CHAPTER 15.0 POST-CONSTRUCTION STORMWATER CONTROLS

15.1 Introduction

Development projects can increase runoff and the discharge of undesirable pollutants that, if left untreated, may be detrimental to the health of receiving waters. This chapter addresses the use of post-construction stormwater control measures (SCMs) that are intended to reduce runoff and prevent or reduce discharge of pollutants to the County's waterways.

The Standards set forth in this chapter are based on the MHFD's Four Step Process for the protection of receiving waters from stormwater impacts, and the County's MS4 permit requirements for post-construction stormwater controls.

15.1.1 Four Step Process for Stormwater Quality Management

The Four Step Process is a long-standing approach recommended by the MHFD for stormwater quality management. The four steps are summarized below and additional information can be found in Volume 3 of the MHFD Manual.

Step 1: Employ Runoff Reduction Practices

This step aims to reduce the amount of runoff generated from a development by implementing low impact development (LID) practices and minimizing directly connected impervious area (MDCIA). Effective implementation of these practices requires careful planning at the beginning of the design process – looking for opportunities to route runoff through vegetated areas, preserve areas with high soil infiltration capacity, and minimizing impervious area overall. Quantifying runoff reduction via procedures in Volume 3 of the MHFD Manual can also result in smaller water quality and storage facilities downstream.

Principles of Low Impact Development (LID) and Minimizing Directly Connected Impervious Areas (MDCIA)

- Preserve natural hydrologic features and minimize disturbance
- Direct impervious surface runoff onto pervious areas
- Avoid concentrated flows where possible
- Utilize multiple controls throughout the site
- Use vegetated swales, buffers and distributed bioretention (rain gardens)
- Reduce volume, resulting in lower peak flows, reduced pollutant loadings, and hydrologic processes that more closely mimic the natural flow regime

Step 2: Implement SCMs That Provide a Water Quality Capture Volume with Slow Release

The runoff that is generated from a development should be captured in a SCM designed to contain and slowly release the water quality capture volume (WQCV). These SCMs provide pollutant removal benefits and, in some cases, additional runoff reduction. A wide variety of SCMs are available to achieve to these objectives; however, proper selection is important as not all SCMs are appropriate for all sites.

Water Quality Capture Volume (WQCV):
The volume of runoff used for optimal stormwater control measure design. Sizing for smaller volumes results in too many events exceeding the capacity of the facility, while designing for larger volumes results in drain times too short for effective pollutant removal.

Step 3: Stabilize Streams

Steps 1 and 2 may not always be sufficient to protect streams from erosion and additional measures may be necessary to keep a stream stabilized. In this context, the County considers "streams" to represent both major drainageways and minor drainageways that exist on or adjacent to a site. CHAPTER 12.0 of these standards addresses open channel design and stabilization techniques.

Step 4: Implement Site Specific and Other Source Control SCMs

This step aims to reduce or eliminate the potential for pollutants to enter the stormwater system on a site. This is particularly important for commercial and industrial sites that may handle or store chemicals, petroleum products or other materials that could cause severe impacts to receiving waters if discharged.

15.2 Runoff Reduction Practices (LID/MCDIA)

Runoff reduction practices shall be implemented to the extent practicable for all Projects. These requirements apply county-wide and regardless of Project size. If the Project is located within a GMA, more stringent requirements may apply.

15.2.1 Runoff Reduction Practices and Design Criteria

The following are the most common runoff reduction practices that can be used to achieve these requirements.

Grass Buffers: Grass buffers are densely-vegetated (typically turfgrass) areas designed to convey sheet flow from upstream impervious areas. The most important aspects of grass buffer design are to ensure that sheet flow is distributed evenly across the width of the buffer and that the buffer length (in the direction of flow) is long enough for effective treatment and infiltration.

Design criteria for grass buffers shall follow those included in Grass Buffer Fact Sheet in Volume 3 of the MHFD Manual.

Grass Swales: Grass swales are densely-vegetated channels designed to convey channelized flow from one location to another. They are most effective at runoff reduction and pollutant removal when designed with low flow depths and velocities – therefore design criteria for runoff reduction grass swales are different than open channel swales and roadside ditches. Design criteria for grass swales shall follow those included in Grass Swale Fact Sheet in Volume 3 of the MHFD Manual.

Permeable Pavement: Permeable pavement allows precipitation to flow through the pavement surface rather than producing runoff. It can also be used to store runoff below the pavement surface to achieve WQCV requirements or detention of larger flood control volumes. Design criteria for permeable pavement shall follow those included in Permeable Pavement Fact Sheet in Volume 3 of the MHFD Manual.

15.2.2 Submittal Requirements

At a minimum, the design engineer shall provide a qualitative discussion in the drainage report/letter on how runoff reduction practices will be implemented to the extent practicable and the design plans shall identify the runoff reduction practice locations and contributing impervious areas.

If the applicant intends to quantify runoff reduction for purposes of reducing downstream WQCV requirements, the design engineer shall also submit runoff reduction volume calculations using the most recent version of the UD-BMP Runoff Reduction Worksheet and detailed design plans/calculations for each practice to demonstrate they are designed according to the design criteria.

If runoff reduction practices cannot be feasibly implemented, a written justification must be provided to the County Engineer.

15.3 Water Quality SCMs

All Projects that disturb an area greater than or equal to 1 acre shall implement SCMs to meet one of the following base design standards, per the County's MS4 permit.

WQCV Standard: Control measures must be designed to provide treatment and/or infiltration of the WQCV for the entire Project site.

Pollutant Removal Standard: Requires treatment of the 80th percentile event to reduce the mean concentration of total suspended solids to 30 mg/L or less for the entire Project site.

Runoff Reduction Standard: Requires infiltration, evaporation, or evapotranspiration of 60% of the WQCV for the entire Project site.

Regional WQCV Facility Standard: If the Project site drains to a regional WQCV facility, at least 20% of the impervious area must be disconnected from the storm drainage system and drain through a receiving pervious area control measure comprising a footprint of at least 10% of the upstream disconnected impervious area.

Constrained Redevelopment Site Standard: If the Project is redevelopment with greater than 75% impervious area and the applicant demonstrates it is not practicable to meet any of the above standards, then the SCM(s) must meet one of the following:

- Meet the WQCV Standard for at least 50% of the impervious area
- Meet the Pollutant Removal Standard for at least 50% of the impervious area
- Infiltrate, evaporate or evapotranspirate 30% of the WQCV calculated based on the overall site impervious area.

These base design standards are summarized from the County's MS4 permit and shall not be interpreted differently from the permit requirements. These standards are also subject to change with future permit revisions.

Exemptions to the water quality SCM requirements may be provided if the Project meets any of the following characteristics:

- Single-family residential lots greater than or equal to 3 acres with a single dwelling and total imperviousness less than 10%, or
- Other "Excluded Sites" as defined in the County's current MS4 permit.

If the Project is located within a GMA, more stringent requirements may apply.

15.3.1 SCM Selection and Application

There is a wide variety of SCMs that can be used to meet the WQCV requirements, however not all SCMs are appropriate for all Projects. The design engineer shall consider factors such as the contributing impervious area, soil type, depth to bedrock/groundwater and impaired waters when selecting the appropriate SCM(s) for a site. Additionally, some SCMs can be incorporated into full-spectrum detention facilities to provide both water quality and storage requirements in a single facility. Table 15-1 below summarizes the most common SCMs and general guidance for selection and application. Volume 3 of the MHFD Manual provides additional guidance that should be considered.

Table 15-1. Water Quality SCM Selection and Application

SCM	Selection and Applicability Considerations
Bioretention	Best-suited for capturing runoff from less than 5 acres of impervious area. Partial- or full-infiltration designs depend on soil type or infiltration rate testing results. Can be designed as a stand-alone WQCV SCM, or incorporated as the WQCV/EURV component of a full-spectrum detention facility.
Constructed Wetland Pond	Best-suited for capturing runoff from more than 5 acres and where consistent baseflows are present. Subject to water rights law that may require reporting and augmentation plans. Can be designed as a stand-alone WQCV SCM, or incorporated as the WQCV/EURV component of a full-spectrum detention facility.
Extended Detention Basin (EDB)	Best-suited for capturing runoff from more than 5 acres of impervious area and are not allowed for contributing areas with less than 1 impervious area. Can be designed as a stand-alone WQCV SCM, or incorporated as the WQCV/EURV component of a full-spectrum detention facility.
Grass Swale	Applicable as a runoff reduction practice only. They do not capture and treat the WQCV. They may be used to achieve MS4 permit requirements if it can be demonstrated that they meet volume reduction requirements.
Grass Buffer	Applicable as a runoff reduction practice only. They do not capture and treat the WQCV. They may be used to achieve MS4 permit requirements if it can be demonstrated that they meet volume reduction requirements.
Green/Blue Roof	Applicable as a runoff reduction practice only or WQCV practice, depending on design. They may be used to achieve MS4 permit requirements if it can be demonstrated that they meet the Runoff Reduction or WQCV standards.
Permeable Pavement	Best-suited for parking lots, driveways and alleys with relatively low traffic loadings. Can be designed as a stand-alone WQCV SCM, or with additional flood detention. Partial- or full-infiltration designs depend on soil type or infiltration rate testing results.
Sand Filter	Best-suited for capturing runoff from less than 5 acres of impervious area. Partial- or full-infiltration designs depend on soil type or infiltration rate testing results. Can be designed as a stand-alone WQCV SCM, or incorporated as the WQCV/EURV component of a full-spectrum detention facility. Bioretention is preferred over sand filters in most applications; however, sand filters may be more appropriate where maintenance is expected to be more frequent due to higher solids loadings from the contributing area. Sand filters avoid the need for irrigation to establish or maintain vegetation.

Retention Pond	Best-suited for capturing runoff from more than 5 acres. Subject to water rights law that may require reporting and augmentation plans. Can be designed as a stand-alone WQCV SCM, or incorporated as the WQCV/EURV component of a full-spectrum detention facility. WQCV must be provided above the permanent pool and reliance on pumps to discharge captured runoff will not be allowed. Cannot be used with flood control in Larimer County.
Underground (proprietary) SCMs	Underground SCMs for water quality will not be allowed unless aboveground SCM options are infeasible. The applicant must demonstrate that the proposed SCM meets one of the MS4 permit base design standards.

SCM Selection for Impaired Waters
Waterbodies with a pollutant concentration exceeding the water quality standard established for a designated use are listed as "impaired waters" under Section 303(d) of the Clean Water Act. A total maximum daily pollutant load, or TMDL, is established for impaired waters and places limits on the pollutant load that may be discharged to a receiving water body. For areas within the County draining to impaired waters, SCM selection must be predicated on the effectiveness of a control measure at treatment of the specific pollutant named in the TMDL. The International BMP Database is one resource that can be used to determine the effectiveness of different SCMs at treating specific pollutants. https://bmpdatabase.org/

15.3.2 Water Quality SCM Design Criteria

The WQCV shall be calculated according to following equation from Volume 3 of the MHFD Manual:

$$WQCV = a(0.91I3 - 1.19I2 + 0.78I) \qquad \text{Equation 15- 1}$$

Where:

WQCV = Water Quality Capture Volume (watershed-inches)

a = Coefficient corresponding to SCM type and based on WQCV design drain time (See Table 15-2 below, taken from the MHFD Manual, Volume 3, *Calculating the WQCV and Volume Reduction* Chapter)

I = Contributing area imperviousness (percent expressed as a decimal) - Note: At a planning level, the imperviousness can be estimated based on the zoned density. When finalizing design, calculate imperviousness based on the site plan.

Table 15-2. Drain Time Coefficients for WQCV Calculations (Taken from MHFD Manual Volume 3)

Drain Time (hours)	Coefficient, *a*
12	0.8
24	0.9
40	1.0

SCMs shall be designed according to the criteria presented in the most recent version of Volume 3 of the MHFD Manual. Those criteria are presented in a series of Fact Sheets and are updated on a regular basis. Any exceptions to those criteria, or the use of SCMs not identified in Table 15-1, will require prior approval from the County Engineer.

15.3.3 Maintenance

The County requires all water quality SCMs be designed with consideration of maintenance access and requirements. In addition, an Operation and Maintenance Plan must be completed for all water quality SCMs and provided to the owner and the County. The owner will be responsible for maintaining the SCM such that it continues to function as designed. Per the Development Agreement, the County reserves the right to perform maintenance activities if the owner refuses or is incapable doing so and the County may seek reimbursement for all costs from the Owner.

15.3.4 Submittal Requirements

Drainage reports and plans shall include the following information (at a minimum) for all proposed water quality SCMs:

- Description and discussion of SCM type(s) and contributing area characteristics (e.g., total area, impervious area, etc.),
- Soil type and/or infiltration test results for infiltration-based SCMs (e.g., bioretention, sand filters, permeable pavement),
- WQCV calculations, and
- Operation and Maintenance Plan.

The County recommends use of the MHFD's UD-BMP workbooks to document many of the requirements above. Additional information may be required by the County Engineer on a case-by-case basis.