

INTRODUCTION

Background

Pittsburgh Water and Sewer Authority (PWSA, or Authority) is committed to Green Infrastructure (GI) and has been developing a “Green First” program, which involves consideration of implementing GI first to capture stormwater at its source to maximize overflow reduction and the myriad of associated local community benefits, often referred to as Triple Bottom Line (TBL) benefits. This “Green First” approach can then inform the necessary implementation of associated gray infrastructure, such that when coupled together into an Integrated Plan, can meet both the City’s and potentially the region’s similar Consent Orders, and overall short-term and long-term Clean Water Act requirements. In this context, gray infrastructure, often referred to as traditional infrastructure, is composed of man-made, engineered components of a system. In the context of stormwater management, gray infrastructure can include gutters, storm sewers, tunnels, culverts, detention basins, pipes, and mechanical devices used collectively in a system to capture and convey runoff. As land developed and cities grew, gray infrastructure was introduced to move stormwater away from homes, businesses, and streets as quickly as possible during a storm. Pavement, pipes, gutters, and mechanical systems, while necessary, can cause significant stormwater management problems since they prevent natural infiltration processes and speed water movement. Since most gray infrastructure is impervious to water, it can contribute to flooding and pollution, which can add to the cost burden of the local community and government. With factors such as increased development contributing to increased runoff, and increasing intensity and frequency of recent and projected storms, not only in Pittsburgh but across the country, this problem will only increase in the future.

GI is defined as ecologically engineered measures that reduce and treat stormwater at its source while also delivering environmental, social, and economic benefits. GI uses vegetation, soils, and other elements to restore some of the natural processes required to manage water locally and create healthier urban environments. At the city or county scale, GI is a patchwork of natural areas that can provide habitat, flood protection, cleaner air, and cleaner water. At the neighborhood or site scale, GI is comprised of stormwater management systems that mimic nature to soak up, store, and either remove or detain water for slow release to a local waterway or back into the sewer system. The numerous benefits of GI also include adding green space to the city street environment, improving air quality, reducing energy demand, and enhancing wildlife habitat and recreational opportunities.

PWSA’s “Green First” program involves exploring and implementing innovative ways to reduce stormwater runoff, reduce combined sewer overflow (CSO) and sanitary sewer overflow (SSO), improve in-stream water quality, reduce localized surface flooding, reduce basement sewage backups, restore habitats, enhance urban settings, and stimulate economic growth.

During 2015, PWSA invested more than \$1 million in projects that have the designed capacity to control 3.7 million gallons of stormwater annually. The Authority introduced the Green Infrastructure Grant Program in 2015, and its primary focus is to encourage the development of more GI in Pittsburgh. The Authority seeks to inspire GI projects that will have multiple benefits, such as managing stormwater runoff, increasing infiltration to the ground, reducing peak flows to streets and storm sewers, improving water quality, and helping to protect people and property

from flooding. Protecting and enhancing stream corridors and other green spaces can be an important component of an overall strategy for the City, helping create a place that people want to live, work, and play.

In 2015, ten grants were awarded through the Green Infrastructure Mini-Grant Program, and seven grants were awarded through the Green Infrastructure Matching Grant Program, resulting in 17 new GI projects underway in Pittsburgh. In spring 2016, PWSA announced GI Grant Program recipients, composed of three mini construction grants, three mini education grants, and seven matching grants.

In 2015, PWSA was tasked by the Mayor of the City of Pittsburgh with evaluating the benefits of incorporating extensive hydraulically-connected and cost-effective GI implementation throughout the City of Pittsburgh (City) that could be incorporated into a “Green First” Plan of green and gray infrastructure to address regulatory requirements as well as provide triple bottom line (TBL) benefits. This work started with the Shadyside/A-22 Sewershed Flooding Solutions and Green Infrastructure Assessment (Shadyside Flooding Assessment) completed in November 2015. The Shadyside Flooding Assessment evaluated gray, green (source control), and watershed scale (or combinations thereof) infrastructure solutions to reduce reoccurring surface flooding and basement sewage backups in the sewershed during intense rain events in the Maryland/Negley/College Avenue study area, as well as the larger overall A-22 combined sewershed. The Shadyside/A-22 Flooding Assessment determined that existing sewer system improvements, coupled with GI alternatives, could cost-effectively reduce localized surface flooding, basement sewage backups, and CSOs, and could be optimized when coupled with proposed improvements to the existing sewer infrastructure as outlined in PWSA’s wet weather feasibility study. This approach could also have positive effects downstream of these system improvements, in the regional sewer system, by reducing peak flows and combined sewage volume.

With these outcomes from the Shadyside/A-22 Flooding Assessment, the City-Wide GI Assessment was developed to analyze the benefits of GI if implemented in targeted areas across the combined sewer system within the City and the hydraulically connected surrounding municipalities.

There were several drivers for implementing this project, and PWSA and City leaders recognized that implementing a Green First stormwater management program could address multiple issues facing the City and surrounding municipalities, such as:

- Chronic surface flooding and associated hazard areas.
- Direct Stream Inflows (DSI), which are surface streams that flow into the combined sewer system contributing to extraneous flows, lost sewer system capacity, high loads of sediment and debris in the existing deep tunnel interceptors, and increased conveyance and treatment costs.
- Poor water quality and recreational opportunity enhancements.
- Urban planning and the City’s ongoing resilience initiatives.
- Regulatory requirements.
 - The Consent Orders and Agreements (COAs) for wet weather overflows expired on March 30, 2015. The COAs required each municipality in ALCOSAN’s service area to prepare a Feasibility Study to address work required to bring

- sewer systems into compliance with the Pennsylvania Clean Streams law, the Clean Water Act, eliminate SSOs, and fulfill the Pennsylvania and U.S. Environmental Protection Agency (USEPA) CSO Policy obligations, with facilities implemented by 2026. PWSA is moving forward with its Adaptive Management approach. PWSA has defined Adaptive Management as an iterative approach to decision-making and project implementation to meet overall regulatory requirements with opportunities to adjust decisions and projects in light of subsequent monitoring and assessment of projects, and learning and knowledge gained of the in-stream water quality and sewer system's performance.
- o In fall 2015, the regulatory agencies issued Consent Orders and Agreements (COAs) to 82 municipalities in the ALCOSAN service area, which require evaluation by December 2017 of the effectiveness of source reduction and GI in reducing CSOs and SSOs. The City and PWSA received similar mandates through an USEPA Section 308 Information Requirement letter from the USEPA in January 2016.

Previous Wet Weather Studies

In its 2013 Wet Weather Feasibility Study Report (WWFS), PWSA recommended including a combination of GI and gray infrastructure, to capture and manage a significant amount of stormwater before it reaches the sewer system. PWSA submitted its WWFS to the regulatory agencies in July 2013. The WWFS outlined a five-phase program for reducing CSOs and eliminating SSOs. PWSA's WWFS included the four-year Adaptive Management Plan; improvements to existing infrastructure; increased conveyance capacity in 14 sewersheds for which PWSA's existing collection system could not adequately convey all typical year flows to the ALCOSAN interceptors; diversion structure modifications; and, outfall screen installations. The capital cost estimate was \$170 million (2012 dollars) and most of the work (all except the work in the Saw Mill Run Basin) was planned to be implemented through 2026. This represented the increased conveyance needed within the 14 sewersheds. The approach assumed that all combined sewer flows would be conveyed to the ALCOSAN interceptors (generally with most outfalls controlled to a level of four overflows per year), and that the new regional tunnel planned by ALCOSAN (not included in PWSA's cost estimate) would be needed as additional conveyance and storage capacity to convey the combined sewage flows to the wastewater treatment plant.

In 2013, PWSA also prepared Greening the Pittsburgh Wet Weather Plan, which provided an approach to reviewing, recommending, and incorporating a plan for the implementation of GI technologies and policies into PWSA's Wet Weather Feasibility Study.

The PWSA Feasibility Study Draft Report was produced in October 2008, and the results presented were developed from combined sewage alternatives analyses from the CSO Long Term Control Plan project conducted from 2002 to 2008. CSO control alternatives for PWSA's outfalls were composed of gray infrastructure techniques such as a tunnel system, sewer separation, and subsurface storage. The total capital costs developed for the entire PWSA sewer system ranged from \$1.43 billion to \$1.58 billion, based on 2007 cost data. These capital costs escalated to 2016 dollars would be approximately \$1.65 billion to \$1.82 billion.

Purpose of This Study

The primary objectives of the City-Wide GI Assessment included:

1. Analyzing 30 combined sewersheds that are currently associated with the planned ALCOSAN plant capacity increase and new tunnel, to determine the site locations within the City, both public and private rights of way, which are most effective at capturing high volumes of stormwater runoff and are the most suitable for GI implementation. These locations are referred to as “high yield drainage areas” and City-Wide GI stormwater overlay maps were developed for these 30 priority sewersheds. The stormwater overlay, discussed in Section 3, is intended as a lens to guide and inform future capital improvement projects and urban planning decisions in the City.

Analysis of the combined and sanitary sewersheds beyond the initial 30 sewersheds will be conducted, as needed, following completion of this City-Wide project, as part of PWSA’s Source Reduction Study scheduled to be completed by December 2017.

2. Outreach activities, in collaboration with the Mayor’s office, other City departments, municipal representatives, regional organizations, multi-municipal organizations, and others to collaborate and coordinate the GI Assessment work with other ongoing new and redevelopment and resilience initiatives. Numerous watersheds throughout the City are influenced by flows from other adjacent municipalities.
3. Evaluating the feasibility and cost-effectiveness of separating and daylighting streams that currently flow into the combined sewer system.
4. Identifying and quantifying the associated benefits of the identified GI implementation and stream daylighting to include:
 - Combined sewer overflow mitigation,
 - Flooding hazard mitigation at flood prone areas within the sewer system and local streams,
 - Opportunities to align urban planning initiatives with GI implementation, and,
 - Triple bottom line financial, socioeconomic, and environmental analysis.

The overall objective is to consider “Green First”, that is, to develop a cost-effective use of GI technologies and to highlight the associated benefits compared to the sizing and performance of gray infrastructure options that have been considered.

Related Projects in the “Green First” Program

The City-Wide GI Assessment is a project that parallels the efforts of three other wet weather related projects that PWSA is implementing:

- Shadyside/A-22 Sewershed Flooding Solutions and GI Assessment – A detailed evaluation of the A-22 sewershed, a high priority sewershed because of chronic surface flooding, historical reported basement sewage backups, and the third largest CSO in the

sewer system based on annual overflow volume. The analysis included evaluation of high yield stormwater locations to effectively manage or remove stormwater from the combined sewer system to reduce basement sewage backups and surface flooding, while also maximizing CSO reduction. Many of the analysis methodologies employed in the City-Wide project were tested and confirmed during the Shadyside/A-22 project.

- Saw Mill Run Integrated Watershed Management (IWM) project - An integrated approach that is utilizing a combination of “green, gray, and watershed-based” solutions to holistically address water quality issues in the entire Saw Mill Run Watershed, including combined sewer overflows, sanitary sewer overflows, nutrients, sediment, and the other pollutants impairing the watershed. This integrated approach has been demonstrated by other communities across the country to be more cost-effective than a “gray only” approach and can result in numerous additional TBL benefits to PWSA and the City. Pittsburgh is one of 12 municipalities that are part of the Saw Mill Run Watershed, so this approach includes a multi-municipal evaluation and implementation.
- Region Wide Source Reduction/GI Assessment - PWSA is encouraging and leading municipalities to join with them in conducting high yield priority analyses in the region, and implementing source reduction/GI demonstration projects in a select number of high yield locations. This approach was developed in response to Pennsylvania Department of Environmental Protection’s (PADEP) COAs issued to the 82 municipalities, and USEPA’s letter to PWSA, in which they all have obligations to evaluate the effectiveness of source reduction/GI in reducing CSOs and SSOs. Using the replicable processes and methodologies developed in this City-Wide project, the Region Wide approach will be an effective means of achieving the short-term goal of demonstrating the effectiveness of source reduction/GI techniques across municipal borders and in watersheds, and achieving the long-term goal of targeted source reduction/GI implementation to reduce CSOs and SSOs and positively influence water quality in the region.

The City of Pittsburgh is implementing or participating in related projects and initiatives, including Resilient Pittsburgh; 100 Resilient Cities network; Preliminary Resilience Assessment; Climate Action Plan; and, Pittsburgh Climate Initiative.