Case Study of Repairs to Failed Bioretention Systems

Numerous bioretention systems have been installed to comply with the Philadelphia Water Department's Stormwater Regulations. There are key considerations and standard requirements in PWD's Stormwater Guidance Manual to guide design of bioretention basins, but some of these constructed systems have failed to infiltrate through the soil media due to various reasons. The corrective actions and results from multiple projects will be presented. Standard procedures will be suggested for fixing future issues with bioretention systems.

What's the Hold Up? Assessing Inlet Conveyance Issues in Philadelphia's Green Stormwater Infrastructure (GSI)

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Abstract

As part of the Green City, Clean Waters Program, more than 1,278 public green stormwater infrastructure (GSI) systems have been implemented in Philadelphia to date. These systems, implemented over a 25-year long program, aim to reduce combined sewer overflows (CSOs) by managing stormwater through infiltration and detention/slow-release systems. The ability of the system inlets (referred to as green inlets) and perforated distribution pipes to rapidly convey stormwater into the SMP is critical to effective stormwater management. A study by Tu and Traver assessed the conveyance of a single system by calculating the hydraulic head differential between the green inlet and the observation well of the system for a series of storms and found instances of surcharging and bypass in the green inlet before the system reached full storage capacity, suggesting a hydraulic restriction. Based on this initial study, PWD expanded monitoring to 8 systems over 4 years to assess hydraulic head differential and quantify the frequency and severity of surcharging and bypass. The design characteristics of these systems and the GSI maintenance regimens are being evaluated alongside the monitoring data to identify causes of the hydraulic restriction. Results showed a significant correlation between storm events where surcharging and bypass occurred and the design of the system. This monitoring effort aims to assess inlet conveyance over time and provide data informed recommendations to PWD's GSI design and maintenance teams to optimize GSI performance.

References

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Cracking the Code: Developing GSI Analysis Tools with No Formal Training

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Abstract

The Philadelphia Office of Watersheds (OOW) performs broad-based monitoring and analysis of its GSI portfolio. At a glance, its dataset includes some 600 sensor-years of time series data, hundreds of thousands of calculated performance metrics, and tens of thousands of field operation records. The scope of the Monitoring, Analysis and Research Support (MARS) Group has grown immensely since its inception, but its staff of permanent employees has increased only from 3 to 6. How, then, has MARS maintained its grasp on the performance of Philadelphia's GSI when its team is dwarfed by the immensity of its portfolio?

MARS has developed a series of software tools that have greatly eased the administration and analysis of its monitoring efforts. Rather than putting a multimillion-dollar contract out to bid for custom software tools, MARS has developed custom tools in-house with open-source software. The software portfolio includes a PostgreSQL database, a library of analysis tools, a collection of web apps, and battery of data management scripts. MARS employees have no formal training in software development or database administration, but all necessary skills and best practices were freely available from reliable online sources. This skill expansion has paid immense dividends for OOW – millions of contract dollars saved, and powerful analysis capabilities obtained.

These tools – open-source database and analysis software – see extensive use in top companies across many disciplines. Through creative application of them, OOW has enabled itself to monitor and analyze its GSI portfolio in ways that would otherwise be impossible. The tools have assisted in marshalling limited resources, investigating novel problems, and allowing analysts to focus on policy-relevant tasks instead of the drudgery of data management. These same benefits are available to your agencies and firms; through technology overviews and case studies of their use, MARS will show you how to implement them yourself.

Fill it up! Construction-Phase Testing of Fully Lined GSI Systems

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Abstract

Since 2020, the Philadelphia Water Department (PWD) has conducted construction phase testing of fully lined GSI systems to improve liner performance, minimize risks to public health and safety, and prevent costly post-construction repairs. This presentation will provide an update since the 2022 Villanova Symposium on the exponential growth in the testing program and the continued improvement in liner performance. Liner performance testing consists of deploying water level sensors, filling the system with water, and measuring the rate at which water leaves the system. The recession rate is currently reported against a 1 inch/hour performance standard to determine pass or failure. If the test fails, the contractor must make repairs and a retest is conducted until a passing result is achieved. In 2022, the initial liner testing pilot program was concluded and 2023 saw a tenfold increase in testing as construction of GSI ramped up. As of March 2024, over 200 tests have been conducted on over 125 fully lined systems. Test results have improved markedly such that recession rates are well below the 1 in/hr standard. PWD is utilizing the results from the first four years of liner testing to develop updated liner testing and design standards to further decrease the risk of leakage from fully lined GSI systems moving forward.