Introduction

In October 2011, the Maryland Department of the Environment (MDE) convened a panel (see Table 1 below) to determine how to evaluate innovative stormwater technologies for compliance with State law and regulations that mandate the use of environmental site design (ESD). Over the next several months, this committee met multiple times to discuss how best to determine what may be considered as ESD. The results of these discussions are presented here.

Any process for evaluating innovative stormwater technologies must be based on a clear understanding of the question "What is ESD?" Both State law[1] and the Code of Maryland Regulations[2] (COMAR) define ESD as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." While capturing the intent of the Stormwater Management Act of 2007 (Act), this definition provides no specific standards for screening whether or not specific techniques or practices are ESD. Before any policy could be developed, ESD standards needed to be established.

Table 1. ESD and Innovative Technology Committee Members

Name	Organization
Brian Clevenger	MDE
Stewart Comstock	MDE
Hye Yeong Kwon	Center for Watershed Protection
Bill Stack	Center for Watershed Protection
Chad Edmondson	Howard County Planning & Zoning
Ted Scott	Stormwater Maintenance, LLC
Tom Pank	BaySaver, Inc.
Stu Schwartz	UMBC-CUERE
Lee Epstein	Chesapeake Bay Foundation
Mark Etheridge	Montgomery County Dept. of Permitting Services
Scott Perry	Imbrium Systems, Inc.

The panel's initial discussions concerned the general nature of ESD and which parameters were considered most critical for practice definition. There was a general agreement that the central tenet of ESD, mimicking natural hydrologic runoff characteristics, means maintaining groundwater recharge and

[1] Environment Article, Title 4, Subtitle 2 Stormwater Management, Annotated Code of Maryland [2] Code of Maryland Regulations (COMAR) 26.17.02

surface flow regimes close to the natural state and minimizing developed areas as much as possible. However, there was less agreement on which parameters are critical with respect to individual practices.

Most panelists agreed that ESD practices should be small-scale or limited in extent. Yet, there were different reasons offered to support this condition. Maintaining groundwater recharge at predevelopment levels was the most common reason. In natural conditions, groundwater recharge occurs over the entire site. ESD practices must be distributed across the developed areas as much as is practical to mimic these conditions. Additionally, limiting drainage areas to individual practices was essential in meeting another basic aspect of ESD, treating runoff closer to the source.

Further discussions focused on these two parameters, drainage area limits and groundwater recharge, that were identified as important aspects of ESD. With respect to limitations imposed on drainage area, there was a consensus that these are a function of mimicking natural hydrology. In natural conditions, rainwater gathers in smaller areas like swales, vernal pools, and on the forest floor where it infiltrates into the ground or slowly flows into small streams. If ESD practices are to recreate these conditions, then drainage areas to individual practices should be small (generally less than an acre) and runoff either infiltrated into the ground or slowly released into receiving waters. However, given the limited information available on what drainage area limitations are appropriate, it was suggested that the current limits, which typically restrict drainage areas to one half acre or less, found in Chapter 5 of the 2000 Maryland Stormwater Design Manual[3] (Manual) should apply until better information is available.

With respect to groundwater recharge, there was a consensus that this parameter is already addressed in COMAR and in Chapters 2 and 5 of the Manual. If ESD is implemented to the maximum extent practicable (MEP) across a site as required, then it is likely that recharge requirements are met as well. There are a small number of approved ESD practices (e.g., green roofs, submerged gravel wetlands) that do not provide recharge. While it is a critical component of every stormwater management plan, the groundwater recharge requirement applies to the design of the site as a whole (e.g., a systems approach) and not necessarily to individual practices. Where individual practices, including innovative technologies, do not provide recharge, additional practices should be used to compensate for any recharge lost.

In summary, the panel agreed that ESD encompasses conserving natural resources (e.g., drainage patterns, soils, and vegetation), minimizing developed areas, and reducing runoff volumes to more closely mimic natural conditions. There was also agreement that of these, mimicking natural conditions is more important when screening innovative technologies. Finally, the panel reached consensus that a series of practices could be interconnected in a "systems approach" to meet the ESD to the MEP mandate. MDE must build upon this consensus in the policy for reviewing innovative stormwater management technologies.

[3] 2000 Maryland Stormwater Design Manual, Volumes I and II, MDE, October 2000 and May 2009

Innovative Technology Policy

The State stormwater regulations (COMAR 26.17.02.08) list the measures (see Table 2 below) that may be used to meet new development stormwater management requirements. These practices are divided into three groups: alternative surfaces; nonstructural practices; and micro-scale practices. Additionally, MDE may approve alternative measures, including innovative technologies, for new development runoff control provided the performance criteria found in the Manual, discussed below, and listed in Table 3 are met.

Table 2. ESD Treatment Practices

Alternative Surfaces		
	Green Roofs	Reinforced Turf
	Permeable Pavements	
Nonstructural Practices		
	Disconnection of Rooftop Runoff*	Sheetflow to Conservation Areas*
	Disconnection of Non-Rooftop Runoff*	
Micro-Scale Practices		
	Rainwater Harvesting	Micro-Bioretention
	Submerged Gravel Wetlands	Rain Gardens
	Landscape Infiltration	Swales
	Infiltration Berms	Enhanced Filters
	Drywells	

*Note: These measures are achievable only through natural means and are not included in this policy.

Alternative Surfaces

MDE currently recognizes three groups of alternative surfaces: (1) green roofs; (2) permeable pavements; and (3) reinforced turfs. Innovative technologies that can be classified into one of these three groups may be used as an alternative surface if:

- The technology is designed and maintained in accordance with the design guidance and criteria for the appropriate alternative surfaces found in Chapter 5 of the Manual;
- Construction and materials meet the specifications found in Appendix B.4 of the Manual; and
- All structural components (e.g., paving blocks, drainage mats) and planting media conform to the industry standards (e.g., ASTM, AASHTO, ACI).

MDE currently assigns a runoff curve number (RCN) to each alternative surface based on how the surface performs over a range of rainfall events. These curve numbers were estimated from a simulated routing of design storms using Natural Resource Conservation Service (NRCS) hydrologic models. A similar analysis may be required if an innovative or proprietary alternative surface system deviates from the specifications listed in the Manual.

Micro-Scale Practices

Micro-scale practices are small water quality treatment measures that are used to capture, treat, and slowly release the runoff volume from discrete areas. These measures often use natural systems, vegetation, and soils and may be used individually or interconnected in a system to address the ESD sizing criteria. Most of the micro-scale practices resemble the larger structural practices (e.g., infiltration and filtering systems) listed in Chapter 3 of the Manual, and accordingly, share similar performance criteria.

Performance Standards: In October 2000, Maryland adopted a unified approach for sizing stormwater management practices. This approach required capturing specific volumes of runoff to meet pollutant removal goals, maintain groundwater recharge, and reduce channel erosion in receiving streams. Performance and sizing criteria for the water quality, groundwater recharge, and channel protection volumes (WQ_v, Re_v, and Cp_v, respectively) are presented in Chapter 2 of the Manual. With the implementation of ESD in 2009, the WQ_v, Re_v, and Cp_v were combined into the environmental site design volume (ESD_v). The performance criteria for the WQ_v, Re_v, or Cp_v also apply to those stormwater measures and/or systems of measures that are used to address the ESD_v.

Type I Practices: Innovative practices that are designed and constructed according to the methods and specifications found in Chapter 5 of the Manual may be used for addressing ESD requirements. To facilitate the product review process, MDE requires the following:

- Product information including all pertinent design standards and specifications;
- Projected maintenance requirements and procedures; and
- Information demonstrating compliance with the design guidance listed in Chapter 5.

After MDE's confirmation that a proprietary product conforms to the design guidance for one of the generic ESD practices found in Chapter 5, that product may be used and is subject to any requirements or restrictions specific to the generic practice.

Type II Practices: Innovative stormwater management technologies that do not conform to the methods and specifications found in Chapter 5 may still be considered for use as stand-alone practices or within a system of ESD practices. MDE will base this determination on how well the innovative practice mimics natural conditions and compares with the general performance standards (see Section 1.2) and sizing criteria listed in the Manual and discussed below.

- **Recharge Volume (Re_v).** Groundwater recharge must be maintained across the site and should be distributed across the developed area as much as practical to mimic natural conditions. Innovative practices that do not meet the water quality volume criteria (see below) may be used to address recharge if capable of maintaining the average annual recharge conditions for the drainage area being treated. Innovative practices that do not provide recharge may be acceptable as part of a systems approach provided that the recharge requirement is addressed elsewhere. However, innovative technologies that will be used as stand-alone practices must be capable of addressing the recharge volume.

- **Water Quality Volume (WQ_v).** The water quality volume is the runoff from 90% of the average annual rainfall over the drainage area. To be considered an effective practice for meeting the water quality treatment criteria, an innovative practice or system of practices shall be capable of removing 80% of the average annual post-development total suspended solids (TSS) load and 40% of the average annual post-development total phosphorus load (TP). Compliance with this standard is presumed if a practice or system of practices is:

  - Sized to capture and treat at least the volume of runoff from one inch of rainfall (i.e., WQ_v);
  - Constructed properly; and
  - Maintained regularly.

- **Channel Protection Volume (Cp_v).** To protect receiving stream channels from erosion, ESD shall be used to the MEP to reduce runoff from the one-year 24-hour storm event to levels reflecting forested conditions. The rationale for this is that runoff will be captured, stored, and released in such a gradual manner that critical erosive velocities will seldom be exceeded in receiving waters.

  ESD practices must be used to the MEP to capture, store, and gradually release the runoff volume from the rainfall target, or "P_E" that is used to determine ESD_v. Most of the ESD practices (e.g., infiltration and micro-filtering systems) listed in the Manual incorporate features that capture, store, and slow down runoff so that discharge levels are similar to those resulting from 24-hour extended detention of the one-year 24-hour design storm (see Appendix D.11 of the Manual). Accordingly, where these practices are used, either separately or as a system, there is reasonable assurance that Cp_v has been addressed. However, there are ESD practices that do not capture and/or slowly release runoff at levels acceptable for addressing Cp_v. Practices or innovative technologies that are not designed to meet the Cp_v requirements may be used provided they are part of a system or treatment train of practices that captures, stores, and slowly releases the required volume of runoff at rates meeting the channel protection flow criteria.

- **Drainage Area Limitation.** As discussed above, drainage areas to individual ESD practices should be limited in size in order to mimic natural hydrology. Therefore, an innovative practice is subject to the same drainage area limitations as the most comparable micro-scale practice found in Chapter 5.

- **Maintenance.** All micro-scale practices must be kept in good working condition to ensure long-term performance. Therefore, micro-scale practices shall have an operation and maintenance plan. Additionally, there shall be direct access to filtering media and other features requiring regular maintenance and/or replacement.

All of the above criteria must be met to be considered as a stand-alone ESD practice. When that is not the case, MDE will consider which criteria are achieved and apply conditions in the approval to assure that overall ESD goals are met. For example, an innovative technology that addresses recharge only will be allowed to be used as part of a system that, as a whole, addresses the remaining ESD requirements. To facilitate the product review process, MDE requires the following:

- Product information including all pertinent design and construction standards and specifications;
- Projected maintenance requirements and procedures; and
- Information, including supporting calculations, demonstrating conformance with the applicable Re_v, WQ_v, and/or Cp_v performance standards and/or design criteria.

Conclusion

When considering a development plan, the ESD and Innovative Technology Panel agreed that meeting the ESD goal of mimicking natural hydrology across the site was more important than ensuring that each innovative technology is capable of addressing the full suite of criteria. The panel also agreed that ESD to the MEP means that ESD measures must be more naturally distributed across a site to more effectively accomplish this goal. There is, however, a practical balance between the widespread use of numerous small-scale measures and centralized stormwater management in one or two facilities that cannot mimic natural conditions. Where this balance lies depends on existing site conditions (e.g., urbanized vs. rural lands) and proposed development patterns. In any situation, designing a site to protect natural hydrology by taking advantage of existing drainage features is essential for meeting ESD goals.

Table 3. Requirements for Innovative ESD Technologies

Recharge Volume (Re_v):
All practices or systems of practices must:
• Be capable of addressing Re_v for the drainage area served
Water Quality Volume (WQ_v):
All practices or systems of practices must:
• Capture and treat at least the runoff from one inch of rainfall • Have an acceptable longevity rate in the field
Channel Protection Volume (Cp_v):
All practices or systems of practices must:
• Capture, store, and slow down runoff so that discharge levels are similar to those resulting from the one year 24-hour design storm under forested conditions (see Manual, Appendix D.11).
Drainage Area:
• Limited to the drainage area of the most comparable micro-scale practice (see Chapter 5)
Maintenance:
All practices must have:
• An Operation & Maintenance (O&M) Plan • Direct access to features (e.g., media) requiring regular maintenance

If there are any questions concerning this policy, please contact the Maryland Department of the Environment, Water and Science Administration at 410-537-3543 or www.mde.state.md.us.