Data Collection and Urban Watershed Modeling of St. Louis Bioretention Areas

Claire A. Croley, Missouri University of Science and Technology, Rolla, MO, Graduate Student, cac9p9@umsystem.edu
Robert R. Holmes, Jr, Missouri University of Science and Technology, Rolla, MO, Adjunct Professor, holmesrr@umsystem.edu

Abstract

The lack of a national standard for bioretention area design and maintenance is due to multiple factors, including the natural variation between regions. To understand the factors impacting performance of bioretention projects within the St. Louis area, data collection and watershed modeling will be conducted at selected bioretention sites. The Metropolitan St. Louis Sewer District (MSD) currently evaluates bioretention areas by utilizing a maintenance inspection checklist to compute a score which rates the performance of a site. Owners with bioretention areas registered through MSD will be invited to participate in a special site evaluation, where sites will be: 1) scored using the MSD maintenance inspection checklist, 2) assessed for site properties using both in situ permeability testing, and assorted lab analysis from collected soil samples, and 3) modeled for their hydrology using an urban rainfall-runoff model with historic rainfall values. The results from the field evaluation laboratory testing, and modeling, will be analyzed to determine what factors lead to successful bioretention solutions.

Needs And Motivation

BMPs are a relatively new concept to stormwater treatment and transport, with standard techniques still being developed. The lack of a standardized model for bioretention areas is due to multiple factors, one being the variance in regions and sites. Factors that contribute to variations at sites include temperature, climate, regional flora and fauna, etc.

The National Stormwater Testing and Evaluation for Products and Practices (STEPP) in the US is currently seeking funding in order to produce BMP standards. BMPDB is an international database of BMP testing, but lacks any established design guidance. The Interstate Technology and Regulatory Council (ITRC) states the following to be the cause of this lack of standards:

"To date, there has been a lack of standardized BMP monitoring protocols nationwide, which has resulted in variable quality, representativeness and documentation of individual BMP studies." (ITRC 2018)

There is no standard documentation, yet there arises the need to understand what bioretention areas are best suited for a site.

Study Site

Bioretention sites will be made up of a collection of bioretention areas registered with MSD. A sample size of about 30 sites is desired. Figure 1, displayed below, shows a snipping from the MSD BMP Map Viewer. The active bioretention areas in the St. Louis area are represented by navy circles.

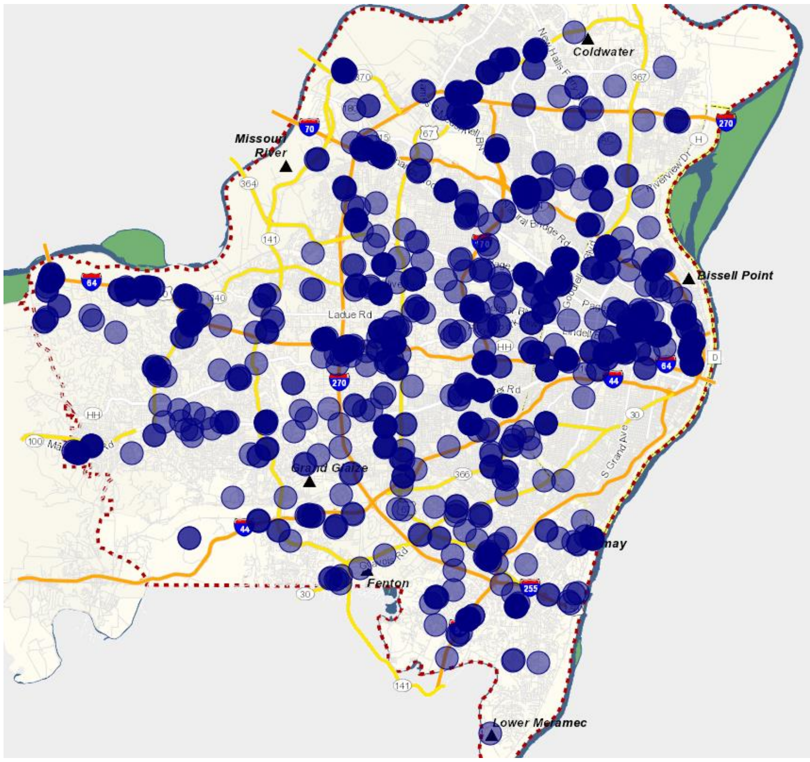

Figure 1. BMP Map Viewer, Active Bioretention Areas in St. Louis Area

To obtain data from bioretention sites, door-to-door invitations will be given to residents who have a bioretention area registered with MSD. These invitations will list what residents should expect from testing and information on how to reach out if interested in testing. Once a satisfactory number of residents have agreed to participate in testing, the data collection will begin.

Data Collection

Potential sites were chosen using MSD's Post-Construction Stormwater BMP Mapviewer. The Mapviewer was, "designed to assist BMP owners and stormwater professionals with locating and identifying stormwater BMPs constructed and approved throughout MSD's Service Area" (Mapviewer). Sites were selected within a pool of privately owned, active bioretention areas.

Door-to-door invitations were given to owners or managing personnel on site. These invitations specified the intent for this research and the data collection to be performed on site. This was also verbally communicated to the owners/personnel; any questions were answered, and a contact email was given to the owners should future questions arise. A total of 20 sites were acquired for data collection.

The BMP checklist, visual data, soil samples, and as-built drawings were collected to understand the unique nature of each site.

To score the sites, the BMP checklist was used to visually score the data. Using the checklist, sites were scored by their different "regions": inlets, pretreatment, treatment area and vegetation, overflow structure, and hazards. Each "region" had certain characteristics that were scored based on the visual judgement of certain characteristics present. To caliber a good understanding of how to score each site, time was spent with MSD employees as they performed walk-throughs of different sites. It was noted that the purpose of this checklist was to determine if the condition of the site met a satisfactory performance. If the site were unsatisfactory, routine or immediate maintenance/replacement would have to be performed.

Photos and notes were taken to document important characteristics of each site. These photos and notes were used for a further analysis of the data once back on campus.

Soil samples were collected from each site. Using a hand auger and shovel, a soil column was taken so to fill the column of a quart-sized plastic bag. This quart-sized plastic bag was sealed so that contaminants do not enter the sample and so that elements of the sample do not escape.

As-built drawings were accessed through Accela, an online database used by MSD to keep records of various sites. Each site is not limited to just as-built drawings; other useful documents that could be present for each site include operation and maintenance documents, design calculations for the basins, vegetation planting guide, and borehole logs.

Experimental Approach for Proposed Work

Data collection will be performed for each bioretention area. Using the MSD maintenance inspection checklist, each site will be scored based on visual characteristics. The types of categories being scored include inlets, pretreatment, treatment area and vegetation, overflow/outlet structure, and hazards. Within each category in the MSD maintenance inspection checklist are sub-categories that help score the respective category. A ranking of 0 to 3 will be given based on the quality of each sub-category. These individual rankings will be used to create an overall ranking for the site.

Outside of the sub-categories found in the MSD maintenance inspection checklist, other variables were chosen based off the scoring criteria found in the checklist and other important criteria not found in the sheet (such as percentage of non-native plants, presence of certain plants, other factors that could be measured based on percentages etc.) These variables and sub-categories will be used in a variable selection model. Statistical Analytical Software (SAS) will be used to build and run the variable selection model.

One variable that will be used in the SAS model is characteristics related to the collected soil samples. This previously mentioned soil sample will later be dried and run through a mechanical sieve on campus. Using the distribution of particles on different meshes of the sieve, a gradation curve will be created for each soil sample. This data will be used to better understand the hydraulic conductivity of the soil.

Another variable used in the SAS model is flow data for each site. To generate flow data, an urban rainfall-runoff model will be created. Site geometry will be created using elevation data from as-built construction drawings. If site characteristics differ from the drawing, then these corrections will be made to the model. Storm data will be collected from historic rainfall values. Different storm events will be tested for each site; such as a 15 year 20 minute rainfall, 2 year 10 minute rainfall, and 100 year 10 minute rainfall.

References

ITRC (Interstate Technology & Regulatory Council). 2018. Stormwater Best Management Practices Performance Evaluation. Stormwater-1. Washington, D.C.: Interstate Technology & Regulatory Council, Stormwater BMP Performance Team.

MSD (Metropolitan St. Louis Sewer District). Post-Construction Stormwater BMP Mapviewer. MSD GIS Department, St. Louis, Missouri.