



# Arapahoe County Stormwater Management Manual

## *Revision History*

Manual Creation Date: January 30, 2007

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- 12/12/2006– Water Quality for Post-Construction Standards and Criteria are established as part of the National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit.  
BOCC Study Session 12/12/2006
- 1/30/2007 – County adopts *Arapahoe County Stormwater Management Manual (SMM)* to replace *Arapahoe County Storm Drainage Design and Technical Criteria Manual (c. 1985)*.  
BOCC Resolution No. 070060
- 7/5/2011 - Revisions to SMM
- Sections 1.4 and 1.5
- change the Engineering Division name to “Engineering Services Division”.
- Section 1.6
- change the text of “reports and construction plans” to “land use documents”; add UDFCD between “all eligible”.
- Section 1.8
- change the statement “be consistent with” to “meet or exceed”.
- Section 1.10
- add ADA (Americans with Disabilities Act) and SEMSWA (Southeast Metro Stormwater Authority) within the Acronyms Table.
- Section 2.1.3
- add the paragraph of “In addition, when permanent conveyance BMPs are proposed, the County requires that the system be designed to convey runoff from the 2-year storm event” at the end of section.
- Section 2.2.6
- change the last sentence from “Storage volume and release rate criteria are based on full spectrum detention and the 100-year recurrence interval storm event” to “Storage volume and release rate criteria are based on full spectrum detention design”.
- Section 2.3.14
- modify the section from “The County requires the implementation of permanent best management practices for enhancement of stormwater quality with all development, redevelopment and expansion within the County” to “The County requires the implementation of permanent best management practices for enhancement of stormwater quality with all development, redevelopment and expansion on projects that disturb an acre or greater, including projects less than one acre that are part of a larger common plan of development within the

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County's MS4 Boundary".

#### Section 2.3.16

- add the new section: "The County requires a minimum 1-foot of freeboard between the lowest accessible surface entrance (i.e. lowest window well/basement window or the first floor elevation, whichever is lower) and 100-year water surface elevation for all structures adjacent to the on-site drainage facilities".

#### Section 2.4.4

- add "and" before "or".

#### Section 2.6.7

- add the sentence of "adjacent to the 100-year floodplain" after the text of "all structures".

#### Section 3.1.12.2

- change the words "this criteria" to "these criteria".

#### Section 3.1.12.3

- change the roadway manual title to "Infrastructure Design and Construction Standards".

#### Section 3.4.4

- insert "and Development" after Public Works.

#### Section 3.5.1

- change the text "Final Development Plans" to "Final Land Use Plans".

#### Section 3.5.4

- add the statement "including the source lot" at the end of the paragraph.

#### Section 4.1

- rename "Transitional Phase II Drainage Report" to "Master Drainage Report"; delete Subdivision Development Plan; and change the text of "Engineering" to Public Works and Development.

#### Section 4.2

- change the text "Acceptance" to "Approval".

#### Section 4.3.2

- add and modify: I. G Case number; II. A. 4 Including land use or zoning information; II.B.9 Groundwater investigation (i.e. whether there may be groundwater issues on the site or that groundwater has or will be addressed in a

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study already performed or to be performed); V. Drainage design Criteria; VI. B 1 Preliminary sizing of detention and water quality facilities; VII. B. 2 Preliminary sizing of structural BMPs; XI. 2 Preliminary design and sizing of storage facilities and structural BMPs.

#### Section 4.3.3

- add and modify: I. G Conceptual location and outline of detention and water quality facilities; I. K Case number in the lower left hand corner.

#### Section 4.4

- add and modify: I. G Case number; II. B.G Was groundwater investigation done (detailed groundwater discussion under heading; V. F Groundwater Investigation); IV Existing Stormwater conveyance or Storage Facilities; V. F. 3 Discuss improvements to mitigate groundwater impacts; X. 2 Reference all criteria, master plans, reports, or other technical information used in development of the concepts discussed in the drainage report; XII. A. 1 Determination of runoff coefficients, times of concentration (Standard Form SF-2), and runoff calculation (Standard Form SF-3), and change CHUP/UDSWMM to CHUP/EPA SWMM.

#### Section 4.4.6

- add N. Basin ID, contributing area, runoff coefficient, % imperviousness, runoff value, design point and the routed flows; and O. Appropriate warning signage provided for the storage facilities.

#### Section 4.5.4

- change the submittal requirements to include “DVD, or other electronic media as approved by the Case Engineer before execution of the plat or plans for Mylar”, and delete 3 1/2” disk requirement.

#### Section 4.6

- change :Transitional Phase II drainage report” to “Master drainage report”.

#### Section 4.6.2

- new section: Drainage Conformance Letter. When improvements propose no significant impacts to the site drainage, a drainage conformance letter is required. The drainage conformance letter shall clearly state that the design, grading, imperviousness, runoff totals and routing are in conformance with what was presented and approved in the pervious Phase III or Master Drainage Study. The letter should include the updated calculations, mitigation, justification and any other items requested by the Case Engineer for any modification.

#### Section 4.9

- add sign requirement: Appropriate warning signage for the detention facility.

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#### Section 4.11

- change the title of “Transitional Phase Drainage Report” to “Master Drainage Report/Plan”, and add Drainage conformance Letter.

#### Section 5.0

- insert a statement of “The County’s Floodplain Policy can be found in Section 2.6 of this Manual” at the beginning of the paragraph.

#### Section 5.6.1

- change the text of “grading” to GESC.

#### Section 5.6.3

- delete item # 7 Permanent BMP Plan (if applicable). Activities which disturb 1 acre of land or more are required to provide Permanent Water Quality Best Management Practices (BMPs) in accordance with Chapter 14. Permanent BMPs shall be designed, approved and constructed in accordance with the County’s requirements, including the submittal of a drainage report and plan and construction drawings for approval.

#### Section 5.7.2

- Item e: add the text “or excess urban runoff volume”; Item j: add the text “temporary” at the beginning sentence.

#### Section 5.10.2

- modify the SFHA information to “When subdivision layout proposes lots outside of, but adjacent to a SFHA, the County will require that the Developer provide a LOMA or LOMR that identifies the platted lots outside of the SFHA prior to building permit approval. Lots that are (within or) adjacent to the SFHA can be burdened with mandatory flood insurance purchase requirements, and that is not acceptable to Arapahoe County. Building permits on the affected lots will be restricted as described above, until the LOMA or LOMR is provided”.

#### Section 5.10.3

- revise freeboard requirement to include structure within and adjacent to the SFHA, and add elevation certificate requirement as “The County will require an Elevation Certificate be provided prior to building permit approval for all structures, as described above, to ensure that the freeboard requirement will be met based on construction drawings. The County will also require an Elevation Certificate be provided prior to Certificate of Occupancy issuance for all structures, as described above, to ensure the structure was built in compliance with the construction drawings and approved elevation”.

#### Section 5.13.5

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- add SEMSWA as agency review list.

#### Section 6.2

- change the method to estimate runoff from UDSWMM to EPA SWMM.

#### Section 6.3

- delete words of “all” and “or the UDSEWER software”.

#### Section 6.3.2

- delete the sentence of “UDSEWER software checks for these eventualities as long as the sub-catchment is properly subdivided”.

#### Section 6.3.4

- remove paragraph of “Weighted runoff coefficients are not acceptable in single land use areas, such as commercial or single family residential areas. In single land use areas, the landscaping and the impervious areas cannot be separated and a new weighted coefficient calculated. Only the accepted values for individual land use classifications can be used, even if they appear to be on the high side for a given situation”.

#### Section 6.4

- update CUHP/UDSWMM to CUHP/EPA SWMM.

#### Section 6

- all reference to UDFCD are changed to the title of the table/figure.

#### Section 7.4.1

- clarify the definition of “finished floor” as the first floor.

#### Section 7.7.1

- clarify the section.

#### Section 7.7.2

- add velocity requirement to be “A minimum velocity shall not be less than 2-fps, and the maximum Froude Number should not exceed 0.8”.

#### Section 7.8

- add a statement in this section as “Based on the velocity within roadside ditch, the County may require additional erosion control protections”.

#### Section 8.1.3

- add the requirement of “within the driveways” at the end of item 1.

#### Section 8.2.2

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- add allowable inlet type: type 13 comb inlet and type 16 inlet.

#### Section 8.3.3

- add a paragraph to include the type 16 inlet information.

#### Section 8.3.4

- add a paragraph to include the type 13 comb inlet information.

#### Section 9.1.1

- delete text of “in a just full condition”.

#### Section 9.2

- update storm sewer pipe material technical memorandum to 3rd Edition dated July 2010; insert word of “for private system” and delete the example pipe of AASHTO M294 – Type S – Corrugated Polyethylene Pipe is applicable for pipe diameters from 12-inches to 60-inches.

#### Section 9.3.1

- add the statement of “It is also the responsibility of the design engineer to meet manufacture recommendations for trench installation (i.e. maximum/minimum cover)” at the end of paragraph.

#### Section 9.3.3

- delete the name of safety racks.

#### Section 9.4.4

- add the section for drainage easement for permanent BMPs.

#### Section 9.5.1

- add the cover requirement as “shall be not less than 12-inches or below any obstruction, whichever is greater, at any point along the pipe”.

#### Section 9.6.1

- add clarification as “except those created by joint deflection within allowable manufacturer’s recommendation” and add a new requirement as “the storm sewer system shall not be installed under sidewalk unless a variance is granted by TRC”.

#### Section 9.6.2

- clarify the clearance requirement as “the County requires a minimum clearance of 10-feet between a storm sewer and a water line or sanitary sewer line with the exception of services lines unless the appropriate Water and Sanitation District Standards dictate differently”.

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#### Section 9.7.2

- add 4' manhole, CDOT MH per M&S Standards.

#### Section 9.8.1

- change the pipe minimum velocity from 4-fps to 3-fps, and minimum slope to 0.5%.

#### Section 9.8.4

- allow using StormCad program per UDFCD's technical paper called "Modeling Hydraulic and Energy Gradients in Storm Sewers".

#### Section 10.1.2

- delete the safety rail requirement of 54 inches for bicycle traffic.

#### Section 10

- modify the figures 1 and 2.

#### Section 11.1.1

- add reference: AASHTO Standard Specifications for Highway Bridges, the latest edition.

#### Section 11.1.4

- insert text of "Federal Funded" prior to stream crossing.

#### Section 11.1.5

- delete the paragraph of "The appearance and safety of structures are important considerations for the County's acceptance of the design. Structure geometry, materials, and the texture, patterning, and color of structure surfaces shall be selected to blend with the adjacent landscape and provide an attractive appearance", and add the sentence of "The selected structure shall also need to meet AASHTO and CDOT safety standards".

#### Section 11.1.7

- add the requirement of "The trail connections shall meet ADA requirements for pedestrian traffic".

#### Table 11-1

- correct the roadway classification

#### Section 11.3.2

- add the word of "and drainage easement" after ROW.

#### Section 11.3.3

- add one reference: CDOT Drainage Design Manual provides design procedure.

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#### Section 11.3.7

- change the minimum flow velocity requirement from 4-fps to 3-fps.

#### Section 11.3.9

- add the text “For skewed culverts, CDOT M & S Standards, the latest edition must be utilized for design”, and delete the word of “major” in the second paragraph.

#### Section 11.3.12

- delete Table 11.2; modify the requirements for trash racks: change the maximum velocity through rack from 2-fps to 3-fps, bars shall be vertical to flow instead of parallel, add requirement of “50% clogged factor shall be included in the calculation”.

#### Section 11.4.4

- 1 foot minimum cover changes to 6 inches.

#### Section 11.4.6

- 2% minimum slope changes to 0.5% slope.

#### Section 11.6.3

- the statement of “As a minimum, all bridges shall be designed to withstand AASHTO HS-20 loading in accordance with the design procedures of AASHTO, “Standard Specifications for Highway Bridges”. The Colorado Department of Transportation is using the Load and Resistance Factor Design (LRFD) method for new bridges and this method is acceptable for State Highway structures. The method may be acceptable for use on other County structures. Please check with the County before selecting a structural design method” needs to be changed to “As a minimum, all bridges shall be designed to withstand AASHTO HS-20 loading. The structural design shall be in accordance with the County’s Infrastructure Design and Construction Standards, Chapter 6, Bridges and Major Drainage Structures, and CDOT Bridge Design Manual. Please check with the County before selecting a structural design method”.

#### Section 11.6.4

- change freeboard requirement from 4-feet to 3-feet.

#### Section 11.6.6

- change “highway” to “roadway”.

#### Section 11.6.7

- delete the statement of “including corrosion, icing and hydroplaning. Ideally bridges shall be placed on crest vertical profile grades and bridges on sags



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vertical curves should be avoided. A superelevation transition on a bridge is not acceptable because of cross flow problems” from the section; and change “curb roll” to “curb”.

#### Section 12.0.4

- add “equal to or” before greater than 130-acres.

#### Section 12.0.6

- change the text of “except” to “unless”.

#### Section 12.1.1

- add “where feasible and practicable” after preserved, and “equate to and” before greater than 130 acres.

#### Section 12.2.3

- the maximum drop height change from 4’ to 5’ per UDFCD’s Manual, add the note that Use of the vertical drop structure shall be reviewed and approved by the County on a case-by-case basis. The design of the vertical drop structure must be in accordance with the design criteria developed by UDFCD, and delete the word of “significant” before experience.

#### Section 12.3.6

- add a foot note to Table 12.2: If a natural major drainageway cannot be preserved the criteria in Table 12-2, Major Drainage Chapter of USDCM shall be applicable.

#### Section 13.1.3

- Add water quality capture volume in the text.

#### Section 13.1.5

- Increase exemption area for detention pond from current value of 2500-sf to 5000-sf.

#### Section 13.2.1

- add statement of “The County requires that all regional detention facilities be sized to include imperviousness from all future roadway improvements within the basin, including water quality for those future improvements” after the first sentence of the second paragraph.

#### Section 13.2.2

- delete the sentence of “and are typically located on a minor drainageway. The definition of a minor drainageway is discussed in Section 12.0.4”.

#### Section 13.3.1

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- insert the word of “approximately” before 72 hours and add the sentence of “Control orifices shall be sized using procedures outlined in the Storage Chapter of the UDFCD manual” at the end of paragraph. Revise the second paragraph of “Arapahoe County requires for Type B, C, and D soils, the 100-year volume provided for full-spectrum detention facilities be equal to the 100-year detention volume calculated using the UDFCD simplified equation plus 1.0 times the Water Quality Capture Volume. For Type A soils, the 100-year volume for full-spectrum detention facilities shall be calculated based on the equation provided in the Storage Chapter of the UDFCD Manual” to “Arapahoe County requires that the 100-year volume provided for full-spectrum detention facilities be equal to the 100-year detention volume calculated using the UDFCD simplified equation plus 1.0 times the water quality capture volume. The UDFCD design spreadsheet provides an option to specify that the water quality capture volume be added to the 100-year simplified equation volume. When the term “100-year volume” is used in these criteria in association with full-spectrum detention, it refers to the sum of the water quality capture volume and the UDFCD 100-year simplified equation or the 100-year volume using the hydrograph methods described in the UDFCD Storage Chapter”.

#### Section 13.3.7

- add the sentence “for regional facilities, and at least 5-feet for the sites qualified to utilize the modified extended detention basin. Adequate maintenance access shall be provided. It is the responsibility of the design engineer to ensure that the design of any earthen embankment is based on specific recommendations of a geotechnical engineer and that the design requirements are clearly identified within the construction plans” within the first paragraph.

#### Section 13.3.9

- change the requirement of “convey a minimum of 1% of the 100 year peak inflow” to “convey a minimum flow capacity equal to the maximum release from the forebay outlet”.

#### Section 13.3.14

- add the sentence of “It is the responsibility of the design engineer to evaluate whether or not a base for the concrete cut-off wall is necessary based on specific recommendations of a Geotechnical Engineer”.

#### Section 13.3.17

- warning sign: change land development code to zoning.

#### Section 13.3.8

- change “granted” to “dedicated”.

#### Section 13.6

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- delete the word of “grading”.

#### Figure 13-7

- minor modification.

#### Section 14.0

- add a statement of “The County requires the implementation of permanent best management practices for enhancement of stormwater quality with all development, redevelopment and expansion on projects that disturb an acre or greater, including projects less than one acre that are part of a larger common plan of development within the County’s MS4 Boundary” at the beginning of the section.

#### Section 14.0.1.4

- add the statement of “If the project qualifies for exemption from post-construction Best Management Practices, Section 14.4.1, the project shall also exempt from post-construction Water Quality Capture Volume requirements, Section 14.4.2” at the end of the paragraph.

#### Section 14.0.1.6

- change the word of “porous” to “permeable”.

#### Section 14.2.2

- clarify the requirement of on-site BMPs for developments tributary to regional water quality facilities.

#### Section 14.3.2

- delete last sentence of “Drainage area defines major and minor drainageways, which in turn dictates the dividing line between sub-regional and regional facilities”.

#### Section 14.4.1.1

- delete the exemption of “Individual residential lots with a disturbed area less than 2.5 acres not part of a larger subdivision”.

#### Section 14.4.3

- add this new section of “Exemptions for all new development and redevelopment within the Cherry Creek Reservoir Watershed”.

#### Section 14.5.3

- modify the design criteria, landscaping consideration, underdrain requirements for grass buffer and swale to meet UDFCD’s updated volume 3 drainage criteria.

#### Section 14.5.4.7

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- add the text of “provide energy dissipation at concentrated points of inflow”.

#### Section 14.5.5.4

- modify the basin storage volume calculation to meet UDFCD’s updated volume 3 drainage criteria.

#### Section 14.5.5.6

- modify the underdrain design to meet UDFCD’s updated volume 3 drainage criteria.

#### Section 14.5.6 6

- modify the underdrain design to meet UDFCD’s updated volume 3 drainage criteria.

#### Section 14.6.3

- change the text “porous” to “permeable”.

#### Section 14.6.4.3

- delete the last sentence of “Porous pavement detention shall only be used in locations that receive runoff from upstream pavement, roofs, or fully stabilized landscape areas (irrigated sod or planting beds with stable mulch layer)”.

#### Section 14.7

- add this new section of “easement requirements”.

#### Figures 14-4, 14-5, 14-6, 14-7, and 14-16

- minor modification.

BOCC Resolution No. 110512

#### 3/20/2012 - Changes to Requirements for Post-Construction Best Management Practice (BMP)

##### Section 14.4.1.1

- Remove exemption providing post-construction BMP for single-family lots with a disturbed area less than 2.5-acres that are not part of a larger subdivision.

##### Section 2.3.14 and 14.0

- Insert statement “the County requires the implementation of permanent best management practices for enhancement of stormwater quality with all development, redevelopment and expansion on projects that disturb an acre or greater, including projects less than one acre that are a part of a larger common plan of development within the County’s MS4 boundary”

BOCC Resolution No. 120239

#### 3/12/2013 - Modifications to SMM to comply with MS4 permit

##### Section 14.4.1

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- Revised Statement #2 to include “provided the exemption does not violate the MS4 permit”.

BOCC Resolution No. 130206

7/1/2019

Modifications to SMM to comply with MS4 permit  
Complete change to Chapter 14

- Revised County Chapter 14 addressed the regulatory requirements placed on the County for post-construction stormwater quality. Changes to the renewed MS4 permit in 2016 have made it more clear, measurable, and enforceable and have resulted in several changes to Chapter 14. The 2016 MS4 permit update required the County to include updated definitions, clearly designate and differentiate the development activities within the Cherry Creek basin, and maintain extensive records and documentation of the County’s use of exemptions and exclusions at a development site to ensure uniform application of criteria.
- Specifically, the updated Chapter 14 -Stormwater Quality, of the Stormwater Management Manual:
  - Expands the enforceable design standards for permanent control measures by adding regional system options and several green infrastructure/infiltration choices;
  - Provides exclusions and exemptions to post-construction water quality requirements for routine roadway maintenance, installation of above and below ground utilities, and selected large lot/park/trail projects
  - References UDFCD Volume 3 and revised construction details to provide the best available design and installation data for permanent water quality facilities; and
  - Synchronizes language, methodology, and processes to allow for one uniform Chapter 14 for both SEMSWA and the County, to assist developers in the City of Centennial and unincorporated Arapahoe County with consistent requirements for efficient application.

BOCC Resolution No. 190349