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](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:

Carolyn Roan, Water Resource Manager
City of Littleton Public Works Department
2255 West Berry Ave
Littleton CO 80120
croan@littletongov.org
303-795-3865

Thank you, and feel to contact the Public Works Department/Engineering Division with any questions.
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<td>501</td>
<td>I = (28.5*P_1)/(10+T_c)^{0.786}</td>
<td>Rainfall Intensity</td>
<td>5.3</td>
</tr>
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STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

601 \[ T_i = 0.395(1.1-C_2)(L^{0.5})(S^{0.33}) \]
Initial time of concentration 6.2

602 \[ V = C_3S^{0.5} \]
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ACKNOWLEDGMENTS

Several members of the current and prior City staff were instrumental in the preparation and review of the July 2019 Criteria:

- Brent Thompson, City Engineer
- Carolyn Roan, Water Resource Manager
- Anastasia Urban, Development Services Manager
- Gary Welp, Consultant
- Bert Whitaker, Engineer
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 (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 Urban Drainage and Flood Control District’s (hereafter called UD&FCD) 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 to Title 11 Chapter 6, Section 4.

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 UDFCD 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, UDFCD approval may be required. It is the City’s intent to maximize eligibility for UDFCD maintenance of drainage facilities, which requires approval of plans by the UDFCD.

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.
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. 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 UDFCD, 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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BMP</td>
<td>Best management practice</td>
</tr>
<tr>
<td>CITY</td>
<td>City of Littleton</td>
</tr>
<tr>
<td>CCR</td>
<td>Colorado Code of Regulations</td>
</tr>
<tr>
<td>CDOT</td>
<td>Colorado Department of Transportation</td>
</tr>
<tr>
<td>CMP</td>
<td>Corrugated Metal Pipe</td>
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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 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.


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: a design method used by the Urban Drainage and Flood Control District for sizing of detention ponds and their outlet structures, that contains and slowly releases a range of rainstorm runoff volumes up to approximately a 10% annual chance rainfall event.
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 this chapter. 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.


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 the UDFCD. 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 ads 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 or used for collecting 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 UDFCD 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: Include, but are 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 development
where multiple separate and distinct construction activities may be taking place at different times on
different schedules, but remain related. “Contiguous” means construction activities located in close
proximity to each other (within ¼ mile).

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”.

CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

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 his 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 is required for all development, except as determined at the pre-application conference. 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 erosion control plan (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 erosion control plans are not required.

The Final Drainage Report shall provide details of proposed drainage facilities, including grading, erosion control, and water quality enhancement, and is to be submitted along with construction
documents (see Section 2.4.3). Construction documents shall include a copy of the grading and erosion control plan.

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-feet 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)
A(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). 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-feet 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 at least twenty (20) working days prior to the consideration of the plat before the City Council or hearing before the Development Review Committee. Before final subdivision plats and site plans can be submitted to City Council for approval:

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

2. All required easements and licenses with the City must be approved by the Director and the City Attorney, and the appropriate title insurance provided, and

3. 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 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 document 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.

2.4.4 Grading and Erosion Control Plan/Stormwater Management Plan

A stormwater management plan (SWMP) consists of a map showing best management practices to control potential erosion and sedimentation during and after construction. When an SWMP is 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 an ESCP will be submitted separately from a drainage report, preparation of the ESCP 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 may be a separate drawing or required information 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, along with mylar (minimum 3 mil.) reproducible copy 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. Consult the City’s Engineering Requirements for Subdivisions for details on specific items to be included on the Record Drawings. 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 detention pond volumes 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 state that Ato 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.\(\Rightarrow\)

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.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CERTIFICATION REQUIRED</th>
<th>CITY APPROVAL REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Drainage Report</td>
<td>Engineer</td>
<td>No</td>
</tr>
<tr>
<td>Final Drainage Report</td>
<td>Engineer and Developer</td>
<td>Yes</td>
</tr>
<tr>
<td>Construction Drawings</td>
<td>Engineer</td>
<td>Yes</td>
</tr>
<tr>
<td>Record Drawings</td>
<td>Engineer/Surveyor</td>
<td>Yes</td>
</tr>
</tbody>
</table>

A checklist for Conceptual and Final drainage reports, for construction plans, and for grading and erosion and sediment control 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 and erosion control 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.
NOTE: Review time increases if any "NO" is received and the submittal is returned for revisions.
## Drawing Symbol Criteria and Hydrology Review Table

<table>
<thead>
<tr>
<th>Design Point</th>
<th>Contributing Area (Acres)</th>
<th>RUNOFF PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minor Storm (CFS)</td>
</tr>
<tr>
<td>XX</td>
<td>XX .XX</td>
<td>XX.X</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Planning Stage</th>
<th>Required Drainage Submittal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rezoning</td>
<td>Conceptual Drainage Report</td>
</tr>
<tr>
<td>Preliminary Plat</td>
<td>Conceptual Drainage Report</td>
</tr>
<tr>
<td>Final Plat</td>
<td>Report Final Drainage Report</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Planning Stage</th>
<th>Required Drainage Submittal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rezoning</td>
<td>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.</td>
</tr>
<tr>
<td>Prior to approval of any Preliminary Plats by the Planning Commission</td>
<td>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 Drainage Report for specific filing</td>
</tr>
<tr>
<td>Final Plat</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

**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.

Date: October 1986
Rev September 2002
| Table 2D |
| City of Littleton Storm Drainage Design and Technical Criteria |
| Drainage Report Checklist |

**Instructions:**
1. Applicant to identify with a "check-mark" if information is provided with report. If applicant believes information is not required, indicate with "n/a" and attach separate sheet with explanation.
2. City will determine if information labeled "n/a" is required and whether information must be submitted.
3. Those items noted with an "*asterisk*" are not required for a conceptual report.
4. Submit three (3) copies of report and include copy of check list bound with report.

**TITLE PAGE**
A. Type of report (Conceptual, Final, Flood Hazard)
B. Project name
C. Preparer name, firm, address, number, and date.
D. Professional Engineers seal of preparer

**INTRODUCTION**
A. Background
   1. Identify report preparer and purpose
   2. Identify date of letter with previous City comments.
B. Project Location
   1. Identify Township, Range, and Section
   2. Identify adjacent street and subdivision names
   3. Reference to General Location Map
C. Property Description
   1. Identify area in acres of entire contiguous ownership.
   2. Describe existing ground cover, vegetation, soils, topography and slopes.
   3. Describe existing drainage facilities, such as channels, detention areas, or structures.
   4. Describe existing irrigation facilities, such as ditches, head-gates, or diversions.
   5. Identify proposed types of land use and encumbrances.
D. Previous Investigations
   2. Identify other master drainage plan for the area.

**DRAINAGE SYSTEM DESCRIPTION**
A. Existing Drainage Conditions
   1. Describe existing topography and provide map with contours extending a minimum of 100-feet beyond property limits
   2. Identify major drainageway or outfall drainageway and describe map showing location of proposed development within the drainageways.
   3. Identify pre-developed drainage patterns and describe map showing pre-developed sub-basins and concentrated discharge locations. Provide calculations of pre-developed peak flows entering and leaving the site.
B. Master Drainage Plan
   Describe location of the project relative to a previously prepared master drainage plan, including drainage plans prepared for adjacent development.
C. Offsite Tributary Area
   1. Identify all offsite drainage basins that are tributary to the project.
   2. Identify assumptions regarding existing and future land use and effects of offsite detention on peak flows.
D. Proposed Drainage System Description
   1. Identify how onsite storm water is collected and conveyed through the site.
   2. Identify sub-basins and describe, in general terms, how onsite storm water is collected and conveyed through the site for each location where storm water is discharged from the site.
   3. Describe detention volumes, release rates and pool elevations.
   4. Identify the difference in elevation between pond invert and the groundwater table.
   5. Describe how stormwater is discharged from the site, including both concentrated and dispersed discharges.
   6. Describe storm water quality facilities.
   7. Describe maintenance access aspects of design
   8. Describe easements and tracts for drainage purposes, including limitations on use.
E. Drainage Facility Maintenance
   1. Identify responsible parties for maintenance of each drainage and water quality facility.
   2. Identify general maintenance activities and schedules.
III DRAINAGE ANALYSIS AND DESIGN CRITERIA

A. Regulations
   1. Identify that analysis and design was prepared in accordance with the provisions of the City's CRITERIA.
   2. Identify other City regulations or criteria which have been used to prepare analysis and design.

B. Development Criteria
   1. Identify drainage constraints placed on the project by a Major Drainageway Planning Study, an Outfall Systems Study, a master drainage plan, or other area wide development plan.
   2. Identify drainage constraints placed on the project from major street alignments, utilities, rapid transit, existing structures, and other developments.

C. Hydrologic Criteria
   (If CRITERIA was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information.)
   1. Identify how storm runoff peak flows and volumes were determined, including rainfall intensity or incremental amounts.
   2. Identify which storm events were used for minor and major flood analysis and design.
   3. Identify how and why any other deviations from the CRITERIA occurred.

D. Hydraulic Criteria
   (If CRITERIA was followed without deviation, then a statement to that effect is all that is required. Otherwise provide the following information)
   * 1. Identify type(s) of streets within and adjacent to development and source for allowable street capacity.
   * 2. Identify which type(s) of storm inlets were analyzed or designed and source for allowable capacity.
   * 3. Identify which type of storm sewers which were analyzed or designed and Manning's n-values used.
   * 4. Identify which method was used to determine detention volume requirements and how allowable release rates were determined.
   * 5. Identify how the capacity of open channels and culverts were determined.
   * 6. Identify any special analysis or design requirements not contained within the CRITERIA.
   * 7. Identify how and why any other deviations from the CRITERIA occurred.

E. Variance from Criteria
   1. Identify which provisions of the CRITERIA a variance is requested.
   2. Identify pre-existing conditions which cause the variance request.

* IV GRADING & EROSION & SEDIMENT CONTROL PLAN (ESCP) See CRITERIA, Chapter 13 for requirements.
   * A. Additional Site Information
     * 1. Describe soils, including hydrologic group, mapping units, erodibility, permeability, depth, texture and structure.
     * 2. Provide estimate of fill and excavation quantities and surface area of disturbance.
   * B. Erosion Control Measures
     Describe methods used to control erosion and sediment discharges from the site during and after construction.
   * C. Schedule
     Identify anticipated start and completion times for site grading construction sequence, BMP installation and removal, stockpiles, exposure time for each area prior to completion of temporary measures.
   * D. Maintenance
     Provide schedule of regular inspections and repair activities, including removal of sediment.
   * E. Cost Estimate
     Provide an estimate of installation and maintenance costs for erosion and sediment control measures for the purpose of determining amount of surety or bonding requirements.
   * F. Calculations
     Provide calculations performed for design of erosion and sediment control facilities.
   * G. Owner's Certification
     A signature page shall be provided for the owner/developer acknowledging the review and acceptance of the responsibility for the plan. The certification shall be worded as provided in Section 2.3.
   * H. Spill Prevention, Containment and Clean-up
     Describe spill prevention, containment and cleanup procedures to be used during construction phase.
   * I. Standard Drainage and Erosion Control Notes
     Include standard drainage and erosion control notes (see Chapter 17)
Drainage Report Checklist

V STORMWATER MANAGEMENT PLAN (SWMP). See CRITERIA, Chapter 15 for requirements.
   A. Storm Water Quality Control Measures
      Describe BMPs to control discharge of pollutants from the project site.
   B. Calculations
      Provide methods and calculations for WQCV, sediment storage, and water quality outlet structure.

VI CONCLUSIONS
   A. Compliance with Criteria
      Compliance with CRITERIA, major drainageway and outfall systems planning studies.
   B. Design Effectiveness
      Effectiveness of drainage design to control impacts of storm runoff.
   C. Areas in Flood Hazard Zone
      Meet requirements of Floodplain Regulations (Title 10-Chapter 66-Article 5) of the City of Littleton, otherwise, Special Use Permit required.
   D. Variances from Criteria
      Applicant shall identify any requested variances and provide basis for approving variance. If no variances are requested, applicant shall state that none are requested.

VII REFERENCES
   Provide a reference list of all criteria, master plans, drainage reports, and technical information used.

TABLES
   Include copy of all tables prepared for report.

FIGURES
   A. General Location Map (see Section 2.4.2(A))
   B. Flood Plain Information (see Section 2.4.2(B))
   C. Drainage Plan (see Section 2.4.2(C))
   D. Other pertinent figures.

APPENDICES
   A. DESIGN CHARTS
      Provide copy of all design charts (i.e.: tables, figures, charts from other criteria) used for the report.
   B. HYDROLOGIC CALCULATIONS (see CRITERIA, Chapters 5 and 6)
      1 Land use assumptions for off-site runoff calculations
      2 Time of concentration and runoff coefficients for pre-existing and post developed conditions
      3 Pre-developed hydrologic computations
      4 Developed conditions hydrologic computations.
   C. HYDRAULIC CALCULATIONS
      1 Capacity of existing channels, streets, storm sewers, inlets, culverts and other facilities.
      2 Calculations for existing storm sewer and open channel.
      3 Irrigation ditch flows and ditch system capacity
      4 Detention pond design (see CRITERIA, Chapter 14 for requirements):
         a. Storage volume, release rates, and pool elevations for 10-year and 100-year storm
         b. Outlet structure dimensions, orifice diameter, weir lengths, pipe headwater and other data.
         c. Outlet velocity and energy dissipation requirements.
         d. Routing of outlet flows and emergency spillway flows.
      5 Street capacity calculations, if data in CRITERIA not used (see Chapter 10).
      6 Storm inlet capacity calculations, if data in CRITERIA not used (see Chapter 9).
      7 Storm sewer capacity calculations, if data in CRITERIA not used (see Chapter 8).
      8 Channel capacity calculations, if data in CRITERIA not used (see Chapter 7).
      9 Culvert capacity calculations. (see CRITERIA, Chapter 11).
      10 Other hydraulic structure calculations (see CRITERIA, Chapter 12)
   D. STORMWATER QUALITY CALCULATIONS
      1 Water Quality Capture Volume (WQCV)
      2 Storage volume for sediment volume and pool elevations for WQCV.
      3 Outlet calculations for required area per row, diameter of individual holes, number of holes per row, and number of holes per column.

ACKNOWLEDGMENTS

Drainage Report checklist was prepared by ________________________________
**Table 2E**

**City of Littleton Storm Drainage Design and Criteria**

**Drainage Construction Plan Checklist**

**Instructions:**
1. Applicant to identify with a "check-mark " if information is provided. If applicant believes information is not required, indicate with "n/a".
2. City will determine if information labeled "n/a" is required and whether information must be submitted.

### I EXISTING FACILITIES

- A. Contours at two-foot intervals, based on USGS datum. Contours to extend at least 50 feet past property line.
- B. Location and elevation of USGS benchmarks or benchmarks referenced to USGS.
- C. Property lines.
- D. Drainage easements.
- E. Street names.
- F. Major and minor channels and floodplains.

### II PROPOSED FACILITIES

- A. Contours at two-foot intervals, based on USGS datum.
- B. Property lines.
- C. Drainage easements.
- D. Street names and grades.
- E. Right of way and easement.
- F. Finished floor elevations for protection from major storm runoff.
- G. Detention pond information:
  1. Location of each detention pond with site plan at 1" = 50' scale or larger with 2-foot contour intervals.
  2. Inlet and outlet structure, and trickle channel design details.
  3. Details of emergency spillway and channel.
  4. Landscape information, including side slopes, vegetation and planting requirements.
  5. Details of water quality outlet structure.
- H. Channel information:
  1. Profiles with existing and proposed grades.
  2. Cross sections on 100-foot stations showing existing and proposed topography and required rights of way.
  3. Locations and size of all existing and proposed structures.
  4. Locations and profiles of adjacent utilities.
  5. Typical channel section and lining details.
- I. Storm sewer information:
  1. Alignment and location of manholes, inlets, and outlet structures.
  2. Profile of invert and pipe crown.
  3. Invert elevations at manholes and inlets.
  4. Lengths and grades between manholes and inlets.
  5. Locations and elevations of utilities adjacent to and across storm sewer.
  6. Easement and other O&M access geometry.
  7. Outlet details, such as end sections, headwall and wingwalls, erosion control, and vegetation.
- J. Street cross section with desigining 100-year flood depth.
- K. Other drainage related structures and facilities, including underdrains and sump pump discharge lines.

### III HYDRAULIC AND HYDROLOGICAL INFORMATION

- Routing and accumulative runoff peaks at upstream and downstream ends of the site and at various critical points.
- A. Onsite for initial and major storms. Inflow and outflow from each subbasin shall be shown for both initial and major storms.
- B. Street cross sections showing 100-year flood levels.
- C. Major and minor channels and floodplains.
- D. Detention pond data:
  1. Release rates for 10- and 100-year storm events.
  2. Required and provided volumes for 10- and 100-year storm events.
  3. Design depths for 10- and 100-year storm events.
  4. Water quality capture volume and pool elevation.
- E. Channel data:
  1. Water surface profiles.
  2. Representative 100-year flow velocity and Froude number.
- F. Storm sewer data:
  1. Profile of water surface for design flow rate.
  2. Peak flows for design flow, 5-year and 100-year storm events.

### IV STANDARD NOTES

- No building, structure, or fill will be placed in the detention areas and no changes or alternations affecting the hydraulic characteristics of the detention areas will be made without the approval of the City Engineer.
- Maintenance and operation of the detention and water quality areas is the responsibility of property owner. If owner fails in this responsibility, the City has the right to enter the property, maintain the detention areas, and be reimbursed for costs incurred.
- Detention pond volumes, all drainage appurtenances, and basin boundaries shall be verified. As-built drawings shall be prepared by a registered professional engineer prior to issuance of certificate of occupancy for any structure within the development.
- Permission to reproduce these plans is hereby given to the City of Littleton for City purposes associated with plan review, approval, permitting, inspection and construction of the work.

### V. PROFESSIONAL ENGINEERS SEAL AND SIGNATURE

### VI. OTHER

- A. Horizontal and vertical control information and ties to existing and proposed features.

**ACKNOWLEDGMENTS**

Drainage Construction Plan checklist was prepared by __________________________
# Table 2F
City of Littleton Storm Drainage and Technical Criteria

**Grading and Erosion and Sediment Control Plan Checklist**

**Instructions:**
1. Applicant to identify with a "check-mark" if information is provided.
   If applicant believes information is not required, indicate with "n/a".
2. City will determine if information labeled "n/a" is required and whether information must be submitted.

## I. PLAN SHEET FORMAT
- A. Scale: 1" = 50' or larger
- B. North arrow
- C. Title Block
- D. Vicinity Map, 1" = 500'
- E. Contour lines at 2' maximum intervals.
- F. 24" x 36" drawing size.
- G. Original and revision dates.
- H. Dated, checked, sealed and signed by a P.E.
- I. Legend
- J. Street names, dimensions and grades.
- K. Match lines and sheet numbers.
- L. Approval block
- M. Standard Notes (see Chapter 17)
- N. Baseline or control line.

## II. PRE-EXISTING SITE CONDITIONS
- A. Site topography extending 50-feet minimum past property line.
- B. Easements and ROWs
- C. Utilities
- D. Drainageways with designated floodplains and floodways
- E. Irrigation facilities.
- F. Buildings, fences, retaining walls, trees and other physical features.

## III. PROPOSED SITE CONDITIONS
- A. Site contours with connection to existing contours
- B. Drainage direction arrows
- C. Grade breaks and slopes 3:1 or greater
- D. Cut and fill areas with quantities, if separate grading permit requested.
- E. Sidewalks, bikepaths and other public improvements.
- F. Driveway dimensions and grades.
- G. Storm drainage structures.
- H. Fences, retaining walls and other physical site improvements.
- I. Cross sections, if necessary to detail features.
- J. Finished floor elevations for all buildings
- K. Erosion protection

## IV. STANDARD DETAILS
- A. City or CDOT standard detail reference
- B. Other appropriate details.
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 Urban Drainage and Flood Control 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 Urban Drainage and Flood Control 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. Additional descriptions of the different types of studies can be found in the Manual, Volume 1, Chapter 3- Planning.

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 6 of the City Code and requirements contained in Chapter 4.

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 6, 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 with total site cumulative weighted-impervious area equal to or exceeding 10,000 square feet or equal to or exceeding 70% weighted imperviousness. 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, 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 with total site cumulative weighted-impervious area equal to or exceeding 10,000 square feet of surface area or equal or exceeding 70% weighted imperviousness, to construct permanent water quality control measures to control the discharge of pollutants to the City’s municipal stormwater system. 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.

<table>
<thead>
<tr>
<th>Drainage Facility</th>
<th>Easement or Tract Width (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm Sewer</td>
<td>20 feet minimum, or based on installation depth and diameter or width of pipe, in accordance with Figure 801, whichever is greater.</td>
</tr>
<tr>
<td>Open Channels</td>
<td></td>
</tr>
<tr>
<td>(a) Swales with Q$_{100}$ less than 50-cfs</td>
<td>15 feet minimum, which includes 6-inches of vertical freeboard</td>
</tr>
<tr>
<td>(b) Minor or major channels with Q$_{100}$ greater than 50-cfs</td>
<td>50 feet minimum, or 10’ beyond width at design discharge with 12” of vertical freeboard, whichever is greater.</td>
</tr>
<tr>
<td>Detention Pond, Water Quality pond/facility</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.

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.

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 Urban Drainage & Flood Control 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

4.1 INTRODUCTION

The regulation of floodplains is necessary to preserve and promote the general health, welfare, and economic well being of the region. 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.

It is the engineer’s responsibility to utilize the most current adopted floodplain regulations as provided in the Code, Title-10, Chapter 6.

Relative to planning and designing new development within a floodplain, the following provisions are emphasized:

1. The base flood is defined as having a 1% chance of being equaled or exceeded in any given year, also called the 100-year flood (10-6-2).
2. A floodway is defined as that portion of a flood plain that must be reserved in order to discharge the base flood without a cumulative increase in the water surface elevation more than one foot due to new development (10-6-2).
3. Appeals from the floodplain regulations may be granted by the Littleton Planning Commission, based on information presented at public hearing (10-6-5).
4. The use of land in floodways is restricted to uses, which will not inhibit or alter flood flows, such as agriculture, recreation, and mineral extraction. Uses by special exception may be granted by the Littleton Planning Commission, such as for utilities, drainage structures, roads, bridges, parking lots, water and sewage treatment facilities (10-6-6(B and C)).
5. Any encroachments into the floodway are prohibited unless certified by a Colorado registered engineer that such encroachments will not result in any increase in the base flood elevation (10-6-6 (D)).
6. Development in the flood storage area (i.e.: area outside of the floodway) may occur if appropriate protective measures are taken (10-6-7). The Littleton Planning Commission must approve the proposed development as a use by special exception, based on a hydraulic analysis (10-6-8).
CHAPTER 5 – RAINFALL

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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)

<table>
<thead>
<tr>
<th></th>
<th>2-year</th>
<th>5-year</th>
<th>10-year</th>
<th>25-year</th>
<th>50-year</th>
<th>100-year</th>
<th>500-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>0.812</td>
<td>1.08</td>
<td>1.31</td>
<td>1.66</td>
<td>1.94</td>
<td>2.24</td>
<td>3.01</td>
</tr>
</tbody>
</table>

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.

\[ I = \frac{28.5 \times P1}{(10 + Tc)^{0.786}} \]  
(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

Rainfall intensity (in/hr) vs. Duration (min)
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CHAPTER 6 - RUNOFF

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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 160-acres). The Colorado Urban Hydrograph Procedure (CUHP) shall be used when the total watershed exceeds 160-acres, but can be used for smaller watersheds.

Procedures 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. Use Standard Form 1, or equivalent, for Time of Concentration calculation (see Chapter 17). These calculations are adaptable to spreadsheet programs and simplifying equations are provided in these Criteria.

b. Use Standard Form 2, or equivalent, for calculation of the Storm Drainage System Design (see Chapter 17). These calculations are adaptable to spreadsheet programs and simplifying equations are provided in these Criteria.

c. 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 RO-3, in Volume 1, “Runoff” section of the Manual.

\[ t_i = 0.395(1.1 - C_5)(L^{0.5})/(S^{0.33}) \]  

(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

d. Percentage Impervious Values for various land uses or surface characteristics shall be obtained from Table RO-3, and from Figures RO-3, RO-4 and RO-5 (for residential sites), as provided in the Manual. These values shall be used in the calculation of runoff coefficients for the Rational Method using equations RO-6 and RO-7 and Table RO-4 from the Manual. A copy of these tables and equations are provided in Chapter 19 of these Criteria for convenience.

e. Rainfall intensity at the time of concentration, \( T_c \), can be calculated from the equation presented in Section 5.3, “Time-Intensity-Frequency Curves” of these Criteria.

f. Travel time calculation in Standard Form #2 are based on velocity of flow in a drainage conveyance, typically a swale, curb/gutter, or storm sewer. Surface velocity can be calculated using equation RO-4 from the Manual. Values of the constant, \( C_v \), are provided
below.

\[ V = C_v S^{0.5} \]  
\[ \text{(Equation 602)} \]

Where  
\[ V = \text{surface velocity, fps} \]  
\[ C_v = \text{Coefficient, depending on surface conditions} \]  
\[ S = \text{Slope, (ft/ft)} \]

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

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

\[ V = (1.49/n) \times (B(D/4)^2) \times ((D/4)^{0.667}) \times S^{0.5} \]  
\[ \text{(Equation 603)} \]

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

h. 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 501.
b. When determining imperviousness for various land uses, it is recommended that a composite value be developed, based on Table RO-3, and Figures RO-3, RO-4, and RO-5 from 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 drainage 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

Date: September 2002

Reference: from Urban Storm Drainage Criteria Manual

City of Littleton

STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

Figure 601
Sample Sub-basin Routing Schematic

LEGEND

A Sub-basin Name
1 Design Point Number
3 Detention Basin Number
# CITY OF LITTLETON
# STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

## CHAPTER 7 - OPEN CHANNELS

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</tr>
</tbody>
</table>

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CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA
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. The criteria presented herein are considered to be 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.

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. 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 not permitted in the City. 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. Channels with liners other than grass are not permitted in the City. 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:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Grass-Lined Minor Channel</th>
<th>Grass-Lined Swale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tributary Area</td>
<td>Less than 130-acres</td>
<td>Dependent of tributary land use, but generally less than 10-acres</td>
</tr>
<tr>
<td>Capacity</td>
<td>From 50- to 400-cfs</td>
<td>Less than 50-cfs</td>
</tr>
<tr>
<td>Flow Velocity</td>
<td>Less than 7.0-fps</td>
<td>Less than 7.0-fps.</td>
</tr>
<tr>
<td>Froude Number</td>
<td>Less than 0.8</td>
<td>Less than 0.8</td>
</tr>
<tr>
<td>Longitudinal channel slope</td>
<td>From 0.2% to 0.7%, subject to other limitations</td>
<td>From 0.5% to 2.5%, subject to other limitations</td>
</tr>
<tr>
<td>Freeboard</td>
<td>Not less than 1.0-feet</td>
<td>Not less than 6-inches</td>
</tr>
<tr>
<td>Curvature</td>
<td>Not less than 50-feet</td>
<td>Not less than 25-feet.</td>
</tr>
<tr>
<td>Roughness Coefficient</td>
<td>In accordance with Manual, “Major Drainage”, Table MD-1</td>
<td>In accordance with Manual, “Major Drainage”, Table MD-1</td>
</tr>
<tr>
<td>Typical cross section</td>
<td>See Figure 701</td>
<td>See Figure 702</td>
</tr>
<tr>
<td>Trickle channel</td>
<td>Required. See Figure 701</td>
<td>Not required. See Figure 702</td>
</tr>
<tr>
<td>Easement Width</td>
<td>Include freeboard and maintenance access.</td>
<td>Include freeboard.</td>
</tr>
<tr>
<td>Flow depth</td>
<td>Less than 4.0-feet</td>
<td>Less than 2.25 feet.</td>
</tr>
<tr>
<td>Grass lining</td>
<td>In accordance with the Manual, “Revegetation”.</td>
<td>In accordance with the Manual, “Revegetation”.</td>
</tr>
<tr>
<td>Erosion control</td>
<td>In accordance with the Manual, “Major Drainage”.</td>
<td>Type VL soil riprap required for slopes 1.0% or greater or if swale drains 0.33 acres or more of impervious area.</td>
</tr>
<tr>
<td>Hydraulic information</td>
<td>If Criteria followed, separate calculations not required. 100-</td>
<td>If Criteria followed, separate calculations not required.</td>
</tr>
</tbody>
</table>

Littleton SDDTC October 1986, rev September 2002
Aesthetics and water quality

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 insure 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
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.

Flow Velocity. The maximum velocity for the major-storm flood peak shall not exceed 5.0 feet per second.

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.

Freeboard. Freeboard not required.

Curvature. The minimum radius of curvature shall be 25 feet.

Roughness Coefficient. Manning’s “n” values shall be in accordance with Manual, “Major Drainage”, Table MD-1.

Grass Lining. The grass lining shall be in accordance with the Manual, Chapter 12, “Revegetations”.

Erosion Protection. Type VL soil riprap with 3” soil cover required for longitudinal slopes 1.0% or greater.

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.

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 to the invert of a channel or drainageway. The purpose of the structure is to minimize channel bank erosion from concentrated overland flow along the 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 rundown is as follows:

7.6.1 Cross-Sections

Typical cross-sections for channel rundown 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 rundown 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.
Rundown Capacity

<table>
<thead>
<tr>
<th>Height of Curb at Entrance to Rundown (inches)</th>
<th>Capacity of Rundown (cfs/foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1.1</td>
</tr>
<tr>
<td>8</td>
<td>1.7</td>
</tr>
<tr>
<td>10</td>
<td>2.4</td>
</tr>
<tr>
<td>12</td>
<td>3.1</td>
</tr>
</tbody>
</table>

7.6.3 Outlet Configuration

The channel rundown outlet shall enter the 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 Type-G12 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 riprap with 3" topsoil cover.

Figure 701

Date: September 2002
NOTES: 1. Grass requirements per MANUAL, "Revegetation".
2. Longitudinal slope from 0.5% to 2.5%
3. Maximum Froude Number = 0.80.
4. Maximum 10%-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

Figure 703
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.

Figure 704

Section A-A, Riprap Option

Section A-A, Concrete Option

Section A-A, Geocell Option

Date: October 1986
Rev September 2002

City of Littleton
CHAPTER 8 - STORM SEWERS

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801 Minimum Easement Width for Storm Sewers
8.1 INTRODUCTION

Except as modified herein, the design of storm sewers shall be in accordance with the MANUAL, Chapter 6, “Streets” and the Pipe Memoranda (References 11 and 12), except as modified herein.

8.2 ALLOWABLE PIPE MATERIALS

Storm sewers may be constructed from non-reinforced concrete pipe (NRCP), reinforced concrete pipe (RCP), aluminized steel pipe (ASP), polyvinyl chloride pipe (PVC), and high density polyethylene pipe (HDPE), in accordance with the standards and specifications provided in the Pipe Memoranda (references 11 and 12). All other pipe materials are prohibited.

A summary of requirements for approved pipe materials is presented in Table 8A. Copies of trench details from Pipe Memoranda are provided in Chapter 19.

Table 8A – Summary of Storm Sewer Standards
(Refer to Pipe Memoranda for complete list)

<table>
<thead>
<tr>
<th>Item</th>
<th>Non-Reinforced Concrete Pipe (NRCP)</th>
<th>Reinforced Concrete Pipe (RCP)</th>
<th>Aluminized Steel Pipe (ASP)</th>
<th>Polyvinyl Chloride Pipe (PVC)</th>
<th>High Density Polyethylene Pipe (HDPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum bury depth (feet)</td>
<td>1.0</td>
<td>1.0</td>
<td>See Pipe Memoranda</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Pipe Size (inches)</td>
<td>12 - 30</td>
<td>12 – 144</td>
<td>12 – 102</td>
<td>12 – 54</td>
<td>12 - 36</td>
</tr>
<tr>
<td>Joints</td>
<td>Watertight Rubber Gasket</td>
<td>Watertight Rubber Gasket</td>
<td>Watertight Band Strip with O-Ring Gasket</td>
<td>Watertight Rubber Gasket</td>
<td>Watertight Rubber Gasket</td>
</tr>
<tr>
<td>Trench Details</td>
<td>See Chapter 18 Standard Details</td>
<td>See Chapter 18 Standard Details</td>
<td>See Chapter 18 Standard Details</td>
<td>See Chapter 18 Standard Details</td>
<td>See Chapter 18 Standard Details</td>
</tr>
<tr>
<td>Minimum Easement Width</td>
<td>See Figure 801</td>
<td>See Figure 801</td>
<td>See Figure 801</td>
<td>See Figure 801</td>
<td>See Figure 801</td>
</tr>
</tbody>
</table>

Note: 1. NRCP not included in Pipe Memoranda. NRCP not allowed within the street right-of-way or where traffic loads are expected.

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 I, 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 Pipe Friction Losses

The Manning=$s\text{An}=$ values to be used in the calculation of storm sewer capacity and velocity are presented in Table-8B below:

<table>
<thead>
<tr>
<th>Material</th>
<th>Manning’s n-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All pre-cast concrete</td>
<td>0.013</td>
</tr>
<tr>
<td>Aluminized Steel (ASP)</td>
<td>0.013</td>
</tr>
<tr>
<td>Polyvinyl Chloride (PVC)</td>
<td>0.011</td>
</tr>
<tr>
<td>High Density Polyethylene</td>
<td>0.012</td>
</tr>
</tbody>
</table>

8.3.2 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.

8.3.3 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 Structural Requirements

Structural requirements, such as minimum cover, pipe thickness, coatings, etc., shall be in accordance with the Pipe Memoranda. Structural calculations are required if the proposed storm sewer is not in compliance with the Pipe Memoranda.

8.4.2 Vertical Alignment

The minimum clearance between storm sewer and water main, either above or below, shall be 12-inches, or as otherwise restricted. 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.
8.4.3 **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-8C below:

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Radius of Curvature</th>
</tr>
</thead>
<tbody>
<tr>
<td>48” to 54”</td>
<td>28.5 feet</td>
</tr>
<tr>
<td>60” to 72”</td>
<td>32.0 feet</td>
</tr>
<tr>
<td>78” to 108”</td>
<td>38.0 feet</td>
</tr>
</tbody>
</table>

8.4.4 **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-8D below presents the minimum pipe size for storm sewers.

<table>
<thead>
<tr>
<th>Sewer Application</th>
<th>Minimum Equivalent Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main trunk line</td>
<td>18 inches</td>
</tr>
<tr>
<td>Lateral from inlet</td>
<td>15 inches</td>
</tr>
</tbody>
</table>

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.

8.4.5 **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 Table-8E below.
### Table 8E – Manhole Requirements

<table>
<thead>
<tr>
<th>Sewer Diameter</th>
<th>Maximum Manhole Spacing</th>
<th>Minimum Manhole Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>18”</td>
<td>400 feet</td>
<td>4 feet</td>
</tr>
<tr>
<td>21” to 36”</td>
<td>500 feet</td>
<td>5 feet</td>
</tr>
<tr>
<td>42” to 48”</td>
<td>600 feet</td>
<td>6 feet</td>
</tr>
<tr>
<td>54” and larger</td>
<td>600 feet</td>
<td>CDOT M-604 for Box Base or T-Base Manholes</td>
</tr>
</tbody>
</table>

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.
CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 9 - STORM SEWER INLETS

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9A    Standard 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:

Table 9A- Standard Inlets

<table>
<thead>
<tr>
<th>Inlet Type</th>
<th>Reference</th>
<th>Permitted Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb-opening</td>
<td>See Chapter 18 Standard Details</td>
<td>All street classifications with a vertical curb on continuous grade or in a sump condition at the low point in the street gutter profile.</td>
</tr>
<tr>
<td>Combination with Type 13 grate or Type 16 vane grate</td>
<td>See Chapter 18 Standard Details</td>
<td>All street classifications with a vertical curb on continuous grade or in a sump condition at the low point in the street gutter profile.</td>
</tr>
<tr>
<td>Grated Type C or D</td>
<td>See Chapter 18 Standard Details</td>
<td>All streets with a roadside ditch or median on continuous grade. Type C or D inlets may require closed meshed grates.</td>
</tr>
<tr>
<td>Grated Inlet Type 13 or 16</td>
<td>CDOT M-604-13 or M-604-25</td>
<td>Alleys, aprons, or private drives with valley gutter with special approval by Director.</td>
</tr>
<tr>
<td>Slotted Drain</td>
<td>Per manufacturer’s specifications</td>
<td>Locations where sheet flow must be intercepted and with special approval by Director.</td>
</tr>
</tbody>
</table>

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).
Copies of “Allowable Inlet Capacity” charts from the October 1986 version of the Criteria are provided in Chapter 19. These charts can be used as a first estimate of the inlet size required to intercept design flows in the street. The reader is cautioned that these capacity charts are based on the street flowing at a depth where the street is at its allowable capacity (see Chapter 10-Street). Therefore, if the street is flowing at a depth less than allowable street capacity, the inlet capacity is also less. A reasonable approximation is to ratio the inlet capacity and street capacity.

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.
CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 10 – STREETS

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1001  Major Storm Limits for Typical Street Cross Sections
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:

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Maximum Encroachment for Calculation of Theoretical Conveyance Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>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.</td>
</tr>
<tr>
<td>Collector</td>
<td>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.</td>
</tr>
<tr>
<td>Arterial</td>
<td>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.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Maximum Encroachment for Calculation of Theoretical Conveyance Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local and Collector</td>
<td>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.</td>
</tr>
<tr>
<td>Arterial</td>
<td>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.</td>
</tr>
</tbody>
</table>
10.2. STREET CLASSIFICATION

Public streets are classified for traffic use in accordance with City Code (Section 11-6-3, rev December 2000) 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

<table>
<thead>
<tr>
<th>Traffic Classification</th>
<th>Hydraulic Classification</th>
<th>Flowline Width (ft)</th>
<th>Right of Way (ft)</th>
<th>Curb Type</th>
<th>No. clear lanes in each direction</th>
<th>Minor Storm Limits</th>
<th>Controlling Criteria</th>
<th>Allowable Depth (ft)</th>
<th>Major Storm Limits</th>
<th>Controlling Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Residential</td>
<td>Type A</td>
<td>36</td>
<td>50</td>
<td>4&quot; hollywood</td>
<td>0</td>
<td>0.33</td>
<td>curb height</td>
<td>0.59</td>
<td>Right of Way</td>
<td></td>
</tr>
<tr>
<td>Local Residential</td>
<td>Type A</td>
<td>36</td>
<td>50</td>
<td>6&quot; vertical</td>
<td>0</td>
<td>0.49</td>
<td>curb height</td>
<td>0.76</td>
<td>Right of Way</td>
<td></td>
</tr>
<tr>
<td>Local MF, Comm.Indust.</td>
<td>Type A</td>
<td>44</td>
<td>60</td>
<td>4&quot; hollywood</td>
<td>0</td>
<td>0.33</td>
<td>curb height</td>
<td>0.63</td>
<td>Right of Way</td>
<td></td>
</tr>
<tr>
<td>Local MF, Comm.Indust.</td>
<td>Type A</td>
<td>44</td>
<td>60</td>
<td>6&quot; vertical</td>
<td>0</td>
<td>0.50</td>
<td>curb height</td>
<td>0.80</td>
<td>Right of Way</td>
<td></td>
</tr>
<tr>
<td>Residential Collector</td>
<td>Type B</td>
<td>44</td>
<td>70</td>
<td>6&quot; vertical</td>
<td>0.5</td>
<td>0.47</td>
<td>free lane</td>
<td>1.00</td>
<td>12&quot; depth</td>
<td></td>
</tr>
<tr>
<td>Secondary Arterial1</td>
<td>Type C</td>
<td>24</td>
<td>100</td>
<td>6&quot; vertical</td>
<td>1</td>
<td>0.27</td>
<td>free lane</td>
<td>1.00</td>
<td>12&quot; depth</td>
<td></td>
</tr>
<tr>
<td>Primary Arterial1</td>
<td>Type C</td>
<td>35</td>
<td>120</td>
<td>6&quot; vertical</td>
<td>1</td>
<td>0.38</td>
<td>free lane</td>
<td>1.00</td>
<td>12&quot; depth</td>
<td></td>
</tr>
</tbody>
</table>

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.
Copies of the “Allowable Gutter Capacity” charts from the October 1986 version of the Criteria are provide in Chapter 19. These charts can be used as a first approximation of street capacity, however, supporting calculations using procedures in the Manual must be included with the Final Drainage report. The reader is cautioned that these charts are based on previous street templates, which may have different allowable flow depths than noted in Table 10A. Therefore, the first approximation of gutter capacity should also include an adjustment for allowable depths.

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

Date: October 1986
rev September 2002
CITY OF LITTLETON
STORM DRAINAGE DESIGN TECHNICAL CRITERIA

CHAPTER 11 - CULVERTS

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11A Allowable Headwater for Culverts
11.1 INTRODUCTION

Except as modified herein, design of culverts shall be in accordance with the Manual, “Culverts” and the Pipe Memoranda (References 11 and 12).

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 non-reinforced concrete pipe (NRCP), reinforced concrete pipe (RCP), aluminized steel pipe (ASP), polyvinyl chloride pipe (PVC) and high density polyethylene pipe (HDPE), in accordance with the standards and specifications provided in the Pipe Memoranda (references 11 and 12). Culverts for private driveways may also be constructed with corrugated metal pipe.

A summary of requirements for approved pipe materials within a public ROW is presented in these Criteria in Chapter 8 “Storm Sewers”, Table 8A. Copies of trench details from Pipe Memoranda are provided in Chapter 19, Reference Tables, Figures and Design Charts.

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 ft$^2$ for arch shapes, and 1.8 ft$^2$ 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 (NRCP, RCP, ASP, PVC, HDPE): - Table-8B.


d. 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: A 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.

e. 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.

11.3.6 Structural Design

All culverts to be designed in accordance with structural design requirements specified in the Pipe Memoranda (Reference 12).
### Table 11A - Allowable Headwater Depths for Culverts

<table>
<thead>
<tr>
<th>Traffic Classification</th>
<th>Storm Type</th>
<th>Allowable Headwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Minor Storm</td>
<td>Overtopping of street not permitted.</td>
</tr>
<tr>
<td></td>
<td>Major Storm</td>
<td>Overtopping of streets shall be less than 12-inches at the gutter. Flow shall not extend past the easement or ROW.</td>
</tr>
<tr>
<td>Collector</td>
<td>Minor Storm</td>
<td>Overtopping of street not permitted.</td>
</tr>
<tr>
<td></td>
<td>Major Storm</td>
<td>Overtopping of streets shall be less than 12-inches at the gutter. Flow shall not extend past the easement or ROW.</td>
</tr>
<tr>
<td>Arterial</td>
<td>Minor Storm</td>
<td>Overtopping of street not permitted.</td>
</tr>
<tr>
<td></td>
<td>Major Storm</td>
<td>Overtopping of the street not permitted.</td>
</tr>
</tbody>
</table>

#### 11.3.7 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.

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:

   \[ K_T = 1.45 - 0.45\left(\frac{a_n}{a_g}\right) - \left(\frac{a_n}{a_g}\right)^2 \]  

   (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.
11.3.8 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 insure 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) 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.
# CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

## CHAPTER 12 - HYDRAULIC STRUCTURES

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<td>12.4. CHECK STRUCTURES</td>
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CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

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:

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 Urban Drainage and Flood Control 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, and chemicals
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 vegetation 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


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                      Date
State of Colorado PE No.__________

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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FIGURES
CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

1401    Trickle Channels For Detention Ponds
1402    Underground Detention
14.1 INTRODUCTION

All new development and redevelopment 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 Urban Drainage and Flood Control District’s Manual, Volume 2 (Storage).

14.2 PURPOSE

Development increases peak flows and volume of stormwater runoff from a site, and can alter the duration of storm runoff. Controlling the stormwater runoff and releasing it at a lesser rate allows larger storms 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 and stream degradation impacts associated with increases in peak, duration, and frequency of runoff from urban surfaces. The city’s detention policy is intended to target sites that pre-dated current criteria at the time of original construction and address cumulative impacts of numerous smaller development and re-development.

14.3 DESIGN CRITERIA

14.3.1 General

A summary table of the requirements and triggers for detention and water quality is presented in Table 15.3.1 of Chapter 15. Sites 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.

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.

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.

\[
\text{EURV}_A = 1.68i^{1.28} \\
\text{EURV}_B = 1.36i^{1.08} \\
\text{EURV}_{C/D} = 1.20i^{1.08}
\]

Where:

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

\( i = \text{Imperviousness ratio (a decimal less than or equal to 1)} \)

**C.** 100-year event.

\[
\text{V}_{100} = \text{P}^1 \times [(0.806i^{1.225} + 0.109i^{0.225})A\% + (0.412i^{1.371} + 0.371i^{0.371})B\% + (0.341i^{1.389} + 0.398i^{0.389})CD\%]
\]

Where:

\( \text{V}_{100} = \text{detention volume in watershed inches} \)
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.udfcd.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).

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

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 \((ft^2)\)
C1, C2, C3 = coefficients based on soil type, see table below.

<table>
<thead>
<tr>
<th>Soil Group</th>
<th>100-year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading Coefficient</td>
<td>C1</td>
<td>0.5622</td>
<td>1.2088</td>
</tr>
<tr>
<td>Slope Exponent</td>
<td>C2</td>
<td>0.2021</td>
<td>0.1677</td>
</tr>
<tr>
<td>Shape Exponent</td>
<td>C3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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 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 permanent water quality BMPs are required to submit documentation of compliance with the above criteria to the city, by providing the data contained in the Stormwater Detention and Infiltration (SDI) Design Data Sheet, available from UDFCD. The city will make the determination whether the control measure requires notification to the state, and will conduct the notification.

**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. Underground detention and multiple detention sites for a single development require approval of the Director. The Director can consider the following factors in his 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.
- 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 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 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:

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 insure 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.

Any modifications to the above criteria require approval of the Director who can consider the following factors in a decision:
14.5 DESIGN STANDARDS FOR PARKING LOT DETENTION

All parking lot detention must be designed to enhance water quality (Policy 3.3.7) and to facilitate maintenance (Policy 3.3.8). All parking lot detention areas shall provide water quality enhancement in a separate facility, in accordance with Chapter 15 of these Criteria.

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:

\[ \Delta V = 0.125 \times A_s \]  

(Equation 1405)

Where:

\[ \Delta V = \text{Additional volume, (cubic feet)} \]
\[ A_s = \text{Surface area of detention pond at 100-year water surface (square feet)}. \]

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 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 areas shall provide water quality enhancement in a separate facility, in accordance with Chapter 15 of these Criteria.

14.6.1 Materials

Underground detention shall be constructed using reinforced concrete pipe (RCP), aluminized steel pipe (ASP), polyvinyl chloride pipe (PVC) or high-density polyethylene pipe (HDPE) in accordance with Section 8.2 of these Criteria.

14.6.2 Configuration

Pipe segments 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.

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.

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-feet diameter maintenance access ports shall be placed according to the following schedule:
### Maintenance Access Requirements for Underground Detention

<table>
<thead>
<tr>
<th>Number of Barrels</th>
<th>Number of Manholes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3</td>
<td>2 each</td>
</tr>
<tr>
<td>4</td>
<td>4 each</td>
</tr>
<tr>
<td>Greater than 4</td>
<td>Two each barrel</td>
</tr>
</tbody>
</table>

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;
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.
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.

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 UDFCD 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
CITY OF LITTLETON  
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

Underground Detention Details

NOTES:  
1. Pipe to be RCP, ASP, PVC, or HDPE, per section 8.2.  
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.

Date: October 1986  
rev September 2002
# CHAPTER 15 – STORMWATER QUALITY PROTECTION AND IMPROVEMENT

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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.

The city requires permanent water quality measures for development and redevelopment sites that have over 10,000 square feet total of area-weighted impervious surface (cumulative over time - including both existing impervious and proposed impervious surfaces) or greater than or equal to 70% area-weighted impervious. This includes individual sites with less than 10,000 square feet of impervious, but are part of a larger common plan or sale. This requirement is intended to bring older sites that 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. These requirements are summarized in Table 15.3.1. Properties under 5,000 square in size are not required to be evaluated for permanent water quality.

Area weighted impervious = 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)

Area-weighted 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.

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. 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.

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 of larger will be considered unless they meet the exemptions permitted by the WQCD as stated in section 15-6.
<table>
<thead>
<tr>
<th>Site Size</th>
<th>Permanent Water Quality</th>
<th>Detention</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10,000 SF</td>
<td>No permanent water quality required</td>
<td>No detention required</td>
</tr>
<tr>
<td>&gt;=1 acre of total disturbance</td>
<td>Permanent water quality required*</td>
<td>Detention required**</td>
</tr>
</tbody>
</table>

*Permanent water quality required* with one of State’s design standards, see Chapter 15.4.3

**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
- **Storage Based** = contain and treat 100% WQCV. Extended Detention Basins, sand filters, raingardens, porous landscape detention, green roof, permeable pavement, wetland ponds

### Terms
- **SF** = square feet
- **Site** = a parcel, property, or common plan of development. Requirements above are not limited to only the portions of a site being developed.
- **Cumulative** = in time over life of the site (existing conditions AND proposed conditions)
- **Weighted** = different land use or cover types within a site and their respective % impervious are added together based on their relative areal coverage of the whole site area.

Percent impervious values shall be based upon those of UDFCD Manual, Volume 1, See Table 15.3.2
Detention shall be Full Spectrum Detention (UDFCD, Volume 1)
<table>
<thead>
<tr>
<th>Land Use or Surface Characteristics</th>
<th>Percentage Imperviousness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business:</strong></td>
<td></td>
</tr>
<tr>
<td>Downtown Areas</td>
<td>95</td>
</tr>
<tr>
<td>Suburban Areas</td>
<td>75</td>
</tr>
<tr>
<td><strong>Residential lots (lot area only):</strong></td>
<td></td>
</tr>
<tr>
<td>Single-family</td>
<td></td>
</tr>
<tr>
<td>2.5 acres or larger</td>
<td>12</td>
</tr>
<tr>
<td>0.75 – 2.5 acres</td>
<td>20</td>
</tr>
<tr>
<td>0.25 – 0.75 acres</td>
<td>30</td>
</tr>
<tr>
<td>0.25 acres or less</td>
<td>45</td>
</tr>
<tr>
<td>Apartments</td>
<td>75</td>
</tr>
<tr>
<td><strong>Industrial:</strong></td>
<td></td>
</tr>
<tr>
<td>Light areas</td>
<td>80</td>
</tr>
<tr>
<td>Heavy areas</td>
<td>90</td>
</tr>
<tr>
<td><strong>Parks, cemeteries</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>Playgrounds</strong></td>
<td>25</td>
</tr>
<tr>
<td><strong>Schools</strong></td>
<td>55</td>
</tr>
<tr>
<td><strong>Railroad yard areas</strong></td>
<td>50</td>
</tr>
<tr>
<td><strong>Undeveloped Areas:</strong></td>
<td></td>
</tr>
<tr>
<td>Historic flow analysis</td>
<td>2</td>
</tr>
<tr>
<td>Greenbelts, agricultural</td>
<td>2</td>
</tr>
<tr>
<td>Off-site flow analysis (when land use not defined)</td>
<td>45</td>
</tr>
<tr>
<td><strong>Streets:</strong></td>
<td></td>
</tr>
<tr>
<td>Paved</td>
<td>100</td>
</tr>
<tr>
<td>Gravel (packed)</td>
<td>40</td>
</tr>
<tr>
<td>Drive and walks</td>
<td>90</td>
</tr>
<tr>
<td>Roofs</td>
<td>90</td>
</tr>
<tr>
<td>Lawns, sandy soil</td>
<td>2</td>
</tr>
<tr>
<td>Lawns, clayey soil</td>
<td>2</td>
</tr>
</tbody>
</table>
15.4 MINIMUM STANDARDS FOR PERMANENT BMPs

15.4.1 Performance Objectives

Objectives for permanent BMPs are provided in the Urban Drainage and Flood Control 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 (with demonstration of legal storage water right from Colorado Department of Natural Resources)
- 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:

\[ WQCV = a(0.91I^3 - 1.19I^2 + 0.78I) \]

Where:

- \( WQCV \) = Water Quality Capture Volume (watershed inches)
- \( a \) = Coefficient corresponding to required WQCV drain time for particular type of BMP and:
\[ I = \text{imperviousness (decimal; \%/100), see Manual, Volume 1 for typical values.} \]

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

\[ V = \left( \frac{\text{WQCV}}{12} \right) \times A \]

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 (DCIA), 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.

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.

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
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 evapotranspire 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 evapotranspirate, 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 permanent water quality BMPs are required to submit documentation of compliance with the above criteria, by providing the data contained in the Stormwater Detention and Infiltration (SDI) Design Data Sheet, available from UDFCD. The city will make the determination whether the control measure requires notification to the state, and will conduct the 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.

15.5 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.

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 UDFCD 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.

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.


13. City of Littleton Municipal Code, Title-10, Chapters 6, 7, and 11.


CHAPTER 17 - STANDARD FORMS

Standard forms have been created to simplify development and review of calculations required to prepare storm water design in accordance with the Criteria. These forms, or similar ones in the Manual, 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). Some forms were created using a spreadsheet (e.g.: Excel7) and can be used to simplify calculations. Standard forms include:

Form - 1, Time of Concentration: Required to check that the initial time of concentration is within specified limits (see Chapter 6.0 - Runoff).

Form - 2, Storm Drainage System: Required to calculate peak runoff rates using the Rational Method and to design and check capacity of streets and storm sewers.

Form - 3, Culvert Rating: Recommended form to use for manual calculation of culvert capacity.
CITY OF LITTLETON  STANDARD FORM -1
TIME OF CONCENTRATION

<table>
<thead>
<tr>
<th>SHEET NO:</th>
<th>Calculated By:</th>
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</thead>
<tbody>
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**SUB-BASIN DATA**

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<thead>
<tr>
<th>AREA DESIGNATION</th>
<th>RUNOFF COEFFICIENT, Cs</th>
<th>AREA, A (acres)</th>
<th>FLOW LENGTH, L (ft)</th>
<th>SLOPE (%)</th>
<th>INITIAL TIME, Ti (MIN)</th>
<th>COMPUTED TIME, (MIN)</th>
<th>FLOW LENGTH, (ft)</th>
<th>SLOPE (%)</th>
<th>VELOCITY (fps)</th>
<th>TRAVEL TIME Tt, (min)</th>
<th>TOTAL LENGTH (ft)</th>
<th>MINIMUM Tc = (L/180 + 10)</th>
<th>FINAL Tc (min)</th>
<th>REMARKS</th>
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Standard Forms 1, 2 and 3 (Spreadsheets), 10/19/2015
CITY OF LITTLETON  STANDARD FORM -2  
STORM DRAINAGE SYSTEM DESIGN  

Manning's n-value = 0.013  

<table>
<thead>
<tr>
<th>STREET</th>
<th>IDENTIFICATION</th>
<th>DIRECT RUNOFF</th>
<th>STREET/INLET</th>
<th>STORM SEWER</th>
<th>TRAVEL TIME</th>
<th>REMARKS</th>
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<tbody>
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<td></td>
<td>Design Point</td>
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<td>Area</td>
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<tr>
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<td>Tc (min.)</td>
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<td>Runoff Coefficient, C</td>
<td></td>
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<tr>
<td></td>
<td>Intensity, I (in/hr)</td>
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<tr>
<td></td>
<td>Area (ac)</td>
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<td>Sum of Area (ac)</td>
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<td>Direct Runoff, Q (cfs)</td>
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<td>Sum of C*A</td>
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<td>Total Runoff, Q (cfs)</td>
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<td>Street Flow (cfs)</td>
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<td>Inlet Design Flow (cfs)</td>
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<tr>
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<td>Street or Inlet Capacity (cfs)</td>
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<td>Carryover (cfs)</td>
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<td>Segment</td>
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<td>Size (in)</td>
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<tr>
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<td>Qfull (cfs)</td>
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<tr>
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<td>Design Flow (cfs)</td>
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<td></td>
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<tr>
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<td>Slope (%)</td>
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<td>Velocity (fps)</td>
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<tr>
<td></td>
<td>Length (ft)</td>
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</tr>
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<td>Travel Time (min)</td>
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Standard Forms 1, 2 and 3 (Spreadsheets), 10/19/2015
Standard Form-3 Culvert Rating

Project: __________________ Location: __________________ Station: __________________

CULVERT DATA

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<thead>
<tr>
<th>TYPE:</th>
<th>n =</th>
<th>LOCATION CONTROL EQUATIONS</th>
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<tbody>
<tr>
<td>INLET:</td>
<td>Q_{in} =</td>
<td>(1) H_w = H + h_0 - L*So</td>
</tr>
<tr>
<td>Ke:</td>
<td>V_{out} =</td>
<td>(2) For Tw &lt; D; h_0 = (dc+D)/2 or Tw, whichever greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3) For Tw &gt; D; h_0 = Tw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4) For box culvert, dc = 0.315*(Q/B)^0.67 (less than D)</td>
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<table>
<thead>
<tr>
<th>Q</th>
<th>INLET CONTROL</th>
<th>OUTLET CONTROL</th>
<th>FINAL HEADWATER</th>
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<tr>
<td></td>
<td>Hw/D</td>
<td>Hw</td>
<td>H</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
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Date: September 2002
CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 18 – DELETED

ALL STANDARD ENGINEERING DETAILS
ARE AVAILABLE ON THE CITY PUBLIC WORKS WEBSITE
CHAPTER 19 - REFERENCE TABLES, FIGURES, DESIGN CHARTS AND DETAILS

The following text, tables, figures and design charts are found in the current edition of the Urban Storm Drainage Criteria Manual (Manual) or other common reference documents. This information is provided for convenience when using these Criteria. They provide information that is routinely used to design and analyze storm drainage systems. However, it is the responsibility of the user to verify that these tables, figures and charts are current and complete. The City of Littleton makes no guarantee that this information is current.
ALLOWABLE INLET CAPACITY

TYPE 13 COMBINATION ON A CONTINUOUS GRADE

NOTES:
1. Allowable capacity = 66% theoretical capacity
2. Maximum inlet capacity at maximum allowable flow depth, proportionally reduce for other depths.

DATE: OCT. 1986
REFERENCE: WRC ENGINEERING, INC., TM-1, October 1986
ALLOWABLE INLET CAPACITY
TYPE - R CURB OPENING ON A CONTINUOUS GRADE

NOTES:
1. Maximum inlet capacity at maximum allowable flow depth. Proportionally reduce for other depths.
2. Allowable Capacity =
   88% (L = 5\text{')})
   92% (L = 10\text{')})
   95% (L = 15\text{')})
   of Theoretical Capacity
3. Interpolate for other inlet lengths.

Date: OCT. 1986
REFERENCE:
WRC ENGINEERING, INC., TM-1, October 1986
ALLOWABLE INLET CAPACITY
TYPE 13 GRATED ON A CONTINUOUS GRADE

NOTES:
1. Allowable capacity = 60% theoretical capacity
2. Maximum inlet capacity at maximum allowable flow depth. Proportionally reduce for other depths.

DATE: OCT. 1986
REFERENCE:
WRC ENGINEERING, INC., TM-1, October 1986
## Hydraulic Data for Corrugated Pipe

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<th>Pipe Type</th>
<th>Pavement Type</th>
<th>Annular Corrugations</th>
<th>Helical Corrugations</th>
<th>CORRUGATION SIZE</th>
<th>PIPE DIAMETER</th>
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<tr>
<td></td>
<td></td>
<td>Diam.</td>
<td>Corrug.</td>
<td>n-value</td>
<td>(1-1/2 X 1/4)</td>
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<td>(2-2/3 X 1/2)</td>
<td>0.024</td>
<td>0.012</td>
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<td>25% Paved</td>
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<td>(2-2/3 X 1/2)</td>
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<td>Fully Paved</td>
<td>ALL</td>
<td>(2-2/3 X 1/2)</td>
<td>0.012</td>
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<td>(3 X 1)</td>
<td>0.027</td>
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<td>(5 X 1)</td>
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<td>0.022</td>
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<td>15-FT</td>
<td>(6 X 2)</td>
<td>0.024</td>
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</table>

### Table 19A

Date: March 2002
CITY OF LITTLETON
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 20 – STANDARD EASEMENT DOCUMENTS

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

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

By: GRANTOR

ATTEST:
COUNTY OF ARAPAHOE )
)ss.
STATE OF COLORADO )

The foregoing instrument was acknowledged before me this ____ day of ____________________, 20____. My Commission Expires:

Notary Public
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

\jgredmon\word\easement\Permanent Access Easement.doc
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 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 temporary 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 travel over, on 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.

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 access 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 regarding, repaving or reseeding of the Easement Premises as needed.

The temporary right of entry herein granted shall commence on the date of the signature below. 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___.

By:

GRANTOR

ATTEST:

COUNTY OF ARAPAHOE )
 )ss.
STATE OF COLORADO )

The foregoing instrument was acknowledged before me this ___ day of ________________, 20___. 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 here to and incorporated herein by this reference (hereinafter the "Easement Premises"), upon which to construct, operate, remove, and repair drainage 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____.

By:

GRANTORS

________________________

________________________

COUNTY OF ARAPAHOE  )

)ss.

STATE OF COLORADO  )

The foregoing instrument was acknowledged before me this ____ day of ________________, 20___. 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