can certificate of occupancy be issued (including temporary cert of occupancy).

A Letter of Map Revision (LOMR) will be required if the project water surface elevation differs from that of the published FEMA FIS by more than 0.3' (increase or decrease) or between pre-project and post-project conditions, or there is more than 25 linear feet of change to the floodplain delineation (width or lateral shift) compared with what is shown in the FIRM.

All residential structures must have lowest floor and supporting utilities elevated 12" (minimum) above the base flood elevation. Non-residential structures and supporting utilities must be flood proofed or elevated to 12" (minimum) above the base flood elevation. Other building types and associated restrictions are outlined in Title 10 Article 7-1 and 7-2 of the code.

Prior to issuing any Building Permits in areas removed from the floodplain by fill or channel realignment, the associated FEMA LOMR or LOMR-F must be approved and effective.

4.5.2 **Specific for Case 1a:**

A hydraulic study is required IF there are surrounding structures within or close to the floodplain edge that would be impacted by any rise. No impacts to surrounding structures are permitted in the city of Littleton, even if the project is located outside of a floodway. The study must demonstrate a no-rise (0.00') condition. These projects may be subject to a CLOMR at discretion of the floodplain administrator even in the case of a no-rise, which will also trigger approval through hearing of Planning Commission.

If there are no surrounding insurable structures to potentially be impacted (by decision of the administrator), and project is in the flood fringe outside of a designated Floodway, then no hydraulic analysis is required.

4.5.3 **Specific for Case 1b:**

A hydraulic study is required and must demonstrate a no-rise (0.00') condition. Even with a no rise analysis, projects within the Floodway are required in the city of Littleton to obtain approval from the Planning Commission through public hearing, and a Conditional Letter of Map Revision (CLOMR) from FEMA prior to construction.

Exceptions: stream restoration projects undertaken by the city and MHFD to restore conditions depicted in an effective FEMA study that are in a degraded condition with lowered channel inverts and all floodplain will be contained in a drainage tract or open space area.

4.5.4 **Specific for Case 1c:**

A hydraulic study is required to determine the project impact to 100-year water surface elevations. If the proposed impact is greater than 6 inches of rise at any location in the project or immediately upstream, then the project must obtain approval from the Planning Commission through public hearing, and a CLOMR prior to construction. If there are insurable structures that may be impacted by any rise at all, then a no rise condition is required.

If the proposed impact is less than 6 inches of rise, the project will be evaluated administratively by the floodplain administrator.

Exceptions: if a balance of effective flow conveyance area (with cut vs fill cross section area) can be demonstrated and certified by an engineer, then hydraulic analysis might not be required, at discretion of the administrator.

Note: the 6" rise criteria is cumulative in time and distance along the stream. Future projects must account for the rise created by previous projects.

4.5.5 Specific for Case 1d:

A hydraulic study is not required.

All residential structures must have lowest floor and supporting utilities elevated 12” (minimum) above the *adjacent* base flood elevation. Non-residential structures and supporting utilities must be flood proofed or elevated to 12” (minimum) above the *adjacent* base flood elevation. Other building types and associated restrictions are outlined in Title 10 Articles 7-1 and 7-2.

4.5.6 All Non-FEMA (local) floodplain projects, Cases 2(a-d):

As-built survey and certificate of compliance will be required after construction. If the project water surface elevation is more than 0.3’ different from that of the FHAD (increase or decrease) or pre-project to post-project, or there is more than 25 linear feet of change to the flood plain delineation (width or shift) compared with the FHAD, then as-built survey, hydraulic modeling and mapping must be approved by MHFD and then submitted to CWCB for approval by resolution of their Board, prior to issuance of building permits in the affected areas.

All residential structures must have lowest floor and supporting utilities elevated 12” above the base flood elevation. Non residential structures must be flood proofed or elevated to 12” above the base flood elevation. Other building types and restrictions are outlined in Code Title 10 Article 7-1 and 7-2..

Prior to issuing any Building Permits in areas removed from the floodplain by fill, the as-built mapping must be adopted by the CWCB.

Upon discretion of the administrator, hydraulic analysis may be required for projects or encroachments as determined necessary to better define the floodway limits or 1% chance water surface elevations, depending on the surrounding land use, insurable structures, and potential impacts.

4.5.7 Specific for Case 2A:

A hydraulic study is required IF there are surrounding structures within or close to the floodplain that might be impacted by any rise. The study must demonstrate a no-rise (0.00’) condition. These projects may be subject to a MHFD review at discretion of the floodplain administrator, even in case of no rise.

If there are no surrounding structures within or near the floodplain and project remains outside of the designated floodway, then a hydraulic study is not required.

4.5.8 Specific for Case 2B:

A hydraulic study is required and must demonstrate a no-rise (0.00') condition. Even with a no rise analysis, projects in this category are required in the city of Littleton to obtain approval from the Planning Commission through public hearing and will be subject to MHFD approval.

As-built survey and certificate of compliance will be required after construction. If the project water surface elevation is more than 0.3' different from that of the FHAD (increase or decrease) or there is more than 25 linear feet of change to the flood plain delineation (width or shift) compared with the FHAD, then as-built survey, hydraulic modeling and mapping must be approved by MHFD and then submitted to CWCBC for approval by resolution of their Board, prior to issuance of building permits in the affected areas.

Exceptions: stream restoration projects undertaken by the city and MHFD to restore conditions depicted in an effective FHAD study which are in a degraded condition with a lower invert, and all floodplain is contained in drainageway tract or open space.

4.5.9 Specific for Case 2C:

A hydraulic study is required to determine the impact to 100-year water surface elevations. If the proposed impact is greater than 6 inches of rise, then the project must obtain approval from the Planning Commission through public hearing, and MHFD approval.

If the proposed impact is less than 6 inches of rise, the project will be evaluated administratively by the floodplain administrator. Projects are subject to MHFD approval.

Exceptions: if a balance of effective flow conveyance area (with cut vs fill cross section area) can be demonstrated and certified by an engineer, then hydraulic analysis might not be required, at discretion of the administrator.

Note: the 6" rise criteria is cumulative in time and distance along the stream. Future projects must account for the rise created by previous projects.

4.5.9.1 Case 2D:

No hydraulic study is required.

4.6 DETERMINATION OF FLOODPLAIN LIMITS

An existing building or portion of a property may be deemed within the floodplain based on how

it is depicted on a floodplain map, or by the elevation of the base flood compared with current topography and building elevations. This determination will be made by the floodplain administrator, pursuant to Section 10-9-1.8(B)(6). Published floodplain maps are sometimes inaccurate, dated, or imprecise. Should an applicant wish to contest a determination by the administrator, the applicant's engineer must provide hydraulic modeling and topographic information to support their position. Whether or not a CLOMR or LOMR is required, to obtain a secondary FEMA review/verification, or to modify the floodplain map, will be determined by the floodplain administrator.

4.7 MODIFICATIONS TO FEMA FLOODPLAINS

4.7.1 Conditional Letter of Map Revision (CLOMR)

The trigger for CLOMR is determined by comparing an Existing Conditions ("pre-project") and Proposed Project ("post project" conditions. This is not necessarily a comparison to published FEMA base flood elevations, see "Definitions". This comparison will be required in Cases 1B and 1C (if over 6 inches rise) as described above, and with discretion in Case 1A.

If project is required to obtain a CLOMR, then multiple models may be required:

- FEMA "Effective" model
- Duplicate effective model (FEMA effective model results duplicated in original format if possible, but might also be in HECRAS)
- Corrected Effective model (Duplicate effective model with corrected errors and/or conversion to NAVD88)
- Existing Conditions model (Corrected Effective model or a new model with updated topography) – also called "pre project"
- Proposed Conditions Model (modified version of Existing Conditions model to reflect proposed conditions) – also called "post project"
- Updated Post Project after construction, with as-built information incorporated

4.7.2 Letter of Map Revision (LOMR)

Any project that creates a change from the FEMA Effective model base flood elevations in excess of 0.3' either increase or decrease, or between pre-project and post project, or changes the floodplain width by more than 25 linear feet in any location (narrowing or widening), must obtain as-built survey and a LOMR after construction. Any Floodplain Development Permit issued in the City for such projects will be *conditional* upon this requirement being met.

A project may require a LOMR which did not require a CLOMR.

4.8 SIGNIFICANT FILL PROJECTS WITH POTENTIAL LIFE SAFETY RISK

Certain projects in the floodplain are prohibited. Projects with "significant fill" placed in order to elevate the ground above the 100-yr floodplain elevation, concentrate floodwaters, and increases the depth and flow velocity of the 100-yr flood such as to be considered a life safety risk are prohibited. A life safety risk is defined when the average 100-yr flow velocity multiplied by the average depth at any location exceeds 7.0, and if that proposed 100-yr flow is not entirely contained within a designated drainage easement or tract. Significant fill is defined as fill covering an area over $\frac{1}{4}$ acre in size, regardless of thickness.

The intent of this regulation is to prevent the modification of floodplains onto another property or into a roadway, or other area not designated for floodwaters.

4.9 SUBSTANTIAL DAMAGE AND SUBSTANTIAL IMPROVEMENT

Existing buildings located within the FEMA floodplain (this is not applicable to non-FEMA floodplains, nor buildings immediately adjacent to the floodplain), are subject to limitations on improvements that can be made to those structures before they must modify the whole structure to comply with the NFIP. A project that is valued at more than 50% of the structure value (not entire property value) at time of the project, is considered a *substantial improvement*. In addition, this limit applies to the addition of multiple projects over a 5 year period. At this point, the entire structure (not just the improved portion) must be brought into compliance with the floodplain regulations. For residential structures, this means raising the lowest floor and supporting utilities 1 foot above the floodplain elevation. Foundations can be elevated by jacking, and basements can be abandoned by filling. The floodplain administrator can assist in reviewing different alternatives and possible assistance in funding.

This can apply to many buildings in the city of Littleton, as many buildings in the floodplain were constructed before that floodplain was delineated and floodplain regulations took effect.

Similarly, if a structure is damaged by any cause (not just flooding), by more than 50% of that structure value at the time of damage, the same conditions apply. *Substantially damaged* buildings must be rebuilt as if they are completely new and comply with the floodplain regulations.

4.10 DEFINITIONS

Base Flood Elevation: the published 100-yr water surface elevation in the FIS and shown on the

FIRM, or in the most recent Flood Hazard Area Delineation for local floodplains. If a water surface elevation is not defined in either document, then the base flood elevation is the elevation determined by the applicant's Existing Conditions Model.

Effective Model: The hydraulic model used to determine the water surface elevations published in the FIS and as delineated on the FIRM.

Existing Conditions or "pre-project": can be either the FEMA effective model, duplicate effective model, corrected effective, or a newly created model based on updated existing topography or other improved information.

Federal Emergency Management Agency (FEMA): The federal agency that regulates floodplains and publishes documents with regulatory floodplain data (FIRM and FIS) used in the NFIP.

Flood Insurance Rate Map (FIRM): The current and effective delineation of the 100-yr floodplain as published by FEMA.

Flood Insurance Study (FIS): The document that contains narrative text describing the analysis, flood profile, and water surface elevation tables, and accompanies the FIRM.

Hydraulic analysis: A detailed evaluation of how floodwaters will be conveyed through a property with a proposed project. This typically involves use of technical computer model designed for this specific purpose, approved by FEMA (typically this is HEC-RAS). The output from the model is used to develop a map of a floodplain area and the elevations of the floodplain. This report is certified by a Professional Engineer in Colorado.

National Flood Insurance Program (NFIP): The federal program that offers flood insurance, and establishes floodplain regulations for construction within floodplains.

No Rise: Zero (0.00') rise when comparing Existing Conditions and Proposed Conditions models. This is not necessarily a comparison of the Proposed conditions to the Effective conditions as published by FEMA, depending on how a study develops its Existing Conditions model (see definition above). However, in the case of a No-Rise certification for work within a regulatory FEMA floodway, the city will require a no rise when comparing proposed model to both existing conditions and the published FEMA base flood elevations.

Proposed Project or "post project" conditions: the existing conditions model modified to include the proposed project elements. Note, if the FEMA effective model is used for Existing Conditions, then it must be modified for the Proposed model. The existing and proposed condition models' topographic geometry components must match except for where the proposed project elements are located.

Other definitions from the code:

100 YEAR OR 1% CHANCE FLOOD: That flood that has a one percent (1%) annual chance

of occurrence in any given year. Also known as the base flood.

100 YEAR OR 1% CHANCE FLOODPLAIN: The area of land that is inundated by the floodwater from a 1% annual chance flood or base flood.

ADDITION: Any activity that expands the enclosed footprint or increases the square footage of an existing structure.

APPEAL: A request for review, held by the City's Planning Commission, of the Floodplain Administrator's interpretation of any provision of these regulations.

AREA OF SHALLOW FLOODING: An area susceptible to base flood depths ranging from one foot (1') to three feet (3') usually designated zone AO or AH on the city's flood insurance rate map (FIRM), or similar designation on an approved study, with a one percent (1%) or greater chance of flooding in any given year, where a clearly defined channel does not exist, the path of flooding is unpredictable, and velocity flow may be evident. Such flooding is characterized by ponding or sheet flow.

AREA OF SPECIAL FLOOD HAZARD: Land within the floodplain subject to a one percent (1%) or greater chance of flooding in any given year. The area may be designated zone A, AE, or A1-A30, AH, AO, or A99 on the city's flood insurance rate map (FIRM) or otherwise designed on an approved study.

BASE FLOOD: A flood having a one percent (1%) chance of being equaled or exceeded in any given year. Sometimes also known as a "100-year flood".

BASE FLOOD ELEVATION (BFE): The elevation shown on a FEMA Flood Insurance Rate Map (FIRM) for Zones AE or A1-A30 that indicate the water surface elevation resulting from a flood that has a one percent chance of equaling or exceeding that level in any given year.

If for a particular waterway BFEs are not shown or published in the FIRM or FIS, this may be the base flood elevation depicted or determined in another approved study.

BASEMENT: Any area of a building having its floor sub-grade (below ground level) on all sides.

CHANNEL: A physical confine of stream or waterway consisting of bed and stream banks, existing in a variety of geometries.

CHANNELIZATION: The artificial creation, enlargement, or realignment of a stream channel.

CODE OF FEDERAL REGULATIONS (CFR): The codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. It is divided into 50 titles that represent broad areas subject to Federal regulation.

COMMUNITY: Any political subdivision in the state of Colorado that has authority to adopt and enforcement floodplain management regulations through zoning, including, but not limited to, cities, towns, unincorporated areas in the counties, Indian Tribes and drainage and flood control districts.

COLORADO WATER CONSERVATION BOARD: An agency of the State of Colorado Department of Natural Resources that regulates floodplains in the State of Colorado.

CLOMR (CONDITIONAL LETTER OF MAP REVISION): FEMA's comment on a proposed project, which does not revise an effective floodplain map, that would upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodplain.

CRITICAL FACILITY: A structure or related infrastructure, but not the land on which it is situated, that if flooded may result in significant hazards to the public health and safety or interrupt essential services and operations for the community at any time before, during and after a flood.

DIRECTOR: The director of the Public Works Department of the city of Littleton.

DEVELOPMENT: Any manmade change to improved or unimproved real property located within a floodplain including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage of equipment or materials.

ELEVATED BUILDING: A non basement building (i) built, in the case of a building in the floodplain, to have the top of the elevated floor above the ground level by means of pilings, columns (posts and piers) or shear walls parallel to the flow of the water and (ii) adequately anchored so as to not impair the structural integrity of the building during a flood of up to the magnitude of the base flood. In the case of floodplain areas, “elevated building” also includes a building elevated by means of fill or solid foundation perimeter walls with openings sufficient to facilitate the unimpeded movement of flood waters.

EXISTING MANUFACTURED HOME PARK OR SUBDIVISION: A manufactured home park or subdivision, for which construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including installation of utilities, construction of streets, final site grading, or pouring of concrete pads, prior to July 18, 1978 (effective date of the floodplain management regulations adopted by the city).

EXPANSION OF EXISTING MANUFACTURED HOME PARK: The preparation of additional sites by the construction of facilities for servicing the lots on which the manufactured homes are to be affixed including the installation of utilities, the construction of streets, final site grading, or the pouring of concrete pads.

FEDERAL REGISTER: The official daily publication for Rules, proposed Rules, and notices of Federal agencies and organizations, as well as executive orders and other presidential documents.

FEMA: The Federal Emergency Management Agency, the agency responsible for administering the National Flood Insurance Program.

FLOOD or FLOODING: A general and temporary condition of partial or complete inundation of normally dry land areas from:

- The overflow from channels and reservoir spillways;
- The unusual and rapid accumulation of runoff of surface waters from any source; or
- Mudslides or mudflows that occur from excess surface water that is combined with mud or other debris that is sufficiently fluid so as to flow over the surface of normally dry land areas (such as earth carried by a current of water and deposited along the path of the current).

Note: a different definition of “flood” is used for determining eligibility for flood loss claims under the NFIP.

FLOOD FRINGE: That portion of a floodplain that is located outside the limits of a FEMA regulatory floodway.

FLOOD INSURANCE RATE MAP (FIRM): The most recently adopted official map on which FEMA has delineated floodplains and the risk premium zones applicable to the city.

FLOOD INSURANCE STUDY (FIS): The most recently adopted official report, entitled "The Flood Insurance Study For Arapahoe County And Incorporated Areas", provided by FEMA, that includes the Flood Insurance Rate Map and flood profiles for studied flooding sources that can be used to determine Base Flood Elevations for some areas.

FLOODPLAIN or FLOODPRONE AREA: Any land area susceptible to being inundated as the result of a flood, including the area of land over which floodwater would flow from the spillway of a reservoir. For administrative purposes, the floodplain is also defined as the land area inundated by the base flood as defined in the flood insurance study, or by other recognized sources.

FLOODPLAIN ADMINISTRATOR (ADMINISTRATOR): The director or a designee that administers and enforces the floodplain management regulations.

FLOODPLAIN DEVELOPMENT PERMIT: A permit required before construction or development begins within a floodplain. Permits are required to ensure that proposed development projects meet the requirements of the NFIP and this floodplain management ordinance.

FLOODPLAIN MANAGEMENT: The operation of an overall program of corrective and preventative measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works, and floodplain management regulations.

FLOODPLAIN MANAGEMENT REGULATIONS: Zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as a floodplain ordinance, grading ordinance and erosion control ordinance) and other application of police power. The term describes such state and local regulations, in any combination thereof, which provide standards for the purpose of flood damage prevention and reduction.

FLOOD CONTROL STRUCTURE: A physical structure designed and built expressly or partially for the purpose of reducing, redirecting, or guiding flood flows along a particular waterway. These specialized flood modifying works are those constructed in conformance with sound engineering standards.

FLOOD PROFILE: A graph of the longitudinal profile of a watercourse which shows the water surface elevation of flood recurrence intervals including the base flood; contained within the Flood Insurance Study.

FLOOD STORAGE AREA: The fringe portion of a floodplain in which flows are characteristically shallower and of lower velocities.

FLOODPROOFING: Any combination of structural and/or nonstructural additions, changes or adjustments to structures which reduce or eliminate flood damage to property, water and sanitary utilities, structures and their contents.

FLOODWAY (REGULATORY FLOODWAY): The channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without a cumulative increase in the water surface elevation more than one-half foot (0.5') for newly studied reaches or due to new development. Previously studied reaches and letters of map revisions to existing floodway delineations may continue to use the floodway criteria in place at the time of the existing floodway delineation.

FREEBOARD: The vertical distance in feet above a predicted water surface elevation intended to provide a margin of safety to compensate for unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood, such as debris blockage or bridge openings and the increased runoff due to urbanization of the watershed.

HIGHEST ADJACENT GRADE: The highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

HISTORIC STRUCTURE: Any structure that:

- Is listed individually on the national register of historic places by the Department of the Interior, or preliminarily by the Secretary of the Interior as meeting the requirements for individual listing on the national register; or by the Colorado Historical Society, or
- Is certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

- Is individually listed on a state or local inventory of historic places in states or communities with historic preservation programs approved by the Secretary of the Interior, or directly by the Secretary of Interior in states without approved programs.

INSURABLE STRUCTURE: A structure which qualifies for coverage under the National Flood Insurance Program; a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a manufactured home. The terms "structure" and "building" are interchangeable in the National Flood Insurance Program (NFIP).

LOMR (LETTER OF MAP REVISION): FEMA's official revision of an effective Flood Insurance Rate Map. LOMRs are generally based on the implementation of physical measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations or the Special Flood Hazard Area.

LOMR-F (LETTER OF MAP REVISION BASED ON FILL): FEMA's modification of the Special Flood Hazard Area shown on the Flood Insurance Rate Map based on the placement of fill outside the existing regulatory floodway.

LOWEST FLOOR: The lowest floor of the lowest enclosed area (including basements). Any floor used for living purposes which includes working, storage, sleeping, cooking and eating, or recreation or any combination thereof. This includes any floor that could be converted to such a use such as a basement or crawl space. The lowest floor is a determinate for the floor insurance premium for a building, home or business, an unfinished or flood resistant enclosure, useable solely for parking or vehicles, building access, or state in an area other than a basement area in not considered a buildings lowest floor; provided that such enclosure is not built so as to render the structure in violation of the applicable non elevation design requirement of Section 60.3 of the National Flood Insurance Program regulations.

MANUFACTURED HOME: A structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities for occupancy. The term "manufactured home" does not include recreational vehicles.

MANUFACTURED HOME PARK OR SUBDIVISION: A parcel (or contiguous parcels) of land divided into two (2) or more manufactured home lots for rent or sale.

MILE HIGH FLOOD DISTRICT (formerly known as the Urban Drainage and Flood Control District (UDFCD)): An agency established by the Colorado legislature in 1969 that partners with Denver area metro cities and counties to design and construct flood control and warning measures, open space, regional paths, and stream maintenance.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP): FEMA's program of flood insurance coverage and floodplain management administered in conjunction with the Robert T. Stafford Relief and Emergency Assistance Act. The NFIP has applicable Federal regulations promulgated in Title 44 of the Code of Federal Regulations. The U.S. Congress established the NFIP in 1968 with the passage of the National Flood Insurance Act of 1968.

NEW CONSTRUCTION: Development for which the start of construction commenced on or after the effective date of floodplain management regulations adopted by the City (July 18, 1978).

NEW MANUFACTURED HOME PARK: A manufactured home park which is constructed, including the installation of utilities, construction of streets, and final site grading, or pouring of concrete pads, after the effective date of floodplain management regulations adopted by the city (July 18, 1978).

NO-RISE CERTIFICATION: A record of the results of an engineering analysis conducted to determine whether a project will increase flood heights in a floodway. A No-Rise Certification must be supported by technical data and signed by a registered Colorado Professional Engineer. The supporting technical data might be on the standard step-backwater computer model used to develop the 100-year floodway shown on the FIRM.

OTHER FLOOD AREAS: Areas of two-tenths percent (0.2%) annual chance flood, areas of one percent (1%) annual chance flood with average depths of less than one foot (1'), or with drainage areas less than one square mile. The area may be designated zone X on the city's flood insurance rate map (FIRM).

RECREATIONAL VEHICLE: A vehicle, built on a single chassis, which is four hundred (400) square feet or less when measured at the largest horizontal projections, is designed to be self-propelled or to be towed by an automobile or light truck, and designed primarily not for use as a permanent dwelling but as temporary living quarters for recreation, camping, travel or seasonal use.

SPECIAL FLOOD HAZARD AREA (SFHA): The land in the floodplain within the city subject to a 1% chance or greater chance of flooding in any given year. Also known as the 100-year floodplain.

START OF CONSTRUCTION: The date a building permit was issued, including substantial improvements, provided the actual start of construction, repair, reconstruction, rehabilitation, addition, placement or other improvement was within 180 days of the permit date. The actual start of construction means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond excavation or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include the excavation for basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure. For substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building, whether or not that alternative affects the external dimension of the building.

SDDTC (Storm Drainage Design And Technical Criteria): The most recently approved version of the city's storm drainage design and technical criteria manual.

STRUCTURE: A walled and roofed building that is principally above ground, including manufactured homes.

SUBSTANTIAL DAMAGE: Damage, of any origin, sustained by a structure which results in cumulative costs (over a 5 year period) to restore the structure to its original condition that equal or exceed fifty percent (50%) of the market value of the structure before the damage occurred.

SUBSTANTIAL IMPROVEMENT: Any repair, reconstruction, or improvement to a structure, the cumulative cost (over a 5 year period) of which equals or exceeds fifty percent (50%) of the market value of the structure before start of construction of the improvement. The value of the structure shall be determined by the local jurisdiction having land use authority in the area of interest. This includes structures which have incurred Substantial Damage, regardless of the actual repair work performed. The term does not include either: a) any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum

CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

necessary conditions, or b) any alteration of any officially designated historic structure provided that the alteration will not preclude the structure's continued designation as a historic structure.

VARIANCE: A grant of relief from the requirements of these regulations when specific enforcement would result in unnecessary hardship. A variance therefore permits construction or development within a floodplain in a manner that would otherwise be prohibited.

VIOLATION: The failure of a structure or other development to be fully compliant with the city's floodplain regulations. A structure or other development where start of construction commenced on or after July 18, 1978, without an elevation certificate, other certifications or other evidence of compliance, is presumed to be in violation until such time as that documentation is provided.

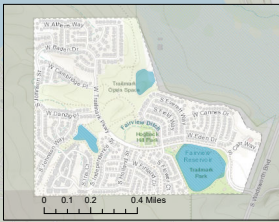
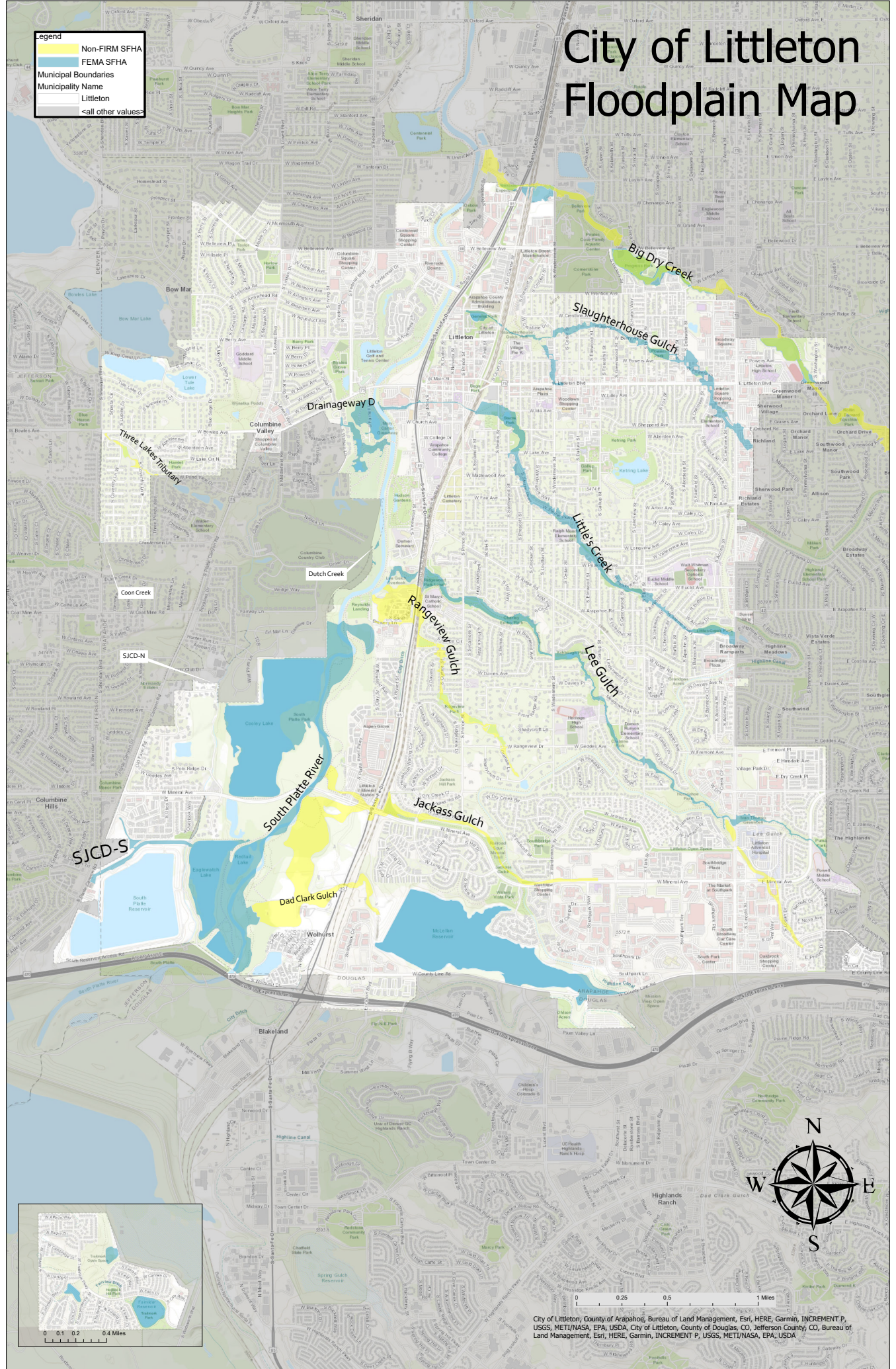
WATER SURFACE ELEVATION: The elevation, in relation to the North American Vertical Datum (NAVD) of 1988 (or other datum where specified), of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas.

WATERCOURSE: A channel, natural depression, slough, artificial channel, gulch, arroyo, stream, creek, pond, reservoir, or lake into which storm runoff and floodwater flows either regularly or infrequently. This includes major drainageways for carrying urban storm runoff.

City of Littleton Floodplain Map

Legend

- Non-FIRM SFHA
- FEMA SFHA
- Municipal Boundaries
- Municipality Name
- Littleton
- <all other values>



0 0.25 0.5 1 Miles

City of Littleton, County of Arapahoe, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA, City of Littleton, County of Douglas, CO, Jefferson County, CO, Bureau of Land Management, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA



CHAPTER 5 – RAINFALL

5.1. INTRODUCTION

Presented in this section are design rainfall data to be used with Rational Method, and for larger drainage basins, the Colorado Urban Hydrograph Procedure (CUHP). All hydrological analysis within the city shall utilize the rainfall data presented herein for calculating storm runoff.

The design storms and time intensity frequency curves for the City were developed using the rainfall data and procedures presented in the Manual and are presented here for convenience.

5.2. DURATION-INTENSITY-FREQUENCY CURVES

The average one-hour design point rainfall values for the City of Littleton (below) are obtained from NOAA Atlas 14, Volume 8, Version 2 (2013). This updated version of the NOAA Atlas 14 was adopted by UDFCD for use in the Denver Metropolitan Area in 2016 after thorough technical review. Additional rainfall information for the city can be obtained at the NOAA Atlas 14 website: <http://hdsc.nws.noaa.gov/hdsc/pfds/>

Table 5-A
ONE-HOUR POINT RAINFALL, LITTLETON, CO
 (inches)

2-year	5-year	10-year	25-year	50-year	100-year	500-year
0.812	1.08	1.31	1.66	1.94	2.24	3.01

The Intensity-Duration curves for each recurrence interval rain storm event were developed by distributing the one-hour point rainfall values (Table 5A) using the procedures and data presented in the Manual. Point values were converted to intensities and plotted on Figure-501. Rainfall intensity values for use in the Rational Method can be read graphically from Figure 501 or the following equation can be used to compute intensity for runoff computations.

$$I = (28.5 * P1) / [(10 + Tc)^{0.786}] \quad \text{(Equation 501)}$$

Where:

I = Rainfall intensity, in/hour

P1 = One hour point rainfall depth, inches (see table 5-A above)

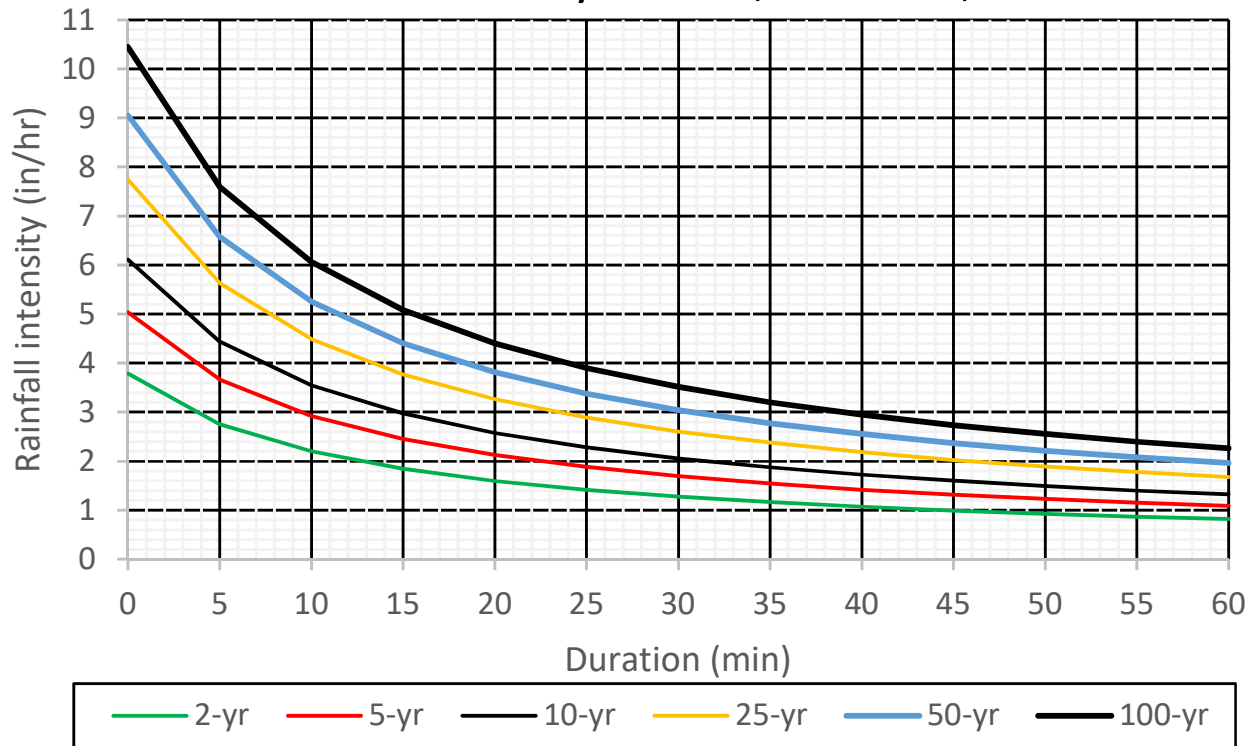
Tc = Time of concentration, minutes

5.3. CUHP DESIGN STORMS

To determine hydrology for larger drainage basins (over 90 acres), the 1-hour point precipitation values (Table 5A) are distributed into 5-minute increments to develop temporal distributions used in the Colorado Unit Hydrograph Procedure (CUHP). The rainfall duration used in CUHP varies with the size of the watershed being analyzed. Many of the calculations are done within the current version of CUHP program available from the UDFCD. Detailed instructions on use of CUHP is not presented here, and the reader is directed to Volume 1 of the Manual.

Figure 501

Duration-Intensity Curves; Littleton, CO



CHAPTER 6 - RUNOFF

6.1 INTRODUCTION

This chapter presents the criteria and methodology for determining the storm runoff design peaks and volumes to be used in the City of Littleton to prepare storm drainage studies, plans, and facility design. The details of the rainfall/runoff models are presented in the *Urban Storm Drainage Criteria Manual* (Manual). The specific input data requirements and modifications to the procedures are presented in this chapter.

6.2 RATIONAL METHOD

The Rational Method can be used within the City to determine peak storm runoff from small urban watersheds (i.e.: less than 90-acres). The Colorado Urban Hydrograph Procedure (CUHP) shall be used when the total watershed exceeds 90-acres, but can be used for smaller watersheds.

Procedures, design spreadsheets, and examples for the Rational Method, as explained in the Manual, “Volume 1, Runoff” shall be followed in the preparation of drainage reports and storm drainage facility designs in the City. Additional requirements for the Rational Method are:

- a. In calculation of the initial time of concentration, t_i , the maximum length of overland flow is 300 feet. Calculation of t_i can be performed using the following equation, in Volume 1, “Runoff” section of the Manual, or use MHFD spreadsheet design tools.

$$t_i = 0.395(1.1 - C_5)(L^{0.5})/(S^{0.33}) \quad (\text{Equation 601})$$

Where t_i = initial time of concentration, minutes
 C_5 = Runoff coefficient for 5-year frequency
 L = Length of overland flow, feet
 S = Average basin slope, ft/ft

- b. Percentage Impervious Values for various land uses or surface characteristics shall be obtained from the Manual. These values shall be used in the calculation of runoff coefficients for the Rational Method using the appropriate equations.
- c. Rainfall intensity at the time of concentration, T_c , can be calculated from the equation presented in Section 5.2, “Time-Intensity-Frequency Curves” of these Criteria.
- d. Travel time calculation are based on velocity of flow in a drainage conveyance, typically a swale, curb/gutter, or storm sewer. Surface velocity can be calculated from the Manual, or obtained from Figure 601. Values of the constant, C_v , are provided below.

$$V = C_v S^{0.5} \quad (\text{Equation 602})$$



Where V = surface velocity, fps
 C_v = Coefficient, depending on surface conditions
 S = Slope, (ft/ft)

<i>Surface Condition</i>	<i>Coefficient, C_v</i>
Forest with heavy ground liter and meadows	2.5
Fallow or minimum tillage cultivation	5.0
Short grass, pasture and lawns	7.0
Nearly bare ground	1.0
Grassed waterway	15.0
Paved, sheet flow, shallow gutter flow	20.0

- e. When runoff is conveyed by a storm sewer, the following equation can be used to facilitate travel time calculations:

$$V = (1.49/n) * (B(D/4)^2) * ((D/4)^{0.667}) * S^{0.5} \quad \text{(Equation 603)}$$

Where: V = full flow velocity, fps
 n = Manning’s n-value (see Table 802)
 B = Constant of 3.14
 D = Inside pipe diameter, feet
 S = Slope, f/f

- f. A schematic of the routing of sub-basins to each design point is to be provided on the Drainage Plan (see Section 2.3.2 of these Criteria). The schematic is to show each sub-basin and how the sub-basin is connected to a design point (e.g.: design points include gutter, inlet, manhole, detention basin), as illustrated on Figure 602. In the example, sub-basin A and B combine at design point 1, which is routed downstream to design point 2. Sub-basin C is discharged to design point 2 and then routed to detention pond #3.

6.3 COLORADO URBAN HYDROGRAPH PROCEDURE

Procedures and examples for CUHP are provided in the MANUAL, “Volume 1, Runoff” and shall be followed in the preparation of drainage reports and storm drainage facility design in the CITY. Specific requirements for CUHP are provided below:

- a. Design storms for the 2-, 5-, 10-, 50-, and 100-year events are presented in Table 5A.

- b. When determining imperviousness for various land uses, it is recommended that a composite weighted value be obtained from references in the Manual.

6.4 STORM FLOW ANALYSIS

When determining the design storm flows, the engineer shall follow criteria and guidelines presented in this section. These procedures apply to both the Rational Method and the CUHP.

6.4.1 Onsite Flow Analysis

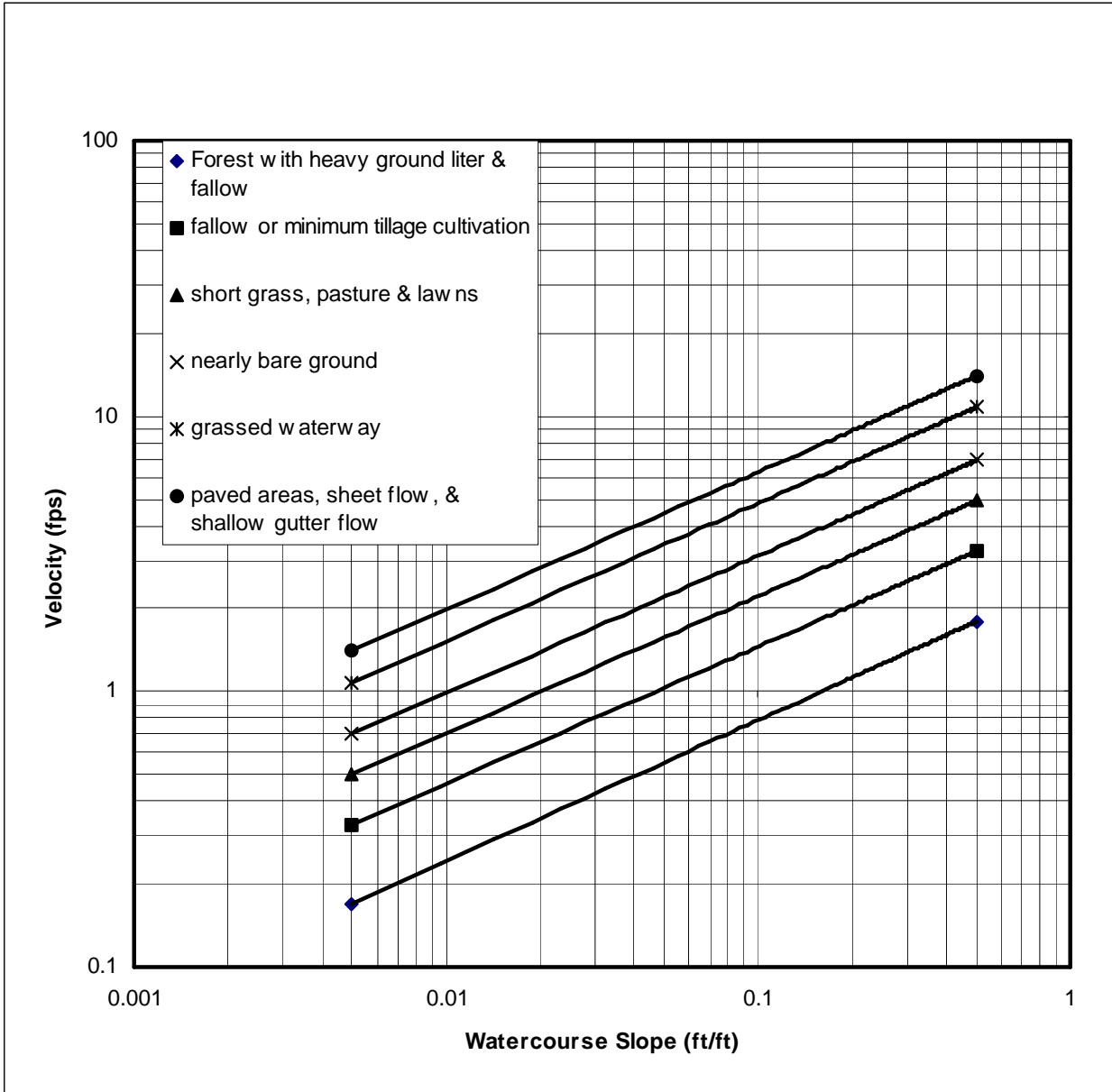
Onsite flow analysis shall be performed for pre-existing conditions and for proposed development conditions. When calculating flood peaks (and volumes using CUHP), the design engineer shall use the proposed fully developed land use plan to determine runoff coefficients or impervious areas. In addition, the engineer shall take into consideration the changes in flow patterns (from the pre-existing site conditions) caused by proposed street alignments. When evaluating surface flow times, the proposed lot grading shall be used to calculate the time of concentration or the CUHP parameters.

6.4.2 Offsite Flow Analysis

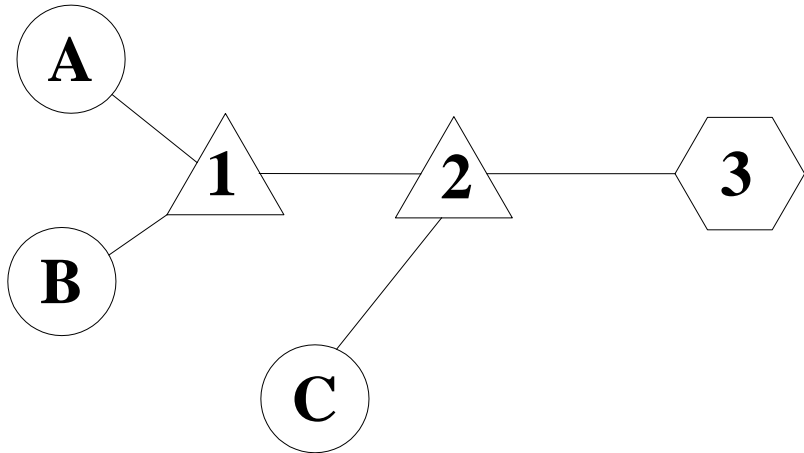
Determination of runoff peaks from areas shall be based on peak runoff rates defined by the appropriate major drainageway plan or outfall systems plan (see Chapter 2). If this information is not available, runoff peaks shall be calculated assuming:

- a. Runoff rates are not reduced by offsite detention facilities, unless facilities are publicly owned and maintained, and
- b. Fully developed offsite area in accordance with actual land uses using impervious values and runoff coefficients (see Section 6.2.1(d)), or
- c. Fully developed offsite areas in accordance with future land use(s) defined by the City. If future land use information is not available, then storm runoff from undeveloped areas shall be calculated using impervious values based on the land use category "Off-site flow analysis" (see Section 6.2.1(d)).
- d. Where the offsite area is fully or partially developed, the storm runoff shall be based on the existing platted land uses and topographic features, unless onsite detention in the offsite area has been constructed and accepted by the City. However, no credit will be given for onsite detention in the offsite area for the minor system design, unless otherwise approved by the Director.

Travel Velocity for Use with Rational Method



Sample Sub-basin Routing Schematic



LEGEND



Sub-basin Name



Design Point Number



Detention Basin Number



CHAPTER 7 - OPEN CHANNELS

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CHAPTER 7 - OPEN CHANNELS

7.1 INTRODUCTION

This chapter addresses the technical criteria for the hydraulic evaluation and hydraulic design of open channels in the City of Littleton; and includes channels of all sizes (such as ditches, swales, or larger major drainageways). The criteria presented herein are considered to be the *minimum standards*. Special design or evaluation techniques may be required. If a master plan has been prepared for the drainageway, refer to the master plan report for specific requirements. Except as modified herein, all open channel criteria shall be in accordance with the *Urban Storm Drainage Criteria Manual* (Manual).

7.2 CHANNEL TYPES

Analysis and design requirements for various channel types are summarized below:

1. **Natural channels.** *Analysis and design requirements for all natural drainageways shall be performed in accordance with procedures in the MANUAL, Volume 2, “Major Drainage”.*
2. **Grass-lined channels.** *Analysis and design requirements for grass-lined channels for major drainage channels shall be performed in accordance with procedures in the MANUAL, Volume 2, “Major Drainage”. Criteria for minor channels and swales are provided in Section 7.4 of these Criteria. This is the preferred channel type in the city.*
3. **Wetland channels.** *Analysis and design requirements for all wetland bottom channels shall be performed in accordance with procedures in the MANUAL, Volume 2, “Major Drainage”.*
4. **Concrete Lined Channels.** *Concrete channels are not permitted by the City, except in select circumstances when absolutely necessary and approved by the engineering division. When identified in approved major drainageway or outfall system plans (see Section 3.3.2 “Master Planning”), the applicant shall propose an alternative to concrete channels.*
5. **Riprap-lined channels.** *Rock lined channels are permitted in the City when necessary for erosion protection, and should be mixed with soil and a range of rock sizes to fill voids (often referred to as “void filled riprap”, and have soil-covered sides above the normal flow level.. When identified in approved major drainageway or outfall system plans (see Section 3.3.2 “Master Planning”), the applicant shall propose an alternative to rock-lined channels.*
6. **Bio-engineered Channels.** *Analysis and design requirements for all bio-engineered channels shall be performed in accordance with procedures in the MANUAL, Volume 2, “Major Drainage”.*



6. **Other channel liners.** *Other channel linings will be considered by the city with engineering data to support its use, and it meets aesthetic requirements. When identified in approved major drainageway or outfall system plans (see Section 3.3.2 “Master Planning”), the applicant shall propose an alternative to channel liners.*

7.3 FLOW COMPUTATION

Uniform flow and critical flow computations shall be in accordance with the Manual, □Major Drainage”.

7.4 DESIGN STANDARDS FOR MINOR CHANNELS AND SWALES

These standards cover the design of channels that are not classified as a major drainageway or outfall system drainageway (see Policy 3.3.4, “Public Improvements”). Analysis and design for minor channels that are classified as natural channels, wetland channels, bio-engineered channels shall be performed in accordance with the Manual, Volume 2 “Major Drainage”.

7.4.1 Design Standards

Analysis and design requirements for grass-lined, minor channels and grass-lined swales are as follows:

Parameter	Grass-Lined Minor Channel	Grass-Lined Swale
Tributary Area	Less than 130-acres	Dependent of tributary land use, but generally less than 10-acres
Capacity	From 50- to 400-cfs	Less than 50-cfs
Flow Velocity	Less than 7.0-fps	Less than 7.0-fps.
Froude Number	Less than 0.8	Less than 0.8
Longitudinal channel slope	From 0.2% to 0.7%, subject to other limitations	From 0.5% to 2.5%, subject to other limitations
Freeboard	Not less than 1.0-feet	Not less than 6-inches
Curvature	Not less than 50-feet	Not less than 25-feet.
Roughness Coefficient	In accordance with Manual, “Major Drainage”, Table MD-1	In accordance with Manual, “Major Drainage”, Table MD-1
Typical cross section	See Figure 701	See Figure 702

CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

Trickle channel	Required. See Figure 701	Not required. See Figure 702
Easement Width	Include freeboard and maintenance access.	Include freeboard.
Flow depth	Less than 4.0-feet	Less than 2.25 feet.
Side slope	Not steeper than 4:1.	Not steeper than 4:1.
Grass lining	In accordance with the Manual, “Revegetation”.	In accordance with the Manual, “Revegetation”.
Erosion control	In accordance with the Manual, “Major Drainage”.	Type VL soil riprap required for slopes 1.0% or greater or if swale drains 0.33 acres or more of impervious area.
Hydraulic information	If Criteria followed, separate calculations not required. 100-year water surface profile required for depths greater than 3-feet or velocity greater than 4.0 fps.	If Criteria followed, separate calculations not required.
Aesthetics and water quality	Per Section 7.4.2 of these Criteria	Per Section 7.4.2 of these Criteria

7.4.2 Aesthetic and Water Quality Requirements

All channels, including ancillary structures, shall be designed with the intent of improving appearance of and water quality within the channel. In many cases, the same aesthetic characteristics also provide water quality benefits. The designer shall address the following:

- a **Structures:** Channel drop structures or retaining walls shall be designed to be compatible with surroundings by including:
 - i) New materials that present a finished appearance are to be used for walls. The use of similar materials proposed for on-site buildings are encouraged. Applicant may be requested to submit samples of materials to ensure compliance with these Criteria.

- ii) Shape, height, and color for structures that are not obtrusive. The use of neutral colors, surface treatment or texture, and shapes that blend in with surroundings are encouraged. Varying shape or surface texture is also encouraged.
- iii) Additional landscaping materials, such as shrubs and trees, that interrupt visual impacts. Landscaping materials shall be placed to not impact design capacity or maintenance access of the channel.
- iv) Access for maintenance and designs that minimize maintenance requirements.

b Channels: Channels shall be designed to be compatible with surroundings by:

- i) Selecting grasses that are similar to surroundings, while protecting the channel from erosion. Adding dense, sod-forming grasses to the seed mix is encouraged.
- ii) Providing topsoil and soil supplements to encourage vegetation establishment and growth density.
- iii) Grading the area adjacent to the channel to avoid channels that appear “uniform” and “deep”. Director may allow strategically placed retaining walls that permit flatter earth slopes.
- iv) Including additional landscaping, such as shrubs and trees, that interrupts visual impacts. Landscaping materials shall be placed to not impact design capacity or maintenance access to the channel.

7.5 ROADSIDE DITCHES

Criteria for the design of roadside ditches are similar to criteria for grass lined channels with modifications for the special purpose of minor storm drainage. Roadside ditches are permitted only in low-density residential areas and written approval from the Director is required. Criteria are as follows (refer to Figure 703):

1. **Capacity.** Roadside ditches shall have adequate capacity for the minor-storm-runoff peaks. Allowable capacity is defined on Figure 703. Where the storm runoff exceeds the capacity of the ditch, a storm sewer system is required.
2. **Flow Velocity.** The maximum velocity for the major-storm flood peak shall not exceed 5.0 feet per second.
3. **Longitudinal Slope.** The slope shall be limited by the average velocity or Froude number of the minor-storm flood peaks. Check drops may be required where street slopes are in excess of 2.5 percent.

4. **Freeboard.** Freeboard not required.
5. **Curvature.** The minimum radius of curvature shall be 25 feet.
6. **Roughness Coefficient.** Manning's "n" values shall be in accordance with Manual, "Major Drainage", Table MD-1.
7. **Grass Lining.** The grass lining shall be in accordance with the Manual, Chapter 12, "Revegetations".
7. **Erosion Protection.** Type VL soil riprap with 3" soil cover required for longitudinal slopes 1.0% or greater.
9. **Driveway Culverts.** Driveway culverts shall be sized to pass the minor-storm, roadside ditch capacity without overtopping the driveway or exceeding depth limitations. The minimum size culvert shall be a 12" and with flared end sections.
10. **Major Drainage Capacity.** The capacity of roadside ditches for major drainage flow is restricted by the maximum flow depth, in accordance with Chapter 10, "Streets" of these Criteria.

7.6 CHANNEL RUNDOWNS

A channel rundown is used to convey storm runoff from the bank of a channel or a roadway to the invert of an adjacent channel or drainageway or bottom of slope. Discharges from a pipe to the middle or top of a slope, and not at the bottom, are discouraged. The purpose of the structure is to minimize channel bank erosion from concentrated overland flow along a relatively steep, channel side-slope. Inlets and storm sewers may be used to convey the minor storm runoff with the rundown conveying the difference between the major and minor storm runoff. The design criteria for channel rundowns is as follows:

7.6.1 Cross-Sections

Typical cross-sections for channel rundowns are presented in Figure-704.

7.6.2 Design Capacity

The capacity of the channel rundown is dependent on the allowable flow depth at the entrance to the rundown. Since many rundowns begin at a curb in a parking lot or street, capacity limitations are based on maximum ponding depth at the curb equal to the curb height. The maximum depth is taken as the specific energy of the flow as it passes through critical depth at the entrance to the rundown. The capacity of the rundown is presented as discharge per unit width of rundown. The minimum rundown width is 12" or as required to convey the minor storm runoff, whichever is greater. The rundown must be shaped adequately to contain the flows on top of and within the limits of erosion protection provided. If riprap is used for the rundown erosion protection, riprap must be underlain by a geotextile fabric to limit winnowing of fines underneath the riprap layer and subsequent failure.

Riprap shall be sized with acceptable methods for steep slopes; see Army Corps of Engineers or Bureau of Reclamation for more information.

Rundown Capacity

Height of Curb at Entrance to Rundown (inches)	Capacity of Rundown (cfs/foot)
6	1.1
8	1.7
10	2.4
12	3.1

7.6.3 Outlet Configuration

If the outlet of a pipe is at top or middle of a slope, the end section of the pipe must have mechanical fasteners to the last segment of pipe and a concrete cutoff wall provided at the end section before discharge to the riprap or other erosion protection.

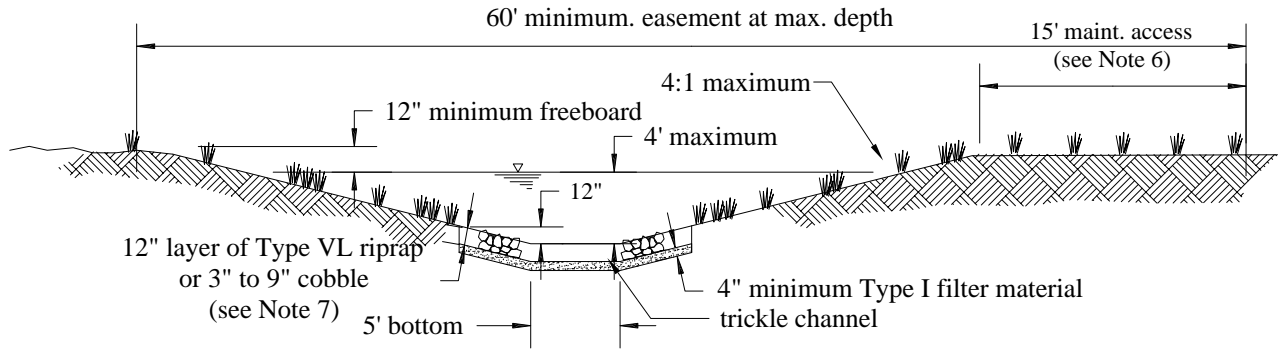
A channel rundown outlet shall enter an adjacent drainageway at the trickle channel, as shown on Figure 704. Erosion protection of the opposite channel bank shall be provided by a 24-inch layer of grouted 12-inch D50 riprap. The width of this riprap erosion protection shall be at least three times the channel rundown width or pipe diameter. Riprap protection shall extend up the opposite bank to the minor storm flow depth in the drainageway or 2 feet whichever is greater.

7.7 CHECKLIST

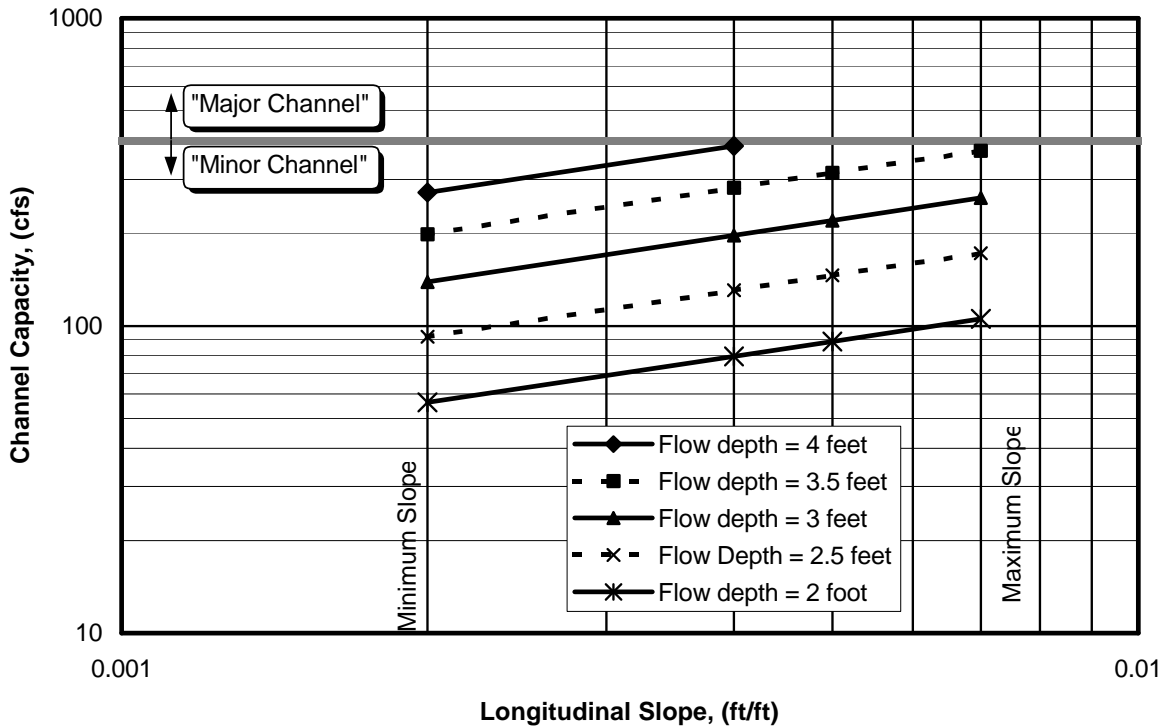
To aid designer, the following checklist has been prepared.

1. Check flow velocity with low Manning’s n-value and capacity with high Manning’s n-value.
2. Check Froude number and critical flow conditions.
3. Grass channel side slopes must be 4:1 or flatter except for roadside ditches which shall be 3:1 or flatter unless approved by the City.
4. Show energy grade line and water surface profile on design drawings.
5. Consider all backwater conditions (i.e., at culverts) when determining channel capacity.
6. Check velocity for conditions without backwater effects.
7. Provide adequate freeboard.
8. Provide adequate ROW for the channel and continuous maintenance access.

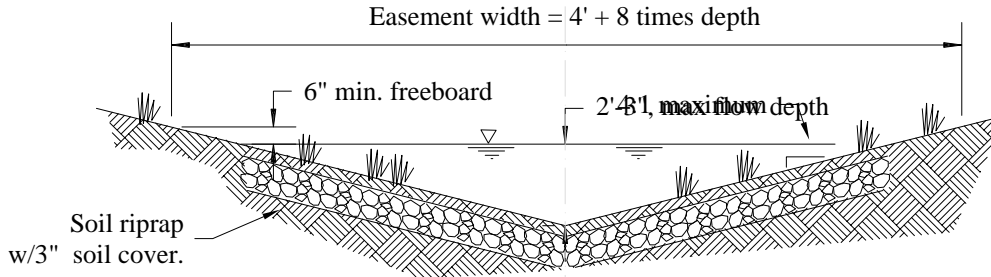
Minor Channel Details



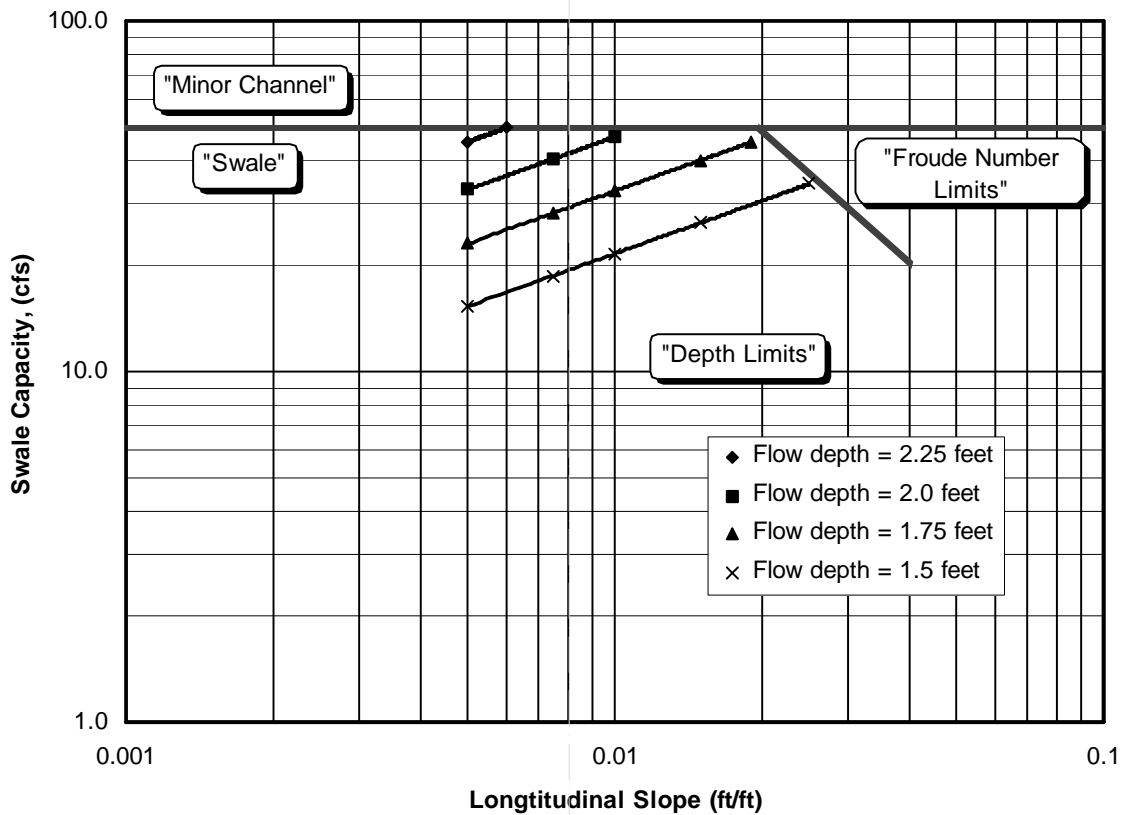
- NOTES: 1. Grass requirements per Manual, Revegetation
 2. Longitudinal slope from 0.2 to 0.7 %.
 3. Maximum Froude Number = 0.80.
 4. Capacity based on n-value of 0.035
 5. Maximum 100-year discharge of 400-cfs. For larger discharges, see Manual Major Drainage.
 6. Provide stable surface or base for vehicle access.
 7. If vandalism is anticipated, use soil pipes with 3"



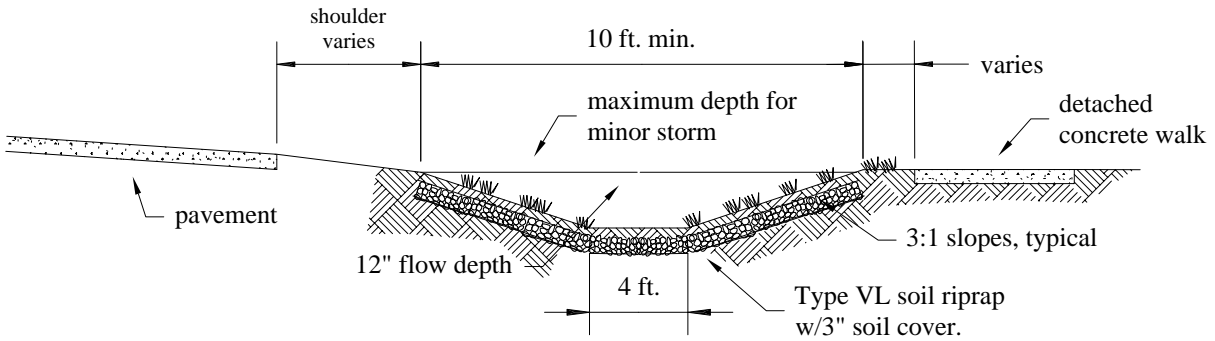
Swale Details



- NOTES:**
1. Grass requirements per MANUAL, "Revegetation".
 2. Longitudinal slope from 0.5% to 2.5%
 3. Maximum Froude Number = 0.80.
 4. Maximum 100-year discharge of 50-cfs. For larger discharges, see "minor channel" requirements, Figure 701.
 5. Capacity based on n-value of 0.05 ("grass, good stand, 6 to 12 in. ").

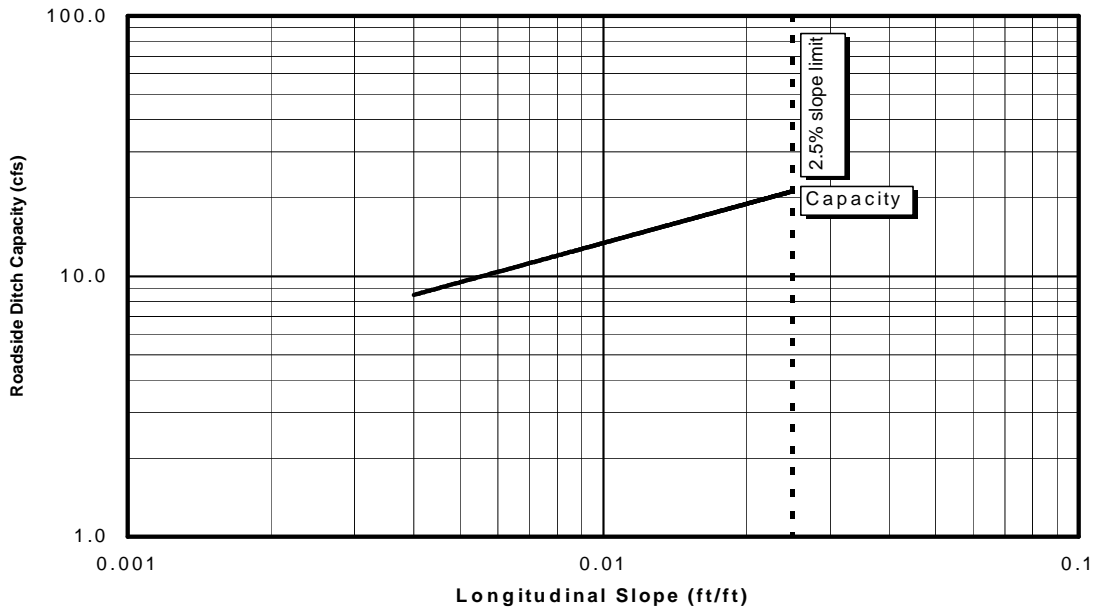


Roadside Ditch Details

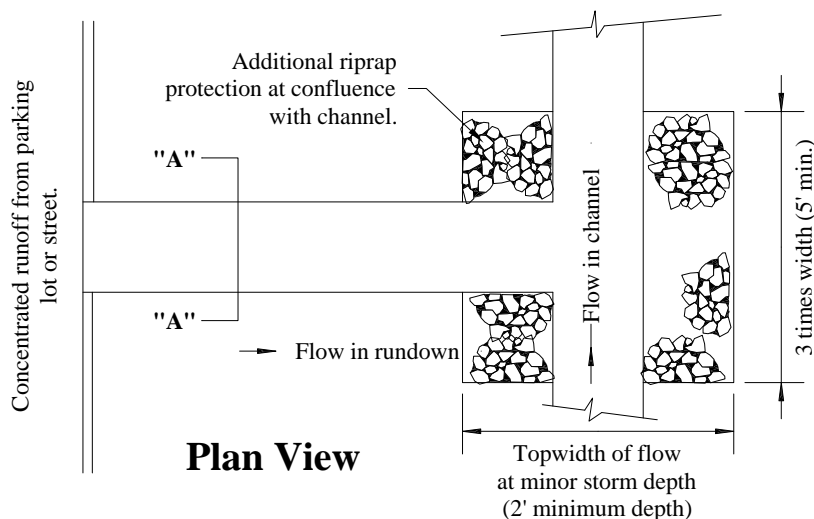


- NOTES:**
1. Grass requirements per MANUAL, "Revegetation"
 2. Longitudinal slope from 0.4% to 2.5%, without check drops.
 3. Maximum Froude Number = 0.8.
 4. Capacity based on n-value of 0.060 ("grass, good stand, 6- to 12 in. ").
 5. For street slopes greater than 2.5%, provide check drops (2-ft max.).

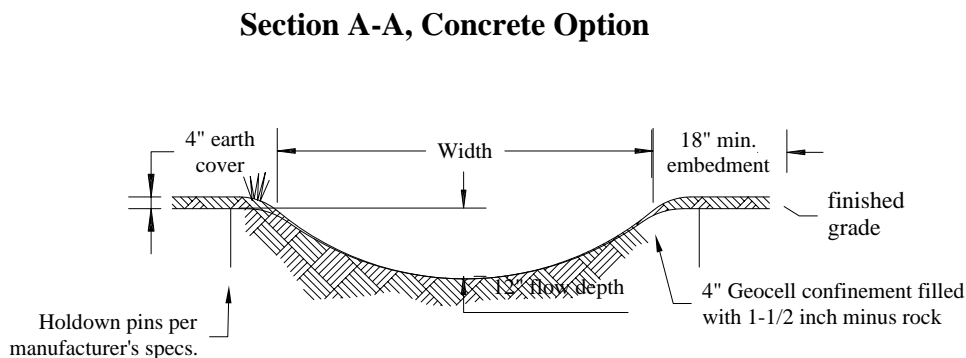
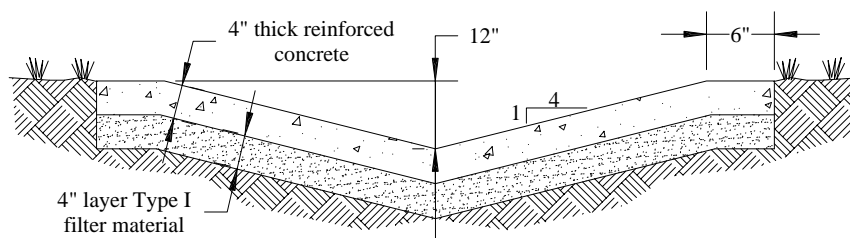
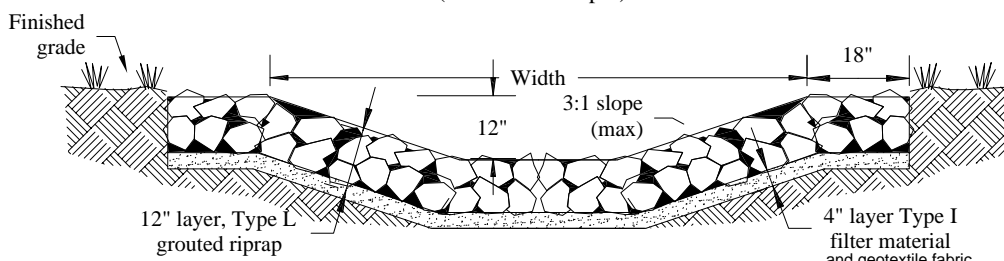
Ditch Capacity vs. Slope



Channel Rundown Details



- NOTES: 1. Additional riprap protection: 24" layer of grouted Type G12 boulders.
 2. See Section 7.6.2 for capacity requirements.
 3. All pipe discharges to extend to 12" above channel invert.



CHAPTER 8 - STORM SEWERS

8.1 INTRODUCTION

Except as modified herein, the design of storm sewers shall be in accordance with the MANUAL, Chapter 6, “Streets”.

8.2 ALLOWABLE PIPE MATERIALS

In general, the City of Littleton follows the Colorado Department of Transportation (CDOT) specifications for storm sewer pipe, and allowable materials as presented in CDOT Standard Specification Section 624 (latest version), with the exception that CSP and PVC pipe are permitted only in certain circumstances with approval of the Engineering Division. In some instances, a particular pipe material may be specified on the construction plans at the discretion of the Engineering Division. Minimum depth of cover shall follow applicable manufacturer recommendations.

8.3 HYDRAULIC DESIGN

Storm sewers shall be designed to convey the minor storm flood peaks without surcharging the sewer. To ensure that this objective is achieved the hydraulic and energy grade line shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, and junction losses. The methods for estimating these losses are presented in the following sections. The final energy grade line shall be at or below the proposed ground surface.

All hydraulic calculations for storm sewers shall be prepared in accordance with the Manual, Volume 1, “Streets”, except as modified herein. Analysis and design of a storm sewer system using computer programs will be permitted, subject to requirements of Policy Section 3.6 of these Criteria.

8.3.1 Velocity Limitations

Maximum full-flow velocity shall be 16-fps and minimum velocity shall be 2.5 fps for all pipe materials. Minimum velocity shall be calculated based on 5 % of full flow capacity. Therefore, minimum velocity is approximately equal to 45 % times full-flow velocity.

8.3.2 Manhole Losses

Energy losses at manholes, inlets and other junction structures shall be calculated in accordance with the Manual, “Streets”.

8.4 STORM SEWER DESIGN



8.4.1 Vertical Alignment

The minimum clearance between storm sewer and water main, either above or below, shall be 12-inches, or as otherwise restricted by Denver Water Department. Concrete encasement of the water line will be required for clearance of 12-inches or less.

The minimum clearance between storm sewer and sanitary sewer, either above or below, shall also be 12-inches. In addition, when a sanitary sewer main lies above a storm sewer, or within 18-inches below, the sanitary sewer shall have an impervious encasement or be constructed of structural sewer pipe for a minimum of 10-feet on each side of where the storm sewer crosses.

8.4.2 Horizontal Alignment

Storm sewers are discouraged within landscaped areas between the curb and sidewalk where trees exist or will be planted.

Manhole access is required at all bends or other changes in alignment.

Storm sewer alignment may be curvilinear for pipe with diameters of 48-inches or greater but only when approved in writing by the Director. The applicant must demonstrate the need for a curvilinear alignment. Generally, a curvilinear alignment will only be allowed where physical constraints dictate the use of a curvilinear alignment. The limitations on the radius for pulled-joint pipe are dependent on the pipe length, diameter, and amount of opening permitted in the joint. The maximum allowable joint pull shall be 3/4-inches. The minimum parameters for radius type pipe are shown in Table below:

Minimum Radius of Curvature for RCP

Pipe Diameter	Radius of Curvature
48" to 54"	28.5 feet
60" to 72"	32.0 feet
78" to 108"	38.0 feet

8.4.3 Pipe Size

The minimum allowable pipe size for storm sewers and for detention outlets is dependent upon a practical diameter for maintenance. The length of the sewer also affects maintenance and, therefore, the minimum diameter. Table- below presents the minimum pipe size for storm sewers.

– Minimum Pipe Diameter

Sewer Application	Minimum Equivalent Pipe
-------------------	-------------------------



	Diameter
Main trunk line	18 inches
Lateral from inlet ¹	15 inches

Note 1. Minimum size of lateral from inlet shall also be based on the water surface inside of the inlet or a minimum distance of 1-foot below the grate or throat.

8.4.4 Manholes

Manholes or maintenance access ports will be required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two or more sewers. A manhole may be required at the beginning and/or end of the curved section of storm sewer. Manhole markers are required and their locations shall be shown on construction plans. The maximum spacing between manholes for various pipe sizes and the required manhole size shall be in accordance with the table below.

Manhole Requirements

Sewer Diameter	Maximum Manhole Spacing	Minimum Manhole Diameter
18"	400 feet	4 feet
21" to 36"	500 feet	5 feet
42" to 48"	600 feet	6 feet
54" and larger	600 feet	CDOT M-604 for Box Base or T-Base Manholes

Larger manhole diameters or a junction structure may be required when sewer alignments are not straight through or more than one sewer line goes through the manhole. Alternate pre-cast or prefabricated manholes may be used.

8.5 STORMWATER QUALITY

All new development must implement best management practices to control the discharge of pollutants into the municipal stormwater system (see Chapter 15). Additional measures (i.e.: BMP) for storm sewers include:

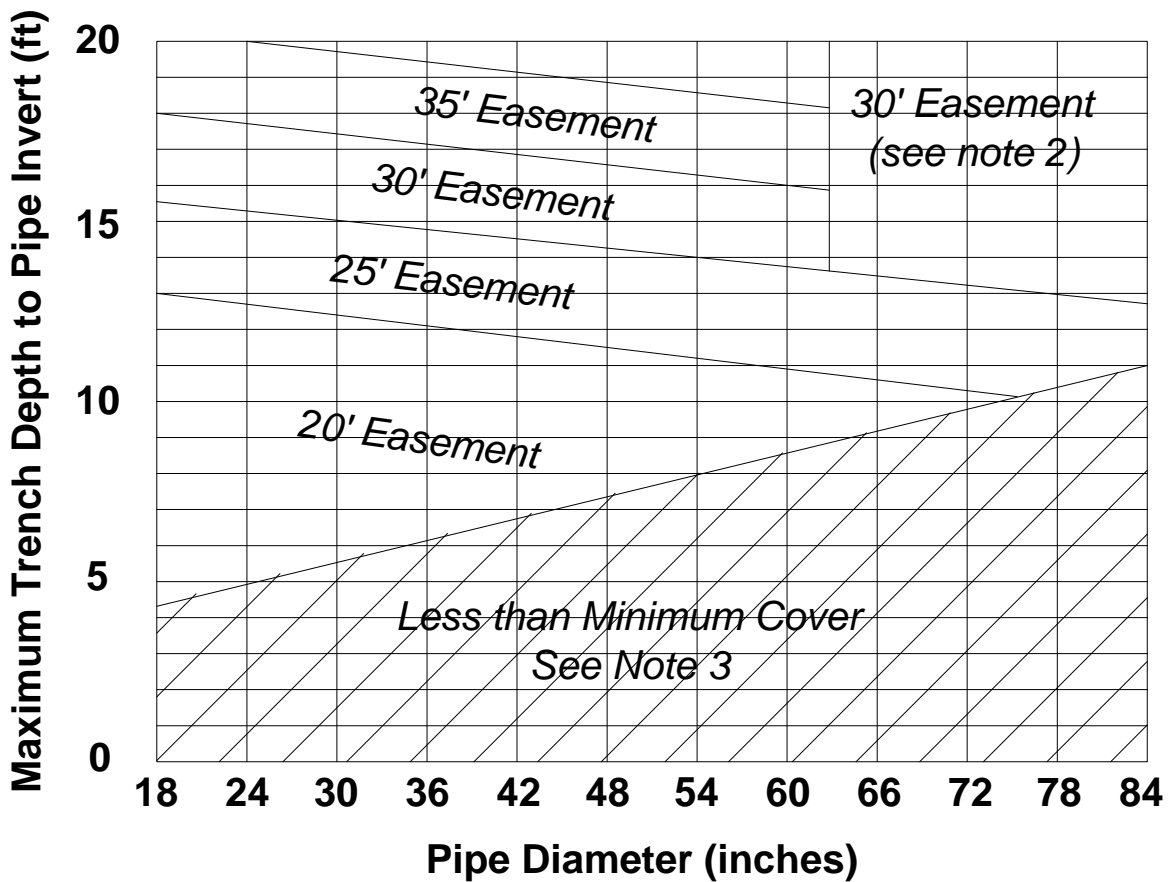
1. Provide adequate maintenance access to the storm sewer system, in accordance with Policy 3.3.8, to facilitate routine maintenance.
2. Prevent unauthorized discharges and connections to the storm sewer system.

8.6 CHECKLIST

To aid the designer and reviewer, the following checklist has been prepared:

- (1) Calculate energy grade line (EGL) and hydraulic grade line (HGL) for all sewers and show on the construction drawings or on a separate copy of the plans submitted with the construction drawings.
- (2) Account for all losses in the EGL calculation including outlet, form, bend, manhole, and junction losses.
- (3) Provide adequate erosion protection at the outlet of all sewers into open channels.
- (4) Check for minimum pipe cover and clearance with utilities.

Minimum Easement Width for Storm Sewers



- Notes: 1. The minimum trench width for repairs is 4-feet.
 2. For pipe diameters greater than 60 inches, repairs can be made internally and the ROW width is not dependent on excavation for repairs.
 3. Area of minimum cover depends on structural requirements and easement location.
 4. Minimum easement width is 20-feet.

CHAPTER 9 - STORM SEWER INLETS

9.1. INTRODUCTION

Presented in this chapter are criteria and methodology for design and evaluation of storm sewer inlets. Except as modified herein, all storm sewer inlet criteria shall be in accordance with the Manual. Allowable inlet capacities are dependent on drainage classification for the street, which is defined in Chapter 10 of these Criteria.

9.2. STANDARD INLETS

The standard inlets permitted for use in the City are those of Colorado Department of Transportation M&S standard details, and the City and County of Denver Type 16 combination and valley inlets. See the city's standard engineering details:

9.3. INLET HYDRAULICS

Allowable inlet capacities shall be calculated in accordance with the Manual "Streets". Inlet capacity calculations shall take into account the following:

- Inlet type and flow condition
- Inlet efficiency for on grade flow condition resulting in "by-pass" or "carry-over" flow.
- Reduction in inlet capacity due to clogging.

Calculation of inlet capacity shall be performed using the "spreadsheet" provided in the Manual and shall be submitted with the Final Drainage report (see Chapter 2 of these Criteria).

9.4. CHECKLIST

To aid the designer the following checklist has been prepared:

- (1) Check for inlet capacity to determine the carryover flow, and account for this flow plus the local runoff in the sizing of the next downstream inlet.
- (2) Place inlets at optimum grade or in sump conditions where possible to increase capacity.
- (3) Space inlets based upon the interception rate of 70 to 80% of the gutter flow to optimize inlet capacity.



CHAPTER 10 - STREETS

10.1. INTRODUCTION

Presented in this chapter are criteria for evaluation of allowable encroachments within public streets for conveying storm runoff. All drainage design involving the use of streets for drainage will be reviewed based on criteria presented herein.

City policy allows the use of streets for conveying the Minor storm runoff within the following limitations:

Street Classification	Maximum Encroachment for Calculation of Theoretical Conveyance Capacity
Local	For 6” curb, no curb overtopping and flow may spread to crown of street, whichever is lower depth. For 4” curb, flow may spread to crown of street or the back of attached walk, whichever is more restrictive. If sidewalk is detached, depth limited to top of curb.
Collector	For 6” curb, no curb overtopping and flow may spread to crown of street, whichever is lower depth. For 4” curb, flow may spread to crown of street or the back of attached walk, whichever is more restrictive. If sidewalk is detached, depth limited to top of curb. Flow spread must leave at least one 10-foot lane free of water, 5-feet each side of the street crown.
Arterial	For 6” curb, no curb overtopping and flow may spread to crown of street, whichever is lower depth. For 4” curb, flow may spread to crown of street or the back of attached walk, whichever is more restrictive. Flow spread must leave at least two 10-foot lanes free of water, 10-feet for each travel direction.

City policy allows the use of streets for conveying the Major storm runoff within the following limitations:

Street Classification	Maximum Encroachment for Calculation of Theoretical Conveyance Capacity
Local and Collector	Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the lowest adjacent grade.



The depth of water at the gutter flowline shall not exceed 12-inches or the water surface shall not extend past the street right-of-way (or adjacent drainage easement), whichever is more restrictive.

Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the lowest adjacent grade. To allow for emergency vehicle access, the depth of water shall not exceed 6-inches at the street crown, 12-inches at the gutter flowline, or the water surface shall not extend past the street right-of-way (or adjacent drainage easement), whichever is more restrictive

Arterial

10.2. STREET CLASSIFICATION

Public streets are classified for traffic use in accordance with City Code (Section 11-6-3) as local, collector, or arterial. The allowable flow depth for the minor and major storm events is provided in Table 10A for each street type. Refer to Figure 1001 for illustration of allowable flow depths for the major storm.

Table 10A – Allowable Flow Depths for Storm Drainage Use of Streets

Traffic Classification	Hydraulic Classification	Flowline Width (ft)	Right of Way (ft)	Curb Type	Minor Storm Limits ²			Major Storm Limits ³	
					No. clear lanes in each direction	Allowable gutter depth (ft)	Controlling Criteria	Allowable Depth (ft)	Controlling Criteria
Local Residential	Type A	36	50	4" hollywood	0	0.33	curb height	0.59	Right of Way
Local Residential	Type A	36	50	6" vertical	0	0.49	curb height	0.76	Right of Way
Local MF, Comm. Indust.	Type A	44	60	4" hollywood	0	0.33	curb height	0.63	Right of Way
Local MF, Comm. Indust.	Type A	44	60	6" vertical	0	0.50	curb height	0.80	Right of Way
Residential Collector	Type B	44	70	6" vertical	0.5	0.47	free lane	1.00	12" depth
Secondary Arterial ¹	Type C	24	100	6" vertical	1	0.27	free lane	1.00	12" depth
Primary Arterial ¹	Type C	35	120	6" vertical	1	0.38	free lane	1.00	12" depth

NOTES: 1 Directional lanes for arterial streets separated by raised island. Flowline width for one direction. Each traveled way is a crowned street. Therefore, clear lane taken as 5' either side of crown. Clear lane taken as center of traveled way in each direction.
 2 Minor storm criteria does not apply to street templates with roadside ditches
 3 If drainage easement is located adjacent to street ROW, then adjust "allowable depth" for those streets where the "controlling criteria" is the right of way.

Allowable depths for flow across a street are also obtained from Table 10A, except that cross street flow is not permitted for arterial classified streets.

10.3. HYDRAULIC EVALUATION

The allowable street capacity for the minor and major storm events shall be calculated in accordance with the Manual, “Streets”. Street capacity calculations shall take into consideration the following:

- Street classification for traffic and hydraulic capacity.
- Street template, including cross slope, gutter type, sidewalk type and location, right-of-way, adjacent drainage easements, and other physical limitations.
- Reduction in theoretical capacity based on street classification and longitudinal slope.

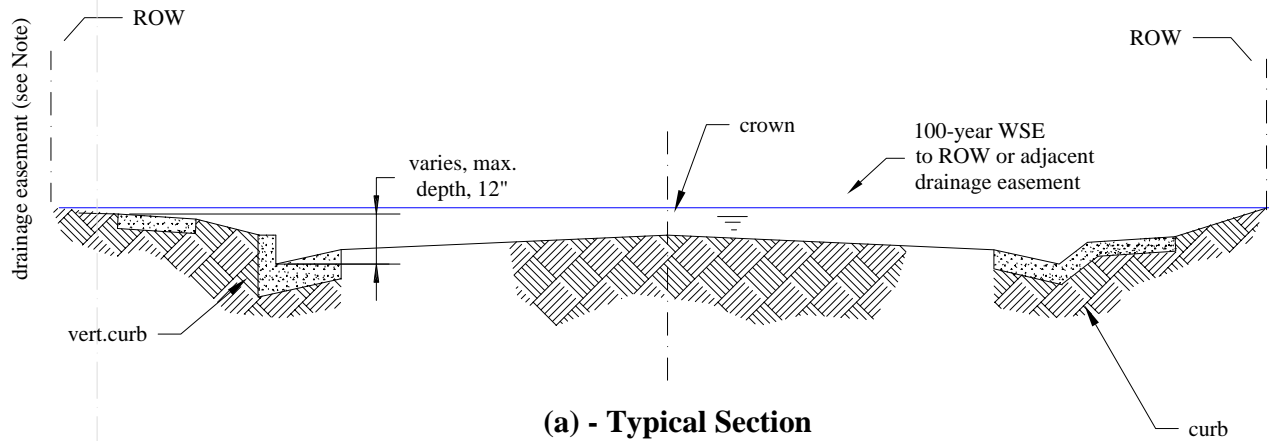
Calculation of allowable street capacity shall be performed using “spreadsheets” provided in the Manual and shall be submitted with the drainage report (see Chapter 2 of these Criteria). Refer to the Manual for design examples.

10.4. CHECKLIST

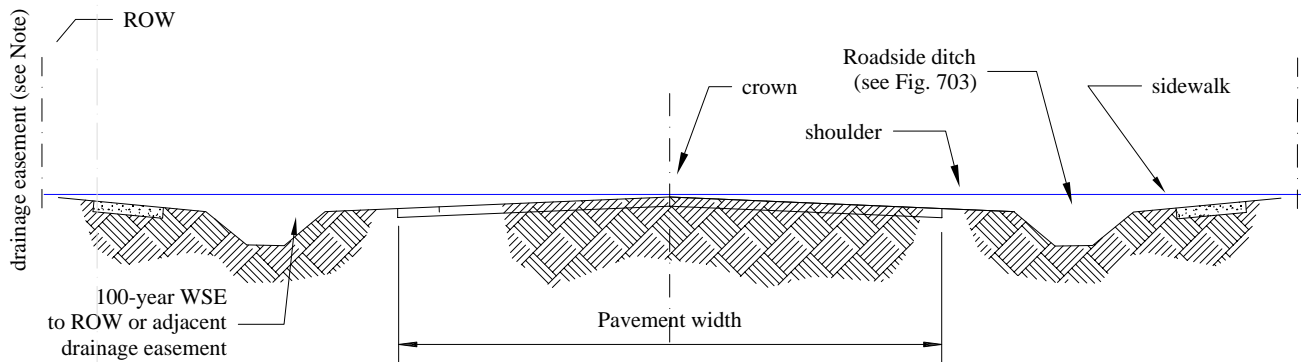
To aid the designer, the following checklist has been prepared:

- (1) Use the flattest street slope to calculate the allowable gutter capacity.
- (2) Determine street classification first, then allowable depth and gutter capacity.
- (3) Non-symmetrical street evaluation.
- (4) Storm sewer required for when gutter capacity exceeded.

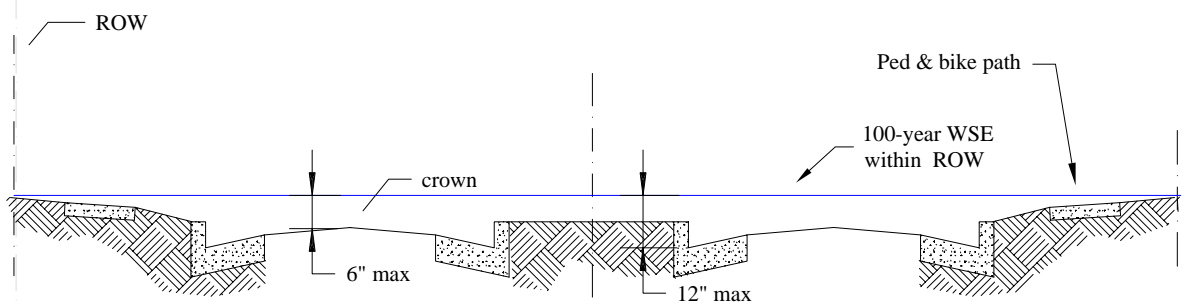
Major Storm Limits for Typical Street Cross Sections



**(a) - Typical Section
 (Local Street, Collector)**



**(b) - Typical Section
 (with roadside ditch)**



**(c) - Typical Section
 Primary/Secondary Arterial**

NOTE: Major storm depth can extend to adjacent drainage easement subject to other limitations



CHAPTER 11 - CULVERTS

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CHAPTER 11 - CULVERTS

11.1 INTRODUCTION

Except as modified herein, design of culverts shall be in accordance with the Manual.

11.2 CULVERT HYDRAULICS

The procedures and basic data to be used for the hydraulic evaluation of culverts shall be in accordance with the Manual, “Street”, except as modified herein. The reader is also referred to the many texts covering the subject for additional information.

11.3 CULVERT DESIGN STANDARDS

11.3.1 Construction Material and Pipe Size

Culverts within a public ROW may be constructed with materials accepted by the Colorado Department of Transportation, see these Criteria, Chapter 8 “Storm Sewers”. Culverts for private driveways may also be constructed with corrugated metal pipe.

The minimum pipe size for culverts within a public ROW shall be 18 inches diameter round culvert, or shall have a minimum cross sectional area of 1.6 ft² for arch shapes, and 1.8 ft² for elliptical shapes. Roadside ditch culverts for driveways shall be a minimum 12” CMP. However, the size of the pipe shall be increased when necessary to accommodate roadside-ditch, hydraulic capacity.

11.3.2 Inlet and Outlet Configuration

All culverts, including for private driveways, are to be designed with headwalls and wingwalls, or with flared-end sections at the inlet and outlet. Flared-end sections are only allowed on pipes with diameters of 42-inches (or equivalent) or less. Multiple barrel installations will be reviewed on a case-by-case basis and will be subject to approval by the Director. The City may require headwalls and wingwalls if a special condition is created by the pipe installation location. Additional protection in the form of riprap will also be required at the inlet and outlet due to the potential scouring velocities. Refer to Section-12.2 and 12.3.

11.3.3 Hydraulic Data

When evaluating the capacity of a culvert, the following data shall be used:

- a. Roughness Coefficient
- b. Entrance Loss Coefficients: Manual, “Culverts”
- c. Capacity Curves - There are many charts, tables, and curves in the literature for the computation of culvert hydraulic capacity. To assist in the review of the culvert design computations and to obtain uniformity of analysis, the following data may be used:

All Culverts: Manual, "Culverts".

Concrete Pipe: Concrete Pipe Design Manual, ACPA, Arlington, Virginia, February, 1970 (Reference-3)

Corrugated Metal Pipe: Handbook of Steel Drainage and Highway Construction Products, AISI, Washington, D.C. (Reference-4)

Copies of the product manuals may be obtained through pipe suppliers.

- d. Design Forms - Standard Form - 3 or forms provided in the Manual can be used for determining culvert capacities. Design examples can be found in the Manual, "Culverts".

11.3.4 Velocity Requirements

- a. Minimum Velocity: A minimum flow velocity of 3-feet per second is required to achieve scouring flows that minimize sediment accumulation in the culvert. Minimum velocity shall be calculated based on 5 % of full flow capacity. Therefore, minimum velocity is approximately 45 % of full flow velocity.
- b. Maximum Velocity: The maximum permissible velocity within the culvert is 16-feet per second.
- c. Outlet erosion protection: Erosion protection at conduit outlets shall be provided in accordance with the Manual, "Hydraulic Structures". The Manual allows riprap protection for Froude Numbers up to 2.5. For a 24" diameter pipe flowing full with an outlet velocity of 16 fps, the Froude Number is about 2.0. Larger pipe sizes will have lower Froude Numbers. Therefore, erosion protection for most pipe outlets can be achieved with riprap.

11.3.5 Headwater Requirements

The maximum allowed headwater for the 100-year design flows shall be 1.5 times the culvert diameter, or 1.5 times the culvert rise dimension for shapes other than round. Allowable headwater at culverts is provided in Table 11A. CDOT may require more stringent standards for culverts in their ROW.

Table 11A - Allowable Headwater Depths for Culverts

Traffic Classification	Storm Type	Allowable Headwater
Local	Minor Storm	Overtopping of street not permitted.
	Major Storm	Overtopping of streets shall be less than 12-inches at the gutter. Flow shall not extend past the easement or ROW.
Collector	Minor Storm	Overtopping of street not permitted.
	Major Storm	Overtopping of streets shall be less than 12-inches at the gutter. Flow shall not extend past the easement or ROW.
Arterial	Minor Storm	Overtopping of street not permitted.
	Major Storm	Overtopping of the street not permitted.

11.3.6 Safety Rack

Safety racks may be required at the entrance of culverts and storm sewers for some installations as designated by the City. Requirements for safety racks are provided in the Manual, “Culverts”, Section 8.0, except as modified herein. Generally, trash racks are discouraged at the exit of culverts for safety reasons.

1. **Materials:** All safety racks shall be constructed from smooth steel pipe with a minimum outside diameter of 1.25-inches. The safety racks ends and bracing should be constructed with steel angle sections. All safety rack components shall have a corrosion protective finish.
2. **Safety Rack Design:** See Manual.
3. **Bar Spacing:** See Manual.
4. **Safety Rack Slope:** See Manual.
5. **Hydraulics:** Hydraulic losses through safety racks shall be computed using the following equation:

$$K_T = 1.45 - 0.45(a_n/a_g) - (a_n/a_g)^2 \quad \text{(Equation 1101)}$$

where: K_T = Head Loss coefficient through Safety rack (feet)
 a_n = Net open area of safety rack (square feet)

a_g = Gross area of safety rack (square feet)

This equation (USBR 1987) applies to all racks constructed normal to the approach flow direction. The coefficient K_T is multiplied times the velocity head to determine the head loss in feet. The velocity normal to the safety rack shall be computed considering the rack to be 50 percent plugged.

11.3.7 Aesthetic Requirements

All retaining wall structures for culverts shall be designed with the intent of improving appearance. The designer shall address the following:

1. **Headwalls/Wingwalls:** Retaining walls shall be designed to be compatible with surroundings by including:
 - a. Materials for walls that are new and present a finished appearance. The use of similar materials proposed for on-site buildings are encouraged. Applicant may be requested to submit samples of materials to ensure compliance with these Criteria.
 - b. Structure whose shape, height, and color are not obtrusive. The use of neutral colors, surface treatment or texture, and shapes that blend in with surroundings are encouraged. Varying shape or surface texture is also encouraged.
 - c. Additional landscaping materials, such as shrubs and trees, that interrupt visual impacts. Landscaping materials shall be placed to not impact hydraulic function of the culvert or maintenance access.
2. **Channel Entrance and Exit:** Channels shall be designed to be compatible with surroundings by:
 - a. Selecting grasses that are similar to surroundings, while protecting the channel from erosion. Adding dense, sod-forming grasses to the seed mix is encouraged.
 - b. Providing topsoil and soil supplements to encourage vegetation establishment and growth density.
 - c. Constructing 4:1 or flatter side slopes with rounded grade breaks..
 - d. Grading the area adjacent to the channel to avoid channels that appear “deep”. Using strategically placed retaining walls to permit flatter channel side slopes is encouraged.

- e. Including additional landscaping, such as shrubs and trees, that interrupt visual impacts. Landscaping materials shall be placed to not impact hydraulic function of the channel or maintenance access.

11.5 CULVERT SIZING CRITERIA

The size of a culvert is dependent upon two factors, the hydraulic classification for the street (i.e., Type-A, Type-B, or Type-C, see Table 10A) and the allowable street overtopping. The allowable street overtopping for the various street classifications is set forth in Section-11.3.5 above. Therefore, as a minimum design standard for street crossings, the following procedure shall be used:

1. Using the future developed conditions 100-year runoff, the allowable street overtopping shall be determined from overflow rating curves developed from the street profile crossing the waterway.
2. The culvert is then sized for the difference between the 100-year runoff and the allowable overtopping.

The criteria are considered minimum design standard and must be modified where other factors are considered more important. For instance, if the procedure still results in certain structures remaining in the 100-year floodplain, the design frequency may be increased to lower the floodplain elevation. In addition, if only a small increase in culvert size is required to prevent overtopping, then the larger culvert is recommended.

The minimum driveway-culvert size for streets with roadside ditches is 12-inch diameter or equivalent for other shapes.

11.6 CHECKLIST

To aid the designer, the following checklist has been prepared:

- (1) Minimum culvert size within the public ROW is 18-inch diameter round or equivalent for other shapes.
- (2) Minimum culvert size for roadside ditches at driveways is 12-inch diameter round or equivalent for other shapes.
- (3) Headwalls, wingwalls, or flared end sections required for all culverts.
- (4) Check outlet velocity and provide adequate protection.
- (5) Check maximum headwater for design condition.
- (6) Check structural requirements.

CHAPTER 12 - HYDRAULIC STRUCTURES

12.1. EROSION CONTROL

The design of hydraulic structures shall be performed in accordance with the Manual, “Hydraulic Structures”. Modifications of specific criteria are presented herein. All hydraulic structures shall be designed and constructed to address aesthetics. Hydraulic structures include riprap, energy dissipators, check structures, bridges, culverts (see Chapter 11), and irrigation ditch crossings.

12.2. RIPRAP

The design of the riprap protection for culverts, channel bottom and banks, check drops, bridges, culverts, gabions or other areas subject to erosion shall be in accordance with the Manual, “Major Drainage” and “Hydraulic Structures”.

12.3. ENERGY DISSIPATORS

When velocities exceed 16-feet per second, such as at outlets of culverts or storm sewers, energy dissipators structures (stilling basins) are required. Designs shall be prepared in accordance with the Manual, “Hydraulic Structures”. However, the designer must include provisions to improve aesthetics, in accordance with Section 12.7

12.4. CHECK STRUCTURES

Check drops shall be designed in accordance with the Manual, “Hydraulic Structures”. Check drops structures shall be designed with the intent of improving aesthetics (see Section 12.7 of these Criteria).

12.5. BRIDGES

Bridges shall be designed in accordance with the Manual, “Hydraulic Structures”. Headwater requirements shall be determined in accordance with Section 11.3.5 and design capacity shall be determined by the method presented in Section 11.5 of these Criteria.

12.6. IRRIGATION DITCH CROSSINGS

Approval by a ditch or irrigation company is required prior to approval by the Director for:

- Any modification to an irrigation facility, such as a ditch, canal, or hydraulic structure.
- Any modification to existing topography that alters quantity, quality or manner in which surface runoff is discharged into the irrigation facility.

12.7 AESTHETIC REQUIREMENTS

All hydraulic structures and associated surface drainage facilities shall be designed to improve appearance and to be compatible with surroundings. The designer shall address the following:

CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA



1. Materials that are new and present a finished appearance. The use of similar materials proposed for on-site buildings are encouraged. Applicant may be requested to submit samples of materials to insure compliance with these Criteria.
2. Structures whose shape, height, and color are not obtrusive. The use of neutral colors, surface treatment or texture, and shapes that blend in with surroundings are encouraged. Varying shape or surface texture is also encouraged. Naturally occurring stone or river rock used as a cover material is preferred.
3. Additional landscaping materials, such as shrubs and trees, that interrupt visual impacts. Landscaping materials shall be placed so as to not impact hydraulic function of the culvert.
4. Selecting grasses that are similar to surroundings, while protecting the channel from erosion. Adding dense, sod-forming grasses to the seed mix is encouraged.
5. Providing topsoil and soil supplements to encourage vegetation establishment and growth density.
6. Constructing 4:1 or flatter side slopes with rounded grade breaks.
7. Grading the area adjacent to the channel to avoid a “deep” appearance. The Director may allow strategically placed retaining walls to permit flatter channel side slopes.



**CHAPTER 13 - EROSION AND SEDIMENTATION CONTROL FROM
CONSTRUCTION ACTIVITIES**

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13.1. INTRODUCTION

To protect stormwater quality, certain construction activities and land disturbances in the city of Littleton shall be required to implement erosion and sediment control during construction, with best management practices (BMPs) appropriate to the type of disturbance proposed. The selection and design of BMPs, and documentation of BMPs by plan layout, details, or narrative, shall vary depending on the size and nature of the construction activity, as described herein. The documents describing the selection, design, installation, and maintenance of BMPs to be implemented on a site is referred to as a *Stormwater Management Plan (SWMP)*. The SWMP must be approved by the Engineering Division prior to final approval of a site development plan, sketch plan, or issuance of a grading or building permit.

13.2. COLORADO DISCHARGE PERMIT

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment (CDPHE) has direction and authority to administer the Environmental Protection Agency (EPA) federally-mandated National Pollutant Discharge Elimination System (NPDES) program. The city of Littleton is authorized to discharge stormwater to the *Waters of the State* through the general permit for Stormwater Discharges associated with Municipal Separate Storm Sewer Systems (MS4), as part of the Colorado Discharge Permit System (CDPS). One element of this MS4 permit sets minimum requirements for a city's stormwater management program in order to reduce or prevent discharge of pollutants to the MS4 from construction sites of 1 acre or larger. The city may implement more stringent standards, including regulation of construction activity of less than 1 acre, as defined by its stormwater program. The city's stormwater program requires control of erosion and sedimentation from construction activities through:

1. Procedures for site planning and review of site plans;
2. Requirements for selection, implementation, installation, and maintenance of best management practices (BMPs) from initial disturbance until final stabilization; and
3. Procedures for site inspection, documentation, and enforcement during construction, with sanctions if necessary.

Items 1 and 2 are addressed by these criteria.

13.3. APPLICABILITY

1. A grading permit and a SWMP are required for projects in the city that meet at least one of the following conditions:
 - a. Ground disturbance over 5,000 square feet in surface area
 - b. Excavation or fill activity exceeding 50 cubic yards
 - c. Significant potential for erosion or other potential pollutant release to stormwater as determined by the Engineering Division. Significant potential for pollutants may include but are not limited to sites or projects that:
 - Are located on steep slopes (over 25%), for all or a portion of the site,
 - Are located immediately adjacent to a creek, stream, river, wetland, pond or other water body, or

- Disturbance of known contaminated soils.
2. Sites with land disturbance of greater than or equal to one acre, or that are less than one acre but part of a larger common plan of development or sale, are required to also obtain a Stormwater Discharges Associated with Construction Activity permit from the State of Colorado Water Quality Control Division (WQCD), in addition to a grading permit from the city.
 3. A construction site may be considered as excluded from these requirements if the applicant successfully demonstrates that the site qualifies for a waiver based upon the WQCD R-factor in accordance with WQCD Regulation 62 61.3(2)(f)(ii)(B) for small construction sites.
 4. An Air Pollutant Emission Notice Construction Permit (APEN) issued by CDPHE, is required for land development sites larger than 25 acres and more than six months in duration. If applicable, a copy of that permit shall be submitted to the Engineering Division prior to issuance of city local permits.

13.4. STANDARDS AND CRITERIA

13.4.1 GENERAL PERFORMANCE STANDARDS

Grading plans and SWMPs shall meet the following standards:

1. Surface disturbances shall be conducted in a manner to effectively reduce discharge of pollutants, and limit accelerated soil erosion and sedimentation.
2. Best management practices shall be implemented from initial land disturbance until final stabilization.
3. Disturbances shall be designed, constructed, and completed in a manner that limits the duration of exposure of potential pollutants.
4. Pollutants shall be reduced to the extent practicable from runoff water before leaving the site.
5. Temporary or permanent facilities for conveyance of runoff around, through, or from surface disturbances shall be designed to limit flow velocities to non-erosive values.
6. Disturbances shall be restored and reach final stabilization (70% of pre-disturbance uniform vegetative cover, or other permanent cover) prior to removal of temporary BMPs, unless otherwise approved by the Director. Temporary BMPs shall be removed by the operator after acceptance of final stabilization.
7. Grading plans shall meet the requirements of Littleton Municipal Code 4-1-5(8).

13.4.2 MINIMUM CONTROL MEASURE STANDARDS

1. Control measures shall be selected, designed, installed, implemented, and maintained in accordance with good engineering hydrologic and pollution control practices.
2. Control measures must be maintained in effective operating condition.
3. Any control measure shall be considered *inadequate* if it is not designed, implemented or operating as required to meet the requirements of this chapter.
4. Any control measure shall require routine maintenance if is still operating in accordance

with its design and the requirements of this chapter but requires maintenance to prevent associated potential for failure during a runoff event.

13.4.3 DESIGN CRITERIA

1. Grading plans shall meet the requirements of Littleton Municipal Code 4-1-5(8).
2. BMPs shall follow the details and minimum design requirements as provided in Mile High Flood District's latest edition of *Urban Storm Drainage Criteria Manual, Volume 3 - Stormwater Quality, Chapter 7 Construction BMP's* (Manual, Volume 3), except as modified herein, or Colorado Department of Transportation *M&S Standards and Standard Specifications for Road and Bridge Construction*, latest versions.
2. Where stormwater is concentrated within a swale or ditch, silt fence shall not be used as a control measure.
3. Straw bales shall not be used as a control measure.
4. Erosion control blankets or soil retention blankets shall be 100% biodegradable (both the mesh and fill material).

13.5 STORMWATER MANAGEMENT PLAN

13.5.1 CONTENTS

- A. If the project includes full construction drawings, then the SWMP must be a part of the construction plan set and shall include the following, at a minimum:
 1. A plan layout identifying all structural and non-structural control measures for the applicable construction activities, which identifies existing and proposed topographic contours and flow direction arrows.
 2. Installation and implementation detail drawings (or a reference to the document with such information) for all structural control measures.
 3. Notes or detail drawings describing installation of non-structural control measures.
 4. Notes describing spill prevention methods with BMPs to prevent potential pollutant spills, contain potential spills to a designated area, and limit ability for storm runoff to reach potential pollutants
 5. Notes describing the inspection and maintenance of BMPs
 6. Inclusion of city's Standard Notes for Stormwater Management Plans (see below) and signature blocks
- B. If the project does not have a full construction plan set, such as for a residential remodel or smaller project, then the SWMP shall consist of the grading permit application with the above materials attached as sketches, copies of standard details, standard notes, and a narrative in the form of a letter. A professional engineer certification on the standard notes is not required.
- C. The SWMP for sites over 1 acre in size requiring a separate permit from the WQCD may require additional information pursuant to WQCD requirements and guidelines.

13.5.2 MINIMUM BMPS

The stormwater management plan shall identify BMPs to control potential pollutants including but not limited to sediment, construction site waste, trash, discarded building materials, concrete truck washout, chemicals, sanitary waste, and contaminated soils, prior to discharge from the site or the MS4 whichever comes first. At a minimum, BMPs must address the following activities, as applicable:

- a. Land disturbance and storage of soils
- b. Vehicle tracking
- c. Loading and unloading operations
- d. Outdoor storage of construction site materials, building materials, fertilizers, trash, chemicals, etc.
- e. Bulk storage of materials
- f. Vehicle and equipment maintenance and fueling
- g. Significant dust or particulate generating processes
- h. Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, and oils
- i. Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment
- j. Dedicated asphalt and concrete batch plants.
- k. Other areas or operations where spills can occur.
- l. 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.

13.5.3 REQUIRED STANDARD NOTES

The applicant must include all the below standard notes and signature block as part of the SWMP in the construction plans. These notes may be slightly different for city-owned projects (see the Engineering Division).

1. The operator, property owner, or their designee is responsible for obtaining applicable permits and the installation and maintenance of all Best Management Practices (BMPs) for erosion and sediment control, even if specific tasks may be designated to others.
2. For all sites disturbing one (1) or more acres, the State of Colorado Department of Public Health and Environment (CDPHE) requires a “Stormwater Discharges Associated with Construction Activity” permit. A copy of that issued permit shall be submitted to the Engineering Division prior to issuance of a local city permit.
3. All BMPs shown on the approved Stormwater Management Plan (SWMP) plan shall be installed properly and inspected by a City representative prior to the start of any construction activity on the site that disturbs the ground. BMPs shall be inspected, cleaned, and maintained by the property owner or designee as needed during construction.

4. Issuance of a grading or building permit with an approved SWMP provides authorization for the city to enter the premises for purposes of inspections and compliance with the approved plans, provisions of Municipal Code Title 7 Chapter 7, and the city's Storm Drainage Design and Technical Criteria.
5. The City may require that the operator, property owner, or their designee provide additional erosion or sediment control measures, should water or wind erosion problems occur or should the implemented Stormwater Management Plan (SWMP) and Best Management Practices (BMPs) not function adequately or as intended.
5. Inspections and needed maintenance of BMPs are required a minimum of every 14 days and after storm events, or alternately every 7 days. The City reserves the right to require the operator to submit copies of inspection reports or other stormwater management documents at any time.
6. SWMPs shall accommodate construction phasing, including clearing and grubbing, utilities, roads, vertical construction, final grading, and stabilization, and shall have redundant downslope BMPs in place to ensure adequate erosion and sediment control during all phases.
7. The operator, property owner, or their designee is responsible to clean all public streets and sidewalks where sediment or mud is tracked onto the paved surface. The operator, property owner, or their designee shall clean the public way immediately or without delay upon being notified by the City. It may also be necessary to periodically clean the public storm sewers and down gradient properties during the development of the site.
8. The operator, property owner, or their designee shall be responsible for implementation and field updates/changes to the Storm Water Management Plan (SWMP) that includes the plan view layout and installation details of appropriate control measures, and maintenance procedures.
9. If the operator, property owner, or their designee fails to implement any of the provisions of the SWMP and ignores the City's verbal or written request for immediate remedy, the City may make arrangements or hire a private property owner or designee to perform maintenance, installation or replacement of BMPs, or clean the public ways. Charges for services will be sent to the operator, property owner or designee for payment. Enforcement procedures are outlined in Littleton Municipal Code 7-7-12.
10. The City may issue a "Stop Work" order to stop any permitted site construction work from proceeding until the BMPs provided on the SWMP and approved plans are installed, implemented as intended, maintained, or until corrective measures are taken and any necessary cleanup is performed. The owner bears all costs associated with any delays in the project.
11. The operator, property owner, or their designee shall not utilize the public street as a staging area for the temporary storage of building materials, excavated materials, or

- construction equipment, except as approved by the City. Use of offsite private property for staging may be subject to review by the Community Development Department.
12. A Construction Dewatering Discharge Permit shall be obtained from CDPHE prior to pumping of any surface or sub-surface water into any city public way or storm drainage system. Adequate sediment control BMPs shall be required at the pump's inlet and outlet.
 13. All soil areas disturbed shall be graded, seeded, and mulched or otherwise vegetated or covered, to stabilize the ground surface within 14 days of completion of grading operations. The City shall approve the seed mix and rate of application prior to seeding the area. If disturbed soil areas are to be left dormant for over 14 days, a temporary stabilizing cover is required, the method to be approved by the City. Weeds are not an acceptable temporary or permanent stabilization cover.
 14. BMPs shall remain in-place and operational until all site paving, permanent landscaping, or adequate vegetative cover establishment is completed. Adequate vegetative cover is defined as a uniform vegetative cover with a plant density (stem or stalks) of at least 70% of the pre-disturbance condition. Temporary irrigation may be necessary to establish plant growth. Adequate vegetative cover will be determined by City staff with an on-site inspection prior to any permit release, including termination of a CDPHE stormwater permit.
 15. After the site has been stabilized as determined by city staff, the operator, property owner, or their designee shall remove all BMPs and clean any storm sewers where construction sediment may have deposited.

13.6 GRADING PERMIT ISSUANCE

A grading permit may be issued after:

1. Review and approval of the Stormwater Management Plan (SWMP) by the Engineering Division.
2. Installation of erosion and sediment control measures on the site.
3. Approval of control measure installation by a city inspector, and;
4. Submittal of proper collateral/surety, if required. See Littleton Municipal Code 7-7.

Issuance of a grading or building permit with an approved SWMP provides authorization for the city to enter the premises for purposes of inspections and compliance with this chapter.



SIGNATURE BLOCK: Signature block shall be placed on either the title sheet of a construction plan set, or with the Stormwater Management Plan Notes if a full plan set is not prepared.

DESIGNER CERTIFICATION:

“I hereby certify that this Stormwater Management Plan was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Littleton’s Storm Drainage Design and Technical Criteria Manual for the owners thereof.”

Registered Professional Engineer
State of Colorado PE No. _____

Date

PROPERTY OWNER CERTIFICATION:

“I hereby certify that this Stormwater Management Plan for _____ is my responsibility to implement and maintain and I accept all of the terms stated above. I understand that the City of Littleton does not and will not assume liability for this Plan.”

Property Owner Printed Name: _____

Signed Name: _____

Address: _____

Date: _____

CHAPTER 14 - DETENTION

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CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

14.1 INTRODUCTION

All new development and redevelopment projects in the city shall provide on-site flood detention, as set forth in Policy 3.3.6. Design shall follow the criteria presented in this chapter and that of Mile High Flood District, Volume 2 (Storage).

14.2 PURPOSE

Development increases peak flows and volume of stormwater runoff and can alter the duration of storm runoff. Temporarily containing the stormwater runoff and releasing it at a lesser rate allows floods to be released at peaks and durations similar to predevelopment conditions. This approach matches predevelopment discharges over a wide range of events, especially in the frequent storms where urban runoff impacts are most evident. The approach has been termed “full-spectrum detention,” and is intended to reduce the flooding (in streets and streams), and stream erosion/degradation associated with increases in peak, duration, and frequency of runoff from urban surfaces. The city’s detention policy is for new development projects, but also re-development at properties with large impervious surfaces that pre-dated current criteria at the time of original construction and lack flood detention facilities. This policy has been developed specifically for Littleton because the city has many such properties, and is an attempt to reduce street flooding and prevent and possibly reverse stream degradation. The policy also seeks to address the cumulative impacts of numerous smaller development and re-development projects.

14.3 DESIGN CRITERIA

14.3.1 General

Detention shall be provided to reduce peak runoff to pre-development levels (before any development of the site) or to the allowable release rates in the Manual, Volume 2 (Storage). A summary table of the requirements and triggers for both detention and water quality is presented in Table 15.3.1 of Chapter 15. Proposed projects less than 5,000 square feet in size are not required to implement detention. Flood detention is permitted as surface ponds, in parking lots, and underground. Rooftop detention is prohibited. Flood detention facilities are not permitted within designated floodplains unless as approved by the Engineering Division.

All detention facilities must include provisions to control stormwater quality. Requirements for water quality are provided in Chapter 15 of these Criteria.

All open detention areas must be landscaped in accordance with Policy 3.4.5 and Section 14.3.8 of these Criteria.

All detention facilities are to be based on Full Spectrum Detention, unless otherwise approved by

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the Engineering Division.

14.3.2 Full Spectrum Detention Design Volume

Full spectrum detention volume is based on three design events, as follows:

1. Water quality capture volume (WQCV).
2. Excess Urban Runoff Volume (EURV) – which includes the WQCV
3. The 100-year event - which includes the EURV.

The total volume of the facility is the 100-year event volume. A detailed explanation and description of the full spectrum detention design method is presented in the Manual, Volume 2. Only a summary of the method is contained here. The reader is encouraged to refer to the Manual, Volume 2 for additional design detail and guidance.

Procedures for calculating the volumes and sizing detention facilities for these design events consist of the following methods:

1. Simplified Equation (for drainage basins less than 10 acres)
2. UD-Detention workbook
3. Hydrograph routing using CUHP and SWMM

14.3.2.1 Simplified Method

- A. The calculation of WQCV is described in Chapter 15 of these criteria.
- B. EURV.

$$\begin{aligned} \text{EURV}_A &= 1.68i^{1.28} \\ \text{EURV}_B &= 1.36i^{1.08} \\ \text{EURV}_{C/D} &= 1.20i^{1.08} \end{aligned}$$

Where:

EURV_K = Excess urban runoff volume in watershed inches (K indicates NRCS Hydrologic Soil Group A, B, or C/D, as defined by the Natural Resource Conservation Service)

i = Imperviousness ratio (a decimal less than or equal to 1)

- C. 100-year event.

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$$V_{100} = P1 * [(0.806i^{1.225} + 0.109i^{0.225}) * A\% + (0.412i^{1.371} + 0.371i^{0.371})B\% + (0.341i^{1.389} + 0.398i^{0.389})CD\%]$$

Where:

V_{100} = detention volume in watershed inches

P1 = one-hour rainfall depth (inches)

i = imperviousness ratio (a decimal less than or equal to 1)

A%, B%, and CD% = indicates percentage of each NRCS soils type (expressed as a decimal)

Facilities that combine the first two events or all three events generally do not require a separate design for WQCV; the WQCV and water quality release rate are “built in” to the Excess Urban Runoff Volume design.

14.3.2.2 UD-Detention Workbook

An Excel-based workbook is available from www.mhfd.org for sizing of full spectrum detention facilities using the Modified Puls reservoir routing method.

14.3.2.3 Hydrograph Routing

Full spectrum detention facilities may also be designed using routing of hydrographs with computer programs CUHP and SWMM. The outlet is still designed to empty the EURV with the specified drain time.

14.3.3 Drain time and maximum release rate

The WQCV and EURV have release rates that are tied to a specified drain time for the type of facility, not a pre-determined maximum release rate (see Manual, Volume 3 for drain times for various types of BMPs). Colorado law requires 97% of the 5-year event to drain within 72 hours. The 100-yr volume (minus the EURV) has a maximum release rate.

The maximum allowable 100-year release rate for a full spectrum detention facility is equal to 90 percent of the predevelopment discharge for the upstream watershed. The predevelopment 100-year unit discharge for specific soil types per acre of tributary catchment varies based on the watershed slope and the watershed shape (described as the ratio of the flow length squared to the watershed area).

$$q = P_1 C_1 S^{C_2} [L^2/A] C_3$$

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Where:

q = peak unit flow rate (cfs/acre)

P₁ = one-hour precipitation depth (in) from NOAA Atlas 14

S = watershed flow path slope (ft/ft)

L = watershed flow path length (ft)

A = area of tributary (ft²)

C1, C2, C3 = coefficients based on soil type, see table below.

		100- year		
	Soil Group	A	B	C/D
Leading Coefficient	C1	0.5622	1.2088	1.3053
Slope Exponent	C2	0.2021	0.1677	0.1651
Shape Exponent	C3	- 0.4286	- 0.3542	- 0.3490

When multiple soil types exist in the watershed, use the table values for each soil type and calculate a weighted average value relative to the area proportion of each soil type.

$$Q = 0.9aq$$

Where: Q = Allowable 100-year release rate (cfs)

a = Area of watershed (acres)

q = weighted average unit release rate based on relative proportions of watershed soil types (cfs/acre)

For information on release rates for events other than the 100-year, see the Manual Volume 2.

14.3.4 Water rights protection

In 2015, Colorado implemented procedures to verify that stormwater facilities are designed to not adversely impact or injure water rights, through C.R.S. §37-92-602 (8). In addition the statute specifies that runoff treated in stormwater detention and infiltration facilities shall not be

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used for any other purpose by the owner/operator/overseer (or that entity's assignees), shall not be released for subsequent diversion or storage by the owner/operator/overseer (or that entity's assignees), and shall not be the basis for a water right or credit.

This statute provides 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 of the runoff from a rainfall event that is less than or equal to a 5-year storm within 72 hours after the end of the event
3. It continuously releases or infiltrates as quickly as practicable, but in all cases releases or infiltrates at least 99% of the runoff within 120 hours after the end of events greater than a 5-year storm
4. It operates passively and does not subject the stormwater runoff to any active treatment process (e.g., coagulation, flocculation, disinfection, etc.)

To meet these requirements, all detention ponds are required to submit documentation of compliance with the above criteria to the city as part of design, and after construction, by providing the data contained in the Stormwater Detention and Infiltration (SDI) Design Data Sheet, available from MHFD. The city will file the SDI with the state.

14.3.5 Hydraulic Design

Hydraulic design procedures and data for certain features, such as outlet structures, emergency spillways, safety racks, and erosion control are provided in the Manual, Volume 2.

14.3.6 Site Selection

Open detention ponds are preferred over parking lot or underground detention. However, the Engineering Division may allow for parking lot or underground detention with consideration of the following:

- Land use for proposed development and surrounding area.
- Pre-existing and proposed site topography.
- Operations and maintenance requirements and responsibilities.
- Impacts on downstream properties.
- Other factors deemed appropriate by the City.

When adjacent property owners are each required to provide on-site detention, a single detention site can be used provided that a maintenance and operation plan clearly delineates responsibilities for both property owners.

When multiple detention sites are approved for a single property, the minimum 100-year volume

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per pond is 3,000 cubic feet, otherwise all detention volume must be provided in one pond.

14.3.7 Sequential Detention Analysis

When one or more detention ponds for a development will be routed through another detention pond that is also provided for the development, the volumes and release rates for all detention ponds shall be determined using CUHP and SWMM.

14.4 DESIGN STANDARDS FOR ABOVE GROUND DETENTION PONDS

Any dam constructed for the purpose of storing water, with a surface area, volume, or dam height as specified in Colorado Revised Statutes 37-87-105 as amended, shall require the approval of the plans by the State Engineer Office. All detention storage areas shall be designed and constructed in accordance with these Criteria. Those facilities subject to the state statutes shall also be designed and constructed in accordance with the criteria of the state.

All detention must include provisions for improving storm water quality (Policy 3.3.7), be designed to facilitate maintenance (Policy 3.3.8) and to enhance aesthetics (Policy 3.4.4).

14.4.1 Grading Requirements

Grading requirements for detention ponds are as follows:

- a. The minimum bottom slope shall be 2.0 % measured perpendicular to the trickle channel and 1% longitudinally to the outlet.
- b. All grade breaks shall be rounded.
- c. Embankment slopes shall be 4:1 maximum
- d. The top of any cut slope and the toe of any fill slope shall be 10-feet or greater from the property boundary.
- e. Walls: The use of retaining walls within a detention site to meet volume and grading requirements is discouraged due to maintenance needs and requires approval by the Director. A maximum of 50% of the pond perimeter may have retaining walls. Safety of nearby pedestrians, cyclists and vehicles must be considered when designing the location of retaining walls and use of railings or other protection measures. Walls in excess of 30" tall shall have a structural analysis by a professional engineer.
- f. All detention facilities shall have maintenance access graded into the facility bottom and to the inlet and outlet structures, provided in an easement, as stated and described in Chapter 3.

14.4.2 Emergency Spillway

All open detention ponds shall include an emergency spillway sized to pass the design 100-year

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pond inflow rate assuming the outlet structure is 100% blocked. Structures are not permitted in the path of the emergency spillway. Buried soil riprap may be required to protect embankment. Soil riprap embankment protection should be sized based on methodologies developed specifically for overtopping embankments.

14.4.3 Freeboard Requirements

Freeboard for detention ponds is defined as the vertical distance from the minimum embankment elevation to the 100-year water surface elevation when the emergency spillway is conveying its design discharge. The minimum required freeboard for above ground detention facilities is 1.0 foot above the computed 100-year water surface elevation.

14.4.4 Trickle Flow Control

All grassed bottom detention ponds shall include a trickle channel to facilitate maintenance. **Figure 1401** presents examples of acceptable trickle flow channels for detention areas.

14.4.5 Outlet Configuration

Outlet structures for detention must include provisions for water quality (see Chapter 15). All detention and water-quality outlet structures must be designed in accordance with the Manual, Volume 3 *Best Management Practices and Volume 2 Storage*. The most common outlet is a drop box with a grated top. The drop box contains vertical walls with orifice holes designed to release volumes in a specified time and rate. The Manual provides details for various full spectrum detention pond configurations to control detention and water quality releases. Hydraulic calculations required for detention ponds are described in the Manual.

14.4.6 Vegetation Requirements

All detention ponds shall be revegetated by either irrigated sod or natural dry-land grasses in accordance with the Manual. All earthen slopes shall be covered with topsoil, vegetated, and mulched or blanketed. Grass seed should be selected based on site specific characteristics such as slope aspect, soil type, and periods of inundation. The use of trees and shrubs are prohibited on dams or fill embankments, and near outlets or inlets where they might interfere with proper functioning.

14.4.7 Operations and Maintenance

Maintenance access shall be provided to the detention facility in accordance with Policy. The outlet structure shall be designed to minimize vandalism.

14.4.8 Aesthetic Requirements

All detention facilities and their outlet structures shall be designed with the intent of improving appearance. The designer shall address the following:

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- a. **Walls:** Headwalls, wingwalls or retaining walls shall be designed to be compatible with surroundings by including:
- Materials for walls that are new and present a finished appearance. The use of similar materials proposed for on-site buildings are encouraged. Applicant may be requested to submit samples of materials to ensure compliance with these Criteria.
 - Structures whose shape, height, and color are not obtrusive. The use of neutral colors, surface treatment or texture, and shapes that blend in with surroundings are encouraged. Varying shape or surface texture is also encouraged. Natural/native stone or river rock used as a cover material is preferred.
 - Structure that is “embedded” into the embankment to minimize visual impacts while meeting hydraulic requirements.
 - Additional landscaping materials, such as shrubs and trees, that interrupt visual impacts. Landscaping materials shall be placed to not impact hydraulic function, operations, or maintenance of the outlet structure.
- b. **Storage Area and Outlet Channel:** The detention basin shall be designed to be compatible with surroundings by:
- Selecting grasses that are similar to surroundings and provide protection from erosion. Adding dense, sod-forming grasses to the seed mix is encouraged.
 - Providing topsoil and soil supplements to encourage vegetation establishment and growth density.
 - Constructing 4:1 or flatter side slopes with rounded grade breaks.
 - Varying slopes within the detention basin.
 - Grading the area to avoid a “deep” appearance. The Director may allow strategically placed retaining walls.
 - Including additional landscaping, such as shrubs and trees. Landscaping materials shall be placed to not impact hydraulic function, operations or maintenance.
 - Using buried soil riprap for the emergency spillway.

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Any modifications to the above criteria require approval of the Director who can consider the following factors in a decision:

- Land use for proposed development and surrounding area.
- Pre-existing and proposed site topography.
- Operations and maintenance requirements and responsibilities.
- Impacts on downstream properties.
- Nature and extent of landscaping, including ground cover and use of retaining walls.
- Other factors deemed appropriate by the City.

14.5 DESIGN STANDARDS FOR PARKING LOT DETENTION

All parking lot detention areas shall provide water quality enhancement in a separate facility, in accordance with Chapter 15 of these Criteria. Projects involving parking lot detention are cautioned because such ponding can be a nuisance. The city regularly inspects all detention facilities in the city, and removal/modification of any parking lot detention facility is a code violation and will be required to be replaced. Also, designers should note that it may be difficult to provide full spectrum detention in a parking lot only, and variance from full spectrum design is subject to approval by the Engineering Division.

14.5.1 Depth Limitation

The maximum allowable design depth of the ponding for the 100-year flood is 12-inches. A minimum of 6-inches of freeboard shall be provided above the 100-year water surface elevation.

14.5.2 Additional Volume Requirements

To account for future pavement overlays in the parking area, additional 100-year volume shall be provided to account for 1-1/2 inches of overlay as follows:

$$\Delta V = 0.125 \times A_s \quad \text{(Equation 1405)}$$

Where:

ΔV = Additional volume, (cubic feet)

A_s = Surface area of detention pond at 100-year water surface (square feet).

14.5.3 Outlet Configuration

Where a drop inlet is used to discharge the parking lot detention volume to a storm sewer or drainageway, the minimum outlet pipe size from the drop inlet is 6-inch diameter. Where a weir and a small diameter outlet through a curb are used, the size and shape are dependent on the discharge/storage requirements, but the circular outlet opening shall have a minimum diameter of

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4 inches.

14.5.4 Operations and Maintenance

To assure that the detention facility performs as designed, maintenance access shall be provided in accordance with Section 3.3.8. The outlet shall be designed to minimize unauthorized modifications, which affect function.

14.6 DESIGN STANDARDS FOR UNDERGROUND DETENTION

All underground detention must be designed to enhance water quality (Policy 3.3.7) and to facilitate maintenance (Policy 3.3.8). All underground detention facilities will be required to have annual inspections by a qualified professional, with any maintenance performed as required. The annual report of inspection and maintenance shall be submitted to the Engineering Division, with attention to the stormwater manager.

14.6.1 Materials

Underground detention shall be constructed using appropriate materials that have been sufficiently tested for conditions expected at the site, designed and certified for site-specific conditions by a licensed Professional Engineer and subject to review and approval by the Engineering Division.

14.6.2 Configuration

Pipe segments or chambers shall be sufficient in number, diameter, and length to provide the required minimum storage volume for the 100-year design (see **Figure 1402**). The minimum pipe diameter is 36-inches. Pipe segments shall be placed side by side and connected at both ends by elbows and tee fittings. Pipe segments shall be continuously sloped to the outlet at a minimum grade of 0.2%.

As an option, the 100-year design can be stored in the pipe segments and the EURV in an open space detention or in a parking lot detention.

Permanent buildings or structures shall not be placed directly above the underground detention and the underground facility will be contained in a drainage easement.

14.6.3 Inlet and Outlet Design

The outlet pipe from the detention shall be a minimum of 6" in diameter. The outlet pipe(s) shall discharge into a standard manhole or into a drainageway with erosion protection provided per Sections 11.3.2, 12.2, and 12.3. If an orifice plate is required to control the release rate, the plate(s) shall be hinged to open into the detention pipes to facilitate back flushing of the outlet pipe(s).

Inlet to the detention pipes can be by way of surface inlets and/or by a local, private storm sewer system.

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14.6.4 Operations and Maintenance

Access easements to the detention site shall be provided in accordance with Section 3.3.8. To facilitate cleaning of the pipe segments, 3-foot diameter maintenance access ports shall be placed according to the following schedule:

Maintenance Access Requirements for Underground Detention

Number of Barrels	Number of Manholes
Up to 3	2 each
4	4 each
Greater than 4	Two each barrel

The manholes shall be constructed in accordance with the detail on Figure-1402.

14.7 EXEMPTIONS

1. An exemption from on-site detention requirements may be granted where a downstream regional detention pond or facility is sized with the capacity to accommodate flows from a fully developed basin that the site is located within.
2. An exemption from the full on-site detention requirements may be considered if it can be demonstrated that to do so would require the removal of existing buildings or portions thereof, in which case a reduced detention volume will be considered.
3. An exemption will be considered for development of parks and recreation facilities, not including parking lots, where the design sufficiently minimizes directly connected impervious surfaces.
4. An exemption from on-site detention requirements may be considered for roadway projects that do not include parking lots.

14.8 SUBMITTAL REQUIREMENTS

Construction plans and supporting documentation for design, installation, and maintenance of detention facilities shall include the following. Submittals will be reviewed in accordance with Chapter 2 of these Criteria.

Construction Plan Submittals

1. Design plan layout of each detention facility, with section and profile views, and details sufficient for construction.

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2. Narrative reference (labeling or notes) on the construction plans for all detention facilities at the site, if applicable.
3. Notations and labels on the plans that reference the Operation and Maintenance Plan.
4. Labeling of the maintenance easement or other legal means for access of the detention facilities for operation, maintenance, and inspection. Include language associated with the easement to ensure inspection maintenance by the landowner in perpetuity, with access permission to the city should the landowner fail to maintain.

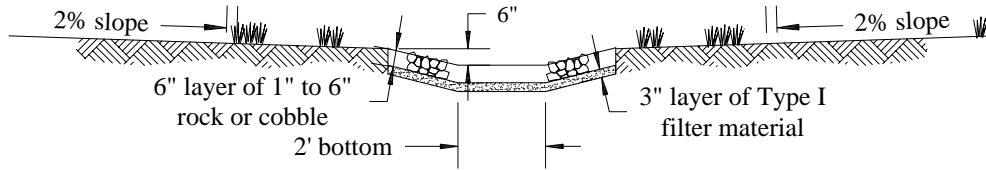
Operation and Maintenance Plan

1. The project shall include an Operation and Maintenance Plan for the site that clearly explains the procedures to ensure the long term observation, maintenance, and operation for each of the detention facilities implemented on the site.
2. The documentation shall include frequencies for routine inspections and maintenance activities.
3. The documentation shall include a commitment statement by the property owner or manager to perform the duties outlined in the O&M manual, for perpetuity.
4. The Manual, Volume 3, Chapter 6 provides information required for O&M Plans.

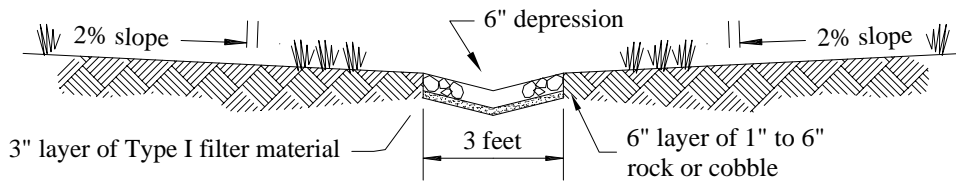
Drainage Report

1. A section of the Drainage Report (see Chapter 2 of these criteria) shall include a narrative describing the detention facilities to be implemented on the site, and all pertinent calculations in accordance with the Manual, Volume 2.
2. Provide documentation that each detention facility will drain as required by Colorado State regulation (Colorado Revised Statute (CRS) §37-92-602 (8)). A copy of the MHFD Stormwater Detention and Infiltration (SDI) Design Data Sheet shall be included in the Drainage Report. The city will perform any state required notification.
3. Identify all detention facilities on the drainage plan of the Drainage Report, in accordance with section 2.3.2 and 2.4.2 of these Criteria.

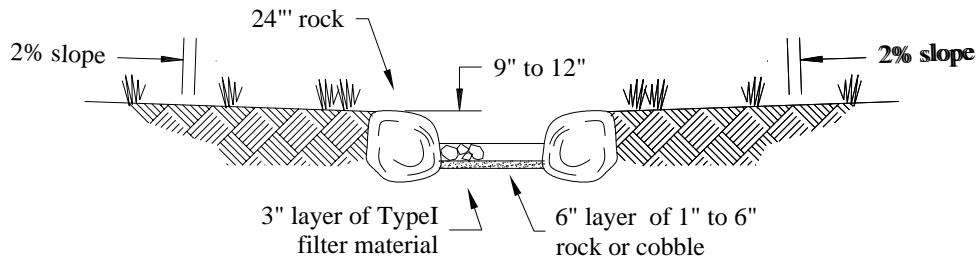
Trickle Channels for Detention Ponds



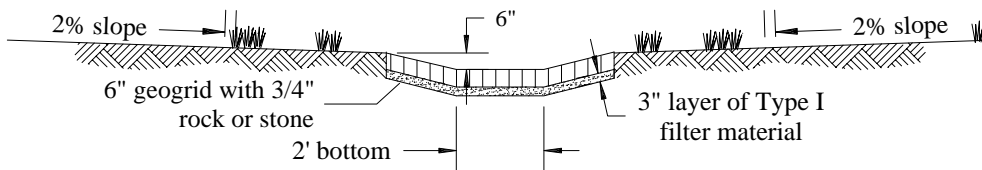
Type IV - Rock Channel



Type III - Rock Swale

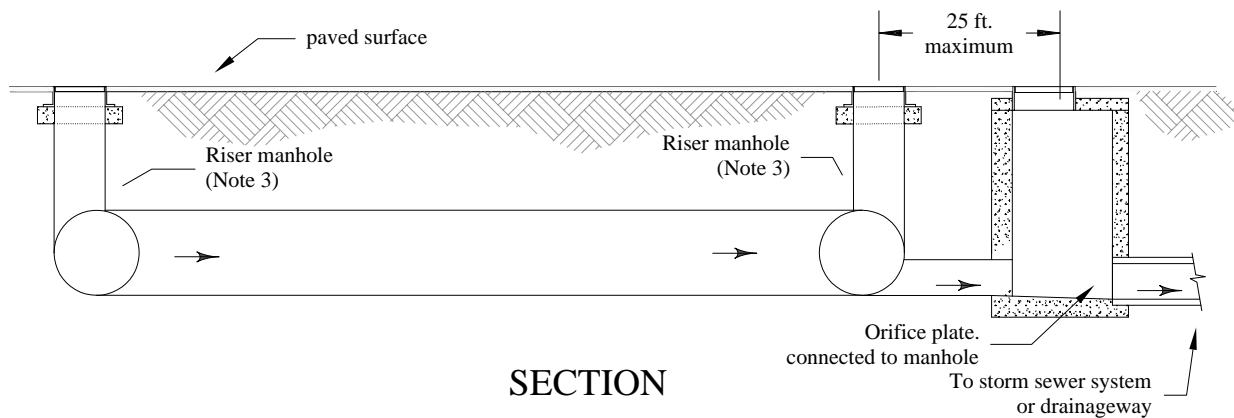
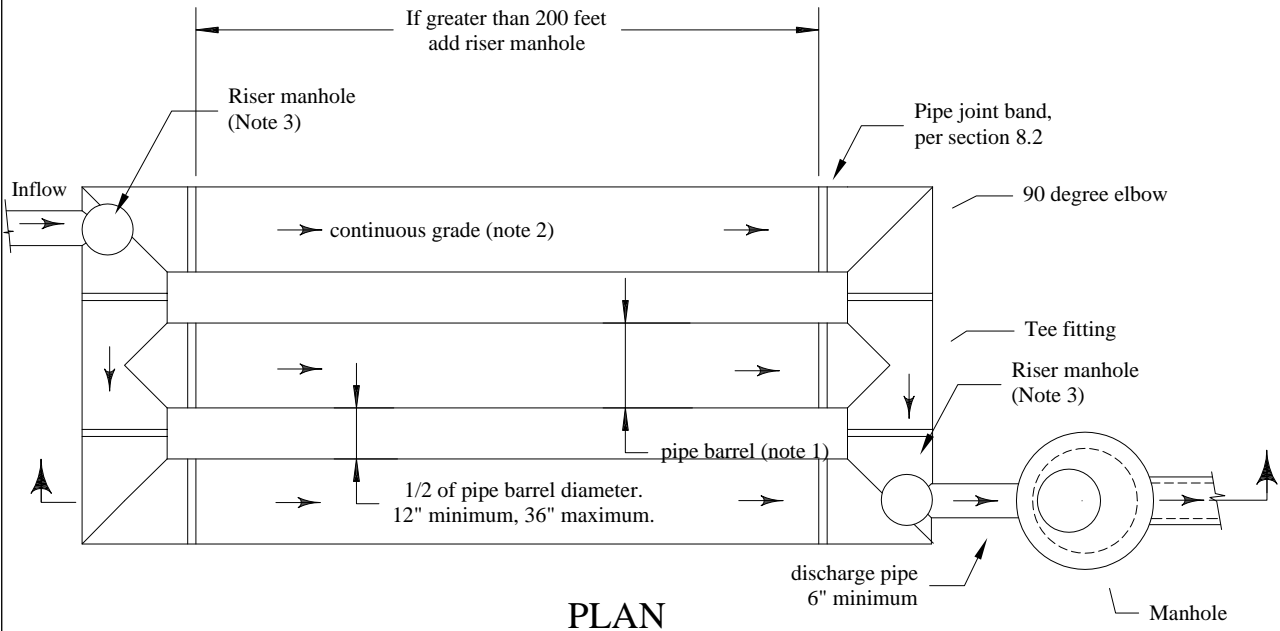


Type II - Boulder Edge



Type I - Rock Filled Geogrid

Underground Detention Details



- NOTES: 1. Pipe to be RCP or HDPE
 2. Pipe to be laid with continuous slope from inlet to outlet at a minimum of 0.2 %.
 3. Riser manholes to be minimum 36" diameter, with 30" diameter ring and grated cover, and access steps.
 4. Arrangement shown is generalized. Other configurations may be accepted.
 5. Water quality storage to be provided on the surface. See Chapter 15.

CHAPTER 15 – STORMWATER QUALITY PROTECTION AND IMPROVEMENT

15.1 INTRODUCTION

To meet the goal of improving stormwater quality in the city, all persons engaged in development or re-development of property shall:

- Provide on-site detention, in accordance with Chapter 14 of these Criteria
- Prepare a grading and Stormwater Management Plan (SWMP) with temporary stormwater controls during construction in accordance with Chapter 13 of these Criteria.
- Provide on-site permanent water quality treatment and protection measures

Included in this chapter:

- Design guidance for permanent water quality best management practices, and Operation and Maintenance Plans for the same;
- Guidance for preparation of a Stormwater Management Plan

15.2 COLORADO DISCHARGE PERMIT

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment has direction and authority to administer the Environmental Protection Agency (EPA) federally-mandated National Pollutant Discharge Elimination System (NPDES) program. The city of Littleton is authorized to discharge stormwater to the *Waters of the State* through the general permit for Stormwater Discharges associated with Municipal Separate Storm Sewer Systems (MS4), as part of the Colorado Discharge Permit System (CDPS). One element of this MS4 permit sets minimum requirements for a city's stormwater management program to reduce or prevent discharge of pollutants to the MS4 from new development and re-development site by requiring permanent water quality control measures. The city's stormwater program includes the following:

1. Procedures for site planning, and review of site plan details of temporary and permanent water quality measures;
2. Requirements for selection, implementation, installation and maintenance of temporary and permanent water quality best management practices; and
3. Procedures for site inspection, documentation, and enforcement, with sanctions if necessary.

15.3 APPLICABILITY

As described in Chapter 3, on-site permanent water quality control measures are required in the City of Littleton for applicable development and redevelopment sites.

The city advocates the 4-step process for water quality management as described in the Manual,

Volume 3. These include:

1. Employ runoff reduction practices: low impact development techniques and minimize directly connected impervious areas
2. Implement BMPs that provide WQCV with a slow release
3. Stabilize streams
4. Implement site specific and source control BMPs: targeted BMPs for certain on-site practices such as spill containment

This chapter describes design guidance for Step 2, but Step 1 and 4 are strongly encouraged. Steps 1 and 4 can effectively reduce the WQCV required in step 2.

Generally, the city requires permanent water quality measures for development and redevelopment projects over 5,000 square feet in size that exceed 70% imperviousness, or larger sites with 10,000 SF of impervious area (see Table 15.3.1 for specifics). This requirement is intended to gradually bring larger older sites with mostly impervious surfaces which pre-dated regulations at the time of their original construction, into compliance with current criteria and improve the overall quality of stormwater runoff within the city.

Impervious area and percent imperviousness can be reduced by implementing Minimal Direct Connected Impervious Areas (MDCIA) and implement pervious buffer areas before runoff leaves the site into adjacent impervious streets, gutters, storm sewer, etc., to arrive at an “effective impervious” value. This is discussed in detail in the Manual, Volume 3. Treatments such as pavers or other permeable pavements are typically treated as having an impervious value of less than 100% but greater than 0%. The engineer must demonstrate an industry standard or independent and reasonable calculation of the imperviousness of proposed treatment method. Volume 3 and associated references can be a good source, as well as manufacturers documentation or associations such as the Interlocking Concrete Pavement Institute.

The city’s requirements for both detention and permanent water quality are summarized in **Table 15.3.1**.

Projects on properties under 5,000 square feet in size are not required to be evaluated for permanent water quality. The small project category of Table 15.3.1 (5,000 – 10,000 square feet) captures re-development trends in historic downtown area, and their cumulative effect on stormwater quality and quantity.

Overall Impervious area can be calculated for a property as the sum of the individual area ratios of different land use or cover types multiplied by their respective percent imperviousness values, for instance:

Given:

- Sub area1 (A_1) with percent impervious I_1
- Sub area2 (A_2) with percent impervious I_2
- Sub area3 (A_3) with percent impervious I_3

Site Area total (A_T)

$$\text{Overall Impervious} = (A_1/A_T) * (I_1) + (A_2/A_T) * (I_2) + (A_3/A_T) * (I_3)$$

Values of percent impervious for different land use and cover types are included in

Table 15.3.2.

As mentioned above, “effective impervious” can be achieved by disconnecting impervious surfaces and implementing other pervious treatments on a site, and this is strongly encouraged.

Exemptions from these requirements may be considered if there is a regional water quality facility downstream of the site that is sufficiently sized to accommodate the runoff from the site. The Engineering Division can assist in determining if a regional facility exists for a particular development site. In limited cases, a city owned regional facility may be under consideration or planning for construction. In this case, a fee in-lieu of providing permanent water quality onsite may be considered to offset costs of city maintenance of the downstream facility. Please inquire with the Engineering Division if your site is located within the older portions of downtown Littleton.

Exemptions may be considered that meet the criteria set forth by WQCD and summarized in section 15-6.

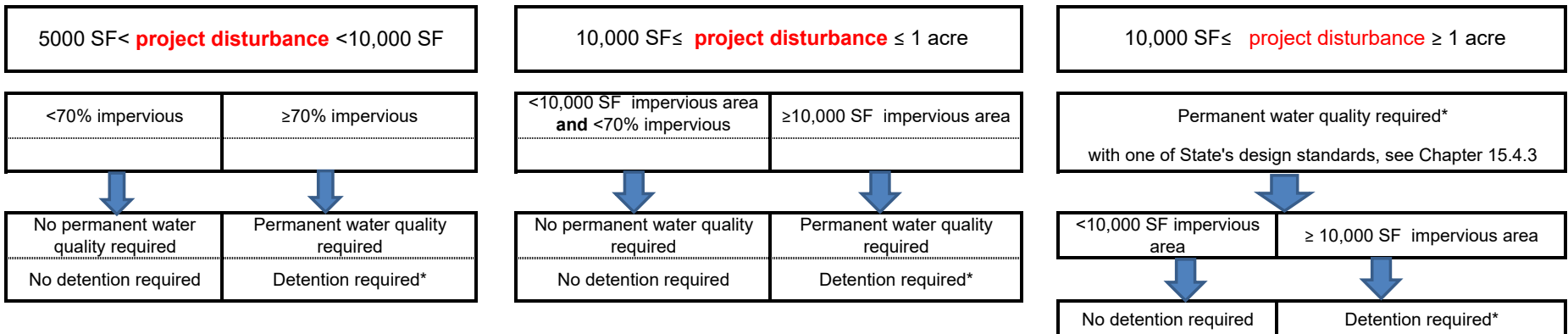
No variances from these criteria for sites of 1 acre or larger will be considered unless they meet the exemptions permitted by the WQCD as stated in section 15-6.

Table 15.3.1: Summary of Littleton's water quality and detention requirements

For New Development and Re-development projects. Please refer to text of Chapters 14 and 15 for additional explanation of Littleton's detention and water quality requirements.

STEP 1: Is the project disturbance (both impervious and pervious area, not including adjacent public ROW area) less than 5000 square feet (SF) in area? If Yes, stop. No detention or permanent water quality is required. If NO, go to step 2.

STEP 2: Is the proposed project area more than 50% of a larger common site/parcel/development (such as a shopping center)? If YES, then the overall common site/parcel/development size is considered the "project disturbance" in the table below. If NO, then only the project area is the "project disturbance" in table below. Based on project disturbance size, determine which column below applies.



*As noted above, when partial redevelopments of larger areas are more than 50% of the overall parcel/site/ common development size, the entire site/parcel/common development shall be treated as new construction and the "project disturbance" mentioned in table above. **Also, the 50% trigger applies for cumulative projects within a 5 year period.**

"Project Disturbance" in this table does not include adjacent public ROW areas that might be part of the overall project

Cumulative = all impervious areas in the project area cumulative over time, existing and proposed; this is NOT just increase in impervious with the project

Impervious % = weighted or effective impervious percentage for the project. Effective impervious may be reduced with partially pervious surfaces and MDCIA, see MHFD Volume 3.

Impervious SF = sum of impervious surface areas (in square feet) for the project. Effective impervious area can be reduced with partially pervious surfaces and MDCIA, see MHFD Volume 3.

MDCIA= minimal directly connected impervious area. Accounts for reduction in runoff due to pervious areas prior to reaching offsite/adjacent impervious surface (i.e. street, gutter or storm sewer)

Percent impervious values shall be based upon those of MHFD Manual, Volume 1, See Table 15.3.2

Detention shall be Full Spectrum Detention (MHFD, Volume 1), unless approved otherwise by the City Engineering Division

**the City strongly encourages the use of runoff reduction techniques to reduce the required volume of storage-based WQ and detention*

Permanent Water Quality BMP Types:

Source Control = Incorporate measures for outdoor storage, equipment maintenance, vehicles parking, deicing and snow storage, waste disposal, landscape maintenance methods

Runoff Reduction = Reduce quantity of runoff, promote infiltration, reduce velocity. Such as MDCIA (minimal directly connected impervious areas), runoff onto pervious surfaces, maximize pervious surfaces

Conveyance Based = no specific volume contained. Such as grass swales, buffers, wetland channels, storage BMPs where less than 100% WQCV is provided. Must be designed to MHFD criteria.

Storage Based = contain and treat 100% WQCV. Extended Detention Basins, sand filters, raingardens, porous landscape detention, green roof, permeable pavement, wetland ponds. Must be designed to MHFD criteria.

Table 15.3.2 Values of Percent Impervious

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

15.4 MINIMUM STANDARDS FOR PERMANENT BMPs

15.4.1 Performance Objectives

Objectives for permanent BMPs are provided in the Mile High Flood District's *Urban Storm Drainage Criteria Manual, Volume 3 - Best Management Practices, Chapter 1 Stormwater Management, and Chapter 2 BMP Selection* (referred to as the Manual, Volume 3).

All storm runoff from development and redevelopment must first be treated by one of the following BMPs prior to discharging into the municipal storm sewer system and from the development site:

- Grass Buffer
- Grass Swale
- Bioretention (Rain Garden or Porous Landscape Detention)
- Green Roof (note green roofs are permitted for water quality control, not flood detention)
- Extended Detention Basin (EDB)
- Sand Filter
- Retention Pond (*with demonstration of legal storage water right from Colorado Department of Natural Resources*)
- Constructed Wetland Pond (*with demonstration of legal storage water right from Colorado Department of Natural Resources*)
- Constructed Wetland Channel
- Permeable Pavements; Permeable Interlocking Concrete Pavements (PICP), Concrete Grid Pavement Porous Gravel Pavement, Reinforced Grass Pavement
- Underground BMPs (such as hydrodynamic separators)

15.4.2 Water quality capture volume

Only best management practices (BMPs) designed and implemented in accordance with the Manual, Volume 3 are permitted. Note that if water quality is incorporated into a detention pond, then full spectrum detention incorporates WQCV into its design and design calculations will vary as indicated in Chapter 14 of these criteria. Permanent water quality control measures with WQCV as the design standard will calculate WQCV and control measure volume as follows:

$$WQCV = a(0.91 * I^3 - 1.19 * I^2 + 0.78I)$$

Where:

$WQCV$ = Water Quality Capture Volume (watershed inches)

a = Coefficient corresponding to required WQCV drain time for particular type of BMP and:

<u>Drain time (hrs)</u>	<u>Coefficient (a)</u>
12	0.8

24	0.9
40	1.0

I = imperviousness (decimal; %/100), see Manual, Volume 1 for typical values.

The WQCV (in inches) is converted to the required volume of the BMP in acre-feet as follows:

$$V = ((WQCV)/12)*A$$

Where

A = tributary catchment area to the BMP (acres)

V = required storage volume (acre-feet)

$WQCV$ = water quality capture volume (inches)

If the development is designed to minimize directly connected impervious areas (MDCIA), or implementation of green infrastructure, the required WQCV can be minimized by reducing the effective imperviousness of the development, as noted in Volume 3 of the Manual. This is strongly encouraged in the city of Littleton.

15.4.3 Design Criteria

BMPs provide water quality treatment via two main mechanisms;

1. Conveyance Based: conveyance and filtration of an undefined volume; or
 2. Storage Based: temporary volumetric storage that is slowly released.
- A. For sites that disturb less than 1 acre, control measures must treat water quality with one of the above mechanisms **in accordance with Table 15.3.1**, using design guidance and criteria in the Manual, Volume 3.
- B. For sites that disturb 1 or more acres, water quality treatment must meet one of the design criteria set forth below, pursuant to the State of Colorado WQCV MS4 permit requirements:
1. Water Quality Control Volume (WQCV) Standard: The control measure(s) is designed to provide treatment and/or infiltration of the WQCV and:
 - a. 100% of the applicable development site is captured, except the applicant may exclude up to 20 percent, not to exceed 1 acre, of the applicable development site area when the applicant has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the applicant must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
 - b. Evaluation of the minimum drain time shall be based on the pollutant removal

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

2. **Pollutant Removal Standard:** The control measure(s) is designed to treat at a minimum the 80th percentile storm event. The control measure(s) shall be designed to treat stormwater runoff in a manner expected to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less.
 - a. 100% of the applicable development site is captured, except the applicant may exclude up to 20 percent not to exceed 1 acre of the applicable development site area when the applicant has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures. In addition, the applicant must also determine that the implementation of a separate control measure for that portion of the site is not practicable (e.g., driveway access that drains directly to street).
3. **Runoff Reduction Standard:** The control measure(s) is designed to infiltrate into the ground where site geology permits, evaporate, or evapotranspiration a quantity of water equal to 60% of what the calculated WQCV would be if all impervious area for the applicable development site discharged without infiltration. This base design standard can be met through practices such as green infrastructure. “Green infrastructure” generally refers to control measures that use vegetation, soils, and natural processes or mimic natural processes to manage stormwater. Green infrastructure can be used in place of or in addition to low impact development principles.
4. **Applicable Development Site Draining to a Regional WQCV Control Measure:** The regional WQCV control measure must be designed to accept the drainage from the applicable development site. Stormwater from the site must not discharge to a water of the state before being discharged to the regional WQCV control measure. The regional WQCV control measure must meet the requirements of the WQCV in Part I.E.4.a.iv(A) of the State of Colorado MS4 permit.

Applicable Development Site Draining to a Regional WQCV Facility: The regional WQCV facility is designed to accept drainage from the applicable development site. Stormwater from the site may discharge to a water of the state before being discharged to the regional WQCV facility. Before discharging to a water of the state, at least 20 percent of the upstream imperviousness of the applicable development site must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10 percent of the upstream disconnected impervious area of the applicable development site. The control measure must be designed in accordance with a design manual identified by the applicant. In addition, the stream channel between the discharge point of the applicable development site and the regional WQCV facility must be stabilized. The regional WQCV facility must meet the following requirements:

- a. The regional WQCV facility must be implemented, functional, and maintained following good engineering, hydrologic and pollution control practices.

- b. The regional WQCV facility must be designed and maintained for 100% WQCV for its entire drainage area.
 - c. The regional WQCV facility must have capacity to accommodate the drainage from the applicable development site.
 - d. The regional WQCV facility must be designed and built to comply with all assumptions for the development activities planned by the applicant within its drainage area, including the imperviousness of its drainage area and the applicable development site.
 - e. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the facility. Consideration of drain time shall include maintaining vegetation necessary for operation of the facility (e.g., wetland vegetation).
 - f. The applicant shall meet the requirements in Parts I.E.4.a.v. and vii. and Part I.E.4.b. of the State of Colorado MS4 permit, for the regional WQCV facility consistent with requirements and actions for control measures.
 - g. The regional WQCV facility must be subject to the applicant's authority consistent with requirements and actions for a Control Measure in accordance with Part I.E.4.a.iv of the State of Colorado MS4 permit.
 - h. Regional Facilities must be designed and implemented with flood control or water quality as the primary use. Recreational ponds and reservoirs may not be considered Regional Facilities. Water bodies listed by name in surface water quality classifications and standards regulations (5 CCR 1002-32 through 5 CCR 1002-38) may not be considered regional facilities.
5. Constrained Redevelopment Sites Standard: The constrained redevelopment sites standard applies to redevelopment sites meeting the following criteria:
- a. The applicable redevelopment site is for a site that has greater than 75% impervious area, and
 - b. The applicant has determined that it is not practicable to meet any of the design standards in Parts I.E.4.a.iv(A),(B), or (C) of the State of Colorado MS4 permit. The applicant's determination shall include an evaluation of the applicable redevelopment sites ability to install a control measure without reducing surface area covered with the structures. 2)
 - c. The control measure(s) is designed to meet one of the following:
 - i. Provide treatment of the WQCV for the area captured. The captured area shall be 50% or more of the impervious area of the applicable redevelopment site. Evaluation of the minimum drain time shall be based on the pollutant removal mechanism and functionality of the control measure implemented,
 - ii. The control measure(s) is designed to provide for treatment of the 80th percentile storm event. The control measure(s) shall be designed to treat stormwater runoff in a manner expected to reduce the event mean concentration of total suspended solids (TSS) to a median value of 30 mg/L or less. A minimum of 50% of the applicable development area including 50% or more of the impervious area of the applicable development area shall drain to the control measure(s). This standard does not require that 100% of

- the applicable redevelopment site area be directed to control measure(s) as long as the overall removal goal is met or exceeded (e.g., providing increased removal for a smaller area), or
- iii. Infiltrate, evaporate, or evapotranspire, through practices such as green infrastructure, a quantity of water equal to 30% of what the calculated WQCV would be if all impervious area for the applicable redevelopment site discharged without infiltration.

15.4.4 Water rights protection criteria

In 2015, Colorado implemented procedures to verify that stormwater facilities are designed to not adversely impact or injure water rights, through C.R.S. §37-92-602 (8). In addition the statute specifies that runoff treated in stormwater detention and infiltration facilities shall not be used for any other purpose by the owner/operator/overseer (or that entity's assignees), shall not be released for subsequent diversion or storage by the owner/operator/overseer (or that entity's assignees), and shall not be the basis for a water right or credit.

This statute provides 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 of the runoff from a rainfall event that is less than or equal to a 5-year storm within 72 hours after the end of the event
3. It continuously releases or infiltrates as quickly as practicable, but in all cases releases or infiltrates at least 99% of the runoff within 120 hours after the end of events greater than a 5-year storm
4. It operates passively and does not subject the stormwater runoff to any active treatment process (e.g., coagulation, flocculation, disinfection, etc.)

To meet these requirements, all detention ponds and permanent BMPs that utilize an Extended Detention Basin design are required to have documentation of compliance with the above criteria, by providing the data contained in the Stormwater Detention and Infiltration (SDI) Design Data Sheet, available from MHFD. The city will submit the state notification.

In addition to providing the SDI Data sheet, the following types of permanent water quality BMPs are subject to requiring water rights:

- Constructed wetland pond
- Constructed wetland channel
- Retention Pond

15.4.5 Aesthetic requirement

Permanent water quality control measures shall be designed with the intent of improving appearance in accordance with requirements under section 14.4.8 of these Criteria. Aesthetic appearance and the

extent to which the project satisfies this requirement shall be at the discretion of the Director.

15.4.6 Highline Canal

Beginning in 2020, the Denver Water Department in collaboration with the Highline Canal Conservancy and participating jurisdictions, began to allow discharge of storm drainage directly into the canal, under certain conditions. Properties adjacent to the canal have potential to discharge to the canal, after it has been treated for water quality and detention according to the local regulations. For more detailed information, see the Stormwater Transformation and Enhancement Program *Pathway Guide*, available from the Highline Canal conservancy website (www.highlinecanal.org/stormwater/) or the city's public works/storm drainage website page: <https://www.littletongov.org/city-services/city-departments/public-works/storm-drainage>

15.5 SUBMITTAL REQUIREMENTS

Construction plans and supporting documentation for design, installation, and maintenance of permanent water quality control measures shall include the following. Submittals will be reviewed in accordance with Chapter 2 of these Criteria.

15.5.1 Construction Plan Submittals

1. Design plan layout of each permanent water quality BMP, with section and profile views, and details sufficient for construction.
2. Narrative reference (labeling or notes) on the construction plans for all non-structural control measures for the site, if applicable.
3. Notations and labels on the plans that reference the Operation and Maintenance Plan.
4. Labeling of the maintenance easement or other legal means for access of the control measure sites for operation, maintenance, and inspection of control measures.

15.5.2 Operation and Maintenance Plan

1. The project shall include an Operation and Maintenance Plan for the site that clearly explains the procedures to ensure the long term observation, maintenance, and operation for each of the permanent water quality control measures implemented on the site.
2. The documentation shall include frequencies for routine inspections and maintenance activities.
3. The documentation shall include a commitment statement by the property owner or manager to perform the duties outlined in the O&M manual, in perpetuity. For underground treatment facilities (such as hydrodynamic separators) this commitment shall include an annual inspection by a qualified professional, and with recommended maintenance performed. This annual report and maintenance work statement shall be submitted to the Engineering Division, with attention to the stormwater manager.
4. The Manual, Volume 3 Chapter 6 provides information required for O&M Plans.

15.5.3 Drainage Report

1. A section of the Drainage Report (see Chapter 2 of these criteria) shall include a narrative describing the permanent BMPs to be implemented on the site, and all pertinent calculations for all permanent BMPs in accordance with the Manual, Volume 3.
2. Provide documentation that each permanent water quality control measure will drain within 72 hours as required by Colorado State regulation CRS §37-92-602 (8)). A copy of the Stormwater Detention and Infiltration (SDI) Design Data Sheet shall be included in the Drainage Report. The city will perform any state required notification.
3. If infiltration or TSS removal standards are being used for the permanent water quality treatment, the drainage report shall include technical references and/or calculations verifying those standards will be met by the selected BMP and its design.
4. Identify all BMPs and details on the drainage plan of the Drainage Report, in accordance with section 2.3.2 and 2.4.2 of these Criteria.
5. For sites 1 acre or larger of disturbance, the drainage report must clearly support and explain how the proposed BMPs meet the requirements set forth in 15.4.3(B) with necessary engineering calculations or technical references as needed.

15.6 ALLOWABLE EXCLUSIONS

1. Sites, or portions of sites, for the rehabilitation, maintenance, and reconstruction of roadway pavement, which includes roadway resurfacing, mill and overlay, white topping, black topping, curb and gutter replacement, concrete panel replacement, and pothole repair. The purpose of the site must be to provide additional years of service life and optimize service and safety. The site also must be limited to the repair and replacement of pavement in a manner that does not result in an increased impervious area and the infrastructure must not substantially change. The types of sites covered under this exclusion include day-to-day maintenance activities, rehabilitation, and reconstruction of pavement. Areas primarily used for parking or access to parking are not roadways.
2. Redevelopment of existing roadways, when one of the following criteria is met: 1) The site adds less than 1 acre of paved area per mile of roadway to an existing roadway, or 2) The site does not add more than 8.25 feet of paved width at any location to the existing roadway.
3. Excluded Existing Roadway Areas: For redevelopment sites for existing roadways, only the area of the existing roadway is excluded from the requirements of an applicable development site when the site does not increase the width by two times or more, on average, of the original roadway area. The entire site is not excluded from being considered an applicable development site for this exclusion. The area of the site that is part of the added new roadway area is still an applicable development site.
4. Activities for installation or maintenance of underground utilities or infrastructure that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior

to the construction activity. This exclusion includes, but is not limited to, activities to install, replace, or maintain utilities under roadways or other paved areas that return the surface to the same condition.

5. A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent. A total lot imperviousness greater than 10 percent is allowed when a study specific to the watershed and/or MS4 shows that expected soil and vegetation conditions are suitable for infiltration/filtration of the WQCV for a typical site, and the applicant accepts such study as applicable within its MS4 boundaries. The maximum total lot impervious covered under this exclusion shall be 20 percent.
6. Non-Residential and Non-Commercial Infiltration Conditions: This exclusion does not apply to residential or commercial sites for buildings. This exclusion applies to applicable development sites for which post-development surface conditions do not result in concentrated stormwater flow during the 80th percentile stormwater runoff event. In addition, post-development surface conditions must not be projected to result in a surface water discharge from the 80th percentile stormwater runoff events. Specifically, the 80th percentile event must be infiltrated and not discharged as concentrated flow. For this exclusion to apply, a study specific to the site, watershed and/or MS4 must be conducted. The study must show rainfall and soil conditions present within the permitted area; must include allowable slopes, surface conditions, and ratios of impervious area to pervious area; and the applicant must accept such study as applicable within its MS4 boundaries.
7. Sites with land disturbance to undeveloped land (land with no human-made structures such as buildings or pavement) that will remain undeveloped after the site.
8. Stream Stabilization Sites
9. Bicycle and pedestrian trails. Bike lanes for roadways are not included in this exclusion, unless attached to a roadway that qualifies under another exclusion in this section.
10. Facilities associated with oil and gas exploration, production, processing, or treatment operations, or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be an applicable construction activity.

CHAPTER 16 - BIBLIOGRAPHY

1. Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3), (online most recent versions), Mile High Flood District.
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3. Concrete Pipe Design Manual, American Concrete Pipe Association, Arlington, Virginia, 1970.
4. Handbook of Steel Drainage and Highway Construction Products, American Iron and Steel Institute, Washington, D.C., 1971.
5. Chatfield Reservoir Clean Lakes Study, □ DRCOG, Denver, Colorado, April 1984.
6. U.S. Department of Agriculture, Soils Conservation Service, 1971. *Soil Survey of Arapahoe County, Colorado*.
7. U.S. Department of Agriculture, Soils Conservation Service, 1983. *Soil Survey of Golden Area, Colorado*.
8. U.S. Department of Agriculture, Soils Conservation Service, November 1974. *Soil Survey of Castle Rock Area, Colorado*.
9. U.S. Department of Interior, Bureau of Reclamation, 1987. *Design of Small Dams*
10. WRC Engineering, Inc. October 1986. *City of Littleton Storm Drainage Design and Technical Criteria – Technical Memo No. 1*.
13. City of Littleton Municipal Code, most recent version.
14. City and County of Denver, Wastewater Management Division, 2020. *Standard Details 2020*.
15. Colorado Department of Transportation, Standard Plans M & S Standards. most recent version
16. Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction, most recent version.

CHAPTER 17 - STANDARD FORMS

Standard forms and design spreadsheets have been created by Mile High Flood District (MHFD) to simplify development and review of calculations required to prepare storm water design. These forms can be found in the Manual or online at www.mhfd.org. These forms are to be used to prepare calculations and are to be included within the appropriate appendices to the drainage report (see Chapter 2 of these Criteria). These include but are not limited to:

- Time of Concentration
- Peak Runoff
- Culvert design
- Water quality facility design
- Detention pond design

CHAPTER 18 – STANDARD EASEMENT DOCUMENTS

The following Standard Easement Documents shall be used when granting easements to the City:

- Permanent Storm Sewer Easement
- Permanent Storm Drainage Easement
- Permanent Access Easement
- Temporary Access Easement/Right of Entry
- Temporary Construction Easement

Also examples notes for a Plat, clarifying responsibilities and rights of access in drainage easements are enclosed.

DRAINAGE AND STORMWATER MANAGEMENT EASEMENT

(language for site plans, plats, etc)

1. The owners of parcel(s) _____ shall be responsible for the maintenance, repair, and any reconstruction of the private stormwater management detention and water quality treatment facilities, and private drainage system located on said parcels.
2. The owners and any respective agents shall follow the approved Operations and Maintenance plan for all detention and permanent water quality treatment facilities.
3. The owners nor their respective agents, employees, contractors, property managers, residents shall damage, destroy, remove or modify the private stormwater management or drainage facilities on said parcels without the prior written approval of the city engineer of Littleton.
4. The city of Littleton retains the right of access to the said parcels to perform maintenance or repair/replacement on any private stormwater management facility should the owner fail to do so.
5. The owners shall be liable for all costs incurred for required maintenance, including those associated with city performed maintenance on their behalf with administrative charges pursuant to city code Title 7 Chapter 7.
6. The approved Operations and Maintenance plan shall be filed prior to issuance of final plat.
7. Access is granted to the city for purposes of routine inspection of stormwater management facilities to ensure that required maintenance is occurring.
8. No permanent buildings, utility, or vegetation is permitted in the associated drainage easements that interfere with the intended purpose, or without the approval of the city engineer of Littleton.
9. The provisions contained herein shall constitute a covenant running with the land, and shall not be amended, modified, or abrogated without the prior written approval of the city. All of the above stated obligations shall be clearly referenced in any covenants, conditions, declarations, and restrictions recorded against the parcels crated by the final plat, and in any deeds or title documentation required for the conveyance of said parcels.
- 10.

PERMANENT ACCESS EASEMENT

KNOW ALL MEN BY THESE PRESENTS THAT _____,
Grantor, for and in consideration of TEN AND NO/100 DOLLARS (\$10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by the Grantor, does, for itself and on behalf of its heirs, successors and assigns, hereby grant and convey to the CITY OF LITTLETON, a municipal corporation of the State of Colorado, the Grantee, its employees, successors, agents and assigns, a non-exclusive permanent access easement and right of entry on that property described in Exhibit "A", which is attached hereto and incorporated herein by this reference (hereinafter the "Easement Premises"), upon which to construct and maintain a public access, including the right to enter upon, occupy, and use the Easement Premises, said Easement Premises lying and being in the City of Littleton, County of Arapahoe, State of Colorado.

Grantor hereby covenants and agrees that it has good title to the Easement Premises; that it has good and lawful right to grant this easement and that it will warrant and defend title and quiet possession thereof against the claims of all persons whomsoever.

Grantor further covenants to and with Grantee that the public and Grantee's officers, agents or employees may at any or all times when necessary or convenient to do so, go over and upon said Easement Premises.

Grantor hereby reserves the right to use and enjoy the Easement Premises for any purposes which are not inconsistent with, and do not interfere with, the easement and rights herein granted to Grantee, provided, however, that such reservation by Grantors shall not include the right to erect or cause to be erected any buildings, structures, trees, or other obstructions on the Easement Premises which would preclude, injure or make more difficult the exercise by Grantee of the easement and rights granted to Grantee hereunder.

Grantee shall have the right to construct, operate, repair or perform any maintenance it may deem necessary in connection with the public access granted herein. Upon exercising these rights,

Grantee agrees to restore the Easement Premises, as reasonably as possible, to the condition it was in immediately prior to any maintenance undertaken herein, should such restoration be necessary. Such restoration shall not include the replacement or repair of any structure or landscaping (such as but not limited to trees, signs, walls, etc.) Such restoration shall only include regrading or reseeding of the Easement Premises as needed.

SIGNED this _____ day of _____, 20____.

By: GRANTOR

Printed name: _____
Title: _____

ATTEST:

COUNTY OF ARAPAHOE)
)ss.
STATE OF COLORADO)

The foregoing instrument was acknowledged before me this _____ day of _____, 20____ by _____ [name] as _____ [title] of _____ [entity name].

My Commission Expires:

Notary Public

PERMANENT STORM DRAINAGE EASEMENT

KNOW ALL MEN BY THESE PRESENTS THAT _____,
Grantor, for and in consideration of TEN AND NO/100 DOLLARS (\$10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by the Grantor, does, for itself and on behalf of its heirs, successors and assigns, hereby grant and convey to the CITY OF LITTLETON, a municipal corporation of the State of Colorado, the Grantee, its successors and assigns, a right of entry and permanent storm sewer easement on that property described in Exhibit "A", which is attached hereto and incorporated herein by this reference (hereinafter the "Easement Premises"), upon which to reconstruct, operate, remove, repair and maintain storm sewer facilities across, on, under and through the Easement Premises, said Easement Premises lying and being in the City of Littleton, County of Arapahoe, State of Colorado.

Grantor hereby covenants and agrees that it has good title to the Easement Premises; that it has good and lawful right to grant this easement and that it will warrant and defend title and quiet possession thereof against the claims of all persons whomsoever.

Grantor further covenants to and with Grantee that the Grantee's officers, agents or employees may at any or all times when necessary or convenient to do so, go over and upon said Easement Premises, and do and perform any and all acts necessary and convenient to the carrying into effect of the purposes for which this grant is made.

Grantor hereby reserves the right to use and enjoy the Easement Premises for any purposes which are not inconsistent with, and do not interfere with, the easement and rights herein granted to Grantee, provided, however, that such reservation by Grantors shall not include the right to erect or cause to be erected any buildings, structures, trees, or other obstructions on the Easement

Premises which would preclude, injure or make more difficult the exercise by Grantee of the easement and rights granted to Grantee hereunder.

Grantee agrees to restore the Easement Premises, as reasonably as possible, to the condition it was in immediately prior to any maintenance activities undertaken herein. Such restoration shall not include the replacement or repair of any structure or landscaping (such as but not limited to trees, signs, walls, etc.) Such restoration shall only include repaving, regrading or reseedling of the Easement Premises as needed.

SIGNED this _____ day of _____, 20__.

GRANTOR

Printed name: _____

Title: _____

ATTEST:

COUNTY OF ARAPAHOE)
)ss.
STATE OF COLORADO)

The foregoing instrument was acknowledged before me this _____ day of _____, 20__ by _____ [name] as _____ [title] of _____ [entity name].

My Commission Expires:

Notary Public

PERMANENT STORM SEWER EASEMENT

KNOW ALL MEN BY THESE PRESENTS THAT _____,
Grantor, for and in consideration of TEN AND NO/100 DOLLARS (\$10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by the Grantor, does, for itself and on behalf of its heirs, successors and assigns, hereby grant and convey to the CITY OF LITTLETON, a municipal corporation of the State of Colorado, the Grantee, its successors and assigns, a right of entry and permanent storm sewer easement on that property described in Exhibit "A", which is attached hereto and incorporated herein by this reference (hereinafter the "Easement Premises"), upon which to reconstruct, operate, remove, repair and maintain storm sewer facilities across, on, under and through the Easement Premises, said Easement Premises lying and being in the City of Littleton, County of Arapahoe, State of Colorado.

Grantor hereby covenants and agrees that it has good title to the Easement Premises; that it has good and lawful right to grant this easement and that it will warrant and defend title and quiet possession thereof against the claims of all persons whomsoever.

Grantor further covenants to and with Grantee that the Grantee's officers, agents or employees may at any or all times when necessary or convenient to do so, go over and upon said Easement Premises, and do and perform any and all acts necessary and convenient to the carrying into effect of the purposes for which this grant is made.

Grantor hereby reserves the right to use and enjoy the Easement Premises for any purposes which are not inconsistent with, and do not interfere with, the easement and rights herein granted to Grantee, provided, however, that such reservation by Grantors shall not include the right to erect or cause to be erected any buildings, structures, trees, or other obstructions on the Easement

Premises which would preclude, injure or make more difficult the exercise by Grantee of the easement and rights granted to Grantee hereunder.

Grantee agrees to restore the Easement Premises, as reasonably as possible, to the condition it was in immediately prior to any maintenance activities undertaken herein. Such restoration shall not include the replacement or repair of any structure or landscaping (such as but not limited to trees, signs, walls, etc.) Such restoration shall only include repaving, regrading or reseeding of the Easement Premises as needed.

SIGNED this _____ day of _____, 20__.

GRANTOR

Printed name: _____

Title: _____

ATTEST:

COUNTY OF ARAPAHOE)
)ss.
STATE OF COLORADO)

The foregoing instrument was acknowledged before me this _____ day of _____, 20__ by _____ [name] as _____ [title] of _____ [entity name].

My Commission Expires:

Notary Public

TEMPORARY CONSTRUCTION EASEMENT

KNOW ALL MEN BY THESE PRESENTS THAT _____,
Grantors, for and in consideration of TEN AND NO/100 DOLLARS (\$10.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged by the Grantors, do, for themselves and on behalf of their heirs, successors and assigns, hereby grant and convey to the CITY OF LITTLETON, a municipal corporation of the State of Colorado, the Grantee, its successors and assigns, a temporary right of entry and construction easement on that property described in Exhibit "A", which is attached hereto and incorporated herein by this reference (hereinafter the "Easement Premises"), upon which to construct, operate, remove, and repair facilities across, on, under and through the Easement Premises, said Easement Premises lying and being in the City of Littleton, County of Arapahoe, State of Colorado.

Grantors hereby covenant and agree that they have good title to the Easement Premises; that they have good and lawful right to grant this easement and that they will warrant and defend title and quiet possession thereof against the claims of all persons whomsoever.

Grantors further covenant to and with Grantee that the Grantee's officers, agents or employees may at any or all times when necessary or convenient to do so, go over and upon said Easement Premises, and do and perform any and all acts necessary and convenient to the carrying into effect of the purposes for which this grant is made.

Grantors further agree that they shall not, in any manner, interfere with the above stated objects, nor disturb, injure or molest the construction site or any activities thereon.

Grantee agrees to restore the Easement Premises, as reasonably as possible, to the

condition it was in immediately prior to any access undertaken herein, should such restoration be necessary.

The temporary easement and right of entry herein granted shall commence on the date when notified in writing by the City of the start of construction. The activities contemplated by the City and permitted by this document will be initiated as soon after execution of this document as possible. The temporary easement and right of entry herein granted shall expire six (6) months after the date of notification by the City of the start of construction.

SIGNED this _____ day of _____, 20__.

GRANTOR

Printed name: _____

Title: _____

ATTEST:

COUNTY OF ARAPAHOE)
)ss.
STATE OF COLORADO)

The foregoing instrument was acknowledged before me this _____ day of _____, 20__ by _____ [name] as _____ [title] of _____ [entity name].

My Commission Expires:

Notary Public