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128 Cockeysville Road, Suite 300, Hunt Valley, Maryland 21030 | phone 410.785.0875 | fax 443.269.0216 | tes@mdswm.com
www.mdswm.com

Green Metrics and Stormwater Management Design

Christina Muzquiz, RLA, LEED AP
Theodore E. Scott, PE, CPESC, LEED AP

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ABSTRACT

The success of implementing green metrics in stormwater management design is dependent upon involving the designer at the inception of the site design process in addition to the client's goals and program. The ability to provide well thought, well researched and defendable stormwater management design solutions is contingent upon the entire design team's flexibility and ability to work collaboratively to generate solutions that meet, and perhaps, exceed the green metrics in play.

Our experience working with clients with varying levels of commitment to green development on a variety of projects, whilst coming into each project at differing times within design development time frame illustrates many of the successes and pitfalls of green metrics and how they inform stormwater management design. The review of three case studies demonstrates how green solutions are possible within Maryland's existing state stormwater legislation. One project's design solutions fall completely within the prevue of Maryland's Stormwater Management Design Manual. Another project required us to push the design criteria of Maryland's Stormwater Management Design Manual due to site and project constraints. Lastly, another project had the goal of surpassing Leadership in Energy and Environmental Design (LEED) and any other applicable green state or county metrics. These varying projects, with varying levels of commitment to green site design, illuminate the challenge of designing stormwater management systems with metrics that are only as good as their client's commitment to the metric and to an integrated, collaborative site design process.

CASE STUDY 1 – MEET REGULATORY CRITERIA

The 2000 Maryland Stormwater Design Manual offers a variety of structural and non-structural design solutions for providing stormwater management. The use, acceptability and approval rate of these solutions varies from county to county within the state, but if designed per the manual's specifications, a multiplicity of practices can be used, approved and built to manage post-development run-off. Our goal when working on traditional development projects is to create site solutions within the prevue of the Maryland Stormwater Design Manual that disperse treatment throughout the site reducing the need for a single, large, "end of pipe," concentrated solution.

Many of the non-structural and landscape based solutions within the Maryland Stormwater Design Manual, such as: Rooftop Disconnection, Non-Rooftop Disconnection, Sheet Flow to [Environmental] Buffer, Raingardens, Grass Channels and Natural Area Conservation, are "green" in concept and intent. They are designed to slow and treat post-development runoff, preserve existing environmental features or areas, and minimize the disturbance generated by structural stormwater management solutions. Traditional residential subdivisions, while not

particularly green in concept or design, can employ the techniques within the Maryland Stormwater Design Manual and provide environmental benefit.

One such subdivision is a 40-acre existing farm. Aside from the existing house (which will remain), the driveway and associated outbuildings, the site is primarily meadow and woods. Its location is approximately ¼ mile from the Middle Patuxent River in Howard County, Maryland. It is located on a ridgeline with drainage flowing in two primary directions. The proposed development includes 14, roughly 1-acre lots, served by a public road, well and septic systems.

Our process is to first look at the drainage divides of the proposed site, and more specifically within those divides, look at the possibility of treating the impervious areas (roofs and driveways) with grading techniques that apply non-structural practices, specifically the Rooftop and Non-Rooftop Disconnection options. Where the project does not meet the criteria for disconnection—maximum of 5% slope, 75' disconnection length—we explore other non structural options: Natural Area Conservation, Sheet Flow to Buffer, Grass Channel, Dry Swales, and Raingardens. Since our strategy is to look at the least invasive options first, if the project cannot meet the Maryland Stormwater Design Manual's criterion for those practices, the next step is to assess the site's compatibility for on-lot landscape based practices such as Bioretention, also frequently termed rain gardens. Lastly, end-of-pipe structural practices are considered if the others are deemed not feasible within the required criteria. This site was able to meet the criteria for several techniques within each individual drainage divide.

Drainage Area 1 is a small drainage area limited to a portion of the open section public entrance road. We chose to keep this drainage area discreet, instead of exploring the potential to shift it's outfall toward a pond or other end-of-pipe facility, as a more traditional "efficiency-based" strategy would consider. As the section of driveway is short within this drainage area, it was feasible to be treated with Grass Channels only. This minimized the size of the resultant pond required in Drainage Area 2 and maintained the outfall point. This approach treated stormwater runoff from the proposed road while maintaining the existing drainage patterns.

Drainage Area 2 is similar to Drainage Area 1, including a short section of public road. As the road was in fill, grass channels were not feasible. In this case, grading was expanded slightly to facilitate treatment with a non-structural practice, Non-Rooftop Disconnection. As with Drainage Area 1, this area was kept discrete and treated individually to maintain existing drainage structures, in lieu of forcing the drainage to the pond in Drainage Area 3.

Drainage Area 3 included the balance of the public road and four residential lots. Although the road is proposed as open section, the larger drainage areas exceeded the allowable velocities in the grass channels under Maryland's criteria. This necessitated an end-of-pipe practice; a micro-pool extended detention facility. A storm drain system was required to convey flows to the facility location. A forebay pretreated runoff from the storm drain prior to conveyance to the micro-pool. The pond was designed to be offline, with larger storm events bypassing the pond to prevent re-suspension of deposited sediment and pollutants. Maintaining existing drainage characteristics and the implementation of a myriad of practices throughout the site reduced the size of this micro-pool extended detention pond.

The proposed land use in Drainage Area 4 was three residential lots with associated driveways. Here, a combination of three practices was employed: Sheet Flow to Buffer, on-lot Bioretention and Landscape Infiltration Berm. By using a combination of these practices, a single larger facility was avoided. This reduced construction expense and minimized clearing and disturbance adjacent to environmentally sensitive areas.

Drainage Area 5 included four residential lots with private panhandle driveways. This drainage area was particularly challenging due to our desire to keep as much existing forest as possible and the existing steep topography. With the use of Non-Rooftop Disconnection, Dry Swales, on-lot Bioretention and Sheet Flow to Buffer we were able to treat all of the impervious areas on the lots without additional clearing.
Our client's requirement was to create a stormwater management plan that would be approved. As such, their metric of concern was simply the Maryland Stormwater Design Manual. Within the client's program we were able to design a "lightly green" solution by employing multiplicity of practices, both structural and non-structural, that are all within the design guidelines and regulations of the Maryland Stormwater Design Manual.

Our goal: to generate the most integrated and greenest solution possible within the client's program, was achieved by using multiple techniques that minimize clearing and disturbance, disperse the flow of water throughout the site by maintaining existing drainage patterns, limit the amount of concentrated flow, and provide as much environmental and aesthetic benefit as possible.

CASE STUDY 2 – GREEN WASHING

Howard County, Maryland is forward thinking with regard to green practices and requirements for new development projects. With both a Traditional Neighborhood Development (TND) ordinance and a Green Neighborhood Program, Howard County strives to be a leader in Maryland's green development and construction. These ordinances make stormwater management more challenging because of additional site requirements, additional program elements and opportunities for new green design and construction techniques. They are also an incentive for developers. The county uses incentives like fast-tracking the review process and releasing more housing allocations to projects that use their green development metrics.

Inspired by the incentive of a fast-track process on a development site with a long history, a client came to us for innovative stormwater management design. The client's goal for the project was to make it as "green" as possible within the County's TND ordinance. Aside from any site constraints, the TND ordinance presented many challenges because of reduced setbacks, street widths, the creation of alleyways, and additional program elements like courtyards, community areas and open space. The ability to create a more tightly clustered neighborhood within the TND ordinance coupled with its additional site amenity requirements reduced the available site area for stormwater management. This project required an alternative approach to stormwater management, and solutions that most likely would not be delineated in the Maryland Stormwater Design Manual.

Not only was the project a challenge because of the limited available space to integrate stormwater management throughout the site, but the physical site had its own list of limitations. For the best opportunity to achieve a design product with integrated, distributed, "green" stormwater management design, we need to be involved early in the project's site design process. This project, however, came to us after the site design had been completed and ready for submission to the County. The streets, lots, open space areas and lot yields were set. Our task was to generate a stormwater management plan on a 27-acre site with a lot count of 156 units that could not be reduced, along with roads and open spaces delineated per the ordinance requirements. In addition, the site is bounded on two sides by the a sensitive riverine system, steep slopes, and significant swaths of high quality forest and wetland areas.

The task quickly became clear: "green wash" the project. A relatively recent phenomenon, "Green Washing" is defined on Wikipedia.org as: "The term is generally used when significantly more money or time has been spent advertising being *green* (that is, operating with consideration for the environment), rather than spending resources on environmentally sound practices." With little flexibility on layout, yield, and project configuration and the desire to turn the fixed project into a "green" project for public relations and marketing purposes, much of the internal design team agreed that this term applied to this project.

After studying the approved site plan, delineating the drainage divides and performing hydrologic calculations in accordance with Maryland's Stormwater Design Manual, we devised a three-fold strategy: find a way to integrate stormwater management into each home's architecture, locate as many areas as possible to treat the runoff with bioretention facilities, and apply the use of pervious paving. These techniques would be employed to reduce the size of the underground storage facilities that would need to be constructed below the proposed roadways.

One "close-to-the-source" solution was to design bioretention facilities to treat each individual home behind knee-walls at the front and/or back of the structure depending on the grading. The roof downspouts would drain directly into the landscaped facilities. This solution did not meet the criteria of the Maryland Stormwater Design Manual. It violated setback and outfall requirements and depended on the good faith of homeowner's to not remove the systems. Although it could have likely been approved, the potential of review delays were a major concern and prevented implementation of these unique measures.

Other bioretention facilities were proposed in the few open space areas that were down-gradient of impervious areas. However, due to the TND requirement for much of the green space to be available for active use, most of these areas could not be used for stormwater management. Unique linear bioretention was also proposed within the center island of the entrance road. The lack of appropriately located green space and the inability to revise the layout reduced the potential of applying these practices to the site.

Lastly, we explored the potential of using extensive pervious paving systems along alleys, walkways, and roadways. As infiltration is not reliable in this area, some of these systems would drain to perforated storm drain systems in gravel, while others would utilize a sand filter layer to treat runoff. Due to the steepness of the site, further detailed study on potentially complex construction practices would have been required to determine the viability of these concepts. These at-the-source approaches can raise construction costs significantly, are not well established in the industry, and had a significant potential to delay the review process. Accordingly, the owner determined they were not preferred on this project.

Coming to this project very late in the design and approval process seriously curtailed the options available to the client and to us as designers. The Client's objective was to make the project as green as possible on a site and within a project with a multiplicity of constraints, to fit the green in. While we were able to meet our goal of designing a solution that was innovative and as integrated as possible, the effectiveness of the results were limited due to our late involvement in the project process.

CASE STUDY 3 – ZERO DISCHARGE

The client's goal was to be "greener than LEED" and have their site development be zero-discharge. Located in Howard County, Maryland, the client was inspired to be the greenest

development project on all fronts: site design, architecture, materials use and re-use, and stormwater management design. One of the most inspired and exciting projects in the area, it includes a commercial site office building expansion on 1.21 acres. This project is on a minor arterial route in a highly developed area. The existing building was renovated prior to LEED and has many green components: solar harvesting, water harvesting, recycled material content and materials re-use, building re-use, natural day-lighting, etc. The program for the new construction building is to exceed LEED standards, to go beyond platinum certification.

The charge presented to us was to develop a stormwater management design solution that would be zero-discharge. The site needed to be zero-discharge not only for the site, but also for off-site drainage flowing through the site, adding an additional 1.03 acres to the total drainage area. Furthermore, the client desired to treat all of the stormwater runoff, harvest and treat the stormwater for an on-site organic farm, and infiltrate the remaining water. While providing a very committed green program to the design team, the entirety of the green program presented some challenges. Space was the primary issue. To make the farm viable, the maximum amount of available open space was of utmost importance. As such, at-grade stormwater management was not the priority.

Located just over the fall line between the Piedmont Plateau and Atlantic Coastal Plain physiographic provinces, the geology and local subsurface conditions of the site presented both challenges and opportunities. The site was underlain with a layer of nearly impervious clay at depths in the range of 15 feet. Typically this condition would preclude any potential of infiltration and render the hope of a zero discharge site mute. However, beneath the clay layer were coastal plain deposits of sand and gravel with extremely high infiltration rates. The challenge, then, for a zero discharge design became how to economically access the infiltration capabilities beneath the clay layer.

Our solution was to provide pretreatment for the stormwater, at-grade, with an undersized landscaped bioretention facility that would also serve as an outdoor amenity for the building users. Close proximity to the building assured frequent maintenance, which would be required to ensure the undersized device will perform reliably. The water would then filter via an underdrain in the bioretention facility to a cistern. The underground cistern would hold the water which would be used for irrigating the crops in farm production. Water in excess of the volume necessary for irrigation would discharge vertically into a concrete structure connected to a gravel infiltration trench, located below the existing clay layer. A perforated pipe would convey the flows into gravel storage to then infiltrate into the native sand and gravels. The extremely high infiltration rates for the soil beneath the clay layer reduced the footprint of the infiltration trench, thus making it feasible for this solution to be zero-discharge approach without significant excavation.

The success of the stormwater management design solution at meeting the client's goal of a zero-discharge site was able to be met primarily because of the existing infiltration capabilities of the soils on-site. The solution does, however, meet the client's other main goal: harvest the stormwater for farm irrigation. The design team was able to work collaboratively to generate a solution that met the client's goals, despite the difficulty in allocating site area for specific program elements. Each designer became an advocate for their green metric, attempting to secure surface area to create a functional solution that integrated into all of the other systems on-site.

CONCLUSION

Challenges abound when adding green metrics into the stormwater management design process. The metrics directing the project, the client's commitment to executing those metrics in built form, and when stormwater management designers are involved in the project's design and conceptualization are key factors affecting what solutions are possible. Knowing the client's goals and generating your own stormwater management design goal within that process are instrumental in completing the project successfully and to your and the client's satisfaction. Creativity and collaboration are the foundation for solutions that are valuable to the client, aesthetically pleasing for site users, and beneficial to the environment.

BIOGRAPHIES

Christina Muzquiz, RLA, LEED AP

A registered landscape architect and LEED Accredited Professional, Ms. Muzquiz has worked in both landscape architecture and engineering firms providing site design services that emphasize site planning, landscape architecture and stormwater management design that is grounded in site context.

Her approach emphasizes using natural and cultural systems models to inform the design process at both the regional and site scales. Ms. Muzquiz strives to take cues from the landscape, to sustain and enhance the intricate balance between cultural and natural resources, as well as preserve the context and place inherent in an environment. Her experience in the field of Landscape Architecture includes ecological planning and design, stormwater management, and the traditional fields of urban, park and residential design.

Theodore E. Scott, PE, CPESC, LEED AP

Mr. Scott has over 20 years experience in site and stormwater management design and is the owner of T.E. Scott & Associates, Inc. (www.mdswm.com). His experience with most aspects of land improvement design coupled with specialization in stormwater management provides unique insight into the current trends in stormwater management design, maintenance, and construction. He is also the owner of Stormwater Maintenance, LLC (www.swmaintenance.com), a construction firm dedicated to maintaining, repairing, and constructing stormwater management systems. Mr. Scott's firms provide services throughout the Mid-Atlantic with clients ranging from small "Mom & Pop" businesses to Fortune 50 Corporations.