Stormwater Design Guidance - Submerged Gravel Wetlands

Maryland's stormwater management regulations require that environmental site design (ESD) be used to the maximum extent practicable (MEP) to produce runoff characteristics similar to "woods in good condition." ESD integrates natural hydrology, site design, and smaller controls to capture runoff. MEP is defined in the Code of Maryland Regulations (COMAR) as designing stormwater management systems so that all reasonable opportunities for using ESD planning techniques and treatment practices are exhausted and, only where absolutely necessary, a structural best management practice (BMP) is implemented.

There are two main aspects to ESD that should guide site design. The first includes distributing micro-scale practices uniformly throughout the development to provide treatment close to the source of runoff. The second and more important aspect is mimicking natural hydrologic conditions, which means choosing ESD practices that accomplish this function. Designs that do not meet either of these criteria may not qualify as ESD to the MEP.

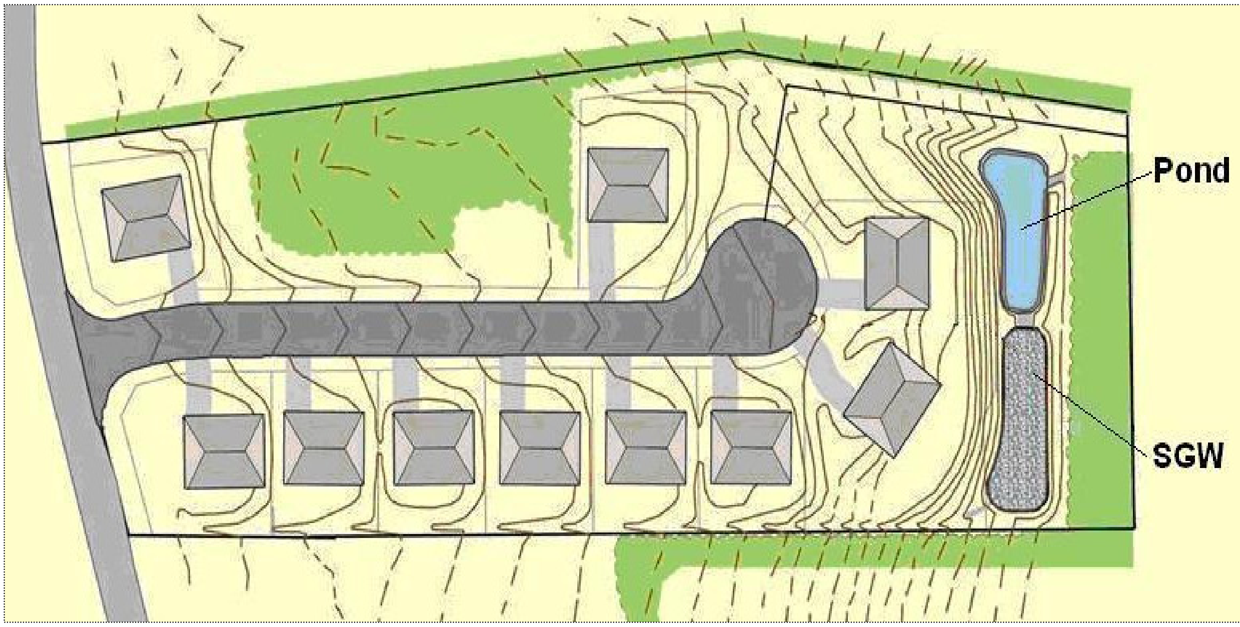
A submerged gravel wetland (SGW) is a micro-scale practice but there is no drainage area limitation. Consequentially, there have been situations where a SGW is not used appropriately and may not be called an ESD practice. Examples of this include using a single SGW in place of other practical ESD options, installing a gravel wetland on hydrologic soil groups (HSG) A or B, or using a liner to ensure a permanent pool. This guidance will explain, by use of two designs, how this practice needs to be used in conjunction with other ESD techniques. The following design guidelines are critical for proper implementation of a SGW to qualify as an ESD practice:

- SGW needs to be used exclusively on C or D hydrologic soils.
- SGW is best suited for soils with high groundwater table or poorly drained soils (e.g., Maryland's Eastern Shore).
- SGW implementation on a site should not exclude the use of other ESD options. Using one SGW to meet all ESD requirements, because it does not have drainage area limitations, undermines the MEP mandate to mimic local hydrology and distribute runoff controls uniformly across the site.
- Only the above ground storage volume may be used for credit toward ESD treatment[1].

<u>Design 1:</u> Figure 1 illustrates the first design of a residential subdivision site plan where ESD volume (ESD_v) and 2-year peak management are required. The project proposes a gravel wetland to treat runoff and a stormwater pond is provided for the remaining volume. This design does not meet the MEP goal because:

- All reasonable opportunities for implementing small-scale ESD practices were not exhausted, thus creating the need to install a structural BMP.
- Other options to improve site design such as impervious area reduction, resource conservation (e.g., vegetation, drainage patterns, and soils) were ignored.

Figure 1. First Design of the Residential Subdivision Site Plan that does not meet ESD to the MEP.



The Maryland Department of the Environment (MDE) did calculations to determine the target ESD_v and 2-year peak discharge. These determinations are shown below. It should be noted, however, that these calculations are based on estimated site data and some values are assumed.

- Site characteristics:
  Total site area = limit of disturbance = 3.5 acres = 152,460 ft^2
  Soil Type = 100% HSG 'C' and RCN = 80 (Manual, Table 5.3)[2]

- Total Imperviousness:

Road	=	12,000 ft^2
Driveways (10)	=	3,600 ft^2
Cul-de-sac	=	2,826 ft^2
House size (10)	=	20,000 ft^2
TOTAL	=	38,426 ft^2

- Percent imperviousness (%I) = 25%

- Calculating Target ESD_v:
  Target P_E = 1.4 inches and R_v = 0.275 (Manual, p. 5.25)[2]
  Target ESD_v = 4,892 ft^3 (Manual, p. 5.25)[2]

- Calculating 2-year peak discharge by "Change in Runoff Curve Number Method"[3].
  P_2 = 3.25 inches (TR-55, Table 2.2)[4]
  Q_2 = 1.445 inches (TR-55, p. 2.27)[4]
  $Q_E = (P_E) \times (R_v) = (1.3) \times (0.275) = 0.36$
  $Q = Q_2 - Q_E = 1.08$
  Reduced RCN = CN* = 74; RCN for woods in good condition = 70
  2-year peak storage volume is: **3,124 ft^3**.

- The total volume to be controlled (Target ESD_v + 2-year peak) = **8,016 ft^3**.

Table 1. Summarizing ESD Volumes from Design 1.

Practice	Dimensions	Volume (ESD_v)
Submerged Gravel Wetland	Area = 4,500 ft^2; 1 ft ponding	4,500 ft^3
Stormwater Pond	-	3,516 ft^3
	Total	**8,016 ft^3**

In Figure 1, the volume of runoff to be controlled is treated by a SGW and a stormwater pond. The total volume provided for Design 1 is shown in Table 1. While the necessary volumes have been met, the design cannot be considered ESD to the MEP for the reasons explained above.

Design 2: Figure 2 shows the modified and improved site design. The dark green enhancements show how ESD may be incorporated by using natural swales, a cul-de-sac island for additional treatment, and how runoff from individual lots can be disconnected and treated.

Figure 2. Second Design of the Residential Subdivision Site Plan that meets ESD to the MEP.

The volume calculations, in Table 2, clearly demonstrate that ESD can be used to treat a much larger volume of runoff as compared to using traditional stormwater BMPs. MDE performed calculations based on the dimensions of micro-scale practices. It should be noted that the volume for each ESD practice is based on the individual drainage area and percent impervious area draining to it.

Design 2 demonstrates that reasonable ESD options may be implemented in conjunction with a SGW. Smaller practices also distributed runoff throughout the site and treated stormwater closer to its source. Also, by using micro-scale practices, the need for the pond was eliminated. Additionally, a SGW is an appropriate ESD practice for this site due to the presence of C soils. This mimics natural hydrology and meets the ESD to the MEP mandate.

Table 2. Summarizing ESD Volumes from Design 2.

Practice	Dimensions	Volume (ESD_v)
Bioretention	Area = 804 ft^2; Filter depth = 2 ft*; 1 ft ponding	1,447 ft^3
Rooftop Disconnects (10)	Area = 2,000 ft^2 each; P_E = 1 inch	1,584 ft^3
Bioswale 1	Area = 500 ft^2; Filter depth = 2 ft*; 0.5 ft ponding	650 ft^3
Bioswale 2	Area = 600 ft^2; Filter depth = 2 ft*; 0.5 ft ponding	780 ft^3
Submerged Gravel Wetland	Area = 4,500 ft^2; 1 ft ponding	4,500 ft^3
	Total	**8,961 ft^3**

* The porosity of the media = 0.4

Conclusion: The goal of ESD to the MEP is met when all reasonable opportunities for implementing ESD are exhausted and structural practices are used only when absolutely necessary. Moreover, the practices used should mimic local hydrologic conditions. A SGW is an ESD practice but it may be used inappropriately because there are no drainage area limitations. Implementation of a SGW on a site should not compromise the intent of ESD to the MEP. A SGW should not be favored in order to eliminate the use of other ESD opportunities. Also, because a SGW needs saturated water conditions, it should be used exclusively on hydrologic soil groups C or D or places with a high groundwater table. Similarly, projects with A or B hydrologic soils need to implement practices that promote natural infiltration such as landscape infiltration. A design is called ESD to the MEP by the use and distribution of appropriate small-scale practices throughout the site.

Resources

[1] UNHSC Subsurface Gravel Wetland Design Specification, June 2009 (http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/unhsc_gravel_wetland_specs_6_09.pdf)

[2] 2000 Maryland Stormwater Design Manual, Volumes I and II, MDE, October 2000 (http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Pages/programs/waterprograms/sedimentandstormwater/stormwater_design/index.aspx)

[3] "Modeling Infiltration Practices Using the TR-20 Hydrologic Program", McCuen, R., MDE 1983 (http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SoilErosionandSedimentControl/Documents/Modeling%20Infiltration%20wTR%2020.pdf)

[4] "Technical Release 55 – "Urban Hydrology for Small Watersheds", United States Department of Agriculture – Natural Resources Conservation Service, 1986