A-8. Guidance on SCM Selection

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Overview

Selecting the most appropriate SCMs for a development is an art as well as a science. This Chapter provides the link between stormwater regulatory requirements and physical site constraints, as well as issues of cost and community acceptance.

For several reasons, there is no one SCM that is best for every site. First, different SCMs are better suited for different aspects of stormwater management (sediment removal, nutrient removal, peak runoff reduction, and volume control). One particular SCM might not provide all of the required stormwater management goals of the regulations that apply to a site. Additionally, each site has unique features, such as slope, soils, size, and development density that encourage the use of some types of SCMs and eliminate the use of other types of SCMs. Issues of cost, community acceptance, and site compatibility are also vital to consider in the SCM selection process. For example, SCM's which feature standing water are inappropriate for airports and other locations where waterfowl present a hazard.

Whether or not a structural SCM is needed will be determined by the applicable regulatory requirements for the site, which are covered in Part B. For an exact determination of the applicable regulations at a site, please check with local planning and zoning authorities, as well as using the Interactive Stormwater Permitting Map.

General SCM Selection Guidance

Prior to selecting a structural SCM, a designer should first consider if it is possible to reduce the impervious surfaces on the site. Reducing impervious surfaces can minimize or eliminate the need for structural SCMs. Strategies for reducing impervious surfaces are discussed in the next section below.

If structural SCMs will be required, the following process is recommended for selecting the appropriate one to use:

1. Determine the treatment capability (TSS removal, nutrient removal, volume reduction, and peak flow control) that is required of the SCM based on the applicable regulatory requirements for the site.
2. Determine which SCMs will meet the treatment capability requirements and create a "short list."
3. Evaluate which of the "short listed" SCMs will be appropriate for the physical site characteristics.
4. Consider other factors such as construction cost, maintenance effort, community acceptance, site compatibility, and wildlife habitat.

When a site has numerous physical constraints and the regulatory requirements are stringent, it can be especially challenging to find an appropriate SCM t. In this case, it may be necessary to modify the SCM design for the site characteristics (see individual SCM chapters) or to provide a combination of SCMs that are suitable for the site in series to provide the required level of stormwater treatment.

Getting even further into the art of good SCM design requires blending the SCM into the natural environment to make it more acceptable to the community (especially in areas with considerable pedestrian traffic such as residential, commercial, and office locations). This often requires collaboration between various professions such as civil engineers and landscape architects.

When siting SCMs, conforming to the natural features of the landscape such as drainage swales, terraces, and depressions should be considered. Many of the more "natural" SCMs can readily achieve these goals, such as filter strips, grassed swales, and restored riparian buffers. Other natural-looking SCMs such as bioretention and stormwater wetlands can be blended into natural areas of site designs, or even create new, small sized natural areas within normally barren portions of the site, such as parking lots, walking areas, and outdoor plazas.

Recent trends in stormwater management favor reintroducing runoff from impervious surfaces into the natural environment as close to the impervious surfaces as possible. Ideally, impervious surfaces should be hydrologically divided so that runoff is delivered in smaller volumes that can be accommodated by smaller, less expensive and less obtrusive SCMs. Large "end-of-pipe" facilities may be less suitable because of their high cost, maintenance requirements, consumption of land, and disruption of the landscape.

Primary Versus Secondary SCMs

In the past, 85% TSS removal has been used as a standard. DEQ is no longer using that standard because it is not reflective of the actual field performance of SCMs. Most SCMs do not remove 85% of TSS, especially at lower concentrations of TSS in the influent.

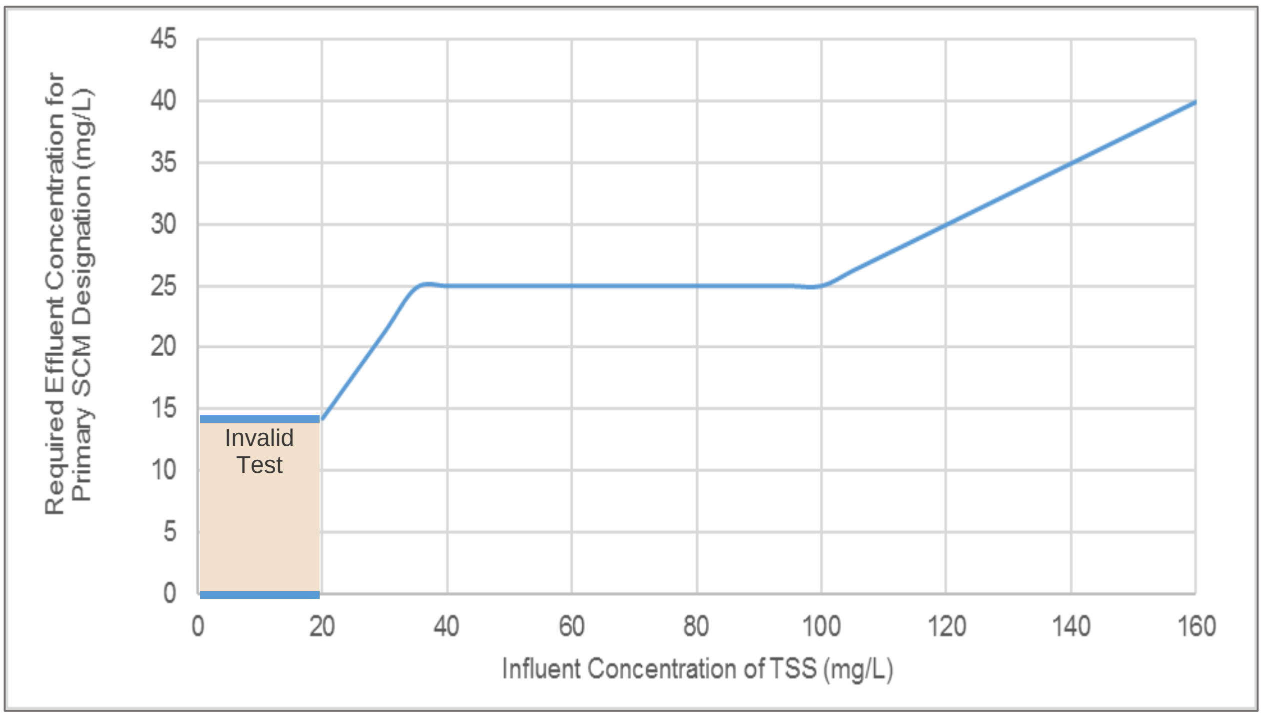
SCMs are designated as either primary or secondary based on their demonstrated performance at TSS removal in research studies. With stakeholder input, DEQ developed the table and graph below to characterize the performance that is required of primary SCMs. In addition to the table below, primary SCMs shall be capable of treating the design storm (1.5 inches in Coastal Counties and 1 inch in the remainder of the state).

Table 1: Potential Siting Constraints for SCMs

Median Influent EMC	Applicable Performance Standard[1,2]
< 20 mg/L	Invalid test
20 – 35 mg/L	> 29% removal
35 – 100 mg/L	< 25 mg/L
100 mg/L	> 75% removal

1 The median effluent EMC requirements may also be considered on a total load basis for SCMs that reduce runoff volume. Divide the performance standard by [100% – (% of runoff reduced)] to determine the corresponding load-based standards.
2 Primary SCMs comply with the above standards as demonstrated through research studies. Proposed new stormwater technologies shall be held to this same standard.

Figure 0-1: Required Performance Standard for Primary SCMs



Based on applying the above criteria to the available research results, the SCMs were designated in accordance with Table 2 below.

Table 2: List of Primary and Secondary SCMs

List & Uses	Primary SCMs	Secondary SCMs
List	- Bioretention Cell - Infiltration System - Permeable Pavement - Wet Pond[1] - Stormwater Wetland[1] - Sand Filter - Rainwater Harvesting	- Green Roof - Disconnected Impervious Surface - Level Spreader-Filter Strip - Pollutant removal Swale - Dry Pond
Uses	- As a stand-alone SCM to treat a new development site (when 100% sized). - As a retrofit.	- In series with a primary SCM to reduce the volume of runoff and thus reduce the size of the primary SCM. - In series with a primary SCM to provide pretreatment. - In series with a primary SCM as a hydraulic device to slowly "feed" the stormwater runoff to the primary SCM, to reduce the size of the primary SCM. - In series with another secondary SCM to treat the design storm in a manner that meets or exceeds performance standard. - As a retrofit.

[1] The research data on wet ponds and stormwater wetlands actually indicate that only about 50% of those studied meet the performance standard shown in the figure above. However, DEQ is retaining these as Primary SCMs due to their history as being considered stand-alone SCMs and their capacity to manage peak flows.

[2] The research data on level spreader-filter strips actually indicate that they do meet the performance standard shown in the figure above. However, DEQ is retaining LS-FS as a Secondary SCM for the present because the research sites were sized 50-300 times larger than the MDC for this SCM require.

Reducing Impervious Surfaces

Most stormwater rules provide an option to avoid the need for engineered stormwater controls if certain low density development criteria are met. Keeping the percent impervious surface low when possible is the preferred method of stormwater control. In addition, reducing the percentage of impervious cover in a high density development may reduce the size of required SCMs.

Some of the options for reducing impervious surfaces are listed below. The local planning jurisdiction will usually determine the availability of these options.

- Reducing road widths
- Reducing minimum parking requirements
- Minimizing use of curb and gutter
- Cluster or open-space developments
- Traditional neighborhood developments
- Mixed-use developments
- The use of permeable pavements
- Shared driveways

Appendix G of the Neuse River Basin: Model Stormwater Program for Nitrogen Control (1999) discusses site design techniques to reduce impervious surfaces in greater detail.

Comparison of SCM Treatment Capabilities

If the low-density option is not chosen or not available, then one or more structural SCMs may be needed. For structural SCMs, one or more of the following general requirements will apply:

- There will be a pollutant removal requirement for TSS (primary vs. secondary SCM) and/or a maximum pollutant discharge limit (maximum pollutant export rate for TN and possibly also TP) imposed.
- There will be a volume of stormwater that must be captured and treated prior to release (typically first 1 inch or first 1.5 inches of rainfall).
- The post-construction peak stormwater discharge rate must be reduced to no greater than the pre-construction peak stormwater discharge rate (usually for the 1-year, 24-hour storm).

Fecal coliform reduction is currently regulated as a narrative requirement rather than a quantitative requirement. Effort should be made to reduce fecal coliform levels in SA waters. The primary mechanism for reducing fecal coliform in stormwater SCMs is through exposure to UV light (sunlight), which happens regularly in devices containing areas which become temporarily inundated with stormwater. Additionally, fecal coliforms can be reduced by filtration, drying events between storms, and sedimentation. Some scientists also believe predation from other microbes can significantly reduce fecal coliform numbers (Hathaway and Hunt, 2008).

Thermal impacts of SCM discharges is of concern in HQW waters that support trout. The higher temperatures reduce dissolved oxygen, reduce reproductive rates, hinder growth, increase disease exposure, and may have other negative impacts. Temperatures are typically increased due to ponded water being exposed to sunlight.

Detailed information and tables on SCM treatment capabilities is available in the SCM Crediting Document located on the NCDEQ Stormwater Design Manual website.

Comparison of SCM Site Constraints

The basic nature of stormwater SCMs often places them in low-lying areas and next to existing waterways, which can conflict with other regulations. The designer should consider other regulations and site constraints when siting SCMs. A non-exhaustive list of possible environmental and regulatory issues is provided below:

- Jurisdictional & isolated wetlands
- Stream channels
- FEMA floodplains
- Riparian buffers
- Forest or tree conservation areas
- Critical water supply watershed areas
- Endangered species
- Standing water near airports

SCMs should also be sited in a manner that avoids the following types of infrastructure: Utilities

- Roads
- Structures
- Septic drain fields
- Wells

A SCM will not work unless it is sited appropriately. It is critical to obtain information about the size of the drainage area, soils and slopes as well as depth to groundwater table and bedrock.

The various site considerations for siting SCMs is presented in Table 1 below. Each of these considerations is discussed below.

The size of drainage area is a primary consideration in selecting a SCM. Some SCMs will only function properly with drainage area that is of sufficient size to maintain a permanent pool of water. Other SCMs, such as bioretention areas and sand filters, may only handle smaller flows and could become overwhelmed if sited at the outlet of a large drainage area.

The space required for a SCM is another important consideration, particularly if the site has limited space to accommodate a SCM and the room to access and maintain it. However, SCMs that require a small space may be relatively expensive (i.e., sand filter) or may not have high treatment capabilities (i.e., grassed swale).

The head required (elevation difference) will also affect the SCM selected. In areas of low relief, costly excavation is often required for basins. In addition, the hydraulic head necessary for some devices to function properly may not be available in low relief areas.

Steep slopes will affect the SCM selection process. Larger SCMs, such as wet detention basins and extended detention wetlands, may be impractical on a site where steep topography results in an impractically large embankment height or slopes that cannot be stabilized with vegetation. Also, steep slopes may create excessive flow velocities for some systems (e.g.: filter strips, swales, restored riparian buffer). When an entire site has steep slopes, it may be best to provide a number of smaller SCMs that can fit into the existing contours of the site.

A shallow water table can limit some types of SCM systems. For example, bioretention areas normally require a minimum depth to groundwater of two feet; otherwise, the bioretention area will actually function as a stormwater wetland.

A shallow depth to bedrock can greatly limit SCM options. Shallow bedrock can restrict the use of infiltration systems, prevent the excavation of basins, and limit the hydraulic functions of certain SCMs. The SCM options available in this scenario may be limited to filter strips, restored riparian buffers rooftop runoff management, and other above ground measures Sites with contaminated soils may require locating SCM's in uncontaminated areas, impervious linings to prevent infiltration from transporting contaminants, removing the contaminated soil, or selecting an SCM that does not involve infiltration.

High sediment input can significantly reduce the longevity of certain SCMs, especially sand filters, bioretention, infiltration systems, stormwater wetlands, and permeable pavement. These SCMs should not be placed in locations where high sediment loads are anticipated upstream in the future (typically from future development). Alternatively, high sediment loads that might adversely affect SCMs can be overcome by providing pre-treatment in the form of filter strips, fore-bays, and sediment basins.

Poorly drained soils are another SCM siting consideration. For example, poorly drained soils may exclude the use of any system relying on infiltration, such as bioretention areas unless an underdrain is utilized   Poorly drained soils may be very well suited, however, for SCMs that retain water, such as a wet detention basin or a stormwater wetland.

Comparison of SCM Costs, Community Acceptance & Site Compatibility

Construction costs and operation and maintenance efforts for each of the SCMs are listed in Table 3. However, it is important to note that some of the lowest cost or lowest maintenance level SCMs also have some of the lowest treatment capabilities. Using low-cost SCMs could result in a need for additional SCMs to achieve regulatory requirements, thereby increasing costs and maintenance requirements. In addition, several of the lowest cost SCMs may be difficult to integrate into the natural features of a site or may be the least desirable from an aesthetic or safety point of view. Often, a slightly more expensive or maintenance intensive SCM may be a better choice for overall site design. Since land cost will vary from site to site it is not included in the table but should also be considered in the selection of the most appropriate SCM.

Sometimes community and environmental factors seem like the least important, but they can actually have a big impact on the public perception and acceptance of a site development. For instance, a prospective homeowner may think twice before buying a property bordering a large, fenced-in dry extended detention basin with a large corrugated metal riser pipe or next to a constructed wetland due to concerns of mosquitos and their role as disease vectors. However, acceptance might be improved if the SCM served as an aesthetic amenity on the site, possibly with birds, frogs, and fish.

Safety is also of concern in the selection of SCMs. Wet ponds, constructed wetlands, and other SCMs that maintain pools of water may not be appropriate for residential areas, schools, or day care facilities where young children may have access to them. Ponded water and accessible confined spaces such as open culverts and risers should be avoided or fenced to prevent unwanted access.

Similarly, airports must manage stormwater in a way that will not compromise aircraft safety. Many traditional stormwater BMPs SCMs promote standing water that may attract wildlife. Wildlife, including birds and mammals, can be a threat to human safety during takeoff and landing, and stormwater BMPs must not increase that threat. Stormwater BMPs SCM should be selected and designed to minimize habitat and associated risks. Table 4 provides information on each SCM's potential safety concerns, community acceptance, and wildlife habitat.

Table 3: Potential Siting Constraints for SCMs

SCM	Size of Drainage Area	Space Needed	Stage Allowed	Works with Steep Slopes	Works with Shallow Water Table	Works with Shallow Depth to Bedrock	Works with High Sediment Input	Works in Poorly Drained Soils
Bioretention without Underdrain	S	L	Low	Y	N	N	N	N
Bioretention with Underdrain	S	L	Low	Y	N	N	N	Y
Stormwater Wetland	S-L	L	Low	N	Y	N	Y	Y
Wet Pond	M-L	M-L	High	N	Y	N	Y	Y
Sand Filter	S	S	Medium	Y	N	N	N	Y
Permeable Pavement	S-M	N/A	Low	N	N	N	N	Y
Infiltration Device	S-L	S-L	High	N	N	N	N	N
Filter Strip	S	M	Low	N	Y	Y	N	Y
Treatment Swale	S	S	Low	Y	Y	N	N	Y
Dry Pond	S-L	S-L	High	N	N	N	Y	Y

Table 4: Cost, Community & Environmental Issues for SCMs

SCM	Construction Cost	Maintenance Level	Safety Concerns	Community Acceptance	Wildlife Habitat
Bioretention	Med-High	Med-High	N	High	High
Stormwater Wetland	Med	Med	Y	Med	High
Wet Pond	Med	Med	Y	Med	Med
Sand Filter	High	High	N	Med	Low
Permeable Pavement	Med-High	High	N	High	N/A
Infiltration Device	Med	Med	N	Med-High	Low
Filter Strip	Low	Low	N	High	Med
Treatment Swale	Low	Low	N	High	Low
Dry Pond	Med	Med	Y	Low	Low
Rooftop Runoff System	Med-High	High	N	High	Med