Determination of suitable locations for implementation of green stormwater infrastructures in Lancaster city, PA

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Highlights

1. We propose a method for determining ‘sweet spots’ of green stormwater infrastructure (GSI)
2. The method provided here, is a multicriteria planning approach that considers different social and environmental benefits of the GSI as well as other feasibility elements
3. We consider multiple schemes for weighting the different factors, including weighting based on resident preference and city priorities, and compare resulting ‘sweet spots.’

Introduction

Cities across the US are struggling to better manage stormwater to comply with Clean Water Act standards, as well as to enhance their resilience to projected changes in precipitation under climate change. Many cities are looking to green stormwater infrastructure (GSI; e.g. bioswales, porous pavement) as a strategy to manage these issues but they often struggle to find the resources to best implement GSI. Here we develop a planning algorithm that hones in on ‘sweet spots’ of GSI implementation that are hydrologically optimal, feasible, and provide equitable access to benefits of GSI. We are applying this approach in a Pennsylvania city with multiple stormwater-related challenges, the City of Lancaster. We are building spatial databases of information on a suite of hydrologic, engineering, feasibility and social parameters for the city. We aim for this to be a relatively simple tool that can assist in maximizing benefits of GSI implementation. Combining the criteria layers lead to the final layer which represents sweet spots for GSI implementation.

Methodology

In the hydrologic layer, we identify areas prone to runoff and pollutant generation, using existing high-resolution topography and land cover data. In the feasibility layer, we aggregate city-scale spatial data on cadastral (property) data, which helps to identify most suitable parcels such as public property or vacant lands for GSI implementation. Another layer focuses on social inequity hotspots. We aggregate data from the American Community Survey on parameters such as socioeconomic status, race, and age. We will combine these layers to map ‘sweet spots’ for hydrologically optimal, feasible, and equitable GSI implementation. We weigh the various contributing layers based on multiple approaches, including even weighting, city regulatory priorities, and responses from a choice experiment survey to the residents. The optimal locations, or ‘sweet spots’, identified from each weighting scheme will be compared to understand how the sweet spots differ by prioritization of certain factors.

Key Findings

By applying the sweetsops method mentioned in this paper we can clearly see that in each layer, there are some locations which needed to be prioritized in GSI implementation, considering the limited budgets assigned for these projects. Many of these locations are located in the downtown portion of Lancaster. Insights from comparing the generated maps from each weighting method are pending, as we finalize survey results from residents. This method can act as a strategic method for planning the GSI related projects in the locations where they are most needed. In addition, most of the data used in this method is publicly available.

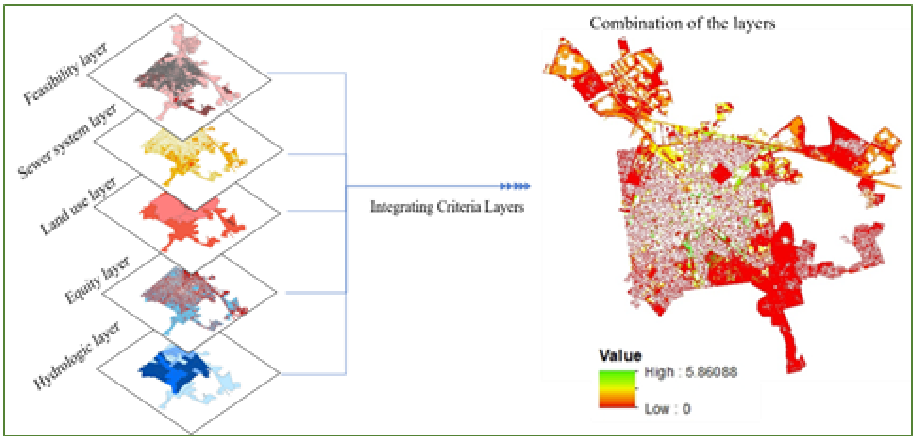

Figure 1. Combination of Feasibility, Sewer system, Land use, Equity and hydrologic layers to create the sweetspots layer

Recommendations

We encourage city planners and stormwater managers to consider a multi criteria GSI planning approach like that proposed. By considering social and property factors in addition to hydrologic and environmental, this can help ensure that GSI has the most benefit to the parts of community who are most in need.

PennDOT Stormwater Control Maintenance Program Collaboration and Training Rollout Statewide

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Highlights

- SCMs often require different maintenance techniques than typical roadside areas.
- Improper training and knowledge can lead to significant SCM damage and costly repairs.
- Maintenance personnel statewide require training and resources to properly maintain PennDOT's SCMs.
- PennDOT has implemented a blended learning approach to train staff on proper SCM maintenance.

Introduction

Stormwater Control Measures (SCMs) are physical features used to effectively control, minimize and treat stormwater runoff. (1) The Pennsylvania Department of Transportation (PennDOT) currently owns over 2,800 SCMs statewide and this number increases yearly with new project construction. Statewide maintenance training has historically focused on standard roadside vegetation and infrastructure management. These typical roadside approaches are typically not wholly applicable to SCMs. Often, well intending personnel following standard roadside procedures inadvertently damage SCMs resulting in costly repairs and regulatory compliance concerns.

Program Objectives

PennDOT's Bureau of Maintenance and Operations (BOMO) developed a comprehensive set of training tools on stormwater control measure (SCM) maintenance for Department maintenance forces. With funding support from the State Transportation Innovation Council (STIC), the blended learning approach consists of a classroom instruction, how-to videos, a field guide, and a Microsoft SharePoint collaboration site.

The classroom, provided virtually or in person, is where maintenance forces participate in instructor-led distance learning consisting of seven core topics. Engagement methods such as polling, chat conversations, full-group discussions, and breakout sessions are utilized to enhance learning. Training will also be adapted for in-person delivery.

BOMO is in the process of creating a SharePoint collaboration site for SCM maintenance, which will be the home for training updates, field guides, and instructional videos. Field guides are one- to two-page illustrated summaries of "do's and don'ts" for common maintenance activities. A library of 13 field guides on common maintenance activities for SCMs has been completed. The instructional videos support the learning objectives in the training by providing short refreshers and expansion on topics, such as pruning and SCM mowing, where special techniques are featured. The first of the training videos was completed for "Mowing SCM Surfaces."

The pilot offering of the training was held in May 2021 in virtual format. Additional offerings are schedule for the fall of 2021. This training in conjunction with the web platform will improve the consistency of proper SCM maintenance, avoid inadvertent damage, and prolonging the lifecycles of PennDOT’s SCMs.

References

Pennsylvania Department of Transportation (2019). Stormwater Control Measure Maintenance Manual, Publication 888, May 2019.

Stormwater Control Measure Design Sizing Under Different Storm Sizes and Periods of Record – A Study of Runoff Capture and Water Quality Sensitivity and/or Success

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Highlights

- SCM design sizing sensitivities under different design storm targets and evaluative timelines
- Comparison and consideration of runoff capture vs. water quality benefits
- Evaluation of differences in performance and programmatic ramifications for different sizing benchmarks

Introduction

Stormwater management programs nationwide have a wide range of aims, goals, and metrics that guide the implementation of effective stormwater management actions. These actions respond to the requirements of local regulations to forge the improvement of watershed conditions with a range of structural and non-structural practices. Structural practices are often accompanied by design standards that have been developed to specifically address the issues needing improvement in a given watershed. Whether the emphasis of a watershed's management strategies are focused on volumetric runoff reductions or if they are based in specific pollutant load reductions, they are almost always accompanied with specific stormwater control measure (SCM) design, sizing, or performance requirements that guide watershed implementation of SCMs in both size and distribution. While grounded in the specific aims of a watershed's management goals, design requirements or benchmarks can lead to very specific watershed prescriptions that don't take in the full range of watershed protection needs that may be required for truly sustainable watershed protection. They can also lock a watershed's protective measures into specific approaches or technologies that may not always be the most impactful or cost-effective.

The two most common SCM design standards are either design storm capture or long-term timeseries performance assessments. Design storm capture standards utilize a given storm frequency size and duration, requiring SCMs to be designed to adequately capture, detain, and treat the runoff associated with the given design storm for a project's drainage area. Long-term timeseries performance assessments size SCMs to treat a certain portion of a drainage area's average annual runoff or pollutant loading over a prescribed number of years to assess a potential SCM's performance across a range of observed climatological conditions. While volumetric runoff capture sizing is also very common, this can also be viewed as a design storm standard of uniform temporal distribution. Each of these approaches to SCM design, guidance, and evaluation can be effective, but they can also result in differently sized BMPs in the same location, different performance effectiveness, and different programmatic recommendations and costs for watershed-wide protective measures when applied to the same locations.

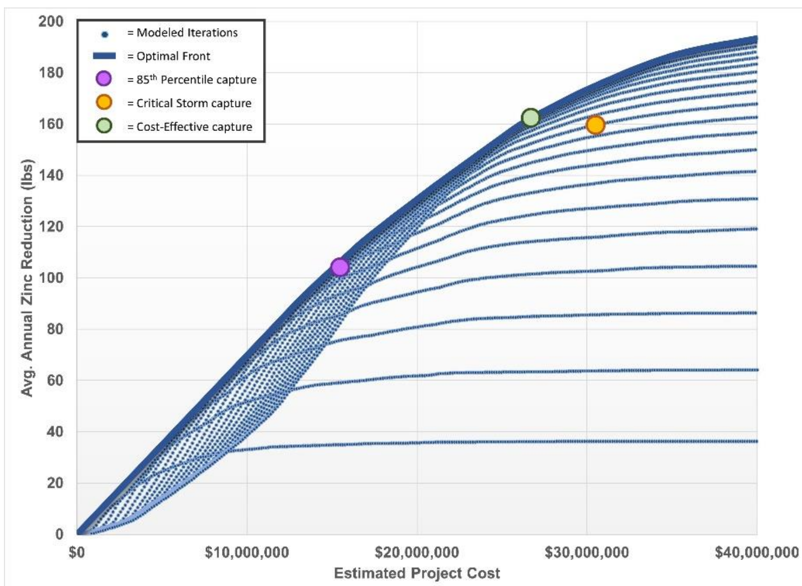

Figure 1. *Different evaluative metrics may result widely different BMP sizes recommended at a single watershed location.*

Methodology

To highlight the differences in SCM sizing and performance under different design evaluation standards and how these criteria influence overall SCM functioning at the singular and programmatic levels, a modeling case study will be utilized with the results serving as fodder for discussion and recommendations. The following key variables will be investigated to fuel this discussion for consideration of sensitivities to these evaluation standards across a range of scales.

Evaluative Criteria

Common design storms used in both East and West Coast locations will be utilized to highlight how BMPs would be sized according to the different climatological regions under differing stormwater management approaches. Long-term timeseries will be utilized from a regional baseline hydrology and water quality timeseries and will be evaluated for time periods of 1-, 2-, 5-, and 10-years of length. Water quality considerations under design storm hydrology will be evaluated for pollutographs that precede, are in phase, and follow the peak of the design storm hydrograph.

SCM Design Sizing & Performance

Both inline and off-line SCMs will be sized and assessed across the evaluative criteria defined above for contributing drainage areas of 10, 100, 500, and 1000 acres of 3 different development compositions (residential, mixed use, dense urban). Design sizes recommended for each evaluative criteria will be assessed for the opposing criteria (design storm vs. long-term) to highlight the differences in size, cost, and performance that might be expected given the specific evaluative criteria used.

Programmatic Planning & Performance

Programmatic recommendations for three 5,000 acre drainage areas of differing development composition will be determined using the different evaluative criteria to fully meet the protective needs prescribed under these different standards. These recommendations will be critically compared according to expected overall program cost, implementation, distribution, and operation. A focus will be made on the difference in projects, project size, and project distribution to inform how these differences might scale up to full watershed planning, decision-making, and implementation.

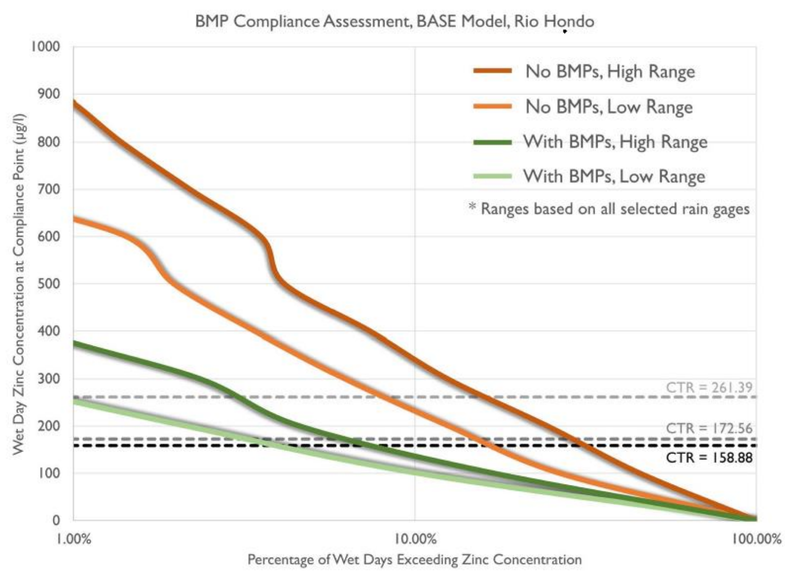

Figure 2. Stormwater control measures needed to reach compliance may vary in distribution and cost needed to impart desired watershed changes depending on the design standards, evaluative metrics, and performance requirements used.

Recommendations

Key recommendations from this study will follow once results are fully developed. These will revolve around SCM design sizing sensitivities under different design storm targets and evaluative timelines and things that watershed managers should consider when focusing SCM strategies around runoff capture or on specific water quality benefits to be achieved. These recommendations will also provide guidance and considerations for scaling evaluative criteria up to the watershed level and any programmatic ramifications that SCM design standards might impart.