# STARTING *at the* SOURCE


## HOW OUR REGION CAN WORK TOGETHER FOR CLEAN WATER

**Technical Report**
**August 2015**



# Technical Report

# 4.0 Municipal Opportunity Assessment & Potential Projects

## 5.0 A Greener Wet Weather Strategy



## 6.0 Source Reduction Incentives



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|---|---|
| 3RWW | 3 Rivers Wet Weather, Inc. |
| AACE | American Association of Cost Engineering |
| ACHD | Allegheny County Health Department |
| ac | Acre |
| ACO | Administrative Consent Order |
| ACT | Alternatives Costing Tool |
| ALCOSAN | Allegheny County Sanitary Authority |
| AMD | Acid Mine Drainage |
| AMIP | Adaptive Management Implementation Plan |
| BG | Billions of Gallons |
| BMP | Best Management Practice |
| BWF | Base Wastewater Flow |
| CCAC | Community College of Allegheny County |
| CD | Consent Decree |
| cf | Cubic Foot |
| CFR | Code of Federal Regulations |
| CIPP | Cured In Place Pipe |
| COA | Consent Order and Agreement |
| COG | Council of Government |
| COP | City of Pittsburgh |
| CSL | Clean Streams Law |
| CSO | Combined Sewer Overflow |
| CSS | Combined Sewer System |
| DC Water | District of Columbia Water and Sewage Authority |
| DCIA | Directly Connected Impervious Area |
| DEP | Department of Environmental Protection |
| DSI | Direct Stream Inflow |
| ENRCCI | Engineering News Record Construction Cost Index |
| EPA | Environmental Protection Agency |
| ERU | Equivalent Residential Unit |
| E&SPC | Erosion & Sediment Pollution Control |
| FSWG | Feasibility Study Working Group |
| ft | foot/feet |
| Gal | Gallons |
| GI | Green Infrastructure |
| GIF | Green Improvement Fund |
| GIN | Green Infrastructure Network |
| GIS | Geographic Information System |
| GPIMD | Gallons per Inch Mile per Day |
| GRJSA | Girty's Run Joint Sewer Authority |

| | |
|---|---|
| GSI | Green Stormwater Infrastructure |
| GWI | Groundwater Infiltration |
| H&H | Hydrologic and Hydraulic |
| HDPE | High Density Polyethylene |
| HP | Higher Performing Assumptions (for simulation) |
| hr | Hour |
| HUD | Housing and Urban Development (Federal) |
| I/I | Inflow and Infiltration |
| in | Inch |
| IPP | Industrial Pretreatment Program |
| IWM | Integrated Watershed Management |
| LEED | Leadership in Energy and Environmental Design |
| LF | Linear Foot/Feet |
| LID | Low Impact Development |
| LTCP | Long-Term Control Plan |
| MAA | Municipal Authorities Act |
| MCES | Twin Cities Metropolitan Council Environmental Services |
| MFS | Municipal Feasibility Study |
| MG | Millions of Gallons |
| MGD | Millions of Gallons per Day |
| MMSD | Milwaukee Metropolitan Sewerage District |
| MSD | Metropolitan Sewer District |
| MSDGC | Metropolitan Sewer District of Greater Cincinnati |
| MWRA | Massachusetts Water Resources Authority |
| NA | Not Applicable |
| NEORSD | Northeast Ohio Regional Sewer District |
| NPDES | National Pollutant Discharge Elimination System |
| O&M | Operation and Maintenance |
| PaDEP | Pennsylvania Department of Environmental Protection |
| PAT | Port Authority Transit |
| PEDF | Pennsylvania Environmental Defense Fund |
| PennDOT | Pennsylvania Department of Transportation |
| PennVEST | Pennsylvania Infrastructure Investment Authority |
| PHF | Peak Hourly Flow |
| PIA | Pittsburgh International Airport |
| POC | Point of Connection |
| POTW | Publicly Owned Treatment Works |
| PVC | Polyvinyl Chloride |
| PWD | Philadelphia Water Department |
| PWEA | Pennsylvania Water Environment Association |

| | |
|---|---|
| PWSA | Pittsburgh Water and Sewer Authority |
| RDII | Rainfall Dependent Infiltration and Inflow |
| ROW | Right of Way |
| SCS | source control study |
| sf | Square Foot |
| SFPUC | San Francisco Public Utility Commission |
| SMR | Saw Mill Run |
| sq. mi. | Square Mile |
| SRIC | Sewer Regionalization Implementation Conference |
| SSES | Sanitary Sewer Evaluation Survey |
| SSO | Sanitary Sewer Overflow |
| SSS | Sanitary Sewer System |
| SUSTAIN | System for Urban Stormwater Treatment and Analysis Integration |
| SUO | Sewer Use Ordinance |
| SWMM | Stormwater Management Model |
| TBD | To Be Determined |
| Twp. | Township |
| USEPA | United States Environmental Protection Agency |
| UPMC | University of Pittsburgh Medical Center |
| WEP | New York Department of Water Environment Protection |
| WERF | Water Environment Research Federation |
| WPC | Western Pennsylvania Conservancy |
| WRDA | Water Resources Development Act |
| WWP | Wet Weather Plan |
| WWTP | Wastewater Treatment Plant |

# 1.0 INTRODUCTION

ALCOSAN is responsible for implementing a Wet Weather Plan (WWP) that reduces sewer overflows caused by stormwater and groundwater entering the sewer system during and following rain and snowfall events. Sewer overflow control solutions fall into four technology types, as depicted in Figure 1-1: remove it, hold it, move it, and treat it technologies. Source controls (or remove-it technologies) aim to reduce the amount of stormwater and groundwater entering the sewer system, and thereby increase the available wet weather conveyance and treatment capacity in the system.


*Figure 1-1: Four Categories of Sewer Overflow Control Technologies*

To better understand the role source controls might play in the WWP, ALCOSAN conducted a regional analysis of opportunities to use the following remove-it technologies as an overflow control solution.

- **Green stormwater infrastructure (GSI)** intercepts stormwater before it reaches the sewer system and manages (or prevents) its entry by:
  - Allowing stormwater to percolate into the soil and re-charge aquifers;
  - Using vegetation to absorb stormwater and release it back into the air; and
  - Temporarily storing stormwater for reuse and/or slow release into the combined sewer system (CSS) or a local stream where directly accessible.
- **Inflow and infiltration (I/I) reduction** addresses the removal of improperly connected stormwater sources such as downspouts and foundation drains connected to the sanitary sewer system (SSS), and reduces unwanted groundwater infiltration through damaged and cracked sewers in both the SSS and CSS.
- **Sewer separation** involves laying separate pipes to take stormwater to receiving waters instead of mixing with wastewater in a CSS.
- **Direct stream inflow removal** involves re-directing streams away from the sewer system.

The study's methods and results documented within this report include:

- A review of national and regional GSI and other flow reduction practices to provide perspectives as to what others are doing, what's working well, and where challenges exist;
- A regional flow reduction analysis to determine how much overflow reduction benefit could be achieved with wide-spread application of GSI and other flow reduction measures;
- A GSI feasibility screening which identified areas where GSI could be most practically considered;

- A cost-performance alternatives analysis that identified areas where GSI and other flow reduction technologies might reduce or eliminate the need for grey infrastructure improvements identified in the ALCOSAN Draft WWP and Municipal Feasibility Studies (MFSs);
- A GSI outreach program aimed at nurturing municipal interest and providing resources, based on study findings;
- An assessment of flow reduction incentives, including what others are doing and how various incentive approaches might work for the ALCOSAN service area; and
- The development of a Green Revitalization of Our Waterways (GROW) flow reduction program that advocates for, and incentivizes the use of, GSI and I/I reduction through the following Green Initiatives.
    1. Begin implementation of its flow reduction financial incentives program.
    2. Work cooperatively with customer municipalities to develop flow reduction plans.
    3. Expand its technical support resources for municipal GSI, direct stream inflow removal, and sewer rehabilitation projects.
    4. Expand its pursuit of outside funding on behalf of interested municipalities and facilitate partnering opportunities between municipalities and key stakeholders, including public private partnerships.
    5. Collaborate with the municipalities, Allegheny County, and other stakeholders towards developing service-area wide model stormwater management, planning and development ordinances, procedures and regional utility coordination efforts.
    6. Grow its long-standing program of sewer flow monitoring to assist the municipalities in identifying and confirming GSI and I/I project locations and in evaluating the efficacy of flow reduction projects.
    7. Accept ownership of and responsibility for inter-municipal trunk sewers transferred from municipalities to ALCOSAN. ALCOSAN anticipates regionalization will support flow reduction initiatives, including the prioritization of sewer rehabilitation projects to reduce I/I along transferred trunk sewers.
    8. Include GSI, community enhancements, opportunities for economic development, and public participation at ALCOSAN wet weather control facilities, wherever feasible.

**ALCOSAN'S GROW PROGRAM GREEN INITIATIVES**

1. **Flow reduction financial incentives program**
2. **Collaborative development of municipal flow reduction plans**
3. **Flow reduction project development support**
4. **Expand search for funding for municipalities and encourage partnerships**
5. **Flow reduction ordinance support**
6. **Long term flow monitoring program**
7. **Regionalization of intermunicipal trunk sewers**
8. **Green enhancements for ALCOSAN-owned wet weather facilities**

# 2.0 SOURCE CONTROL PRACTICES

## Section Summary

The application of green stormwater infrastructure (GSI) has evolved organically from a low impact development practice to a strategic environmental compliance solution used by municipalities and authorities in complying with stormwater management and combined sewer overflow (CSO) control regulations. The evolution of GSI into a wet weather control strategy has been progressing nationally over the past decade or so, largely because of its many co-benefits. In addition to controlling sewer overflows, GSI provides other environmental, social, and economic benefits such as restoring the natural hydrologic cycle of watersheds, improving air quality, and creating green jobs.

The physical and institutional nature of GSI cuts across the traditional legal, institutional, and political boundaries of municipal public works delivery systems. Over time, municipalities and wastewater and stormwater agencies overcome these impediments. The rapidly evolving and growing number of urban regions that are incorporating GSI as a component of their wet weather programs demonstrates that over time, local impediments can be conquered.

As evidenced by the growing number of GSI installations within the Pittsburgh region, no fatal flaws to the implementation of GSI on public properties (e.g. street rights of way) have been identified. Similarly, there are no insurmountable impediments to the installation of GSI on private properties by property owners. Municipal policies such as Pittsburgh's code that requires the use of GSI for certain redevelopment projects and the developing County Stormwater Management Plan will facilitate regional applications of GSI. Widespread municipal adaption and standardization of GSI-enabling policies and codes throughout Allegheny County would expedite the growth of GSI.

**SECTION OVERVIEW:**

- **GSI has evolved rapidly into a CSO control strategy that offers many environmental, social, and economic co-benefits**
- **GSI implementation cuts across traditional municipal lines of authority**
- **While ALCOSAN can support and facilitate GSI, the municipalities are best suited to implement GSI**
- **There are no "fatal flaws" precluding implementation of GSI within the ALCOSAN service area; the municipalities, ALCOSAN, county and state government, and other stakeholders will need to work together to overcome institutional barriers**
- **I/I reduction is another sustainable source control practice municipalities are using to address sewer overflows**
- **Municipalities, with support from ALCOSAN, appear to have the legal and institutional capacities to address I/I from private sources**

Paralleling GSI, wet weather source control through inflow and infiltration (I/I) reduction has been evolving nationally. Municipalities are addressing I/I control from private property lateral sewers through various inspection and rehabilitation programs (incentive programs relating to private source I/I removal are described in Section 6 of this report). Pursuant to their Consent Order and Agreements (COAs) from the Allegheny County Health Department (ACHD), the sanitary sewered municipalities within the ALCOSAN service area require illicit source inspections when properties are transferred. Some ALCOSAN customer municipalities and a number of municipalities across Pennsylvania also require periodic lateral inspections and repairs as necessary. As the owners of the municipal collection systems, the municipalities or their respective municipal authorities have the legal capacity to implement I/I reduction programs through sewer renewal and replacement. A number of the ALCOSAN municipalities have made substantial investments in I/I reduction and system repairs.

As a regional conveyance and treatment authority, ALCOSAN has no direct ability to mandate or implement the use of GSI on public or private properties. ALCOSAN is similarly limited in its ability to mandate or implement I/I reduction projects and other source controls, such as sewer separation and direct stream inflow removal, which are discussed further in Section 3. As the region's wastewater authority, ALCOSAN has and will continue to play a leading role in facilitating the use of GSI and I/I reduction through its partnerships with municipalities, property owners, economic development agencies and the non-profit community. Working together will be a key success factor in realizing the water quality and community benefits GSI provides.

## 2.1 Green Stormwater Infrastructure

### 2.1.1 Benefits of Green Stormwater Infrastructure

To fully understand the benefits of GSI it is helpful to have an understanding of the natural hydrologic cycle and water management history. Before European settlement, when the Pittsburgh region was covered in natural Oak-Hickory forests, most rain and snow melt would soak into the ground. Trees and other plants would draw up the groundwater, which would evaporate from the leaves. The groundwater that was not used by trees and plants would work its way into deeper aquifers or move down-gradient, emerge as springs and flow into creeks, streams, and rivers.

The arrival of cities with paved streets, buildings, courtyards, and other impervious surfaces disrupted this natural process. Stormwater drainage systems were constructed to move water away from buildings and streets to the nearest stream as quickly as possible. As the population grew and indoor plumbing became commonplace, man-made and natural stormwater drainage systems were utilized to convey sewage away from population centers. Most urban streams were enclosed and became large combined sewers within the City of Pittsburgh (e.g. the Four Mile Run trunk sewer along Panther Hollow conveys wastewater and stormwater from Oakland along what had been the Four Mile Run creek.).

Our current urban water management system contains the legacy of these early practices. In wet weather, when the current system reaches capacity, excess combined wastewater and stormwater discharge to rivers and streams and degrade water quality. Traditional approaches to controlling wet weather discharges, such as those proposed in ALCOSAN's Wet Weather Plan (WWP), are designed to solve this problem by upgrading the existing sewer system to store, transport, and treat significantly larger flows. GSI can help to store stormwater runoff and release it slowly to combined sewers, so that more flow and pollutants reach the wastewater treatment plant and less reaches rivers and streams.

One of the key benefits of GSI is that it aims to renew natural hydrologic processes as it reduces pollutant discharges to surface waters. GSI not only helps contain sewer overflows by keeping stormwater out of the CSS, or storing it for slow release, it also helps repair the natural ecosystem of our urban centers. As described succinctly in a report by American Rivers includes:

> *"… runoff control measures that 'harvest, infiltrate, and evapotranspire stormwater,' and which allow a site to be developed while maintaining as much of the natural hydrology as possible…*[2-1]
>
> *… these approaches reduce pollutants and excessive volume by using natural processes or similar approaches that capture, infiltrate, and reuse precipitation, better approximating the natural hydrologic cycle. Green infrastructure prevents stormwater from accumulating and running off developed properties by reducing impervious areas, allowing rain to infiltrate into the soil, to be taken up by plants or captured for later use in cisterns or rain barrels. In addition to water quantity and quality gains, many of these practices provide additional benefits such as improved groundwater recharge, increased energy efficiency and improved air quality."*

Pollutants that are present in urban runoff can be captured and filtered out of the released stormwater. Moreover, reducing the volume and velocity of stormwater that can charge unabated from storm drainage systems reduces the scouring and other physical impacts on the natural environments in streambeds.

Studies of GSI benefits have attempted to quantify the magnitude of various benefits – for example, air pollutant emissions avoided or jobs created. Some of these benefits are financial in nature, such as savings on a customer's electric utility bill due to cooling effects of trees. In other cases, the benefits are not obviously financial (for example, health improvement or stress reduction). A brief survey of these interrelated environmental, social, and economic benefits discussed in the literature is included below.


**Figure 2-1: ALCOSAN Design Rendering for McKinley Park in the Beltzhoover Neighborhood of Pittsburgh**

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2-1 Permitting Green Infrastructure: A Guide to Improving Municipal Stormwater Permits and Protecting Water Quality Jeffrey Odefey, published by American Rivers, January 2013.

### Environmental Benefits in Addition to Water Quality Improvement

- Increased urban wildlife habitat and biodiversity;
- Sustainable watershed management practices which recharge aquifers and reduce storm damage to riparian habitats through stream channel erosion, and use less energy by limiting the pumping of flows through traditional conveyance and treatment systems; and
- Reductions in greenhouse gas emissions from power plants.

### Social and Health Benefits

- Health benefits beyond sewer overflow control, such as reduction of urban heat island effect;
- Improved air quality, leading to human health improvements such as asthma reduction and reduced cardiovascular risk;
- GSI enhances recreation by improving access, appearance, and opportunities.

### Economic Benefits

- Economic opportunities for GSI contractors with entry-level landscaping and maintenance jobs;
- Aesthetic enhancements that can increase the quality of urban life, which may be reflected by higher property values as neighborhoods become more desirable.

Additional information about GSI technologies and benefits can found in Appendix A.

## 2.1.2 National and Regional Perspectives on Controlling CSOs through Green Stormwater Infrastructure

## National Perspectives

Nationally, many urban combined sewered communities are integrating GSI into their Long-Term Control Plans (LTCP). These investments vary depending on the specific needs of each city and typically supplement a larger capital investment in grey infrastructure.

Certain cities are planning the implementation of GSI to control significant portions of their Combined Sewer System (CSS) area. These include the Philadelphia Water Department's *Green City, Clean Waters* CSO LTCP[2-2] which aims to control the first inch of runoff across approximately 42% of the impervious area of the CSS. New Your City's goal is to achieve one inch of runoff control for 10% of the CSS area.[2-3]

Other examples of hybrid green and grey wet weather control strategies include:

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2-2 *Green City, Clean Waters* accessed at: http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan

2-3 *New York City Green Infrastructure Plan* accessed at: http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml



***Onondaga County, New York (Metropolitan Syracuse)*** – Amid public concern over the locating of regional treatment facilities in disadvantaged neighborhoods, and due to the potential for cost savings, local officials evaluated the feasibility of including more GSI into their LTCP. In 2009, a revised Consent Judgment was approved. This was the first judicially enforceable order to include the reduction of combined sewage overflows with GSI.

***Defined GSI Investments*** – The Louisville (KY) Metropolitan Sewer District, Northeast Ohio Regional Sanitation District (Cleveland, OH) and St. Louis (MO) Metropolitan Sewer District are examples of authorities under federal consent decrees that have recently completed LTCPs with a defined capital investment in targeted GSI. Their commitments to GSI ranged between 1.4% and 8.7% of total anticipated capital cost of their LTCP. The LTCPs also include provisions for adaptive management based on the performance of their investments.

***DC Water*** - The District of Columbia Water Authority had an approved LTCP in 2005 and amended the Consent Decree (CD) in 2015 to incorporate the use of source controls and extend the overall implementation schedule. The use of GSI and targeted sewer separation in the Rock Creek and Potomac River basins are planned to allow for the elimination of the Rock Creek Tunnel, downsizing of the Potomac River Tunnel and the extension of the construction schedule for some facilities from 2025 to 2030. The amended CD includes a GSI feasibility and effectiveness review following the construction of the first projects in each sewershed to determine the practicability of completing the GSI projects as planned.

**HIGHLIGHTS OF HYBRID WET WEATHER PLANS:**

- **Seattle can substitute GSI for approved grey projects where feasible**
- **DC Water received a schedule extension that includes using source controls to downsize grey infrastructure**
- **With a few exceptions, the percentage of total capital costs targeted for GSI has been relatively low (less than 10%)**
- **Philadelphia's GSI capital costs are planned to represent at least 65% of *Green City, Clean Waters* capital expenditures over 25 years.**

***City of Seattle and King County, Washington*** - These governments have entered into a consent decree in which GSI and I/I reduction can be substituted for planned grey infrastructure for approved overflow control projects. These agreements also include provisions for using an Integrated Planning Proposal for water quality improvements using the U.S. Environmental Protection Agency (USEPA) Framework. Neither the City nor County has tied a planned capital investment to their GSI commitment to date.

A sampling of GSI programs in the contexts of national wet weather programs is shown on Table 2-1.

Additional details and other examples of GSI implementation practices in other cities can be found in Appendix A.



***Table 2-1: National Data of Green Stormwater Infrastructure Capital Cost Commitments and Projects***

| City / Authority | New York City[2-4] | Onondaga County[2-5,2- 6] (Syracuse, NY) | DC Water[2-7,2-8] | Philadelphia Water Department[2-9] | Lancaster, PA[2-10] | Louisville MSD[2-11] | Cincinnati MSD [2-12,2-13] | NEORSD [2-14] Cleveland, OH | Milwaukee MSD[2-15] | Kansas City, MO [2-16] | St. Louis MSD[2-17] | San Francisco Public Utilities Commission [2-18] | Portland, OR[2-19, 2-20] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Institutional Structure** | Municipality CSO | Authority CSO, SSO | Authority CSO, SSO | Municipality CSO | Authority CSO | Authority CSO, SSO | Authority CSO, SSO | Authority CSO | Authority CSO | Municipality CSO, SSO | Authority CSO, SSO | Department of the City and County of San Francisco | Municipality CSO, SSO |
| **Program Schedule *(End Year)*** | 20 years (2010 to 2030) | 20 years (1998 to 2018) | 25 years (2005-2030) | 25 years (2011 to 2036) | 25 years (1998-2023) | Compliance targets: CSO in 2020 SSO in 2024 | Phase 1: 8 years (2010 to 2018) Phase 2: To Be Determined | 25 years (2010 to 2035) | 16 years, completed (1977 to 1993) | 25 years (2012 to 2035) | 23 years (2011 to 2034) | Phase 1: 2012-2023<br>Yet to be authorized Phases: 2014-2032 | 20 years, completed (1991 to 2011) |
| **Program Cost Estimate** | Prepared to spend $5.3 Billion lifetime costs through 2030 (2010 Dollars) | $300 Million spent through 2011 | $2.6 Billion | $1.2 Billion Capital + O&M (Present Value, 2009 Dollars)<br>$2.4 Billion Capital + O&M (25-year cost) | $18 Million spent through 2011 | $540 Million Capital (2008 Dollars) | Phase 1 $1.15 Billion<br>Phase 2 $2.1 Billion (2006 Dollars) | $3 Billion Total Program Cost (2009 Dollars) | Over $3 Billion spend through 2010 | $2.4 Billion (2008 Dollars) | $1.8 Billion Capital (2009 Dollars) | Phase 1: $2.7 Billion<br>Yet to be authorized Phases: $6.4 Billion | $1.4 Billion Spent through 2011 |
| **Commitment to GSI** | $187 Million capital in public funded GSI in first four years, prepared to spend $1.5 Billion through 2030.<br>Anticipate $900 Million in additional private investment in GSI (2010 Dollars) | $87 Million Capital committed to GSI projects between 2009-2018 | Implement GSI and targeted sewer separation to control 365 impervious acres in Rock Creek and 138 impervious acres in the Potomac River Basin at an anticipated cost of $90 Million through 2030 | $1.67 – 2.09 Billion Capital + O&M Public Funded GSI Installed (25-year cost) | No commitment to date<br>Estimate $77 Million capital cost to integrate GSI into redevelopment infrastructure over 25-years<br>(2010 Dollars) | $47 Million capital cost in GSI projects<br>$51 Million capital cost in I/I removal efforts<br>(2009 Dollars) | Incorporating GSI and stream daylighting as part of $244 Million *Revised Original Lower Mill Creek Partial Remedy* submission approved by USEPA.<br>The total cost of GSI investments for this project has not been published. | $42 Million in GSI projects | To Be Determined | $28 million to GSI pilot projects and $40 million to distributed green storage | $100 Million Capital (2009 Dollars) | $57 Million in early action projects funded by San Francisco PUC grants. | $145M spent on "cornerstone" green projects which include infiltration sumps, downspout disconnection, sewer separation with stormwater treatment and stream diversion<br>In 2008 created 5-year, $55 Million "Grey to Green" program to continue investment in GSI |

Note: Unless stated, source controls do not include sewer separation projects. *All reported values based upon published information but should be considered subject to change*

2-4 New York City, *NYC Green Infrastructure Plan*. 2010.
2-5 Onondaga County, New York, *Save the Rain Program 2010-2018 Green Infrastructure Plan*. 2012.
2-6 US EPA Region 2, Region 2: Onondaga County, New York Green Infrastructure Program Community Partner Profiles. 2011.
2-7 District of Columbia Water and Sewer Authority, *Briefing on DC Water's Long-Term Control Plan Modification for Green Infrastructure*, May 20, 2015.
2-8 DC Water Executive Summary, Long Term Control Plan Modifications for Green Infrastructure, May 2015.
2-9 Philadelphia Water Department, *Amended Green City Clean Waters Program Summary*. 2011.
2-10 City of Lancaster (PA), *Green Infrastructure Plan*. 2011.
2-11 Louisville Metropolitan Sewer District, Integrated Overflow Abatement Plan Final CSO Long-Term Control Plan (2009)
2-12 Cincinnati Metropolitan Sewage District, *Final Wet Weather Improvement Plan*, 2009.
2-13 Cincinnati Metropolitan Sewage District, *Lower Mill Creek Partial Remedy Study Report,* 2012.
2-14 Northeast Ohio Regional Sewer District, *Green Infrastructure Plan*. 2011.
2-15 Milwaukee Metropolitan Sewerage District. *Determining the Potential of Green Infrastructure to Reduce Overflows in Milwaukee*, 2011.
2-16 City of Kansas City (MO), *Overflow Control Plan Overview* 2009.
2-17 Metropolitan St. Louis Sewer District, *CSO LTCP Update*, 2009.
2-18 Kubik, Karen. *San Francisco Green Infrastructure Program*. Proceedings from National Developments in the Regulation and Control of Urban Wet Weather Discharges Conference, May 23, 2013.
2-19 City of Portland, OR, *Watershed Management Plan, 5-Year Strategy,* 2012.
2-20 Ryan, William F. (Chief Engineer, Portland Bureau of Environmental Services) *Portland's Completed CSO Program*. Proceedings from National Developments in the Regulation and Control of Urban Wet Weather Discharges Conference, May 23, 2013.



# Regional Perspectives

## Municipalities on the Front Line of GSI Delivery

GSI is a source control technology that intercepts stormwater before it reaches municipal collection sewers by way of many geographically distributed facilities such as rain gardens, pervious pavement and retention planters. Implementing these wet weather controls is therefore closely tied to municipal collection system characteristics and land development practices. Given their responsibilities for collection systems and land management practices, the municipalities are best situated to implement source control measures and related land development codes/ordinances.

- **GSI controls stormwater before it enters the municipal collection sewers**
- **GSI installations are distributed throughout sewersheds on public and private property**
- **GSI installations are controlled through municipal land use policy**
- **Municipalities are in the best position to own or facilitate GSI.**

ALCOSAN does not have the jurisdiction to modify municipal collection systems to intercept stormwater runoff through GSI or reduce I/I entering municipal collection systems. Nor does ALCOSAN have the authority to implement or modify ordinances or codes to require the implementation of GSI or other source controls. ALCOSAN is in a strong position to assist the municipalities in implementing GSI projects.

## Overview of Roles & Responsibilities

The implementation of GSI projects within the ALCOSAN service area can involve a diverse group of individuals and institutions including private and public property owners, non-governmental organizations, municipalities, counties, state and federal agencies. Current and future roles and responsibilities are summarized in Table 2-2. The roles and responsibilities of the various participants identified on Table 2-2 are detailed in Appendix A of this document.

*Table 2-2: Regional Roles & Responsibilities for Green Stormwater Infrastructure Implementation*

| Entity | Roles & Responsibilities |
|---|---|
| Private[2-21] Property Owners, Developers & Builders | ▪ Construct GSI on property in compliance with relevant codes and standards (currently no single standard exists county-wide)<br>▪ Maintain GSI (responsibilities and maintenance agreements may differ for different types of property owners) |
| Non-Governmental Organizations | ▪ Offer opportunities for partnerships during installation and potentially serve as a link to the community where GSI is proposed |
| Municipalities and Municipal Authorities | ▪ Establish and enforce ordinances/codes for GSI installation and performance<br>▪ Develop agreements for inspecting/maintaining GSI installations on public property<br>▪ Implement and maintain GSI projects on municipal properties where feasible<br>▪ Maintain and enforce municipal subdivision and land development ordinances, and coordinate with the Allegheny County Act 167 Stormwater Management Plan. |
| Pittsburgh Water & Sewer Authority | ▪ Develop GSI alternatives to grey controls pursuant to its July 2013 Feasibility Study through five-year adaptive management process<br>▪ Coordinate with neighboring municipalities through CONNECT and other mechanisms |
| ALCOSAN | ▪ Provide technical and in-kind assistance, and financial incentives to municipalities and other groups for GSI planning and implementation.<br>▪ Provide regional leadership towards the integration of GSI into municipal feasibility plans and the WWP<br>▪ Advocate for regulatory flexibility from USEPA, PaDEP and the ACHD on behalf of the municipalities<br>▪ Integrate proposed GSI implementations into regional H&H model<br>▪ Evaluate GSI source reduction and update the WWP in coordination with the municipalities' feasibility studies<br>▪ Provide assistance for a regional Flow Reduction Program |
| Allegheny County | ▪ Implement GSI at county properties where feasible<br>▪ Develop, adopt, and implement a county-wide stormwater management plan<br>▪ Maintain and promote the Allegheny County Comprehensive Plan |
| Allegheny County Health Department | ▪ Update as necessary Article XIV (Sewage Disposal) and Article XV (Plumbing and Building Drainage) of the County Rules and Regulations |
| Allegheny County Conservation District | ▪ Review and enforce erosion and sediment pollution control (E&SCP) plans for all delegated projects involving earth disturbance pursuant to Chapter 102 of the PA Clean Streams Law<br>▪ Review and enforce other delegated activity related to green stormwater infrastructure projects outside of Chapter 102 (Chapter 105 of the PA Clean Streams Law, Act 167, etc.) |
| 3RWW | ▪ Assist municipalities with obtaining regulatory flexibility to evaluate GSI<br>▪ Develop GIS analysis and planning tools<br>▪ Partner with ALCOSAN in the regional evaluation of GSI and source reduction |
| State of Pennsylvania (PaDEP) | ▪ Provide regulatory flexibilities within the context of the municipal consent order and agreements and the ALCOSAN consent decree<br>▪ Establish and refine design standards for non-structural stormwater control BMPs, which includes GSI installations |
| State of Pennsylvania (PennDOT) | ▪ Cooperate with municipalities in the implementation of GSI along municipal streets that are designated as state or federal highways<br>▪ Integrate GSI where applicable into state and federal highway projects |
| USEPA | ▪ Provide regulatory flexibilities within the context of the Clean Water Act, the CSO Policy and the Integrated Planning Framework |

2-21 For the purpose of GSI and I/I source reduction facilities and projects, Private Properties are all real properties that are not owned and/or controlled by the municipality.



### ALCOSAN Roles in Promoting GSI and Other Source Controls

For more than 20 years, ALCOSAN has taken a lead in advocating flow management practices such as source controls in coordination with its customer municipalities, who have control over the flows ALCOSAN receives. ALCOSAN's advocacy includes providing technical information and support in developing green concept plans, the successful pursuit of approximately $40 million in federal and state funding for municipal projects, partnership with municipalities in the implementation of green projects, development and distribution of public education fact sheets, and the construction of GSI at the wastewater treatment plant (WWTP).

Examples of ALCOSAN's roles to date include:

- Regionalization of the Saw Mill Run intermunicipal trunk sewer from the City of Pittsburgh and Castle Shannon Borough;
- Creation of the Three Rivers Wet Weather (3RWW), Inc.;
- Providing technical information and support to municipalities such as regional flow monitoring in support of source reduction and municipal planning;
- Direct stream inflow removal and stream restoration projects – ALCOSAN secured funding for and provided technical services related to stream restoration projects such as Nine Mile Run in Pittsburgh's Frick Park, in Sheraden Park, and for the rerouting of streams that flow into municipal combined sewer systems such as Pine Hollow in Kennedy Township and McKees Rocks Borough.;
- Funding and technical assistance for a downspout disconnection project using rain barrels in the Nine Mile Run watershed; and
- GSI and LEED certification of new buildings at the ALCOSAN WWTP.

Additional details on ALCOSAN's support of GSI and source reductions are provided in Appendix A.

## 2.1.3 Current Green Stormwater Infrastructure in the Pittsburgh Region

As part of its ongoing urban renaissance, the Pittsburgh region has an accomplished record of incorporating green technologies into redevelopment efforts. Through the many public and private Leadership in Energy and Environmental Design (LEED) certified buildings and brownfield redevelopment efforts at former industrial sites along all three rivers, Pittsburgh has embraced the merits of investing in green technologies. This trend has extended to stormwater management through the efforts of several regional groups which are undertaking studies and implementations of GSI technologies. These groups have developed a variety of GSI studies and implementations concurrent to ALCOSAN and municipal efforts which will continue to provide insights on ways which GSI can be expanded in the Pittsburgh region.



## Recent Highlight Projects

A number of municipalities, private property owners and organizations have completed GSI projects that exemplify the wet weather source reduction and community benefit potentials that are available through GSI:

***Etna Borough***: As detailed in Section 4.4.4, Etna Borough, a combined sewered municipality within the ALCOSAN service area, has completed its Green Infrastructure Master Plan. This plan includes locations targeted for 23 GSI projects within this 0.81 square mile municipality, with a first phase of implementation and project completion that started in the Summer of 2014.

***Nine Mile Run Watershed Association:*** Nine Mile Run Watershed Association, a community non-profit organization founded in 2001, provides outreach programs to engage residents of the watershed (including citizens of Edgewood, Pittsburgh, and Wilkinsburg) about local water issues. This includes improving rainwater management through source control initiatives such as Stormworks, which provides technical assistance to install rain barrels, rain gardens and tree plantings for residents and businesses in the Nine Mile Run Watershed and vicinity.

***Panther Hollow:*** In November 2012, the Pittsburgh Parks Conservancy received state financing to implement stormwater management improvements to the Panther Hollow Watershed within Schenley Park. Working with ALCOSAN, the City of Pittsburgh, the Richard King Mellon Foundation, and other partners, the Pittsburgh Parks Conservancy has embarked on a plan to restore the natural hydrology and aquatic habitat in free-flowing Panther Hollow through GSI. Improvements to be constructed as part of the initial pilot project include the creation of a wildflower meadow, construction of bio-swales and drainage structure improvements. As a partner in this project, ALCOSAN will also install a grit chamber at the bottom of Four Mile Run to remove grit and sediment upstream of its regional conveyance interceptor sewer.

One of the goals of the project is to contribute to the reduction of combined sewer overflow events by capturing and infiltrating more stormwater within the watershed. GSI installations will be designed to capture of the first inch of rainfall. Increasing infiltration will also help to restore the base flow of Panther Hollow's stream closer to its pre-development levels. Details of this project can be found at: http://www.pittsburghparks.org/pantherhollow

## GSI Project Inventories

Green stormwater management practices within the Pittsburgh region are growing rapidly, making any published compendium of projects rapidly out of date. There are efforts to track and inventory the growing number of GSI installations within the Pittsburgh region through on line data bases. The Green Infrastructure Network (GIN), a voluntary partnership of more than 50 organizations, business, academia, authorities and governments, is documenting green infrastructure implementation in the region and developing monitoring protocols to illustrate its effectiveness. This effort is being coordinated by the Pennsylvania Environmental Council and 3RWW. More information on this partnership can be found at: http://www.pecpa.org/green-infrastructure/green-infrastructure-network.

A list of GSI projects that currently exist or are planned to be installed within ALCOSAN's customer municipalities as of November 2014 is provided in Appendix B of this document. The database is updated periodically by 3RWW and a searchable map of the GSI Projects is located at the website: http://www.3riverswetweather.org/green/community-map.

Some GSI controls installed in the region include monitoring equipment such as installations at Carnegie Mellon University, the University of Pittsburgh, and the Allegheny County Office Building in Downtown Pittsburgh. These efforts enable the owners to examine the benefits of the GSI with data to determine stormwater capture as well as heat reduction and energy usage for green roof installations such as was installed at the Soldiers and Sailors Memorial Hall and Museum in the Oakland section of Pittsburgh.

# 2.2 Inflow and Infiltration (I/I) Source Reduction

## 2.2.1 What is Inflow and Infiltration Source Reduction?

"Inflow" is water, other than wastewater, that enters a sanitary sewer pipe through sources such as roof leaders, yard drains, foundation drains, submerged manhole lids, cross connections with storm sewer systems, etc. "Infiltration" is groundwater that enters sewer pipes through defective pipes, pipe joints, manholes, foundation drains, etc. Stormwater inflow and groundwater infiltration (GWI) take up hydraulic capacity in the pipes and can lead to sewer overflows (Figure 2-2).

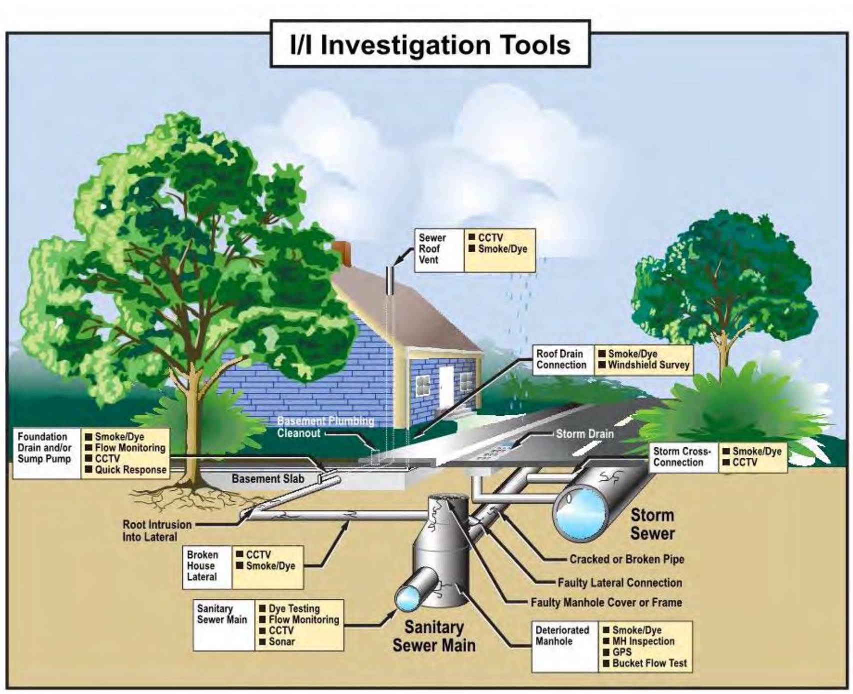


*Figure 2-2: Pathways of Infiltration and Inflow (I/I) into Sanitary Sewer Systems and Various I/I Investigation Tools*

I/I source reduction is intended to preserve the hydraulic design capacities of sewer systems by repairing structural defects that allow groundwater infiltration, and in sanitary sewer systems, removing the sources of stormwater inflow into the sewers.

The intent of controlling GWI is to preserve the hydraulic design capacities and reverse the effects of deterioration for pipes in both combined and separate sanitary sewer systems. Techniques to control GWI can involve the sealing of leaks around joints of otherwise structurally sound pipes through the remote application of grouts and sealants without excavating the pipes.[2-22]

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[2-22] Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems prepared by the New England Interstate Water Pollution Control Commission, 2003.

Structural defects in sewer pipes can be repaired by the replacement of defective pipe segments or through the lining of existing pipes using trenchless technologies. The pipes can be "slip lined" by pulling a flexible plastic inner pipe of slightly smaller diameter through the existing pipe. Pipe linings can also be "cured in place" in which a thermoplastic resin impregnated material such as felt is inverted (pulled inside-out) through the pipe and then heat cured using hot air or hot water. Pipe bursting can also be used. Under this technique, a bursting tool is pulled through the existing pipe to break it and make room for a new continuous high density polypropylene (HDPE) or polyvinyl chloride (PVC) plastic pipe, often of a somewhat larger diameter, thereby increasing hydraulic capacity.

Stormwater inflow into SSSs are controlled by identifying inflow sources such as roof leaders through inspection through smoke testing or other means and the physical re-routing of the stormwater away from the SSS. For example, roof leaders can be permanently removed from the sanitary sewerage and rerouted into rain barrels or rain gardens.

### 2.2.2 Benefits of I/I Reduction

Stormwater and groundwater in municipal SSSs take up the hydraulic capacities of the pipes that are intended for the conveyance of sewage to the WWTP. Reducing I/I and recovering the pipe capacities can provide the following municipal and regional benefits:

- The reduction in the frequency, volume, intensity, and duration of sanitary sewer overflows (SSOs) during wet weather;
- A reduction in basement backups, surface discharges from manholes, and other public health hazards and nuisances;
- The preservation of pipe hydraulic capacity for economic growth and redevelopment;
- The extension of the useful life of existing municipal sewer system assets; and
- Long term capital savings for the municipality.

### 2.2.3 National and Regional Perspectives on I/I Reduction

### National Perspectives

Rainfall-derived infiltration and inflow (RDII) is the portion of I/I that enters the sanitary sewer system in response to rainfall and snowmelt. In most systems, RDII is the major component of peak wastewater flows and is typically responsible for capacity-related SSO and basement backups. Reducing and managing RDII has been a major wastewater utility priority requiring significant resources. As regulations of wet-weather overflows and other wet weather discharges continue to develop along with increased fiscal constraints, the regulatory agencies have increasingly turned their attention to effectively removing excessive RDII from collection systems.

Nationally, numerous municipalities have established RDII reduction programs since the 1970s – primarily to address capacity issues. Since then, the wastewater utility has been gaining progressively deeper knowledge of do's and dont's in implementing RDII reduction and management programs which resulted in a varying range of success. Significant knowledge has been gained in

RDII source detection approaches and understanding of the role private property RDII reduction plays in achieving meaningful source reduction. Wastewater utility experts have been grappling with reasons why different municipalities have gotten widely varying results in RDII reduction effectiveness and whether wastewater utilities can zero in on best practices for achieving and documenting consistent RDII reductions.

In recent years, many RDII reduction programs have been brought under the context of asset management framework and to assure aging sewer assets are repaired/rehabilitated/replaced to manage the risk of failure and to assure the intended level of service is delivered. While the early RDII removal program goals were toward capacity recovery, the most recent programs are more balanced in achieving broader infrastructure renewal goals combined with cost-effective removal of RDII through sewer rehabilitation.

It is a slowly but steadily developing trend that the communities and regulatory agencies are taking a holistic approach of cost-effectively reducing RDII through rehabilitation of sewers in poor structural condition and removing inflow first, and then determine supplemental storage and conveyance infrastructure needs to improve system capacity. This approach aligns both objectives of renewing aging infrastructure and achieving RDII reduction.

Expectations for the amount of RDII reduction depends on many factors and are very site specific as it relates to the complexity of the rainfall response of a SSS described in the previous section. In many cases, sewer laterals that connect individual buildings on private properties to sewer mains are a major source of RDII. RDII reduction on both private properties and in the public right-of-ways is needed to achieve meaningful wet weather flow reduction and to help optimize supplemental infrastructure needs of a wet weather program.

Table 2-3 below shows a synthesis of national statistics summarized for various types of rehabilitation programs based on national experience and wastewater utility observations.

***Table 2-3: Estimated RDII Reductions from Sewer Rehabilitation***

| Level of Sewer Rehabilitation | RDII Reductions | |
|---|---|---|
| | Volume | Peak Flow |
| Point Rehabilitation of municipal collection sewers (cumulative) | 15 – 30% | 0 – 10% |
| Point Rehabilitation of municipal collection sewers and private lateral (building) sewers (cumulative) | 25 – 50% | 0 – 20% |
| Comprehensive rehabilitation of municipal collection sewers | 30 – 60% | 10 – 35% |
| Comprehensive rehabilitation of municipal collection sewers and point repair of private lateral sewers | 35 – 70% | 15 – 40% |
| System-wide comprehensive rehabilitation of municipal collection systems and of building laterals | > 70 | > 50 |

Another national perspective is provided in a 2013 WEFTEC publication[10-23] that summarizes an

[2-23] WEF. Realistic I/I Reduction: What Can We Really Remove?, Oriol, Heidi G.; Tran, Jenny H.; Kepke, Jacqueline T.; Cunningham, Richard; Proceedings of the WEF, WEFTEC 2013: Session 10 through Session 19, January 2013, pp. 1054-1078

extensive literature review and evaluation of I/I reduction project effectiveness, as performed by a regional utility with support from its seven satellite collection system agencies. The literature search identified 270 I/I reduction studies and selected 46 of these studies that were well-documented and used robust methods. The study summarized I/I reduction performance within each of seven sewer rehabilitation categories, and the performance was found to vary widely as shown in Table 2-4. The results illustrate the wide range of rehabilitation methods that may be employed and the significant uncertainty associated with predicting I/I reduction effectiveness.

***Table 2-4: I/I Reduction by Type of Sewer Rehabilitation***

| Sewer Components Included in Rehabilitation | Number of Selected Case Studies | I/I Reduction Range |
|---|---|---|
| Manholes-only | 3 | no measurable reduction - 23% |
| Sewer Mains-only | 5 | 16-42% |
| Service Laterals-only | 8 | 5-76%<br>(30-75% if at least 40% of laterals were addressed) |
| Manholes and Mains | 10 | 0-69%<br>(20-69% if at least 30% of manholes and mains were addressed) |
| Mains and Laterals | 8 | 17-88% |
| Manholes, Mains and Lower Laterals | 7 | 0-65%<br>(25-65% if at least 25% of system was addressed) |
| Manholes, Mains, Lower and Upper Laterals ("Comprehensive") | 5 | 42-87% |

More information related to national perspectives on I/I reduction can be found in Appendix D of this document.

## Regional Perspectives

### Regulation of Inflow/Infiltration Sources on Private Property

Lateral sewers, which are the sewer pipes that connect building plumbing to the municipal collection sewer systems, are a significant source of I/I. Two-thirds of the municipalities in a 1999 survey cited I/I problems from private laterals and estimated that between 5% and 50% of the inflow and infiltration in their systems could be attributed to private sources.[2-24] Nationally, it is estimated

**PRIVATE PROPERTY INFLOW & INFILTRATION:**

- **Responsible for up to 50% of the I/I in sanitary sewer systems**
- **66% of municipalities cite it as a problem for their collection systems**
- **Responsible for 27% of sanitary sewer overflows nationally**

[2-24] Methods for Cost-Effective Rehabilitation of Private Lateral Sewers Water Environment Research Foundation document 02-CTS-5 page 1-12



that 27% of all SSOs are caused by I/I from public and private sources (USEPA, 1996).[2-25]

The sanitary sewered municipalities entered into Administrative Consent Orders (ACOs) with the ACHD in 2004. Paragraph 7 of the standardized orders contains the following provisions to address inflow and infiltration from private properties through the municipal sewer use ordinances:

- By November of 2004, prohibit the connection of surface stormwater drainage to SSS;
- Require visual inspection and dye testing to identify stormwater connections prior to the sale of properties.

The municipalities also were required to complete corrective actions to remove 97% of private or public catch basins and other stormwater sources from the SSS by November 30, 2007.

## Regulation of Inflow/Infiltration Sources on Municipal Property

Infiltration and inflow entering or occurring within municipal sanitary collection sewer systems are not regulated directly under state or federal statute or regulation. Pennsylvania's Clean Streams Law (CSL) does not address I/I. I/I becomes a regulatory issue when it causes or contributes to sewage overflows. Sewage overflows are not specifically addressed in Pennsylvania's CSL. Discharges of sewage must be permitted under Article II Section 202. SSOs are likely in violation of Section 3 of the CSL which declares that the "Discharge of sewage or industrial waste or any substance … which causes or contributes to pollution… is hereby declared not to be a reasonable or natural use of such waters… and to be a public nuisance".[2-26] In Allegheny County, the Local Health Administration Law provides the ACHD with the authority to order the abatement of nuisances such as SSOs.[2-27]

The ACHD ACOs that were issued and entered into covering the municipalities in 2004 included a number of provisions concerning municipal collection system I/I:

1. Internal inspection of sewer lines for defects that would allow excessive infiltration or inflow into the system (Paragraph 5(d)(i));
2. Repair of all structurally deficient manholes that accept stormwater or surface inflow (Paragraph 8(a)(i)); and
3. Establish standards for rehabilitation and repair projects (Paragraph 17(b)(v)(a)).

The ACHD orders do not include a definition of "excessive infiltration or inflow". EPA regulations relating to the old Construction Grants Program (which evolved into the State Revolving Loan Program, e.g. PennVEST) based the definition of excessive infiltration or inflow on the cost-effectiveness of source control:

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[2-25] Private Lateral Inflow And Infiltration Elimination Project Delaware County Regional Water Quality Control Authority Chester, Pennsylvania, June 2010 Prepared by Weston Solutions, Inc. Page 1-1

[2-26] Pa Clean Streams Law Article I Section 3.0

[2-27] Local Health Administration Law, Act 315, Section 12

> "…the quantities of infiltration/inflow which can be economically eliminated from a sewer system as determined in a cost-effectiveness analysis that compares the costs for correcting the infiltration/inflow conditions to the total costs for transportation and treatment of the infiltration/inflow."[2-28]

> The Construction Grants Program regulations had a test for excessive infiltration which, if exceeded would trigger the need for an I/I analysis:

> "If the flow rate at the existing treatment facility is more than 120 gallons per capita per day during periods of high groundwater…"[2-29]

The Secondary Treatment Rule (40 CFR 133 et seq.) provides an empirical definition of excessive inflow, also borrowed from the Construction Grants Program:

> "The determination of whether the less concentrated wastewater is the result of excessive I/I will use the definition of excessive I/I in 40 CFR 35.2005(b)(16) plus the additional criterion that inflow is non-excessive if the total flow to the POTW (i.e., wastewater plus inflow plus infiltration) is less than 275 gallons per capita per day."[2-30]

**WHAT IS "EXCESSIVE" I/I?**

- **No clearly controlling regulatory definition**
- **That which is cost-effective to remove (EPA Construction Grants program)**
- **More than 275 gallons per capita per day (EPA Secondary Treatment Rule)**

More regional information regarding I/I reduction can be found in Appendix D.

## 2.3 Source Control in Municipal Feasibility Studies

The municipalities within the ALCOSAN service area with sanitary sewerage were placed under ACOs from the ACHD. Those with combined sewerage were issued Consent Order Agreements (COAs) from PaDEP. In both cases, the municipalities were required to prepare Municipal Feasibility Studies (MFSs) evaluating the municipality's options to address any overflows within the municipality's collection system and their contributions to overflows downstream of their collection systems. If the municipality's control strategy included the conveyance of its wet weather flows to ALCOSAN's Regional Conveyance System, the MFSs were to also address the conveyance capacities of the trunk sewers connecting the municipality to the ALCOSAN system. The studies were submitted to ACHD or PaDEP on or before of July 31st, 2013.

The significant majority of the studies recommended increased conveyance to the ALCOSAN system, and in a few cases this also included new storage facilities. A number of the studies also identified regionalization of intermunicipal trunk sewers (or even entire collection systems) as their recommended alternative, including the implication that the proposed improvements would be implemented by ALCOSAN after regionalization takes place. The studies included a few commitments to source controls, as summarized below:

2-28 40 CFR 2005(16)
2-29 40 CFR 2120(c)(2)
2-30 40 CFR 133.103(d)

- The Pittsburgh Water and Sewer Authority (PWSA) included a $9.6 million effort by PWSA towards meeting Pittsburgh's wet weather control requirements.
- Etna Borough intends to achieve further reductions in combined sewer overflows, at selected locations through the use of targeted GSI and through a continuation of its existing downspout disconnection and Green Streetscape programs.
- McKees Rocks Borough included three GSI projects in its feasibility study.
- A number of other municipalities mentioned GSI as something that may be given further consideration in the future.
- Only one municipality, the Borough of Bellevue, proposed capital I/I reduction projects via sewer rehabilitation as their sole means to meet their wet weather control requirements. A number of other municipalities mentioned I/I reduction efforts, some of which are part of meeting wet weather control requirements.
- Several studies mentioned stream removal, and in a couple cases is something that may be considered further with ALCOSAN.
- Several studies identified sewer separation projects as the primary means of control addressing a total of eight point of connections sewersheds.

The obligations of the 2004 municipal ACOs and COAs officially terminated on March 30, 2015. In July 2015, the ACHD and PaDEP provided new COAs to the Customer Municipalities. The primary intent of these COAs is for Customer Municipalities to explore flow reduction opportunities, including green infrastructure. Municipalities that do not sign the COA, or submit a Corrective Action Plan, will be subject to possible enforcement action by EPA.

# 3.0 REGIONAL SOURCE CONTROLS ANALYSIS

## Section Summary

The 2008 Consent Decree (CD) requires that ALCOSAN "discharge from the Conveyance and Treatment System only to the extent that such Discharges, as demonstrated by Post-Construction compliance monitoring, will meet the requirements of the Clean Water Act (CWA), consistent with the Environmental Protection Agency's (EPA's) Combined Sewer Overflow (CSO) Policy." ALCOSAN's draft Wet Weather Plan (WWP) proposed a set of capital improvements, the Selected Plan, developed specifically to meet these requirements. A key objective of the source control study (SCS) is to identify opportunities to accomplish equivalent overflow volume reduction using more green stormwater infrastructure (GSI) than was proposed in the Selected Plan, at an equal or reduced cost to ratepayers.

Some studies have suggested that GSI may present cost advantages when it can be substituted for a portion of traditional infrastructure.[3-1] Comments on ALCOSAN's draft WWP also inquired about whether this could be the case for the ALCOSAN's regional sewer overflow control strategy. This section aims to address this question specifically for the ALCOSAN service area using the best local information available, including hydrologic and hydraulic (H&H) models of the ALCOSAN and municipal conveyance and treatment system; geo-climatic information like topography, land use, impervious cover, precipitation, soils (infiltration rates), and evaporation; and construction and operating cost estimates. This section explores the following:

- A review of the function, performance, and cost of GSI and inflow and infiltration (I/I) reduction measures, including establishing the basis for cost-performance analyses;
- An analysis of the overflow reduction potential of large scale source control implementation in the combined and sanitary sewered areas of the ALCOSAN service area, as applicable, and
- The identification of opportunities to cost effectively eliminate or downsize traditional grey infrastructure projects proposed in the Selected Plan by employing GSI and I/I reduction.

This regional source controls analysis has determined that there are numerous opportunities to reduce sewer overflows using GSI and other source control techniques. Source controls can play a key role in meeting the region's water quality improvement needs, and the requirements of ALCOSAN's CD and the municipalities' corresponding orders.

The study has identified areas within the combined sewer system where GSI investments of $44M have the potential to eliminate the need for approximately $81M in ALCOSAN and municipal grey infrastructure, resulting in regional cost savings around $37M. Similarly, approximately $61M in strategically focused I/I reduction investments have the potential to eliminate the need for $122M in ALCOSAN and municipal grey infrastructure, leading to a regional cost savings of $61M, or nearly

[3-1] e.g., EPA. 2007. Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices. EPA 841-F-07-006. Accessed at http://water.epa.gov/polwaste/green/upload/2008_01_02_NPS_lid_costs07uments_reducingstormwatercosts-2.pdf

$100M in total thus far. On-going municipal coordination is expected to result in additional cost savings opportunities.

Another key ratepayer cost savings opportunity is implementing GSI through redevelopment. The implementation of county-wide stormwater management ordinances could require development and redevelopment projects to manage runoff on site, preferably using GSI, wherever feasible. In addition, GSI could be incorporated into ongoing public works projects, particularly municipal, county and Pennsylvania Department of Transportation (PennDOT) road reconstruction projects. These activities could lead to hundreds of millions of dollars invested in beneficial GSI. Over many years, as the region re-develops, very significant reductions of stormwater inflow to the municipal and ALCOSAN systems would be realized.

Since GSI and other source controls can cost effectively reduce sewer overflows, while also providing other valuable community benefits, it will be important that ALCOSAN and its customer municipalities work together to integrate these solutions into the regional WWP. Section 3 results also determined that source controls will be most effective when strategically paired with critical treatment and conveyance capacity upgrades that are necessary to meet water quality improvement requirements, even with intensive flow reduction. The key to identifying the best mix of green and grey infrastructure system improvements is through continued coordination with customer municipalities, regional planning agencies, EPA, Pennsylvania Department of Environmental Protection (PaDEP), Allegheny County Health Department (ACHD), and other clean water partners. These alliances will serve as the pathway to bringing these opportunities to life through partnerships that focus on the best interest of the region and maximizing water quality benefits.

Although this analysis has focused on opportunities to reduce the cost of the Selected

**SECTION FINDINGS:**

- **GSI and other source controls can play a significant role in reducing sewer overflows in the ALCOSAN service area**
- **GSI has the potential to save the region $37 million if it is used in strategic locations where it can eliminate the need for grey infrastructure**
- **Similarly, strategically applied inflow and infiltration reduction has the potential to save the region an additional $61 million**
- **Nearly $100M in potential regional cost savings have been identified so far**
- **The identification of more cost savings opportunities are expected as municipal coordination continues**
- **A county wide development and redevelopment ordinance requiring on-site stormwater management, preferably using GSI, could lead to more cost savings and other community benefits**
- **Traditional grey infrastructure improvements will also be needed to meet consent decree requirements**



WWP, which has been determined to be unaffordable, there are many other valuable source control opportunities within the ALCOSAN service area.

Here are just a few GSI examples:

- Locating GSI in areas where there is particular public or municipal interest in GSI.
- Locating GSI upstream of small combined sewer overflows that are being addressed without associated capital cost in ALCOSAN's Selected Plan.
- Locating GSI in special focus areas of neighborhood revitalization.
- Locating GSI in areas facing affordability limitations; investing in areas with less ability to pay for water quality improvements would represent a high-return social and environmental investment.
- Locating GSI in areas not receiving new conveyance facilities during initial phases of WWP implementation.

## 3.1 Source Control Performance and Costs

### 3.1.1 Green Stormwater Infrastructure Performance/Function

GSI functions through several physical mechanisms. These mechanisms are generally well understood and experienced design professionals can design facilities to take advantage of them with a high degree of confidence. This sub-section explores the function and performance considerations of each physical process that GSI utilizes in contributing to sewer overflow reduction.

#### GSI as Enhanced Distributed Storage

In general, each GSI facility functions much like a small storage tank, with many small storage tanks located throughout the landscape. Storage takes place on the surface of the landscape and underground in soil pores and other porous media. In one sense, each of these small tanks is more efficient than a traditional storage tank. As long as the bottom of the storage facility is open to the underlying soil or fill, infiltration into the underlying soil will occur in most soil types. Even relatively small soil infiltration rates result in significant cumulative volumes of runoff removed from the system over time. Unlike a storage tank, not all the water held in storage will drain out after a wet weather event. If the storage element includes a porous medium (typically a planting soil or sand), a portion of the stored water, the field capacity, is held in tension in the pores of the soil media following the end of the event. This water is then available to evaporate or to be taken up by plants. In fact, evaporation and transpiration are the only possible pathways for this water to leave the storage because it is bound too tightly to soil particles for gravity to affect it. The water-holding capacity of a healthy soil ecosystem with growing plants can even increase over time as organic matter is added to the soil and as roots help to keep soil loose.

Every gallon of runoff that reaches deep groundwater, or that is evaporated or transpired into the atmosphere, is a gallon of runoff that will not contribute to CSOs, although some water that infiltrates surface soil close to older, leakier sewers may enter the sewer as rainfall-dependent inflow and infiltration. In this sense, GSI is more efficient than traditional storage infrastructure, which can store water temporarily and control the rate of flow, but as typically designed cannot reduce the volume of runoff reaching the sewer system, just the release (dewatering) timing.

GSI design professionals can take full advantage of physical processes – storage, infiltration, evaporation, and transpiration – within the constraints imposed by a particular development site. In cases where infiltration, evaporation, and transpiration are insufficient to manage the quantity of runoff required while considering the time between wet weather events, a slow release of flow back to the combined sewer system or some other outlet can be incorporated into the design. Such a design follows the same principles used to dewater a traditional storage tank or tunnel, but is implemented in many locations on a small scale rather than in one location on a large scale. The most common design is a submerged orifice sized so that the peak release rate does not exceed some specified target.

Conceptually, this target peak release rate can be chosen so that, on a unit area basis, it does not exceed the wet weather conveyance and treatment capacity of the downstream system. As more drainage area is brought under control over time, the peak flow entering the combined sewer system will be reduced and brought closer to what can be conveyed and treated. However, the target peak release rate must account for wet weather conveyance capacity that is required to convey rainfall-dependent infiltration and groundwater inflows. ALCOSAN's service area includes significant areas with separate sanitary sewer systems tributary to the combined sewers. System-wide, the total separate sanitary area is more than three times the size of the combined area. Due to their age and condition, and simply due to the size of the drainage area, these sewers currently contribute significant wet weather flows during and after wet weather events, leaving limited capacity for conveying and treating combined sewage.

Figure 3-1 illustrates this point for a few wet weather events under existing conditions with 250 mgd of treatment capacity. In these events, the slow release mechanism of GSI will be ineffective due to the limited treatment capacity for a period during and after some wet weather events. When sufficient treatment and conveyance capacity are available for dewatering GSI, the slow release mechanism provides valuable overflow reduction benefit for applicable wet weather events. This also illustrates how increased regional conveyance and treatment capacity is necessary to realize the full overflow reduction benefit of GSI.

## Planning Assumptions

To study the potential benefits of GSI in ALCOSAN's service area, we have made reasonable planning-level engineering assumptions about how this infrastructure would most likely be designed and operated in the future. These assumptions are based partly on precedents set by GSI leaders among ALCOSAN's peer utilities, but they have been fine-tuned to the unique local conditions of ALCOSAN's service area. The design assumptions discussed below are storage volume, infiltration capacity, infiltration footprint and loading ratio, draindown time, and slow release design, and evaporation and transpiration rates.

The sizing of GSI is driven by the volume and rate of runoff. Because impervious cover is a critical factor determining the amount of runoff, impervious cover also tends to be the most important factor driving the sizing of GSI. Evaluating the composition of the impervious surfaces in the service area provides insights into opportunities and challenges for GSI. Estimates of total impervious cover, including buildings, roadways, and parking lots for the ALCOSAN service area are developed based on existing geospatial data sources, listed in Table 3-1. Land parcel data, based on the Allegheny County Office of Property Assessments, is utilized to associate impervious area with categories of land use (such as Commercial, Residential, etc.). This review allows for identification of the scale of opportunities available in public and private land.

*Table 3-1: Impervious Area Data Resources*

| Dataset | Source Year | Data Source |
|---|---|---|
| **Aerials** | 2013 | PAMAP Program |
| **Buildings** | 2008 | Allegheny County GIS |
| **Parking Lot** | 2000 | Allegheny County GIS |
| **Roadway** | 2006 | Allegheny County GIS |
| **Parcels** | 2011 | Allegheny County GIS |
| **Sewershed Areas** | 2011 | ALCOSAN |

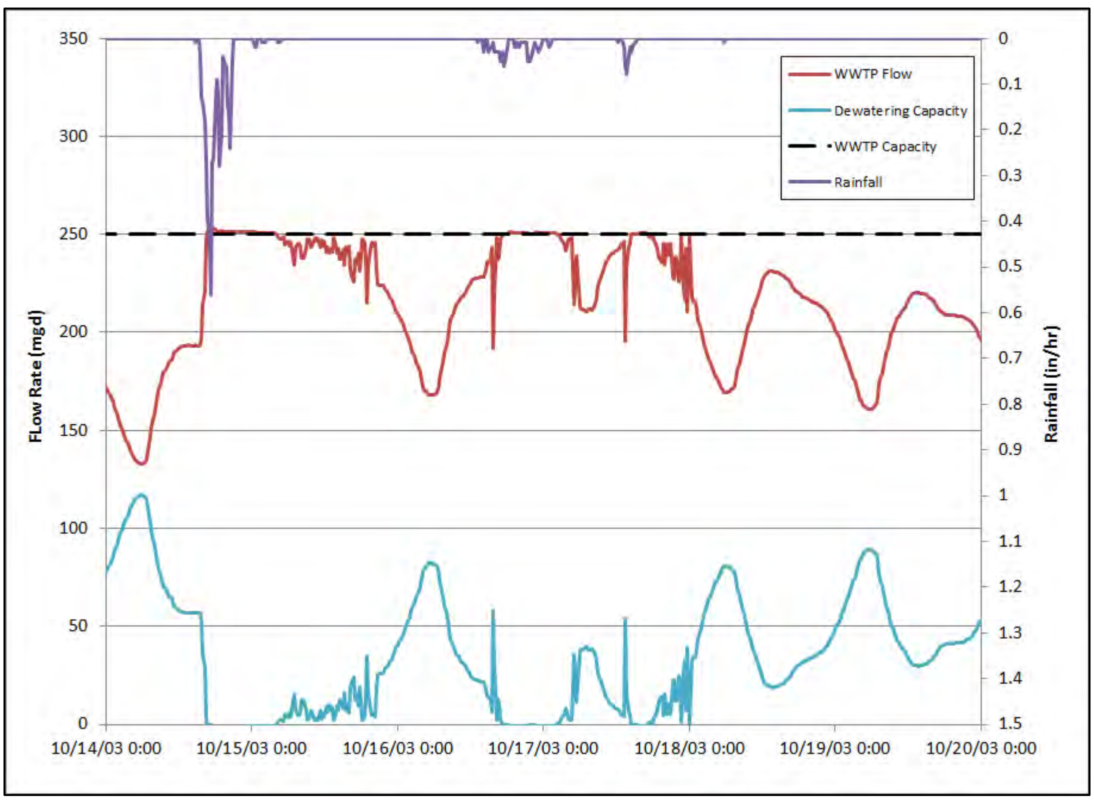


*Figure 3-1: Example of System Wet Weather Treatment and Dewatering Capacity*

There are three categories of area within the ALCOSAN service area: 1) area served by combined sewers (including non-sewered area that contributes runoff to combined system), 2) area served by separate sanitary and storm sewers, and 3) non-sewered area that does not contribute runoff that is categorized as "Non-Contributing". Table 3-2 indicates total land area and total estimated impervious area by system type. The total land area tributary to combined sewers is approximately 34,000 acres with 11,100 acres of impervious area.

***Table 3-2: Impervious Area Estimate by Sewer System Type***

| | Sewer System Total | | | Impervious Estimate Total | | |
|---|---|---|---|---|---|---|
| **Sewer System Type** | **Square Miles** | **Acres** | **System Type: % of Total Area** | **Square Miles** | **Acres** | **System Type: % Impervious** |
| **Combined** | 53.1 | 34,000 | 17% | 17.3 | 11,100 | 33% |
| **Separate** | 161.3 | 103,200 | 52% | 30.8 | 19,700 | 19% |
| **Non-Contributing** | 94.6 | 60,600 | 31% | 3.4 | 2,200 | 4% |
| **Total** | 308.9 | 197,800 | 100% | 51.6 | 33,000 | 17% |

Table 3-3 summarizes the impervious cover composition in the combined-sewered portion of ALCOSAN's service area, categorized by land use. Based on this analysis, about 40 percent of the impervious area in the combined system is associated with land that is owned by municipalities or other governmental agencies. Since some limited runoff from impervious area on private property does reach the public right of way (ROW) and some small categories of impervious area like sidewalks are not accounted for in the source data, the amount of impervious area tributary to public land could be higher than 40 percent.

***Table 3-3: Breakdown of Impervious Surfaces in Combined-Sewer Portion of Sewer System, by Land Use (Acres)***

| Category | Building | Parking Lot | Road | Total Impervious | Total Area | % Impervious |
|---|---|---|---|---|---|---|
| **Agricultural** | - | - | - | - | 100 | 0% |
| **Commercial** | 1,270 | 870 | 130 | 2,300 | 5,600 | 41% |
| **Industrial** | 500 | 250 | 20 | 800 | 1,300 | 57% |
| **Other** | 80 | 50 | - | 100 | 300 | 33% |
| **Residential** | 2,710 | 50 | 60 | 2,800 | 12,700 | 22% |
| **Private Land Subtotal** | **4,600** | **1,200** | **200** | **6,000** | **20,000** | **30%** |
| **Government** | 390 | 280 | 190 | 900 | 5,190 | 17% |
| **Utilities** | 20 | 40 | 30 | 100 | 710 | 13% |
| **Public ROW** | 60 | 160 | 3,890 | 4,100 | 8,020 | 51% |
| **Public Land Subtotal** | **500** | **500** | **4,100** | **5,100** | **14,000** | **36%** |
| **Grand Total** | 5,100 | 1,700 | 4,300 | 11,100 | 34,000 | **33%** |

In the wider consideration of implementation opportunities outside of the public ROW, there may be additional opportunities to control other small categories of impervious area that are not accounted for in the source data including small parking lots, driveways, recreational areas such as basketball courts, patios, etc.

### Storage Volume

Stormwater capture is often expressed in terms of a depth over the drainage area tributary to the GSI storage element. At the planning level, a convenient shorthand approach is to express storage volume in terms of a particular depth of runoff over the directly connected impervious area tributary to the GSI storage element. This assumption means that, for example, if we design for the equivalent of 1.0 inch of runoff from 1.0 acre of directly connected impervious cover, the capture volume will need to be 1.0 ac-in of storage. Using this assumption, we expect a GSI storage element to completely intercept most wet weather events of 1.0 inches of rainfall or less, even if they are very intense. Because not all storms are intense and because GSI installations incorporate infiltration, evapotranspiration, and slow release mechanisms, which are active during the storm, we can expect the actual performance to be equal or better than this conservative concept design assumption.

To determine a reasonable range of storage capacity assumption for GSI in ALCOSAN's service area, we can approach the problem from two different directions. First, we can estimate a range of storage sizing that is feasible to construct at the site level. We can do this both by developing concept designs and by examining precedents set by peer cities and utilities. Second, we can examine the rainfall distribution in Southwest Pennsylvania and estimate the event volume that, if managed, can be expected to contribute toward a high level of combined sewer overflow control. For example, if GSI controls could serve the whole drainage area, establishing a level of control to handle the tenth largest storm in a typical year would reduce the number of overflows during the typical year to fewer than ten. Although controls will not actually be able to serve the full drainage area in the short term, they can be sized in such a way that as the level of GSI area managed increases over a long period of time, the system will begin to approach a designed level of control.

A number of cities and utilities have produced design guidance and requirements requiring management of event volumes in the range of 1.0 to 1.5 inches of runoff from impervious cover. For example, the City of Philadelphia in southeastern Pennsylvania requires private development to store runoff equivalent to 1.0 inches of runoff from impervious area, and targets 1.5 inches of storage on stormwater management projects using public funds. The City of Pittsburgh's stormwater ordinance already requires 1.0 inch of storage to be implemented during private redevelopment, and also requires on-site retention of the 95$^{th}$ percentile rainfall event, equivalent to 1.5 inches of storage, by means of feasible GSI technologies for projects using public funds. Because southeastern Pennsylvania experiences more intense rainfall, on average, than southwestern Pennsylvania, a given amount of storage should result in a higher level of control in southwestern Pennsylvania.

To develop an understanding of sizing requirements to store runoff from a 1.0- to 1.5-inch rainfall event on a development site, imagine a site with 1.0 acre of impervious cover, for example, a building and parking lot or a public street with sidewalks. If the footprint of the GSI facility is to be

10% of the total drainage area, within the range of industry practice[3-2], and assuming the storage media is a soil or gravel with one-third pore space, the required depth of the storage element is between 2.5 ft. (to provide storage for 1.0 inches of runoff from impervious cover) and 3.75 ft. (to provide storage for 1.5 inches of runoff from impervious cover). These depths are within typical and feasible ranges for GSI storage.

Figure 3-2 shows the cumulative distribution of wet weather event volumes in the Pittsburgh area. From the graph, it is evident that for a typical hydrologic year with approximately 90 wet weather events, approximately 9 to 10 events will occur with rainfall depths greater than 1.0 inch and 2 to 3 events with rainfall depths greater than 1.5 inches. These results suggest that, for drainage areas completely controlled by green stormwater infrastructure, storage depths in this range will reduce the frequency of uncontrolled runoff to a range generally assumed to approach water quality objectives. For this study, we have generally chosen a conservative storage assumption of 1.0 inch over the directly connected impervious area tributary to each control. However, for the purposes of understanding how much additional benefit might be realized from a 1.5-inch assumption, and to ensure that GSI opportunities were not overlooked, a limited number of model simulations considered 1.5 inches as a "high-performance" assumption.

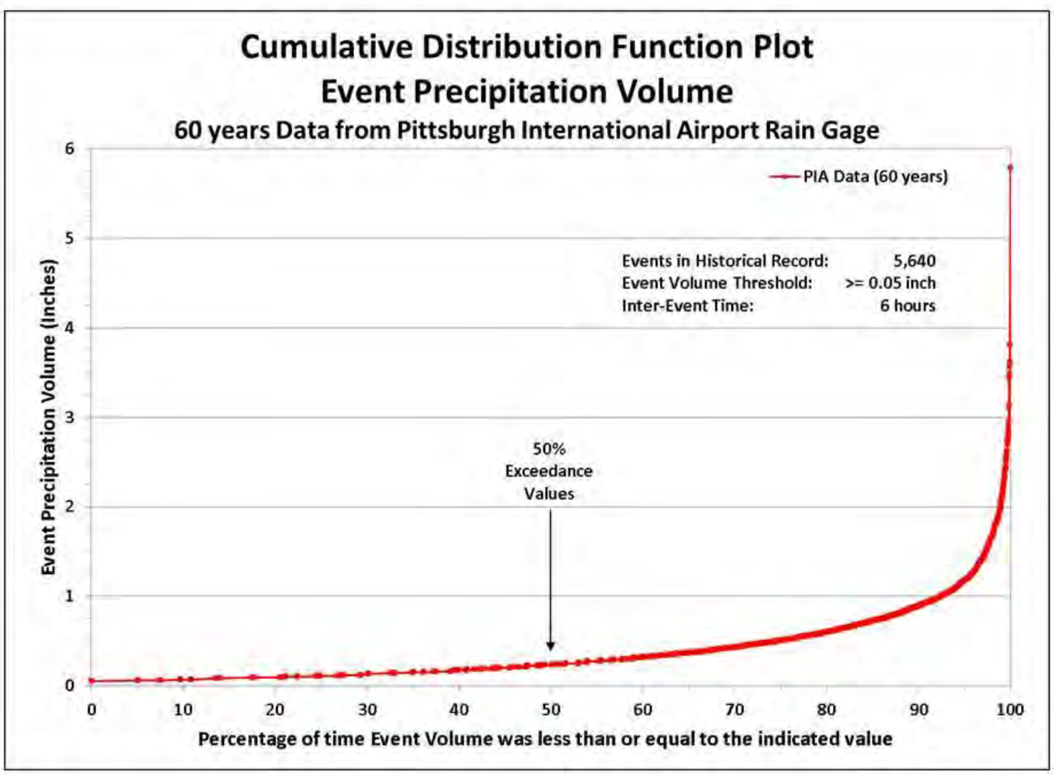


*Figure 3-2: Cumulative Distribution of Rainfall Event Volumes*

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[3-2] For example, the 2006 Pennsylvania DEP Stormwater Best Management Practices Manual recommends a maximum 5:1 ratio (implying infiltration area is at least 17% of impervious drainage area). However, higher ratios are being implemented successfully in high-density urban areas such as Philadelphia.

## Infiltration Capacity

Limited information is available on urban soils and urban fills in the ALCOSAN combined sewered areas at the depths which are typical of GSI installations. Obtaining better data will allow more precise planning assumptions in the future. However, ALCOSAN's existing validated hydrologic models are based on near-surface soil assumptions for each sewershed that have proven suitable for rainfall-runoff modeling (saturated vertical hydraulic conductivity, pore tension, and soil moisture deficit at the beginning of wet weather events). The cumulative distribution of saturated vertical hydraulic conductivities for the modeled sewersheds is shown in Figure 3-3.

Approximately half of the sewersheds have hydraulic conductivities less than 0.25 in/hr., typical of a silty clay loam or sandy clay loam. 25% of sewersheds have hydraulic conductivities estimated during rainfall-runoff calibration of 0.10 in/hr. or less, typical of sandy clays and clays, while less than 2% of sewersheds have hydraulic conductivities determined through rainfall-runoff calibration of 0.5 in/hr. or greater, typical of permeable loams and sands. However, even at these relatively low permeability assumptions, the simulation results presented later in this section will show that significant infiltration occurs over the course of a year.

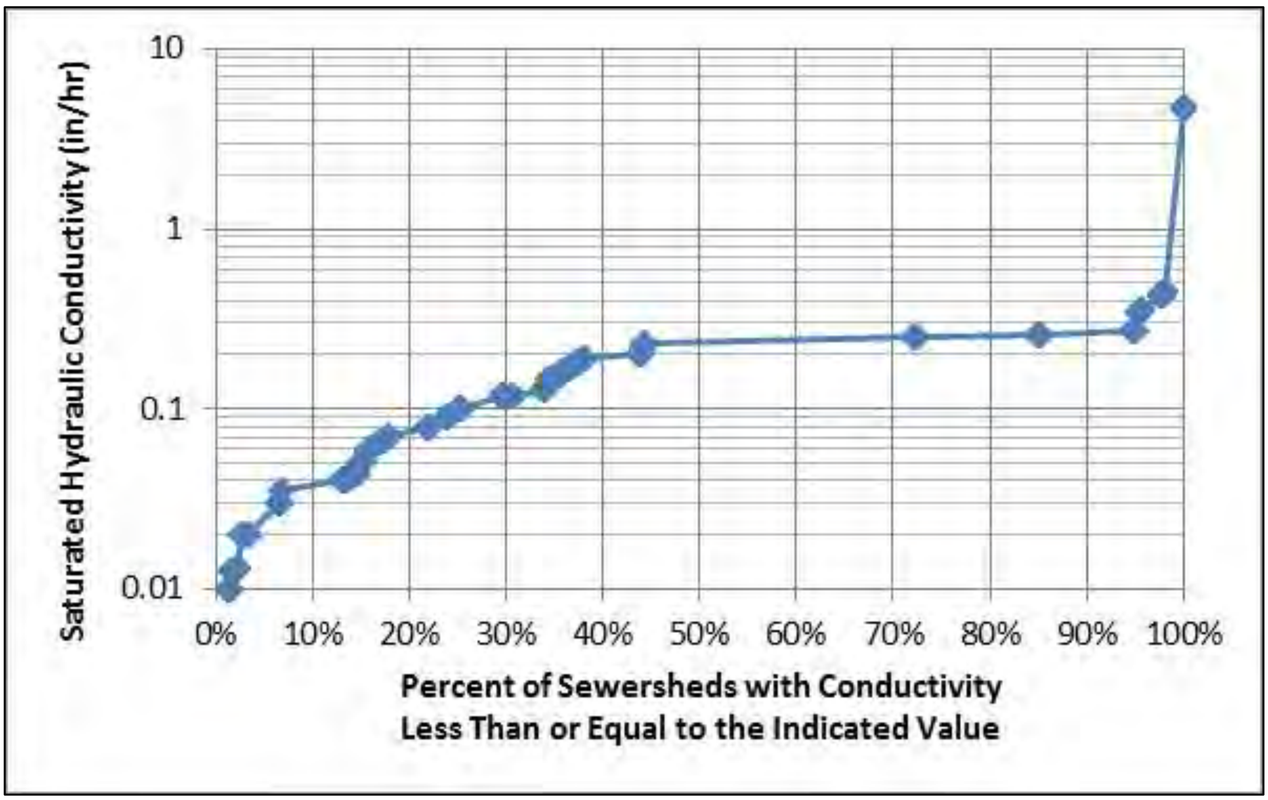


*Figure 3-3: Cumulative Distribution of Saturated Vertical Hydraulic Conductivity Assumptions in Hydrologic Models used in the WWP*

Because the limited data collected and analyses conducted so far suggest that permeabilities are relatively low, and because, as demonstrated earlier, wet weather treatment rates in ALCOSAN's system are relatively small, we have chosen a range of planning and design assumptions: from more conservative assumptions to assumptions that maximize the amount of infiltration that will occur. Assumptions for infiltration footprint, draindown time, and orifice design (all discussed further below) all affect infiltration.

## Infiltration Footprint and Loading Ratio

Increasing infiltration footprint (the surface area across which infiltration can take place) will tend to increase infiltration. The term "loading ratio" (see Figure 3-4) is sometimes used to express the ratio of drainage area to the surface area or infiltration area of the green stormwater infrastructure facility. Typical planning assumptions are in the range of 5 units of drainage area per unit of infiltration area, to 20 units of drainage area per unit of infiltration area. Pennsylvania DEP guidance recommends designing at the lower end of this range (5:1) when possible. We have chosen two loading ratio assumptions for use in this study. The first is a more conservative assumption of 10.7 units of impervious drainage area for each unit of stormwater management facility area. The second is a "high performance" assumption of 5.0 units of impervious drainage area for each unit of management facility area.

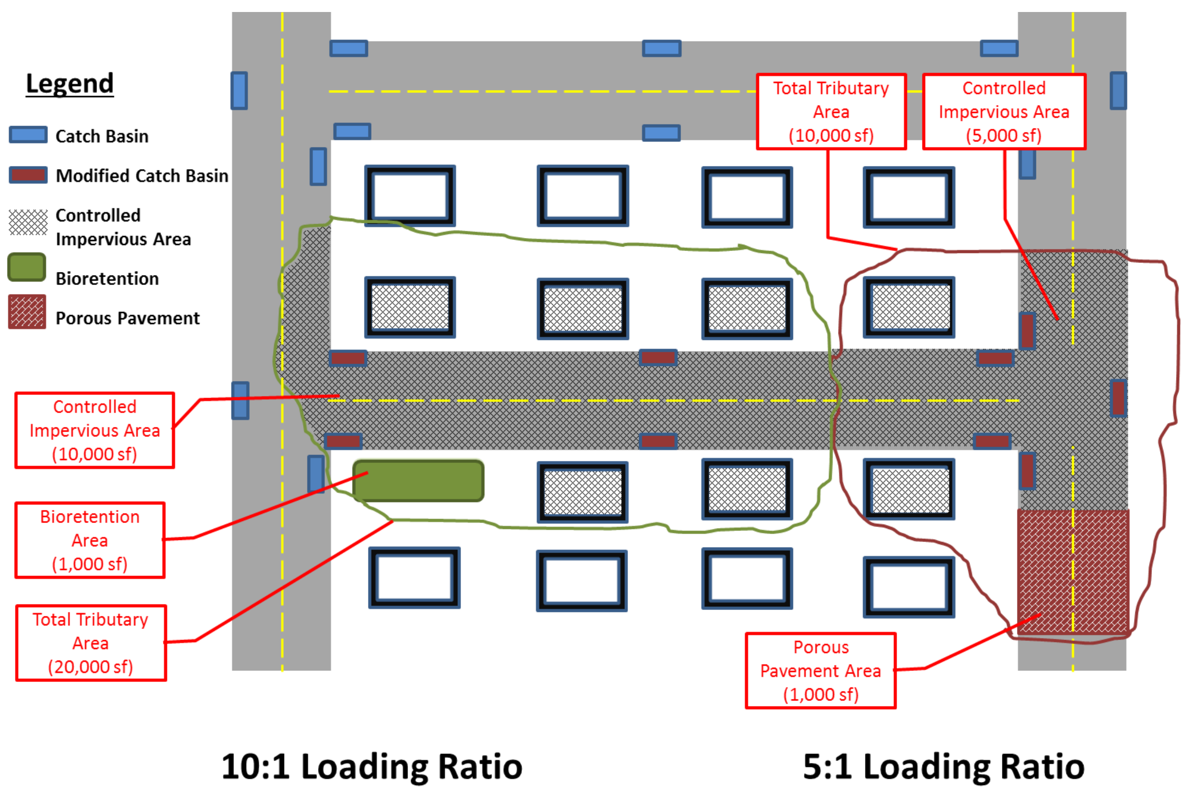


*Figure 3-4: Illustration of Loading Ratio Definition*

### Draindown Time and Slow Release Design

Absent any consideration of multiple events, draindown times could be extended indefinitely to reduce slow release rates. However, draindown times in the range of 24-72 hours are typically recommended by peer utility design manuals. This range is generally expected to avoid mosquito and aesthetic problems, although local stakeholders may have a range of preferences on duration of surface ponding. This also coincides with ALCOSAN's assumption that traditional storage facilities will have a draindown time of 48 hours. We have chosen one set of planning assumptions at each end of this range – a conservative assumption of 24 hours and up to 72 hours, an upper bound reasonable for ALCOSAN's climate and for aesthetic and mosquito control purposes. This calculated maximum draindown time is conservative for at least two reasons – first, the maximum draindown time will occur only for storms that completely fill the storage, whereas many events during the year will be smaller and will not completely fill the storage. Second, this draindown assumption neglects the effects of infiltration, which will tend to reduce the actual time for the storage element to empty.

Another important factor in slow release design is to avoid short-circuiting, where stored water that could infiltrate goes through a slow release orifice instead. If infiltration and evapotranspiration are sufficient to remove the design volume in 24-72 hours under conservative design assumptions, a slow release design can be avoided entirely. This is the most beneficial outcome both for the combined sewer system and in terms of cost to the site developer. If this condition cannot be achieved, the designer can first experiment with ways to increase infiltration, such as an increased footprint. When a slow release design is still deemed necessary, the most common slow release design is a submerged orifice, although other designs and technologies have been proposed. With a submerged orifice design, our assumption is that the outflow elevation can be raised so that no volume that could otherwise infiltrate in 72 hours can flow through the orifice.

### Evaporation and Transpiration Rates

The simulation results discussed in this section assume that evapotranspiration rates over the surface of GSI elements are the same as those assumed in the model over the tributary drainage area. Evaporation values used in rainfall-runoff algorithms in the validated hydrologic model do not necessarily reflect design choices that may be able to elevate transpiration rates in GSI. Design professionals can try a combination of methods to maximize evapotranspiration, for example incorporation of open water, larger evaporative areas or choice of specific tree or plant species.

## Costing Assumptions

### Capital Costs

As part of the source control study, ALCOSAN performed a literature review to identify published construction costs of green stormwater infrastructure technologies from other cities implementing GSI as part of their wet weather program. The full literature review is included in Appendix C of this report. The goal of this review was to compare published unit costs for specific GSI technologies with the planning level costs used by ALCOSAN for estimating GSI in ALCOSAN's Alternatives Costing Tool (ACT).

The ACT includes construction and operations and maintenance (O&M) unit costs for four GSI technologies that manage the first inch of runoff from impervious cover:

- Bioretention;
- Green roofs;
- Porous pavement; and
- Subsurface infiltration.

Unit costs for the four GSI technologies included in the ACT are provided in Table 3-4. Unit costs were developed for retrofit and redevelopment GSI installations for both construction and capital costs. For purposes of the ACT, the construction costs and capital costs are defined in Table 3-5. The terms retrofit and redevelopment are defined in Figures 3-5 and 3-6.

Cost estimates generated by the ACT are considered American Association of Cost Engineering (AACE) Class IV planning level cost estimates. For a Class IV estimate, the range of probable cost is +50%/-30% of the cost generated from the ACT[3-3]. ALCOSAN's literature review examined whether published costs of constructed GSI technologies would provide insights as to whether the costs for built projects would be within the accepted range of the planning level unit costs in the ACT. All costs used in the ACT are reported in 2010 dollars to maintain consistency with the alternatives developed in ALCOSAN's WWP, thus allowing for direct comparison to grey technologies proposed as part of the Selected Plan.

*Table 3-4: Unit Costs of Green Stormwater Infrastructure in the ACT*

| Best Management Practice | Type[1] | $ / Impervious Acre Controlled | | $/ Square Foot of GSI Assuming 5:1 Loading Ratio | | $/ Square Foot of GSI Assuming 10:1 Loading Ratio | |
|---|---|---|---|---|---|---|---|
| | | Construction Cost[1] | Capital Cost[2] | Construction Cost[1] | Capital Cost[2] | Construction Cost[1] | Capital Cost[2] |
| **Bioretention, Porous Pavement, Subsurface Infiltration** | Retrofit | $199,000 | $287,000 | $ 23 | $ 33 | $ 46 | $ 66 |
| | Redevelopment | $164,000 | $226,000 | $ 19 | $ 26 | $ 38 | $ 52 |
| **Green Roof** | Retrofit | $570,000 | $821,000 | N/A | | N/A | |
| | Redevelopment | $299,000 | $413,000 | | | | |

All costs in 2010 Dollars: ENRCCI 8641; RS MEANS 99.6.

[1] Connections to collection system are assumed as 4 per impervious acre managed. Green roofs are assumed to have no connections to collection system. Construction costs include a 25% construction contingency.

[2] Capital costs include a 20% markup on construction costs for engineering and implementation. In addition retrofit projects are assumed to have a 20% project contingency and redevelopment projects are assumed to have a 15% project contingency

[3-3] As defined in the source document for the cost estimate classification system titled "AACE International Recommended Practice No. 18R-97."

*Table 3-5: Cost Items Included in ALCOSAN ACT Definition of Construction and Capital Cost*

| GSI Project Cost Item | Construction Cost | Capital Cost |
|---|---|---|
| **General Conditions** | X | X |
| **Mobilization/Demobilization** | X | X |
| **Bonds & Insurance** | X | X |
| **Overhead & Profit** | X | X |
| **Sub-contractor Markups** | X | X |
| **Construction Contingency** | X | X |
| **Design & Construction Engineering** | | X |
| **Administration** | | X |
| **Geotechnical Analysis** | | X |
| **Surveying** | | X |
| **Permitting / Legal** | | X |
| **Public Engagement** | | X |
| **Project Contingency** | | X |

ALCOSAN's literature review consisted of sources from around the United States of cities or authorities that are implementing GSI as part of a CSO control program. The cost data reported was normalized to Pittsburgh locational costs and in 2010 dollars. Cost information from local green infrastructure installations was sought through 3RWW's green infrastructure project database, but it was determined that sufficiently detailed cost data was limited and applications of GSI were inconsistent with the types of public right-of-way GSI retrofit or redevelopment projects that make up the ACT's GSI unit costs.

Published GSI construction cost data were reviewed from Cincinnati, Ohio; Onondaga County, New York (metropolitan Syracuse); and Washington, DC. Published GSI capital cost data were reviewed from Northeast Ohio Regional Sewage District (metropolitan Cleveland) and Washington, DC. Figure 3-7 and Figure 3-8 compare ALCOSAN's ACT construction and capital costs to these cities on a cost per square foot of GSI footprint basis.



*Figure 3-5: GSI Redevelopment Example: ALCOSAN Customer Service Building*

*GSI redevelopment costs in the ALCOSAN ACT account for the marginal construction cost (beyond the cost of traditional measures) to implement each GSI approach assuming that redevelopment is already taking place. Redevelopment unit costs are independent of whether the project is publicly or privately funded.*

*Figure 3-6: GSI Retrofit Example: Local 95 Operating Engineers Union Building on Saline Street*

*GSI redevelopment costs in the ALCOSAN ACT account for the full construction cost required to implement each GSI approach by retrofitting traditional development on an existing site. This is a more common approach to building GSI into a developed urban landscape.*

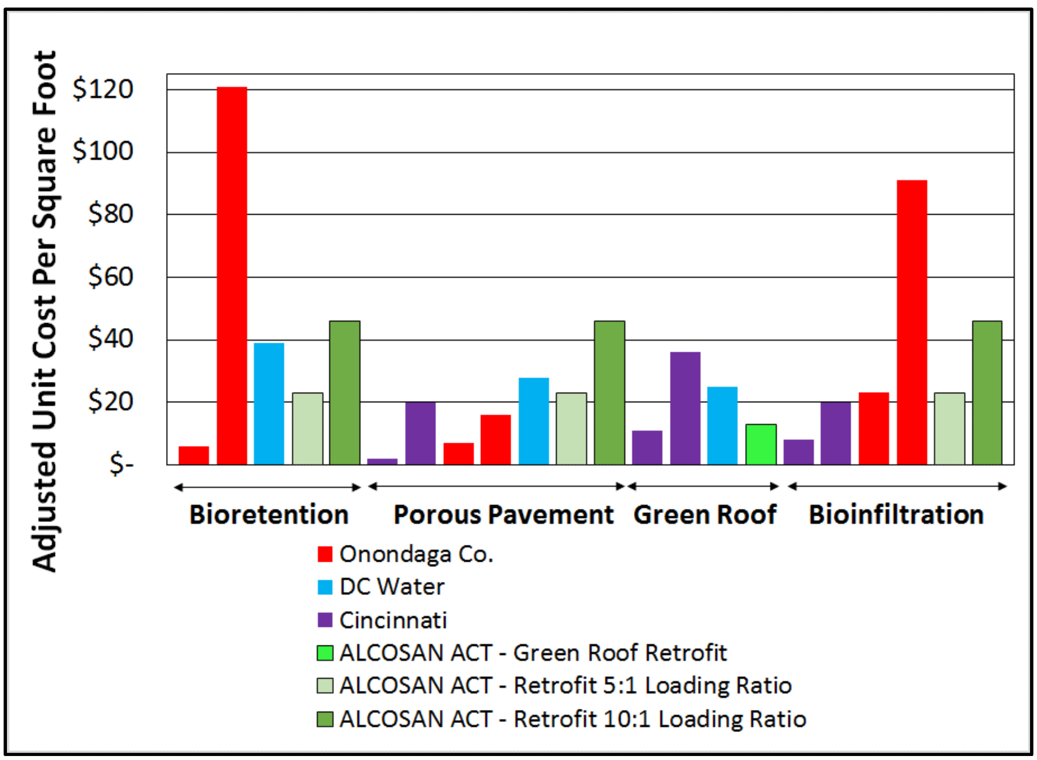


*Figure 3-7: National Comparison – Construction Cost ($ per Square Foot) of Installed GSI*

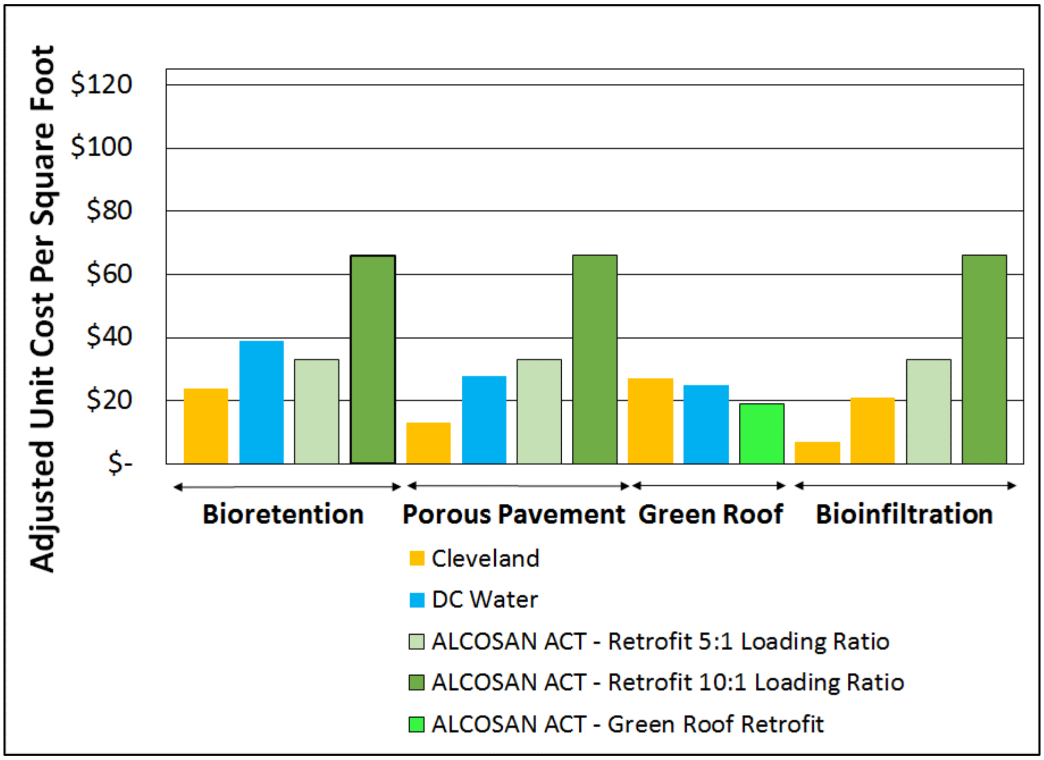


*Figure 3-8: National Comparison – Capital Cost ($ per Square Foot) of Installed GSI*

This literature review confirms that there is a wide variation of actual construction and planning level cost opinions among agencies that are implementing GSI as part of a CSO program. There are numerous reasons for this, with some common examples including:

- The design storm capture rate varies among cities (e.g. some cities design GSI to capture the first 1” of runoff, others design to capture 0.5”, etc.);
- Site-specific soil conditions can have significant variation within a given city and can impact the performance of the GSI and the required footprint of the GSI;
- The degree to which a GSI project accommodates site specific features to meet community benefit goals and the design includes items not intended for stormwater control;
- The degree to which utility conflicts and relocation (both known and unforeseen) can increase costs to excavate for GSI; and
- The location of a project and surrounding land use can add cost to maintain traffic and implement safety measures during construction.

These findings suggest that site specific variations make it difficult to consider GSI costing within the intended planning level accuracy range (+50/-30% of the estimated cost) for any single site. However, GSI cost estimation within the intended planning level accuracy range is suited for planning larger concentrations of GSI technologies over several sites in terms of the dollars per impervious acres managed. When applied in this manner, the ACT is in reasonable agreement with the range of construction costs seen in other cities and it was determined reasonable to continue to use the ACT for the preliminary screening of GSI projects in the ALCOSAN service area. Planning level estimate unit costs from other cities offered little additional insight as to whether the ACT would need to be adjusted due to the lack of details offered on the basis of GSI designs.

The ACT continues to be available as a planning tool for ALCOSAN's customer municipalities. As well-defined projects are identified and conceptual designs are developed with municipalities, site specific cost estimates should be developed using actual materials and labor estimates for the actual quantities of work involved.

## O&M Costs

In addition to capital cost planning of GSI, O&M costs were also projected using the ACT. GSI-specific O&M activities, equipment, durations, and frequencies were determined using guidance and labor projections set forth by the Philadelphia Water Department, adjusted for the Pittsburgh region. As with capital cost estimates for GSI in the ACT, O&M is calculated based on impervious acres designed to be captured by the GSI technology. Table 3-6 summarizes the annual unit cost applied for each GSI technology in the ALCOSAN ACT.

*Table 3-6: ALCOSAN ACT O&M Costs for Green Stormwater Infrastructure*

| GSI Technology | Annual O&M Cost ($/impervious acre/year, 2008 Dollars) |
|---|---|
| **Porous Pavement** | $2,000 |
| **Subsurface Infiltration** | $2,400 |
| **Green Roof** | $3,300 |
| **Bioretention** | $2,600 |

## Cost Implications of GSI Resulting from Stormwater Management Ordinances

A draft Allegheny County Stormwater Management Plan summarizes stormwater management ordinances in place in the county.[3-4] Of 130 municipalities surveyed, 68 reported having stormwater regulations in place. When housing, commercial developments, and infrastructure are redeveloped in urban areas over long periods of time, this provides opportunities to incorporate source controls into stormwater performance requirements. In lower density areas, traditional stormwater controls like retention and infiltration ponds with specially designed outlet structures are an option, while in higher-density urban areas, a range of technologies is available such as bioretention basins, green roofs, and subsurface storage. Even increases in urban tree canopy can act as a source control, reducing the volume and rate of runoff into sewer systems.

While projections of the effect of future redevelopment on impervious cover are not readily available, forecast population growth in ALCOSAN's service area might reasonably be expected to correlate with redevelopment rate. The Southwest Pennsylvania Planning Commission predicted a

[3-4] Allegheny County Department of Economic Development. April, 2014. Draft Allegheny County Stormwater Management Plan: Phase 1 Report. http://www.alleghenycountyswmp.com/phase-i-report. Accessed September 17, 2014

population increase of 16.3% between 2010 and 2046 (an annualized rate of 0.18%), while information provided by municipalities themselves predicted an increase of 13% (an annualized rate of 0.15%).[3-5] These estimated rates included areas served by both combined sewered and separate sewered municipalities, and estimates were not made of respective rates in the areas served by each type of sewer system. To get a rough idea of the recent rate of redevelopment and infrastructure renewal in the service area, ALCOSAN has conducted interviews with area planning and engineering staff and estimated the recent rate at 0.02-0.13% of area per year, based on very limited information.

Without a definitive forecast of the rate of redevelopment, we can still estimate the benefits and costs of GSI for a range of assumed redevelopment rates with ordinances in place. The benefits of GSI accrue to the environment and the population as a whole. The financial costs of GSI accrue to rate payers or tax payers, if public funding is used, or to private property developers and owners, if ordinances require implementation on private lands. In this sense, GSI implemented through ordinances may be thought of as a financial value to rate payers and tax payers. Figure 3-9 indicates that at a 0.1% redevelopment rate, runoff from approximately 3% of impervious cover in the combined sewered area would be managed through GSI at a rough order-of-magnitude value of $100 million. At a 0.5% redevelopment rate, 15% of impervious cover could be managed at a rough order-of-magnitude value of $500 million. These projections are based on what could be accomplished by 2046, which is the planning horizon reflected in the WWP and mandated in ALCOSAN's CD.

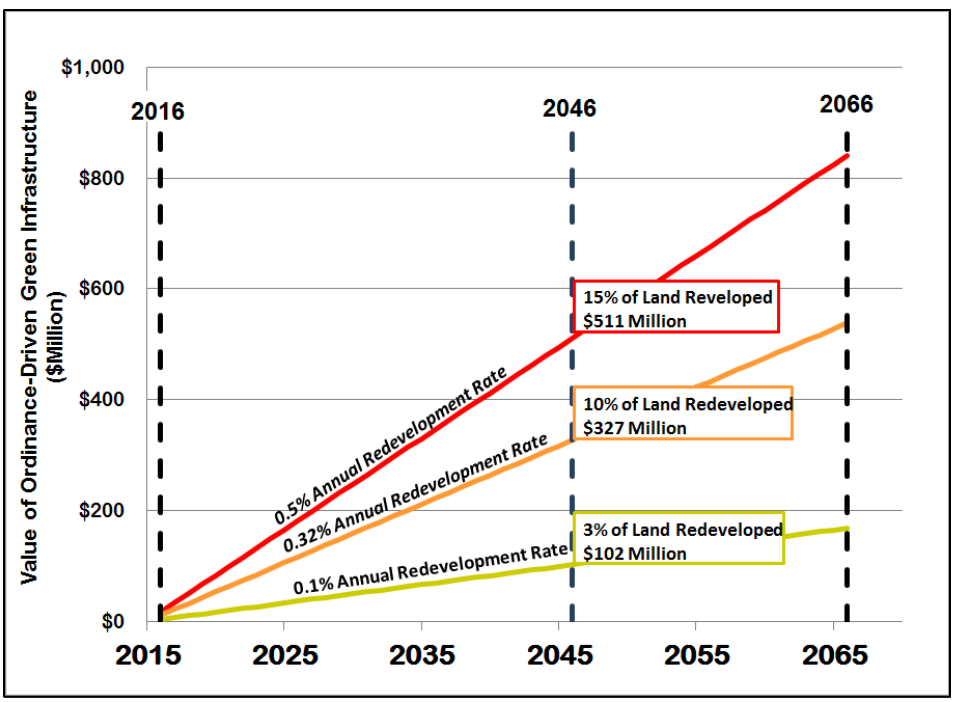


*Figure 3-9: Potential Value of Development/Redevelopment Ordinances*

3-5 ALCOSAN Wet Weather Plan, 2013, p. 7-6, Table 7-1

### 3.1.2 I/I Reduction

Stormwater and snowmelt are not the only sources of wet weather flow in the collection system that contribute to sewer overflows. Rainfall-dependent inflow and infiltration (RDII) into sanitary sewer systems has long been recognized as a major contributor to poor performance of many sewer systems, often resulting in sewer system overflows. The extent of RDII often (but not always) correlates with other condition-related factors associated with aging sewers. The three major components of wet-weather wastewater flow in a separate sanitary sewer system are base wastewater flow (BWWF), groundwater infiltration (GWI), and RDII, as illustrated in Figure 3-10. I/I reduction as a source control includes any measures used to reduce RDII and/or GWI, but the primary focus of this report is RDII which drives the wet weather issues that need to be addressed. Appendix D provides an overview of RDII sources, RDII reduction benefits and challenges, and rehabilitation approaches and methods. It also includes a sampling of national and regional references on the topic.

Based on ALCOSAN's validated hydrologic and hydraulic models for the typical year, the ALCOSAN collection system collects approximately 7.5 BG/year of RDII, with about two-thirds originating in separate sanitary sewer systems and one-third originating in combined sewer systems. In addition, it is estimated to collect more than 40 BG/year of GWI, or more than 60% of average dry weather flow, if we assume that 80% of the minimum night time flow is GWI. It's estimated that about 55% of the GWI originates in combined sewer systems with the remaining 45% coming from separate sanitary sewer systems. While the volume of GWI in the separate sewer system is larger than the RDII, RDII is the major component of peak wastewater flows and is typically responsible for capacity-related sanitary sewer overflows (SSOs) and basement backups. Furthermore, RDII from both the separate and combined areas can contribute to some downstream CSOs.

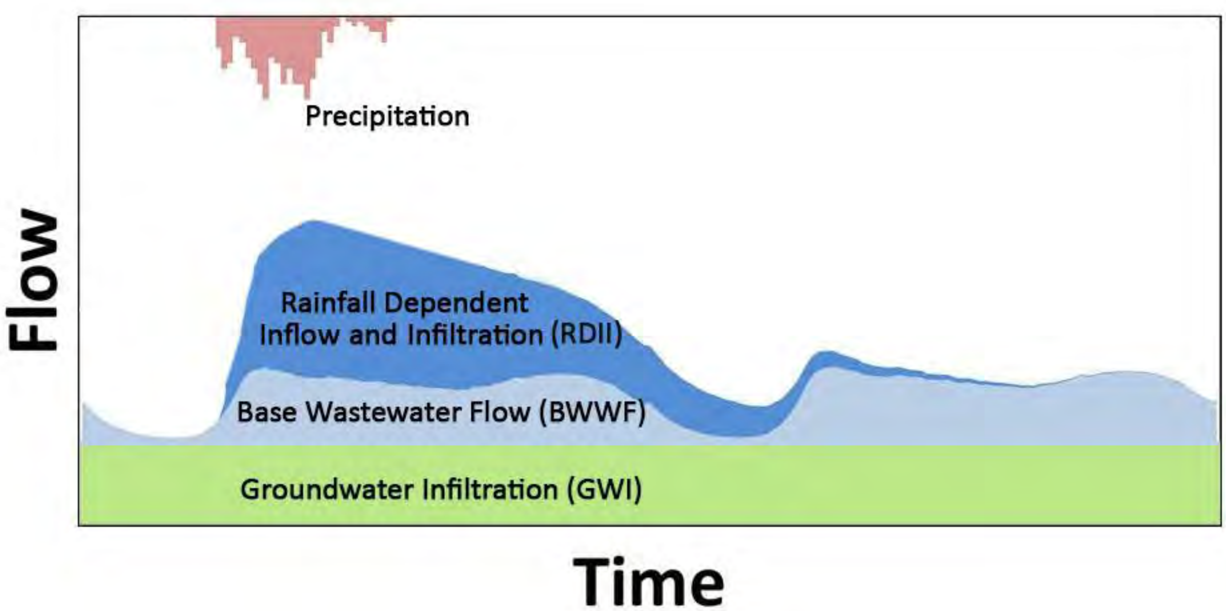


*Figure 3-10: Three Components of Wastewater Flow in Separate Sanitary Sewer Systems*

The I/I treated at the ALCOSAN WWTP enters the collection system through multiple parts of the system including through property connections (e.g. sewer laterals, foundation drains), through about 4,100 miles of municipally-owned collection systems, and through about 90 miles of ALCOSAN interceptors. The amount of I/I coming from each source is unknown system-wide, and in any given portion of the municipal collection system the amount of I/I coming from private and public property versus municipal pipes can vary widely depending on many factors, including geography and local plumbing practices. The difficulty in determining how much I/I is coming from private versus public sources, and from which specific locations, makes reducing and managing RDII to sanitary sewer systems a challenge that requires significant time and money.

The challenge of identifying and quantifying the specific sources of I/I is one of the reasons that the municipal feasibility studies included minimal use of I/I reduction to meet their wet weather compliance obligations. A few of the other most significant reasons are as follows:

- The difficulty in accurately predicting the performance and cost of GWI and RDII reductions in portions of a municipal system that have not already been studied in detail;
- Due to those difficulties, an I/I reduction-based solution instead of a conveyance alternative creates a greater risk that the proposed project will not meet its required performance, that may still require additional conveyance improvements, thus leading to a higher cost than either of the original alternatives;
- For most of ALCOSAN'S retail customers, the ALCOSAN charges for sewer service ("transport and treat" costs) are based on billed water consumption with no accounting for the amount of I/I. So there is no financial incentive for municipalities to remove I/I from their systems. The absence of such an incentive – and the expectation that such an incentive might be implemented in the future – was cited in a number of municipal feasibility studies as a reason I/I reduction was not the recommended alternative now, but could be in the future. Understandably, this consideration was reinforced in guidance prepared by the 3RWW Feasibility Study Working Group (FSWG) to the municipalities regarding decision making on I/I reduction. In this guidance, the following items were among the list of key topics to be considered in determining if I/I reduction was beneficial:
    - Is there an existing surcharge for I/I?
    - Will a surcharge for I/I be implemented regionally as a financial or institutional alternative for capital cost recovery? [3-6]

In considering the sections which follow, it is important to acknowledge there are differing philosophies on how I/I reduction should be approached. Per two guidance documents prepared by the 3RWW FSWG, municipalities were given guidance to use flow isolation studies, which focus on measuring GWI and not RDII, to help determine when and where I/I reduction was a viable alternative:

[3-6] 3RWW Feasibility Study Working Group. Document 009: *Infiltration/Inflow Screening Guidelines, Flow Isolation Study Decision Criteria Guidelines*, October, 22 2009.

*"It is recognized that flow isolation studies in sanitary sewer systems are required to undertake flow reduction alternative analysis within the collection system. Other analytic efforts (e.g. modeling, unit hydrograph derivation etc.) direct effort toward generally short-duration capacity related measures but do not address volumes and attendant costs associated with long term transport and treatment costs."* [3-7]

On the contrary, a number of other I/I reduction programs nationally focus on using measured RDII (peaks and volumes) as the primary basis for when and where to consider I/I reduction, although GWI may be considered as well. This is because RDII (the wet weather response), not GWI (the dry weather infiltration), is usually the main driver for a proposed sanitary system conveyance or storage project that the I/I reduction efforts are seeking to avoid.

This distinction between a GWI focus and an RDII focus would be a moot point if areas with high GWI correlated well to areas of high RDII, as GWI-focused rehabilitation would essentially be addressing areas of high RDII. However, flow monitoring data in the ALCOSAN service area do not appear to support such a correlation. Figure 3-11 shows the relationship between GWI (estimated as the average minimum dry weather flow divided by the average daily dry weather flow) and RDII (as represented by a peaking factor calculated from the average of the 5 largest monitored hourly flows divided by the average daily dry weather flow) for around 240 sanitary sewer flow meter locations in the ALCOSAN service area. The plot shows no clear correlation between RDII and GWI, so GWI alone (as measured by flow monitoring or flow isolation) does not appear to be a reasonable metric for prioritizing areas for rehabilitation efforts seeking to address RDII-driven wet weather problems such as system surcharging and control of SSOs.

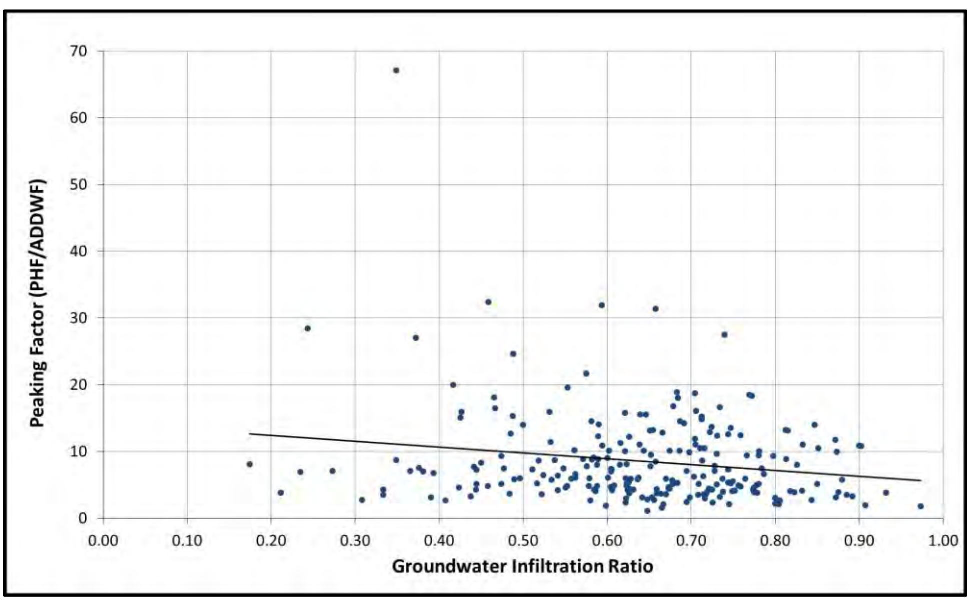


***Figure 3-11: Relationship between Wet Weather Peaking Factor and Groundwater Infiltration in the ALCOSAN Service Area***

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3-7 3RWW Feasibility Study Working Group. Document 012: *Guidelines for the Performance of Flow Isolation Studies*, January, 14 2010.

## Performance/Function

Numerous communities across the United States have established RDII reduction programs since the 1970s – primarily to address capacity issues in their sewer system. Since then, the industry has been gaining progressively deeper knowledge of do's and dont's in implementing RDII reduction and management programs which resulted in varying degrees of success. Significant knowledge has been gained in RDII source detection approaches and understanding the role of private property RDII reduction to achieve meaningful capacity improvements. Industry experts have also been grappling with reasons why different agencies have obtained widely varying results in RDII reduction effectiveness and whether the industry can zero in on best practices for achieving and documenting consistent RDII reductions. This national perspective is discussed further in Appendix D.

Expectations for the amount of RDII reduction that can be achieved depend on many factors and are very site specific as it relates to the complexity of the rainfall response of a sanitary sewer system described in the previous section. In most cases, sewer laterals that connect individual buildings on private properties to sewer mains are often a major source RDII. RDII reduction in both private property and public right-of-way (R/W) is needed to achieve impactful RDII reduction and help optimize supplemental infrastructure needs of a wet weather program. Well-designed pilot studies can help develop system specific RDII reduction programs with focus on both private and public R/W efforts. Table 3-7 shows a synthesis of national statistics summarized for various types of rehabilitation programs based on national experience in RDII reduction programs and industry observations. A sampling of some other studies is included in Appendix D. Note that the higher end statistics are contributed by unique system-specific RDII characteristics and distributions.

*Table 3-7: Estimated Range of RDII Reductions for Various Rehabilitation Practices*

| Level of rehabilitation | Volume | Peak Flow |
|---|---|---|
| Point Rehabilitation in Public R/W | 15 – 30% | 0 – 10% |
| Point Rehabilitation in Public R/W and Private Property | 25 – 50% | 0 – 20% |
| Comprehensive Rehabilitation in Public R/W | 30 – 60% | 10 – 35% |
| Comprehensive Rehabilitation in Public R/W w/ point repair of service lines | 35 – 70% | 15 – 40% |
| System-wide comprehensive rehabilitation | >70 | > 50 |

## Costs

ALCOSAN's ACT provides modules for developing planning level cost estimates of sewer rehabilitation efforts to reduce I/I in both private and municipal sewers. For municipal sewers, three separate unit cost curves were developed during the development of the ALCOSAN WWP. These costs are based on national and local data for cured-in-place pipe, including actual cost data compiled by a costing subcommittee of the 3RWW-led FSWG and by the Pittsburgh Water and Sewer Authority (PWSA). The local costs were developed based on a series of projects in Western Pennsylvania, including some within the ALCOSAN service area. Figure 3-12 displays a plot of all local project unit cost data provided for ACT development and Table 3-8 provides a summary of the unit costs applied for these two local cost curves within the ACT. These unit costs are construction cost values that include contractor profit and indirect costs. As noted in Table 3-5, appropriate contingencies, engineering, overhead, profit and implementation costs are applied as percentages within the ACT to develop total capital cost values for

I/I reduction costs. The ALCOSAN ACT also allows for planning level cost estimates for other various municipal I/I reduction measures for repairs/rehabilitation of manholes, catch basins and service laterals.

*Table 3-8: Municipal Pipe Lining Unit Costs in ALCOSAN ACT ($/LF, 2008 Dollars)*

| Pipe Diameter (in) | FSWG Municipal CIPP Data | PWSA CIPP Data |
|---|---|---|
| **8** | $53 | $89 |
| **10** | $61 | $105 |
| **12** | $70 | $120 |
| **15** | $82 | $144 |
| **18** | $95 | $167 |
| **21** | $108 | $190 |
| **24** | $120 | $213 |
| **27** | $133 | $237 |
| **30** | $145 | $260 |
| **36** | $171 | $306 |
| **42** | $196 | $353 |
| **48** | $221 | $399 |

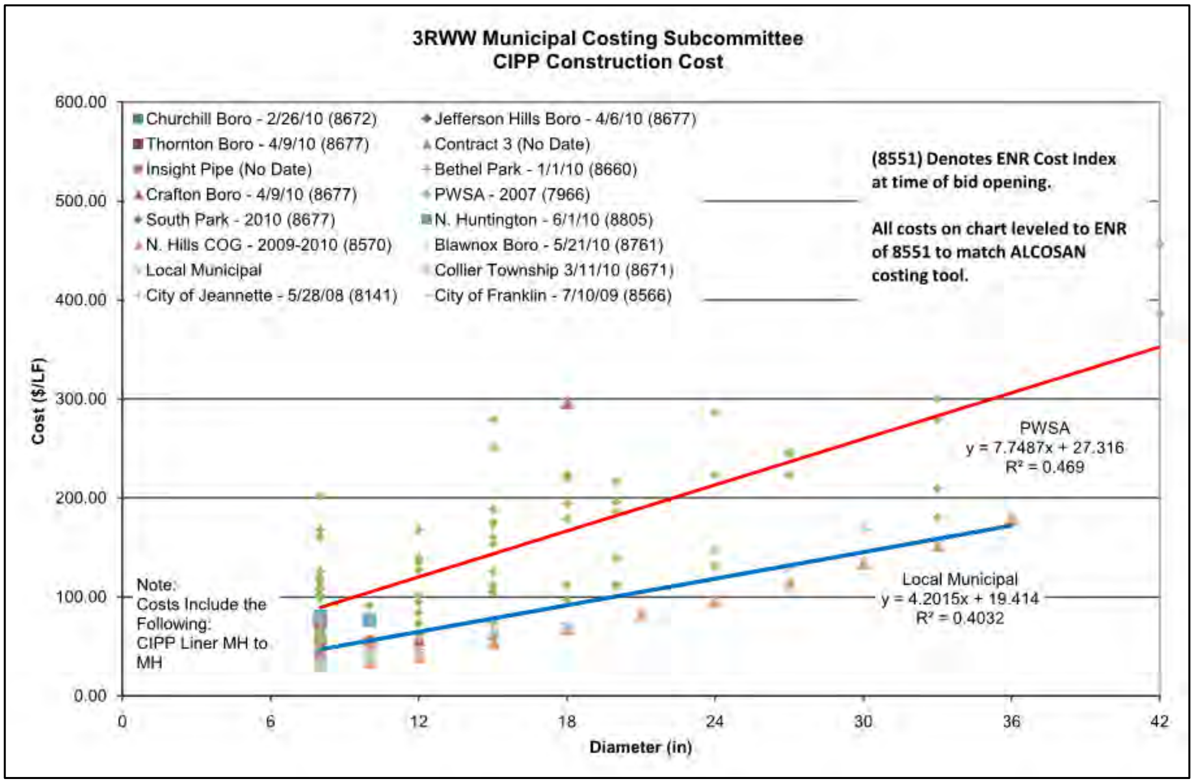



*Figure 3-12: Data Plot of Local CIPP Construction Data*

## 3.2 Benefits and Cost-Effectiveness of Large Scale Source Control Implementation

The following sections address the overflow reduction potential and cost-effectiveness of I/I reduction and GSI, when applied at a large scale throughout the service area. Sewer separation was not evaluated, as large-scale sewer separation (all combined sewer areas) was previously evaluated in the WWP. At an estimated cost of $10 billion, large scale sewer separation was far more costly than the Selected Plan.

### 3.2.1 Green Stormwater Infrastructure

This section presents results and conclusions about the cost and effectiveness of GSI as a stand-alone wet weather control technology. Simulations 1 through 3 examined the effects of GSI, without any other source controls such as I/I controls or traditional grey infrastructure controls. In these three simulations, GSI was assumed to intercept and manage runoff from 10%, 25%, and 50% of impervious cover in the combined sewer portions of the ALCOSAN service area, respectively, using future baseline (2046) flow projections and the most conservative set of GSI sizing and performance assumptions:

- Storage equivalent to 1.0 inch of runoff from impervious cover;
- A loading ratio of approximately 11:1; and
- Drain down time of no more than 24 hours.



Management of runoff from 50% of impervious cover is a practical upper bound assumption within the time frame set by ALCOSAN's CD (2046), and is greater than the level proposed by the most ambitious GSI programs. For comparison, New York City is targeting 10% and Philadelphia 34%. GSI implemented through redevelopment of public and private parcels through enforcement of applicable stormwater management ordinances has the potential to achieve high levels of control over very long periods of time. However, to achieve a high level of control within the CD period, significant control must also come from the public right-of-way (roads, streets, and sidewalks), which are estimated to make up on the order of 35-40% of impervious cover. Therefore, an aggressive program in the right-of-way, coupled with redevelopment, might be able to achieve 50% as an upper limit. The GSI reflected in these model simulations is summarized in Table 3-9.

***Table 3-9: GSI Represented in Model Simulations with Conservative Performance and Sizing Assumptions***

| Simulation # | Impervious Combined Area Controlled by GSI (% of total) | Impervious Combined Area Controlled by GSI (acres) | DCIA Controlled by GSI (acres) | Total GSI Storage (MG) | Total GSI Storage (acre-ft.) | Total Maximum GSI Dewatering Rate (MGD) |
|---|---|---|---|---|---|---|
| **1** | 10 | 1,052 | 839 | 23 | 70 | 27 |
| **2** | 25 | 2,629 | 2,098 | 57 | 175 | 68 |
| **3** | 50 | 5,258 | 4,197 | 114 | 350 | 136 |

The ALCOSAN ACT was used to calculate the capital and present worth cost of controlling the impervious area for the three simulations. In the planning level context, there is not always a defined location and technology for all GSI projects to control this amount of impervious area, which is precisely why the ACT approximates GSI costs based on impervious area captured. As determined in the development of the ACT, the relative unit costs per impervious acre of runoff are in the same range for bioretention, subsurface infiltration and porous pavement. Thus, when estimating costs for large impervious areas, it was assumed that a combination of these basic functional types of GSI technologies would constitute all of the GSI applications without needing to apply a specific location where each technology would be applied. With this general principle established, the capital cost estimates for the three simulations were estimated in the ACT with the following underlying assumptions:

- For a given acre of impervious area controlled by GSI, 95% of the impervious area would be controlled by a combination of bioretention, subsurface infiltration and porous pavement; and 5% would be controlled via green roofs;
- It was assumed that 100% of the projects would be retrofit into the existing urban landscape;
- All projects would be assumed to be in the public right-of-way, public land or on private land that allowed for an easement to build GSI. Under this assumption, no additional land ownership costs were applied to the unit costs to construct GSI; and

- For costing purposes, it was assumed that all GSI would require a slow release connection to the combined sewer system. Costs for connecting the GSI to the existing system were included at one connection assumed per quarter acre of impervious area.
- No learning curves were applied. In other words, it was assumed that the cost of GSI in current dollars will not change over time as the technology matures and local experience increases. Further, it was assumed that the economics of the overall system will not be significantly impacted by outside factors during the implementation period, for example major technological advances or climate change leading to major changes in historical land use patterns or demands on infrastructure.

Figure 3-13 is a visual depiction of the estimated capital cost and overflow reduction benefits of GSI for the three levels of impervious area managed in the simulations. These results (representing simulations 1, 2, and 3) do not include sewer I/I controls.

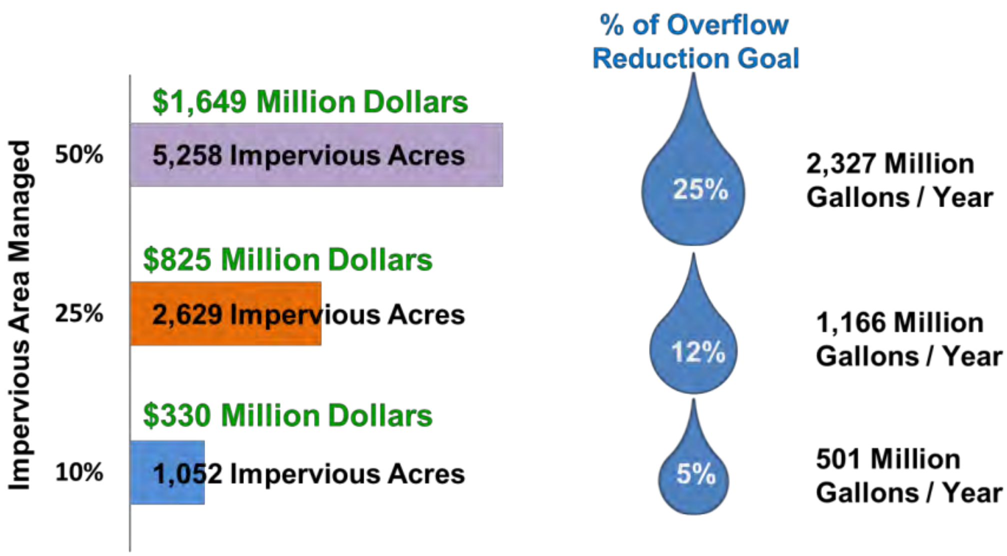



*Figure 3-13: Capital Cost and Overflow Reduction Benefit of Green Stormwater Infrastructure (Simulations 1, 2, 3)*

Under future baseline conditions, a capital investment of $330 million in GSI would achieve approximately 5% of the WWP overflow reduction target of more than 9BG. A large program with a capital investment of $1.6 billion, controlling 50% of the impervious area, would achieve approximately 25% of the Wet Weather Plan overflow reduction target, indicating that large scale use of GSI throughout the combined sewer area cannot meet CD requirements if not also coupled with other sewer overflow controls.

Several caveats should be considered when interpreting these results. First, both capital cost and simulated performance of GSI are subject to uncertainty. The uncertainty in source control capital costs is at least as great as the estimated +50% / -30% range assumed to apply to traditional infrastructure cost opinions in the 2013 WWP. Actual capital cost and performance would be affected by localized site conditions, institutional considerations such as land ownership and public policy, and ability for local labor force to gain experience and familiarity implementing GSI projects within ALCOSAN service area. In addition, capital costs are influenced by future economic conditions such as the market for public and private construction, interest rates and the bond market, inflation, how the GSI projects are packaged for bidding, and many other factors. Also, the GSI elements sized according to conservative assumptions rely more on storage and slow release, rather than on infiltration, and are therefore more sensitive to downstream conveyance and treatment capacity, regional hydraulic grade lines, and CSO regulator settings. GSI under these conditions may require additional downstream conveyance capacity to function effectively. As a result, to further verify findings, a higher-performing set of assumptions that relies more on infiltration will be presented later in this report.

Figure 3-14 illustrates the relatively small difference in cost-effectiveness for simulations 1, 2, and 3, from a cost per gallon of overflow eliminated perspective. Using the described assumptions, we can conclude that an opinion of probable cost for large-scale GSI as a stand-alone control is between $0.60 and $0.70 per gallon of overflow eliminated during the typical year. Cost-effectiveness of any individual GSI project could differ significantly based on local soil and site conditions, basis of design assumptions, available downstream wet weather conveyance capacity, etc.

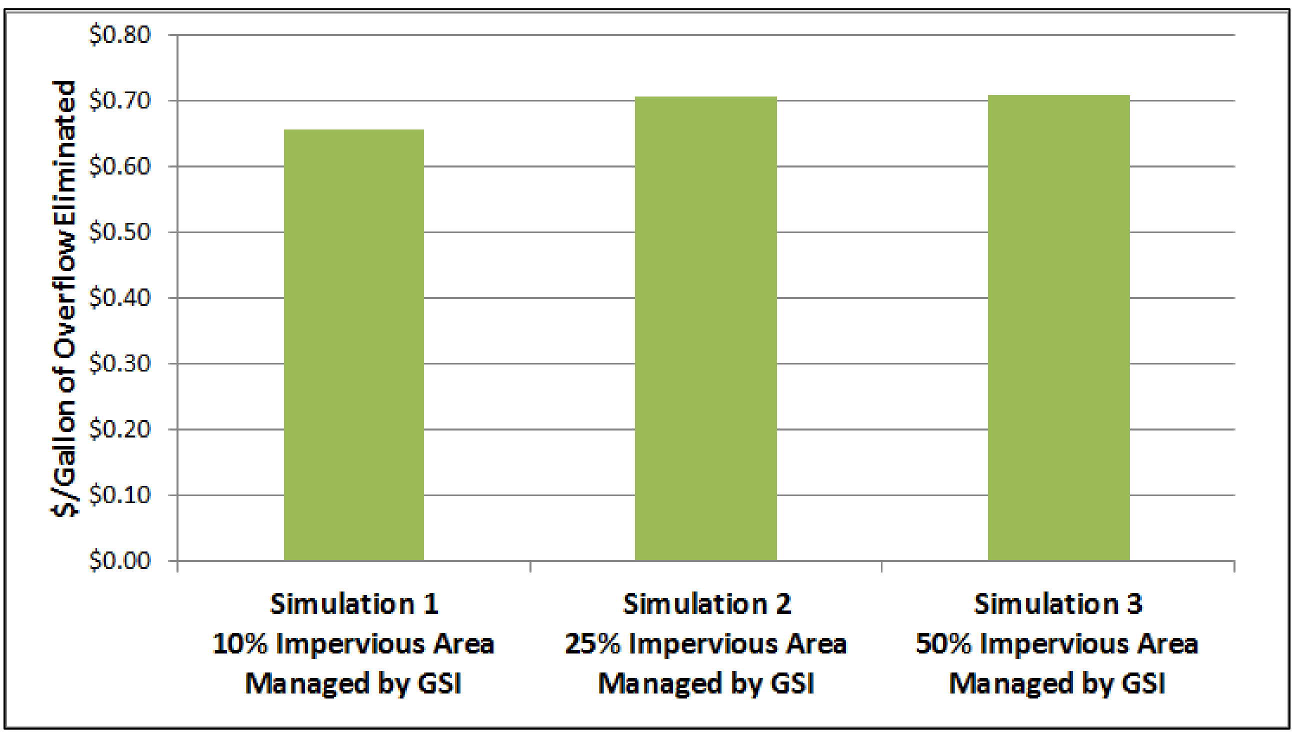



*Figure 3-14: Range in Cost-Effectiveness for Simulations 1, 2, and 3*

## 3.2.2 I/I Reduction

This section presents results and conclusions about the cost and effectiveness of I/I reduction as a stand-alone wet weather control technology. Three simulations examined the effects of I/I reduction applied conservatively, moderately, and aggressively, without any other source controls such as GSI. In these three simulations, it was assumed that all public sewers and manholes would be completely rehabilitated in certain areas with high I/I, using three different sets of criteria as shown in Table 3-10. The areas in which rehabilitation were applied are shown in Figure 3-15 for the Aggressive scenario. The resulting quantities of municipal collection system which were rehabilitated are shown in Table 3-11. The simulations used future baseline (2046) flow projections.

*Table 3-10: Rehabilitation Assumptions for I/I Reduction Model Simulations*

| Scenario # | Scenario Name | Areas Assumed to Be Rehabilitated | | Model Parameter | Reduction Applied in Areas with Rehab | |
|---|---|---|---|---|---|---|
| | | Separate Sewer Areas | Combined Sewer Areas | | Separate Sewer Areas | Combined Sewer Areas |
| 4 | Conservative | Areas with Annual Average R > 8% | None | R Value | 20% | - |
| | | | | GWI | 10% | - |
| 8 | Moderate | Areas with Annual Average R > 6% | None | R Value | 40% | - |
| | | | | GWI | 20% | - |
| 9 | Aggressive | Areas with Annual Average R > 6% | Areas with GWI > 7,500 GPIMD | R Value | 40% | - |
| | | | | GWI | 20% | 15% |

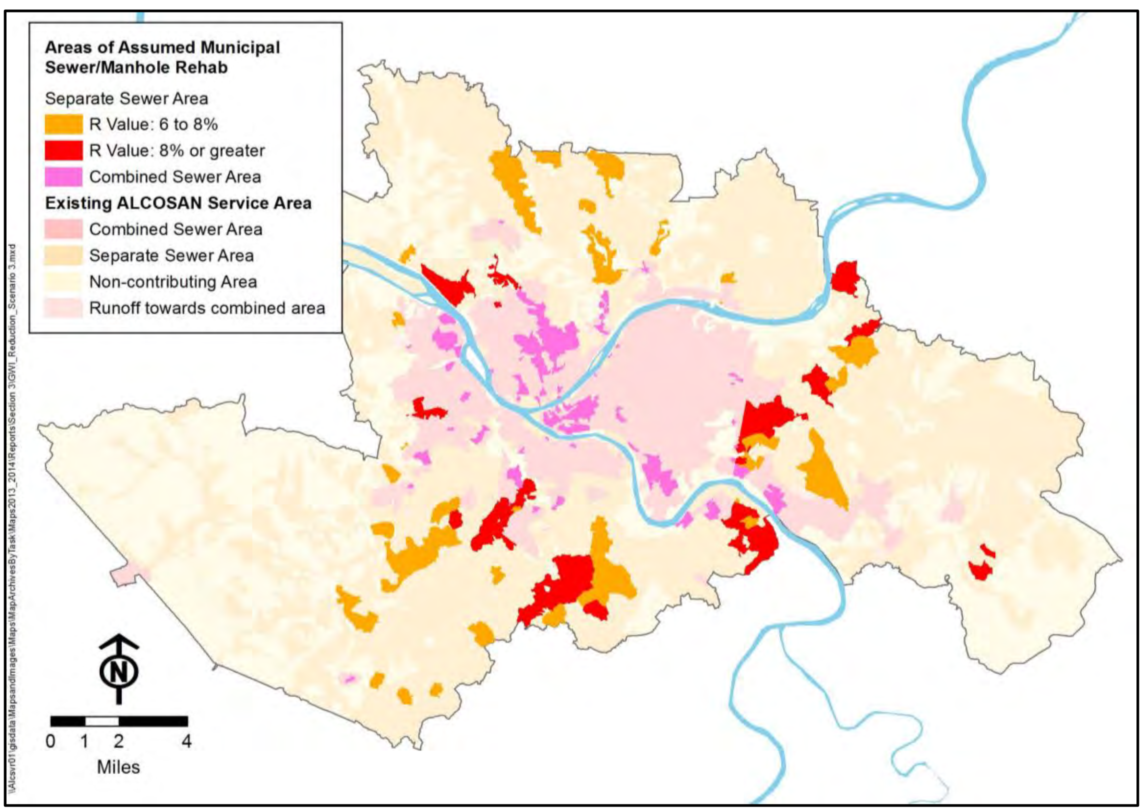



*Figure 3-15: Sewer Rehabilitation Target Areas*

*Table 3-11: Public Sewer Lengths for Which Rehabilitation Was Assumed*

| | Separate Sewer System Improvements | | Combined Sewer System Improvements | |
|---|---|---|---|---|
| **Simulation #** | **Sanitary Sewer Rehabilitation (miles)** | **Sanitary Sewer Rehabilitation (in-miles)** | **Combined Sewer Rehabilitation (miles)** | **Combined Sewer Rehabilitation (in-miles)** |
| **4** | 437 | 3,731 | - | - |
| **8** | 710 | 5,846 | - | - |
| **9** | 710 | 5,846 | 120 | 2,098 |

Capital cost estimates for the three I/I reduction scenarios were developed using the Municipal I/I Removal module of the ACT as described in Section 3.1.2. The estimates were developed using the 3RWW FSWG developed municipal cost curves for CIPP, with additional costs of manhole rehabilitation included using the ACT default pipe lining unit costs. The regional H&H model inventory of municipal pipes allowed for these unit costs to be applied by diameter of pipe to the total length of pipe for areas not meeting the threshold I/I criteria for combined and separate sewered areas.

For this initial analysis, the cost estimates assume that 100% percent of the sewers in an area must be rehabilitated in order to achieve the assumed RDII reduction. However, in areas as large as shown in Figure 3-15 (previous page), it is much more common to perform a sewer system evaluation survey (SSES) and find subareas with relatively low I/I and others with relatively high I/I. In this scenario, rehabilitation efforts would only target the subareas with relatively high I/I. The portion of the system requiring rehabilitation cannot be determined without more detailed monitoring in each area of interest, but it could be less than half or even a third of the total area studied. Based on this reality, less comprehensive cost assumptions are used in a later section in order to identify a greater number of potential opportunities for I/I reduction to eliminate the need for proposed conveyance improvements.

Figure 3-16 is a visual depiction of the estimated capital cost and overflow reduction benefits of I/I reduction for the three sets of sewer rehabilitation assumptions reflected in the simulations. It is important to note that this analysis only considers the I/I reduction benefits of sewer rehabilitation. Other benefits such as reductions in O&M costs and reduced risk of structural failure are primarily municipal benefits so are not included in the regional cost analysis. These results (representing simulations 4, 8 and 9) do not include GSI controls. A capital investment of $290 million would reach approximately 4% of the Wet Weather Plan overflow reduction target under future baseline conditions. A large program with a capital investment of $607 million would reach approximately 14% of the WWP overflow reduction target.

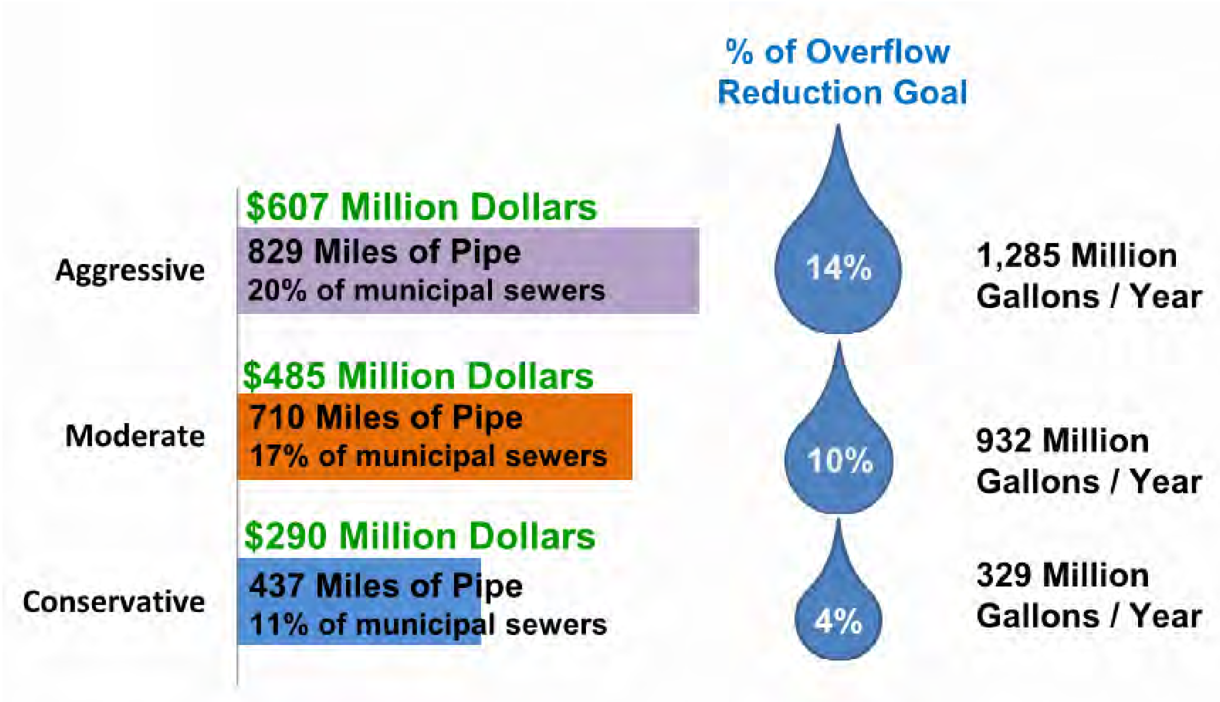



*Figure 3-16: Capital Cost and Overflow Reduction Benefit of I/I Reduction (Simulations 4, 8, 9)*

As with GSI, both capital cost and simulated performance of I/I reduction are subject to uncertainty. Actual capital cost will depend on local sewer system conditions, what percent of the pipe network must be rehabilitated, how the work is contracted, etc. The actual RDII reductions achieved will also vary from place to place depending on system condition, rehabilitation methods, project performance specifications, etc.

Figure 3-17 illustrates the range in cost-effectiveness between simulations 4, 8, and 9, from a cost per gallon of overflow eliminated perspective. Using the conservative performance criteria which only addresses the highest RDII areas in the sanitary system, the opinion of probable cost for large-scale I/I reduction as a stand-alone control is close to $0.90 per gallon of overflow eliminated during the typical year. Using the aggressive performance criteria and addressing a larger amount of high RDII areas in the sanitary system, as well as the highest GWI areas in the combined system, the opinion of probable cost is a little less than $0.50 per gallon of overflow eliminated during the typical year. The conservative criteria and rehabilitation extent is less cost-effective than for large-scale green infrastructure (~0.70/gallon for Simulation 3 as shown in Figure 3-14), while the aggressive criteria and rehabilitation extent are more cost-effective than for large scale green infrastructure. The cost-effectiveness of any individual I/I reduction project could differ significantly based on local conditions and a number of other factors as mentioned earlier.

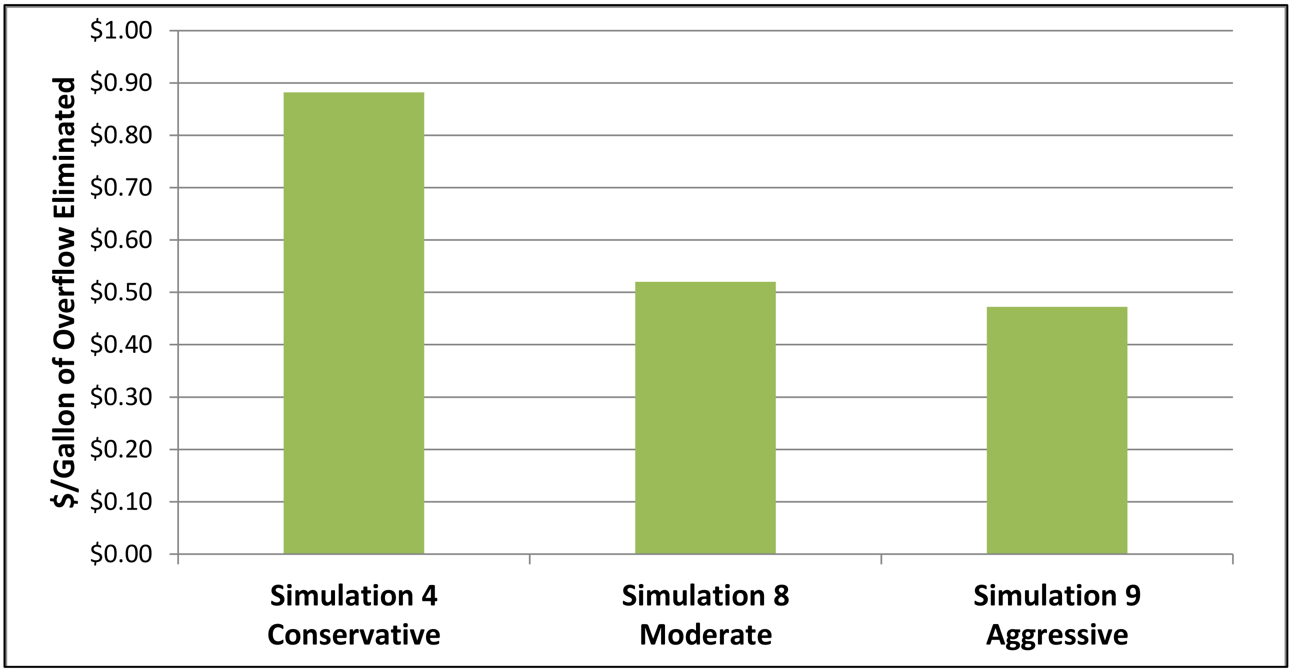



*Figure 3-17: Range in Cost-Effectiveness for Simulations 4, 8, and 9*

### 3.2.3 Combination of GSI and I/I Reduction

Analyses presented in Sections 3.2.1 and 3.2.2 indicate that aggressive implementation of GSI alone might achieve 25% of the long term sewer overflow solution and I/I alone might accomplish 14% of the solution. This section will explore the overflow reduction potential of coupling GSI with I/I reduction controls. Simulations 5 through 7 and 10 through 13 evaluate combinations of GSI coupled with sewer rehabilitation. For simulations 5, 6, and 7, GSI was assumed to intercept and manage runoff from 10%, 50%, and 90% of impervious cover, respectively. For these three simulations, I/I rehabilitation is applied only in the selected areas within the separate sanitary sewer systems, using the more conservative criteria previously described in Section 3.2.2. Simulations 10, 11, 12, and 13 assign GSI to 25%, 75%, 90%, and 50% of impervious cover, while applying the most aggressive I/I control criteria in selected areas within both the separate-sewered and combined-sewered areas. These simulations are summarized in Table 3-12 and were developed to evaluate a full range of conservative to aggressive source control applications.

With all GSI assumed to be constructed at ratepayer expense, as in the previous simulations, the cost-effectiveness of the scenarios is presented in Figure 3-18 and range from $0.59 to $0.75 per gallon. The most cost-effective scenario is Simulation 10, which involves managing runoff from 25% of the impervious cover in the combined sewered area using GSI, and taking an aggressive approach to I/I reduction. This emphasizes that whether or not source controls can eliminate the need for grey infrastructure, source controls can be most cost-effective using a joint approach that addresses both GSI and I/I reduction together.

*Table 3-12: Summary of Simulations Representing Combinations of Green Stormwater Infrastructure and Sewer Rehabilitation*

| Simulation # | Separate Sewer System Improvements | | Combined Sewer System Improvements | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sanitary Sewer Rehab (miles) | Sanitary Sewer Rehab (in-miles) | Combined Sewer Rehab (miles) | Combined Sewer Rehab (in-miles) | Combined Impervious Area Controlled By GSI | Impervious Area Controlled by GSI (acres) | DCIA Controlled by GSI (acres) | Total GSI Storage (MG) | Total GSI Storage (acre-ft.) | Total Maximum GSI Dewatering Rate (MGD) |
| **5** | 437 | 3,731 | - | - | 10% | 1,052 | 839 | 23 | 70 | 27 |
| **6** | 437 | 3,731 | - | - | 50% | 5,258 | 4,197 | 114 | 350 | 136 |
| **7** | 437 | 3,731 | - | - | 90% | 9,464 | 7,554 | 205 | 629 | 244 |
| **10** | 710 | 5,846 | 120 | 2,098 | 25% | 2,629 | 2,098 | 57 | 175 | 68 |
| **11** | 710 | 5,846 | 120 | 2,098 | 75% | 7,887 | 6,295 | 171 | 525 | 203 |
| **12** | 710 | 5,846 | 120 | 2,098 | 90% | 9,464 | 7,554 | 205 | 629 | 244 |
| **13** | 710 | 5,846 | 120 | 2,098 | 50% | 5,258 | 4,197 | 114 | 350 | 136 |

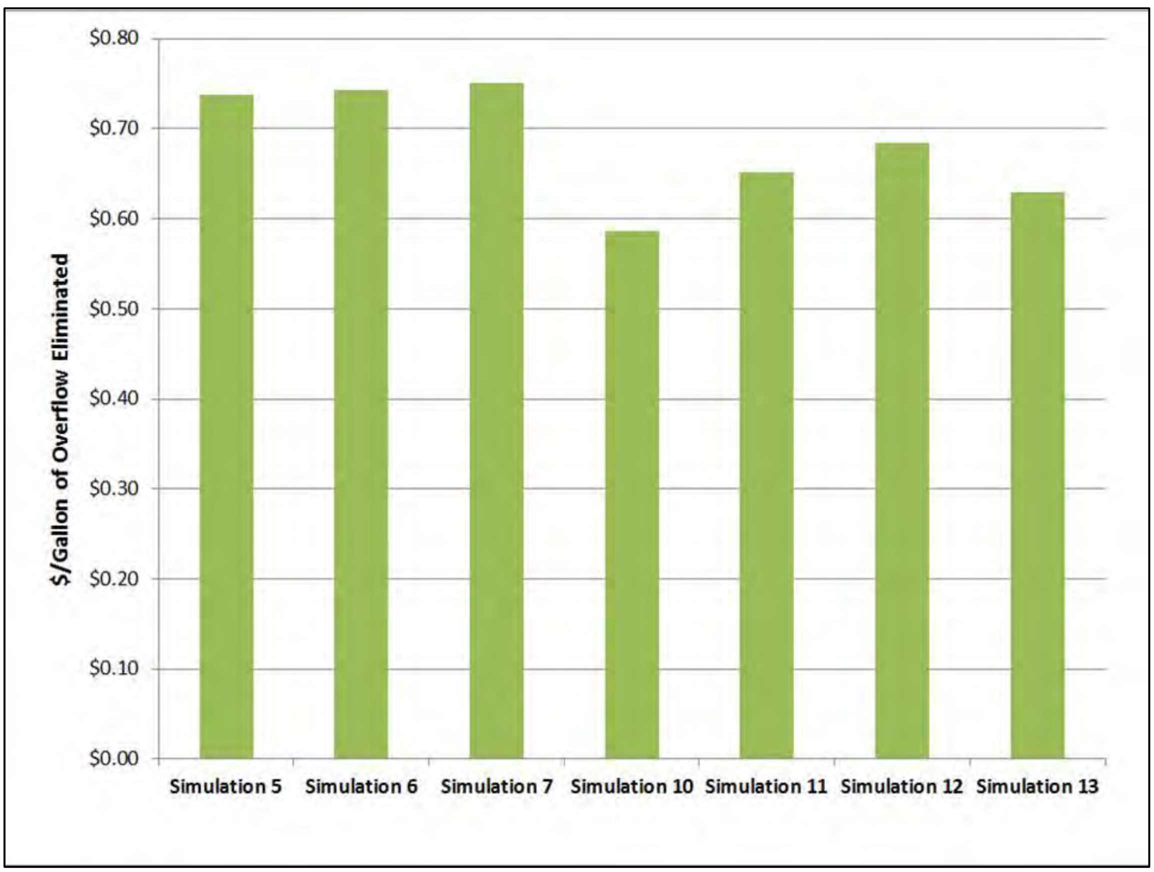



*Figure 3-18: Range in Cost-Effectiveness for Simulations 5, 6, 7, 10, 11, 12 and 13*

Figures 3-19 and 3-20 summarize the capital cost and overflow reduction performance of I/I controls alone, GSI alone, and combinations of the two. Figure 3-19 assumes that all GSI is funded by ALCOSAN rate payers as retrofit projects. The results show that regional use of source controls can lead to significant overflow volume reduction. However, source controls alone cannot achieve the overflow reductions necessary to meet full compliance with water quality requirements of the CD. ALCOSAN's Selected Plan, which was developed to meet all CD requirements, is included on the plot for comparison purposes. It would result in about 800 MG of annual overflow volume remaining. Although 50% impervious cover managed represents a practical upper limit for GSI implementation, Simulation 12 evaluates managing 90% of the impervious cover to put perspective on the bounds of possibility for using GSI as a primary control measure for the ALCOSAN service area. Simulation 12 also includes an aggressive level of I/I reduction; however, it still is projected to result in about 5 BG of annual overflow volume. The dashed line connecting future baseline conditions and the Selected Plan represents an average cost efficiency for the Selected Plan of $0.36/gallon of overflow eliminated annually, meaning that points above and to the left of this line are less cost efficient than the Selected Plan and points below and the right are more cost efficient.

Figure 3-20 assumes that ordinances are in place requiring the private sector to install green stormwater infrastructure during redevelopment. Redevelopment is assumed to affect 0.3% of impervious cover per year over the course of WWP implementation (through 2046). At this redevelopment rate, runoff from approximately 10% of the impervious cover in the combined sewered area would be managed through stormwater ordinance driven GSI at a rough order-of-magnitude value to rate payers of $370 million. Figure 3-20 shows that stormwater management ordinances can have a big impact on the cost efficiency of GSI and other source controls, particularly in the range of 10-25% impervious area managed with GSI.

As previously noted, all the conclusions above are based on GSI elements sized according to the conservative assumptions that rely more on storage and slow release, rather than on infiltration, and are therefore more sensitive to downstream conveyance and treatment capacity, regional hydraulic grade lines, and CSO regulator settings than an approach that relies heavily on infiltration. Therefore, to assess the impact these assumptions have on performance, another simulation (Simulation HP) was evaluated based on a higher-performing set of assumptions that relies more on infiltration. Ultimately, the best way to assess which assumptions are most appropriate would be through the collection of a large sample size of data at GSI locations in ALCOSAN's service area. At a minimum this data would need to include representative infiltration testing data at the depths at which GSI is to be installed, and the actual construction costs, maintenance costs and performance of numerous GSI projects distributed throughout ALCOSAN's service area.

Both Simulations 13 and HP reflect large scale GSI implementation to manage the runoff from 50% of the combined sewer area impervious cover, as well as aggressive assumptions for reducing I/I in selected areas of the separate and combined sewer areas. Both simulations are based on future baseline (2046) flow conditions with no other municipal or ALCOSAN improvements in place. The differences in the planning assumptions for the simulations are compared in Table 3-13. Both sets of assumptions are within ranges set in standard design guidance and professional practice.

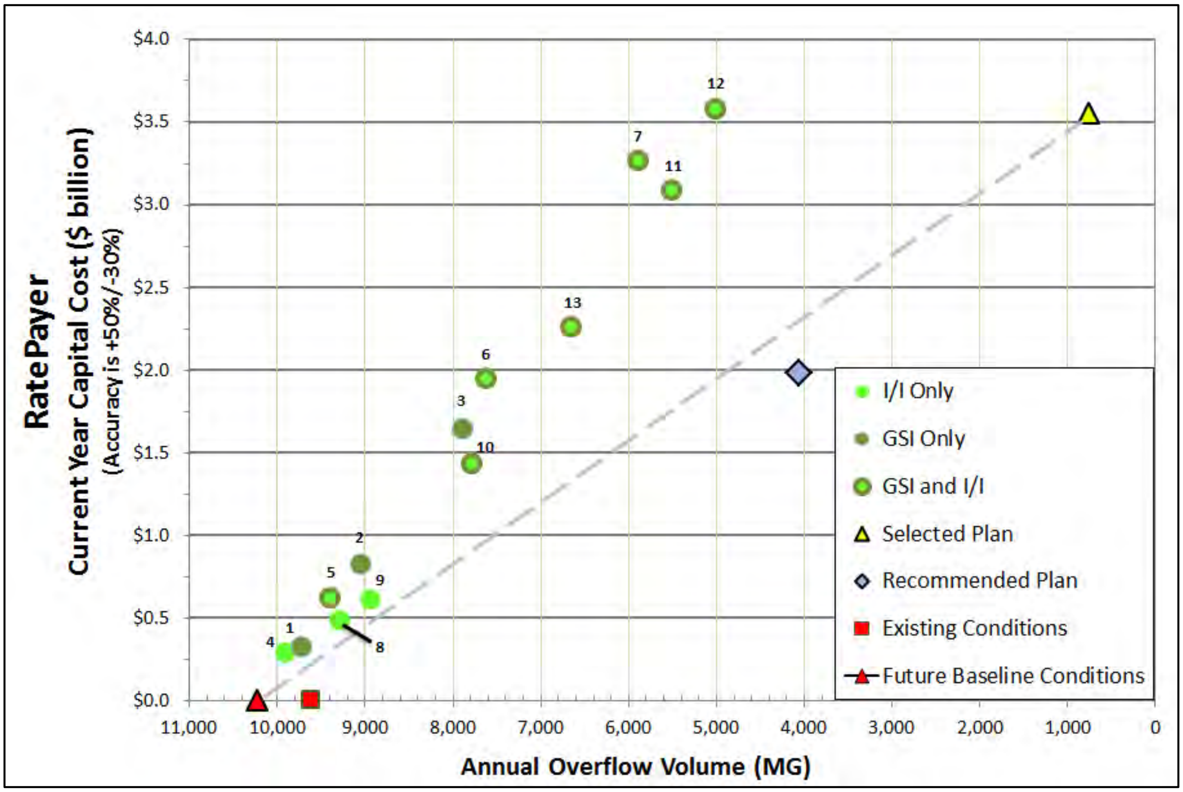



*Figure 3-19: Capital Cost and Overflow Reduction without Redevelopment*

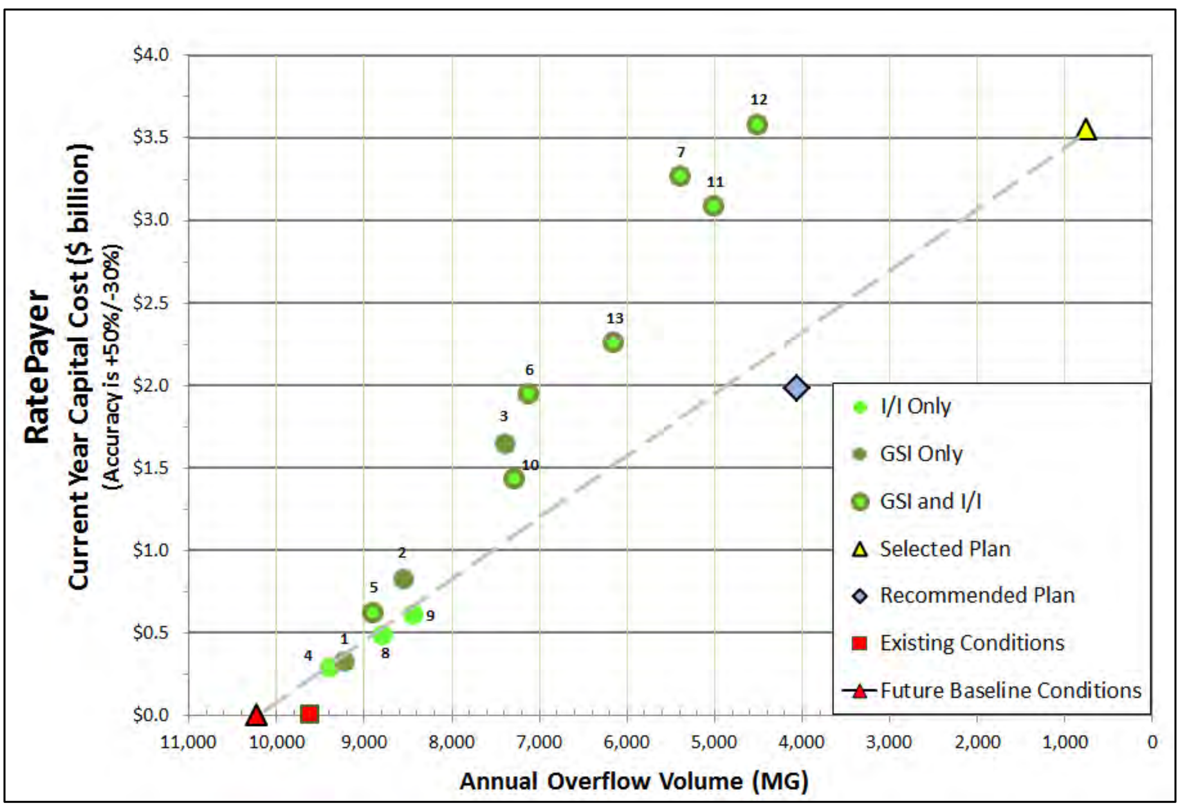



*Figure 3-20: Capital Cost and Overflow Reduction with Redevelopment*

*Table 3-13: Comparison of Planning Assumptions for Simulations 13 and HP*

| Element of GSI Sizing | Conservative Assumptions (Simulation 13) | Higher-Performing Assumptions (Simulation HP) |
|---|---|---|
| **Storage volume (inches of runoff from impervious cover)** | 1.0 | 1.5 |
| **Loading Ratio** | 11:1 | 5:1 |
| **Draindown Time (hours)** | 24 | 72 |

Table 3-14 compares the simulation results for Simulations 13 and HP. The simulation using higher-performing assumptions which provides more storage volume and prioritizes infiltration over slow release, significantly reduces the volume of runoff entering the combined sewer system "runoff reduction" over the course of the typical year. The results confirm that soil infiltration is the main mechanism of inflow removal in the simulation. The volume that is stored and slowly released to the combined sewer system is significantly decreased. The high-performance simulation assumptions result in a 17% reduction in overflow volume to waterways of approximately 600 MG. There is a greater cost to size storage to control 1.5 inches of runoff rather than 1.0 inches of runoff. However, this cost difference is less than 50% because many of the costs of construction are fixed – for example, mobilization, demolition, and repaving. Storage volume can be increased by digging deeper, increasing area, using more surface storage, or using higher-porosity materials. For this planning-level analysis we have assumed a cost increase of 20% to increase storage from 1.0 inches to 1.5 inches. With this assumed additional capital cost to build the additional storage, there is no significant change in the cost per gallon of overflow reduced. These results suggest that given the limited dewatering capacity in ALCOSAN's system, GSI should be designed to maximize infiltration.

*Table 3-14: Comparison of Results for Simulations 13 and HP*

| Portion of Source Controls | Metric of Comparison | Conservative Assumptions (Simulation 13) | Higher-Performing Assumptions (Simulation HP) |
|---|---|---|---|
| **Combined Effect of GSI & Aggressive I/I** | Overflow volume reduction (MG) | 3,560 | 4,160 |
| | Estimated capital cost ($M) | $2,260 | $2,590 |
| | Overflow reduction cost ($/gal) | $0.63 | $0.62 |
| **Effect of GSI Only** | Volume removed by GSI projects via infiltration and evapotranspiration (MG) | 2,700 | 3,470 |
| | Volume drained from GSI storage back to the combined sewer system (MG) | 790 | 140 |
| | Estimated capital cost of GSI only ($M) | $1,650 | $1,980 |
| | Costs for volume removed by GSI cost ($/gal) | $0.61 | $0.57 |

These results answer the question of whether source controls alone can reasonably be expected to meet all the requirements of ALCOSAN's CD. Although widespread and aggressive source controls can provide significant overflow volume reduction, additional treatment rate and conveyance capacity improvements would still be necessary to meet all CD requirements. This is in part because ALCOSAN's combined sewer system receives significant wet weather flows from separate sanitary sewered areas, which consume wet weather conveyance and treatment capacity for significant periods of time following wet weather events. This makes it difficult for GSI focused on storage and slow release to perform optimally. Although coupling GSI with I/I reduction measures can improve system performance, the existing treatment and conveyance capacities of the system would still be sufficiently limited to inhibit full attainment with CD requirements. This analysis does indicate significant potential for GSI and I/I reduction to cost effectively complement traditional treatment plant and conveyance interceptor expansion projects. The remaining sections of this SCS will evaluate these opportunities in more detail.

## 3.3 Opportunities to Eliminate Traditional Infrastructure in the Selected Plan

As shown in Figure 1-5, the proposed ALCOSAN improvements in the Selected Plan focus primarily on traditional tunnel conveyance/storage, tank storage, additional conveyance and increased treatment capacity. The Selected Plan also includes $530 million in municipal improvements which focus primarily on additional conveyance capacity to convey flows to an existing point of connection to the ALCOSAN's regional system. The preferred – and in some cases assumed – municipal wet weather improvements as reflected in ALCOSAN's H&H models and cost estimates in the WWP, are shown in Figure 3-21. These improvements are described in detail in Section 9.3 of the WWP. The municipalities proposed minimal use of source controls for purposes of wet weather compliance.

Following ALCOSAN's submission of its WWP in January, 2013, municipal feasibility studies were prepared by the 83 customer municipalities and associated sewer authorities and submitted to the regulatory agencies in July, 2013. Updated municipal H&H models corresponding to these studies were not supplied to ALCOSAN. However, most of the proposed improvements, costs and flow projections were the same or similar to the information previously supplied to ALCOSAN and reflected in its WWP. Therefore, ALCOSAN used the best available ALCOSAN and municipal information to evaluate opportunities to eliminate proposed ALCOSAN and municipal traditional (grey) infrastructure with GSI and other source controls. This included the ALCOSAN H&H models with municipal improvements as reflected for the WWP, with updated costs for the improvements as reflected in the municipal feasibility studies. While accounting for total present worth costs are important in identifying source control opportunities, the initial screening process focused on capital costs as a means of identifying and prioritizing opportunities. As the highest priority opportunities are explored further in cooperation with the municipalities, total present worth costs can also be accounted for when the necessary information can be obtained from the municipalities based on their latest plans and after consideration of recent agency feedback.

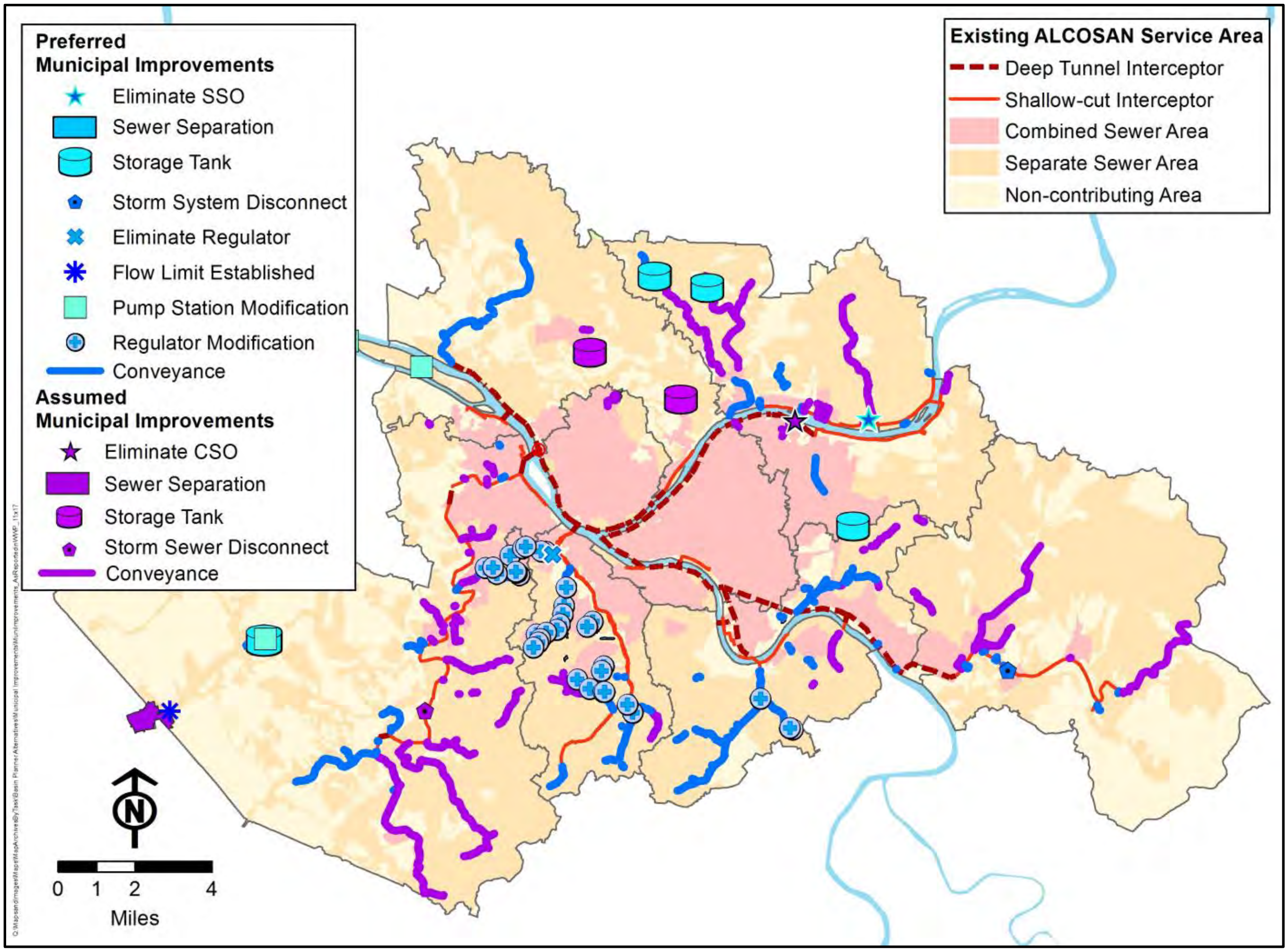



*Figure 3-21: Preferred and Assumed Municipal Improvements as Reflected in ALCOSAN's WWP (August 2012)*

Opportunities to eliminate grey infrastructure with source controls were evaluated, including GSI, direct stream inflow, I/I reduction, and sewer separation. In evaluating opportunities, the regional costs (ALCOSAN plus municipal) for the traditional approach were compared to the regional costs (ALCOSAN plus municipal) for a source control approach that would achieve the same or close to the same improvement in terms of overflow volume or frequency reduction, as applicable. This approach is "blind" to who would pay for the source controls, and focuses on the lowest cost solution from a regional perspective.

It is recommended that the potential opportunities described here-in be refined in the future via cooperation with the customer municipalities for the following reasons:

- The challenges facing this region are too large for any one entity to solve alone, and can only be solved by working together;

- Community values and additional benefits such as increased community open space, reductions in operations and maintenance costs, and reduced risk of structural failures can only be accounted for when they have been expressed by a municipality;
- There are a few situations where a proposed project in the feasibility studies may differ from how that project is represented in the H&H models;
- While the municipal feasibility studies generally had sufficient information to meet regulatory requirements, there was insufficient detail in some of the feasibility studies to determine costs for controlling certain outfalls or points of connection; and
- Two new regional priorities were emphasized by USEPA at a regulatory meeting in June, 2014: regionalization of inter-municipal trunk sewers, and flow reduction. These new priorities are expected to generate additional requirements for GSI and other source controls, but it will take time before all implications of these new priorities are known and can be considered.

This future cooperation could include obtaining more specifics about the municipalities' latest plans, obtaining updated H&H models and costs for those plans, quantifying additional community values and benefits, and understanding how municipal plans may be affected by regionalization and flow reduction.

## 3.3.1 Green Stormwater Infrastructure

As evaluated in Section 3.2, large-scale implementation of GSI over the combined area can result in a significant reduction in overflow volumes and frequency. While large-scale implementation of GSI is unable to achieve the CD-required systemwide water quality requirements, there are still multiple opportunities for GSI to be a stand-alone solution for some outfalls. To evaluate the opportunities for GSI to cost-effectively eliminate the need for proposed grey infrastructure, an analysis was performed based on 50% of the impervious cover in combined sewer areas managed using GSI, which was previously described in Section 3.2.1. The simulation used future baseline (2046) flow projections and the following conservative set of GSI sizing and performance assumptions:

- Storage equivalent to 1.0 inches of runoff from impervious cover;
- A loading ratio of approximately 11:1; and
- Drain down time of no more than 24 hours.

The analysis was conducted to address two questions:

1. Can any individual municipal or ALCOSAN CSO outfall be controlled solely with GSI?
2. For each CSO outfall that has the potential to be controlled with GSI, how does the municipal/ALCOSAN grey infrastructure cost compare to the GSI only cost?

The benefits of GSI were quantified in terms of reduction in overflow frequency during the Typical Year, compared to Future Baseline conditions. For the purpose of evaluating the cost-effectiveness of GSI, all GSI was assumed to be installed as a ratepayer funded retrofit projects costing $287,000 per impervious acre managed. As shown in Table 3-4 this capital cost assumes the GSI is installed as some combination of bioretention, subsurface infiltration, and porous pavement.

Figure 3-22 addresses the first question above showing the number of outfalls that will discharge for three overflow frequency ranges: 0-6, 7-10, and more than 10 overflows per typical year. There are 66 CSO outfalls that are already controlled to 6 or fewer overflows per year under Future Baseline conditions. Based on 50% impervious area managed using GSI, 39 additional CSO outfalls could be controlled to 6 or fewer overflows per typical year and 37 outfalls to 7-10 overflows. 202 outfalls would still discharge more than 10 times per year and would generally require supplemental overflow control measures, such as traditional grey infrastructure. The 76 outfalls (22% of all CSOs) represented by the yellow and orange bars in Figure 3-22 represent potential opportunities to utilize GSI as the primary control measure. Figure 3-23 shows the location of the combined sewer area tributary to these 76 outfalls. A total of 142 CSO outfalls have annual overflow frequencies of 10 or fewer with GSI controlling 50% of the impervious cover, so the area upstream of each of these outfalls represent potential opportunities for GSI.

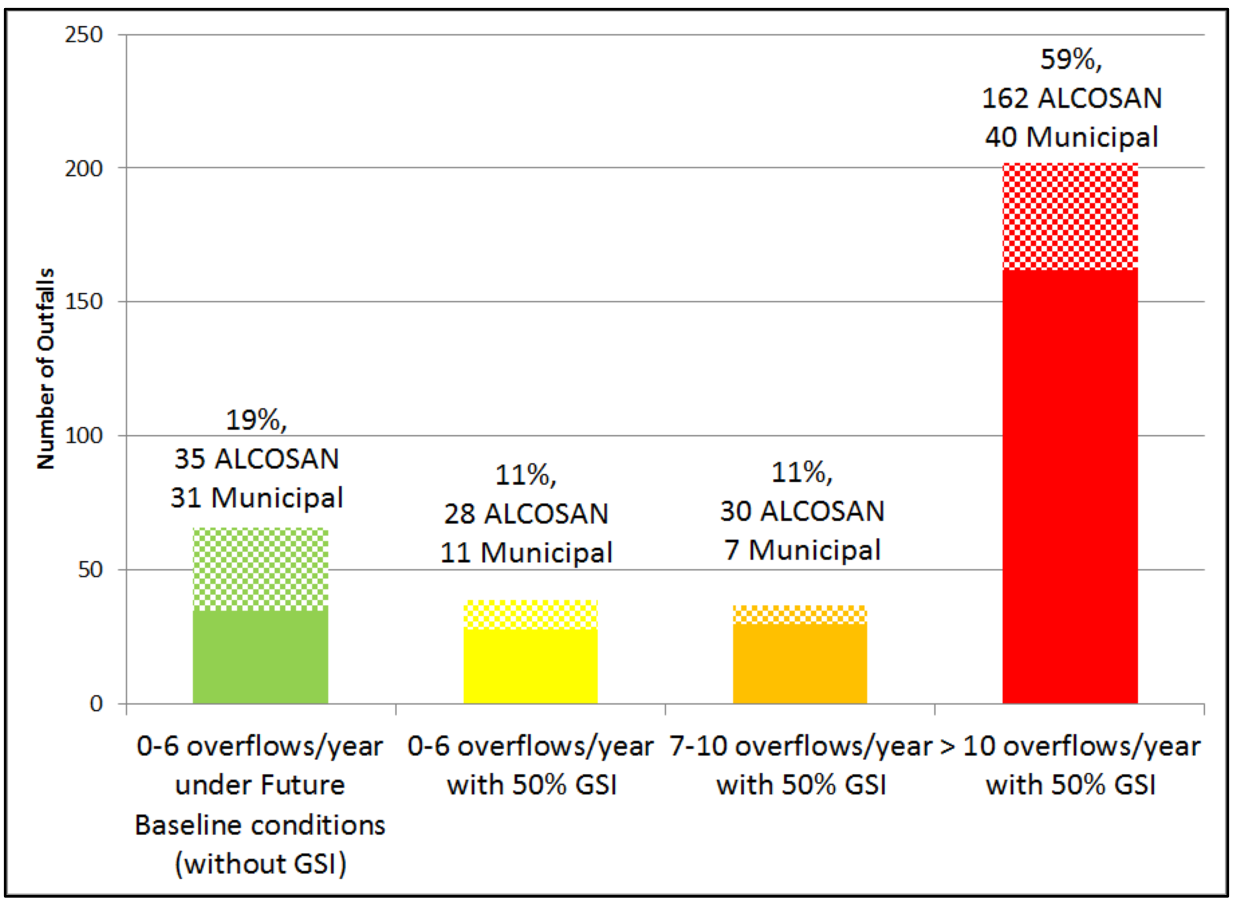



*Figure 3-22: Count of outfalls in various Overflow Frequency ranges for the GSI only Alternative*

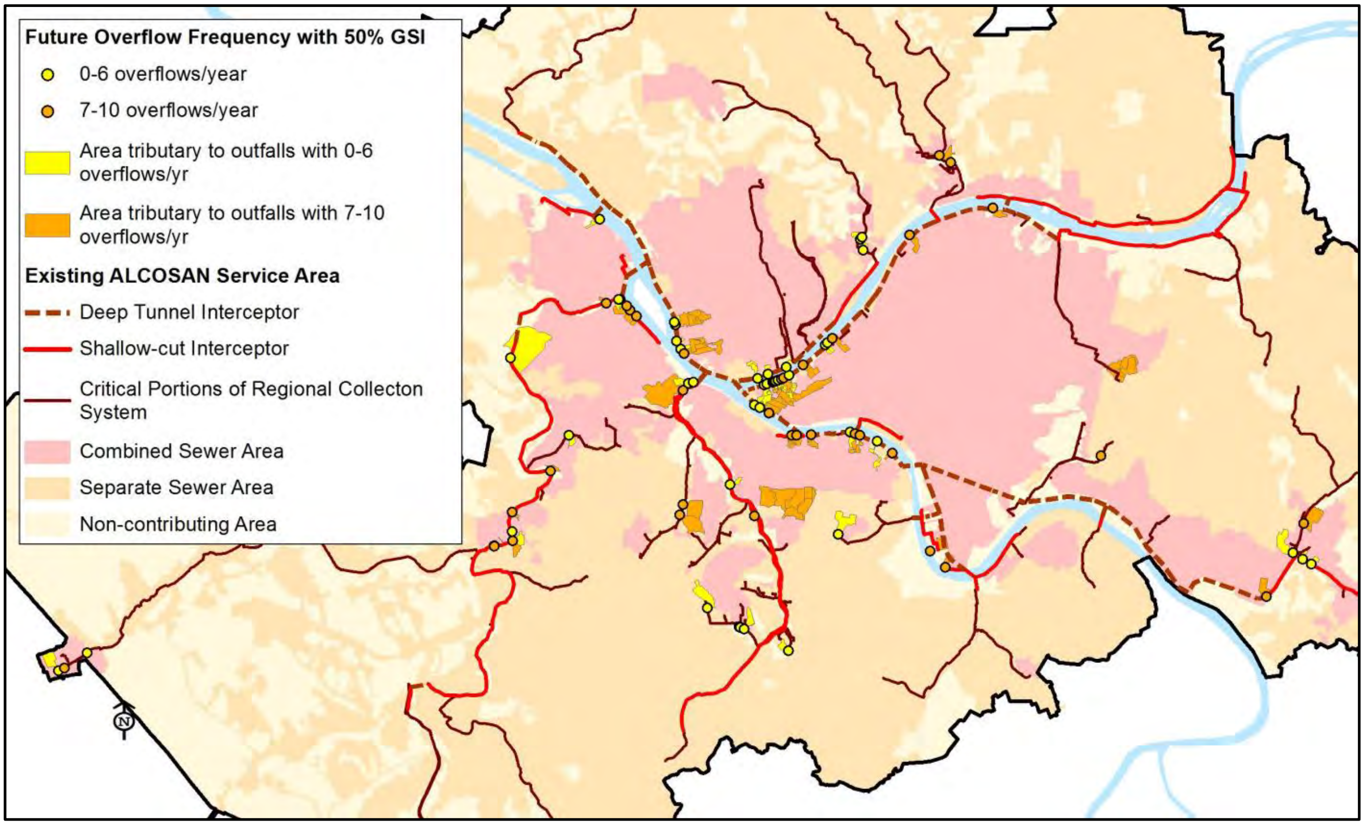



*Figure 3-23: Outfalls in various Overflow Frequency ranges for the GSI only Alternative*

To answer the second question above, the analysis focused on only those outfalls which have a municipal or ALCOSAN grey infrastructure cost associated with ALCOSAN's Selected Plan. With this in mind the CSO outfalls fell into three categories:

- 19 outfalls had associated grey infrastructure costs and were analyzed.
- 44 outfalls either do have or may have associated grey infrastructure costs but there was insufficient detail in the municipal feasibility studies in order to determine outfall-specific costs to complete the analysis. 15 of these outfalls are expected to be eliminated near the end of 2014 based on long term sewer separation projects in McDonald Borough, but it is recommended that opportunities for the remaining 29 outfalls be explored in the future through municipal cooperation.
- 79 outfalls had no associated grey infrastructure costs so analysis was not necessary.

For the 19 outfalls analyzed, the capital cost of green versus grey infrastructure was evaluated by computing the ratio of the green cost to the grey cost. Figure 3-24 can help illustrate this approach using outfall M-20 as an example. The GSI cost was estimated based on managing runoff from 50% of the impervious area (designated with red shading) within the catchment boundary upstream of this outfall. This GSI would potentially eliminate the need for the purple consolidation sewer conveying most of the flow from M-20 to a proposed drop shaft east of M-20. Table 3-15 shows the grey and green costs for each outfall and the resulting green to grey ratio. If the ratio was found to be less than 1, it indicated the capital cost of 50% GSI control could be lower than the capital grey infrastructure cost, as reflected in the Selected Plan. Figure 3-25 depicts the same capital cost comparison for the 19 outfalls evaluated.


*Figure 3-24: Example of Evaluating Opportunities to Eliminate Grey Projects with GSI for Outfalls M-17, M-18 and M-20*

*Table 3-15: Comparison of Green to Grey Costs for Outfalls with Available Municipal Outfall Specific Costs*

| Outfall | POC | Outfall Owner | Grey Infrastructure Capital Cost ($M) | | | Capital Cost for 50% GSI ($M) | Ratio of GSI Cost to Grey Cost |
|---|---|---|---|---|---|---|---|
| | | | ALCOSAN | Municipal | Total | | |
| O-43-OF | O-43 | ALCOSAN | $ 9.62 | $ - | $ 9.62 | $ 1.41 | 0.15 |
| A-56-OF | A-56 | ALCOSAN | $ 3.39 | $ - | $ 3.39 | $ 0.84 | 0.25 |
| S-34-OF | S-34 | ALCOSAN | $ 1.55 | $ - | $ 1.55 | $ 0.42 | 0.27 |
| 1071-OF | A-42 | COP/PWSA | $ - | $ 15.80 | $ 15.80 | $ 5.50 | 0.35 |
| S-28-OF | S-28 | ALCOSAN | $ 3.70 | $ - | $ 3.70 | $ 1.31 | 0.35 |
| M-17-OF | M-17 | ALCOSAN | $ 2.25 | $ - | $ 2.25 | $ 0.88 | 0.39 |
| M-18-OF | M-18 | ALCOSAN | $ 1.51 | $ - | $ 1.51 | $ 0.73 | 0.49 |
| M-20-OF | M-20 | ALCOSAN | $ 1.61 | $ - | $ 1.61 | $ 0.89 | 0.56 |
| A-47-OF | A-47 | ALCOSAN | $ 2.11 | $ - | $ 2.11 | $ 1.29 | 0.61 |
| O-40-OF | O-40 | ALCOSAN | $ 0.65 | $ - | $ 0.65 | $ 0.40 | 0.62 |
| S-42-OF | S-42 | ALCOSAN | $ 9.08 | $ - | $ 9.08 | $ 5.68 | 0.63 |
| S-46-OF | S-46 | ALCOSAN | $ 8.07 | $ - | $ 8.07 | $ 5.17 | 0.64 |
| S-29-OF | S-29 | ALCOSAN | $ 16.33 | $ - | $ 16.33 | $ 11.85 | 0.73 |
| T-11-OF | T-11 | ALCOSAN | $ 0.63 | $ - | $ 0.63 | $ 0.48 | 0.77 |
| TR-01-OF | TR-01 | ALCOSAN | $ - | $ 1.75 | $ 1.75 | $ 2.14 | 1.22 |
| T-03-OF | T-03 | ALCOSAN | $ 1.13 | $ - | $ 1.13 | $ 1.50 | 1.33 |
| T-13-OF | T-13 | ALCOSAN | $ 0.31 | $ - | $ 0.31 | $ 0.62 | 2.01 |
| CSO_032N001 | M-34 | COP/PWSA | $ - | $ 0.36 | $ 0.36 | $ 1.13 | 3.14 |
| TR-02-OF | TR-02 | ALCOSAN | $ - | $ 0.65 | $ 0.65 | $ 2.07 | 3.18 |
| | | **TOTAL:** | **$ 61.94** | **$ 18.56** | **$ 80.50** | **$ 44.31** | **0.55** |

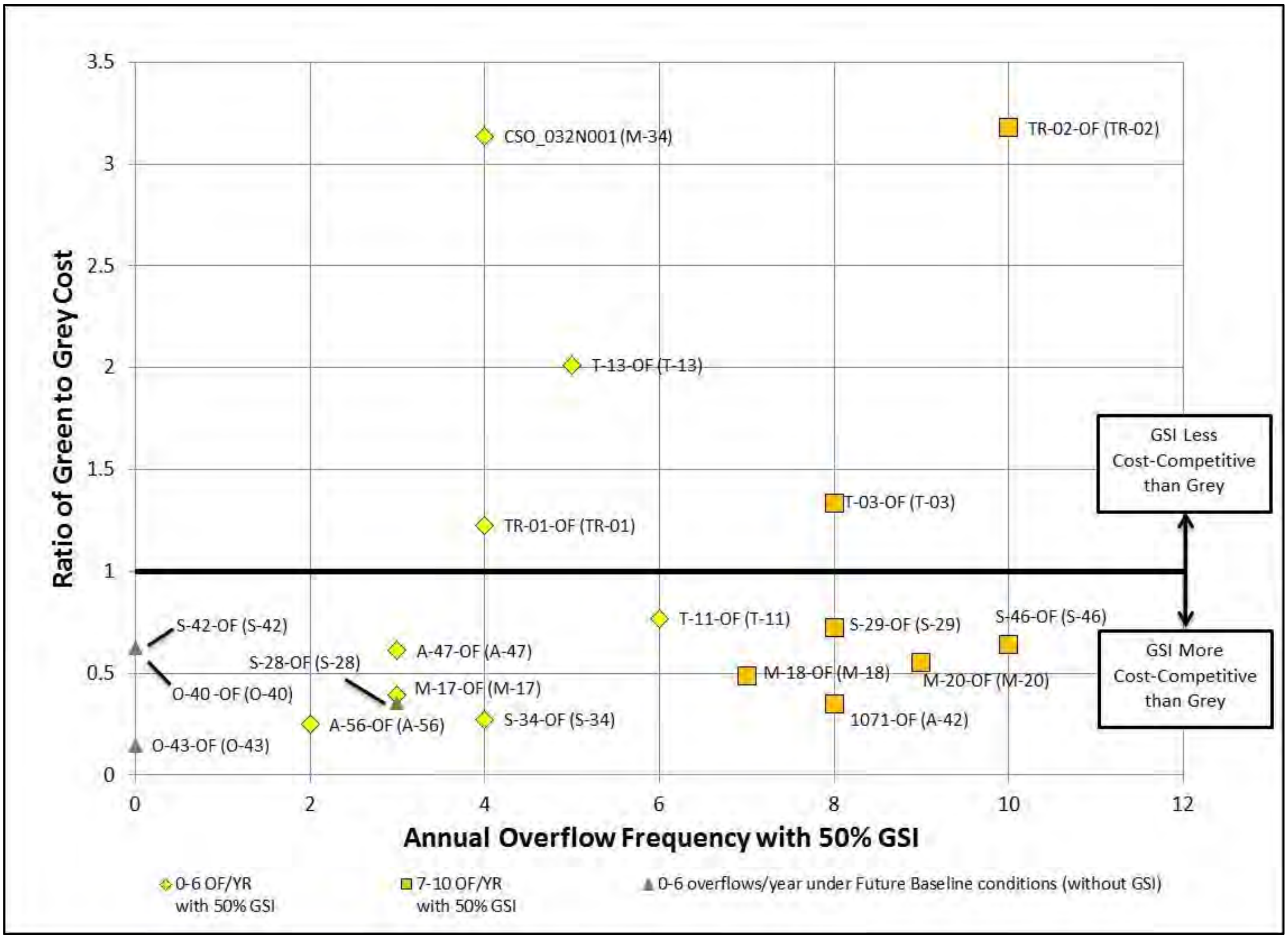



*Figure 3-25: Cost Comparison Results for 19 Outfalls Analyzed with 50% of Impervious Cover Managed with GSI*

As shown in Figure 3-25, 14 of the 19 outfalls lie below the green to grey ratio line of 1, indicating GSI could cost less than the original grey alternative proposed at these outfalls. Regardless of the computed ratio, it is recommended that all these opportunities be explored further in cooperation with the customer municipalities in order to also evaluate total present worth costs, and to consider the many other factors that could change the cost comparison and possibly help identify additional outfalls with green opportunities:

- The ratepayer-funded GSI cost could be reduced if there are known redevelopment plans with ordinance-driven on-site storm water management plans, or other similar projects upstream of these outfalls that would provide some of the overflow reduction benefit through other mechanisms. For example, the 21st Street GSI project would reduce the amount of ratepayer-funded GSI required to control outfall M-17 shown in Figure 3-24.
- The portion of GSI cost paid by a municipality could be reduced if grants or other supplemental funding sources became available to support a green alternative.

- The municipal capital and total present worth cost of the GSI alternative could differ if ALCOSAN were to institute some form of source control incentive, or were to institute some form of a wet weather charge system for its retail customers. This is discussed in detail in Section 5 of the report.
- The estimated GSI costs are based on planning level costs for managing 50% of the impervious cover as reflected in the model, but the actual amount of GSI required will vary by outfall and will depend on the outfall-specific level of control. If managing 50% of impervious cover provides a greater degree of control than is needed for a particular outfall, then 20%, 30% or 40% might be sufficient and the GSI costs would decrease accordingly. On the other hand, 60% GSI or more might be required for a few outfalls.
- The municipality would need to provide updates for the proposed grey infrastructure improvements for each outfall including outfall-specific capital and annual O&M costs, and the proposed and required level of CSO control. In some cases, written agency comments on the municipal feasibility studies, the verbal EPA feedback provided in June 2014, and implications of a new flow reduction priority could significantly alter the project proposed in the feasibility studies. Sewer drawings would also be needed to confirm the tributary drainage areas for each municipal and ALCOSAN outfall.
- The number and location of GSI projects needs to be identified based on the required percentage of impervious cover that needs to be managed for each outfall. Once the number and location are identified, more realistic site-specific cost estimates can be performed for the area upstream of each outfall.
- As ALCOSAN proceeds into advanced facilities planning for grey infrastructure projects, refined cost estimates will be prepared for the grey projects associated with these outfalls based in part on additional field investigations, geotechnical borings, and analysis of alternative conveyance alignments and construction methods.
- Further discussion is needed regarding potential cost-sharing for the GSI opportunities that could be regionally cost-effective, but that do not appear cost-effective when viewed solely from the municipal perspective. This is sometimes the case because the regional cost savings comes from eliminating an ALCOSAN grey infrastructure project, in exchange for GSI implementation by municipalities.
- All municipal and ALCOSAN combined sewer regulator settings are set to operate properly with consideration of downstream interceptor and treatment capacity as it exists today. Once the WWTP is expanded to treat 480 MGD of wet weather flows, and the initial tunnel segments are constructed to convey additional wet weather flow to the WWTP, many regulator settings are expected to be "opened up" to convey more flow downstream for treatment. Future I/I reduction efforts could also free up more wet weather conveyance and treatment capacity in the future. For each outfall whose regulator capacity is increased due to increased downstream capacity, reduced upstream GSI will then be required at a reduced cost to achieve the level of control indicated in these simulations. If regulator capacity is "opened up" selectively, giving more capacity to certain areas where GSI could be a stand-alone solution as analyzed under these future conditions, this could also create more GSI opportunities.
- In the future as plans for I/I reduction become better defined, additional opportunities for GSI could be identified for some outfalls with combined areas having upstream separate sanitary areas targeted for I/I reduction. One example is the area upstream of CSO outfall S-18, which

has a very large separate sanitary area and minimal combined area. Aggressive I/I reduction in this shed is predicted to reduce the CSO frequency from 21 overflows per year to 3.

- ALCOSAN and its customer municipalities are actively working towards regionalization of inter-municipal trunk sewers. This initiative is likely to create more opportunities for GSI to eliminate the need for grey infrastructure. First, municipalities could be incentivized to consider GSI as a condition of transferring these sewers to ALCOSAN. Second, many of the proposed municipal wet weather improvement projects will become ALCOSAN's responsibility to implement, which will create an opportunity to revisit the preferred alternatives for these projects. This could involve re-examining the proposed level of control for CSO outfalls and ensuring that opportunities for GSI alternatives have been fully evaluated.
- As noted earlier, the regulatory agencies have also indicated that flow reduction needs to become a high priority for the region. The full implications of this directive are not yet known, but they are expected to generate additional requirements for GSI and/or other source controls.

In summary, a number of opportunities have been identified where approximately $45M in GSI has the potential to eliminate the need for approximately $81M in ALCOSAN and municipal grey infrastructure, for a potential regional capital cost savings of $37M. Many additional opportunities could arise in the future due to the many factors described above. One of the keys to realizing the benefit of these opportunities is ongoing cooperation with the customer municipalities.

### 3.3.2 I/I Reduction

As reflected in the municipal feasibility studies, approximately $250M in municipal grey infrastructure projects in separate sewered areas are proposed for a wide variety of reasons including elimination of SSOs, reducing surcharge, addressing basement back-ups, providing capacity for future growth, providing a higher level of service, and meeting varying interpretations of agency requirements for what the municipal feasibility studies (MFS) were to address. While SSOs are required to be eliminated, the projects are also sized based on a wide variety of design criteria that set a practical upper limit for what constitutes elimination of SSOs or what flow must be conveyed without surcharging a pipe, such as a
2-year or 10-year summer or winter design storm, or more than one of these conditions.

Implementation of I/I reduction measures in targeted "wet areas" is expected to reduce the peak and volume of RDII in separate sewers, as well as the volume of GWI. For some sewersheds, this reduction could be large enough to completely address the municipality's primary reason for the project, such as eliminating a predicted SSO even with future (2046) flow conditions, or reducing surcharging to acceptable levels. Many I/I reduction projects and programs in other cities are similarly driven by efforts to avoid a large capital improvement project to increase conveyance to downstream treatment.
Section 3.2.2 evaluated large-scale implementation of I/I reduction as a stand-alone control measure under a conservative, moderate and aggressive set of assumptions and pipe extents. This section compares the results of Simulation 9 and its aggressive assumptions versus future baseline conditions (2046) to identify specific locations that have the most potential for I/I reduction.

The analysis was conducted to address two questions:

1. Can any individual municipal or ALCOSAN SSO outfalls be controlled solely with I/I reduction?
2. For each such SSO outfall, how does the municipal and/or ALCOSAN grey infrastructure cost compare to I/I reduction only cost?

The 2-year summer and winter design storm simulations were used to compare overflow volumes between Simulation 9 (aggressive I/I) and future baseline conditions. Both simulations used future (2046) flow projections, and neither simulation included any proposed municipal or ALCOSAN improvements. Aggressive I/I reduction assumes complete rehabilitation of the "wettest" portions of the municipal sewer systems as previously described in Section 3.2.2, and is implemented in the models as follows:

- A 40 percent reduction in each monthly R-value for the targeted separate sewer areas with annual average R-values greater than 6 percent, except the reduced value for each month was not allowed to go below 3%; and
- A 20 percent reduction in all GWI flows for the targeted separate sanitary areas with annual average R- values greater than 6 percent; and
- A 15 percent reduction in all GWI flows for the targeted combined sewer areas with GWI greater than 7,500 GPIMD (gallons per inch mile per day).

Simulation 9 and the future baseline model reflect the flow projections provided to ALCOSAN and reconciled by ALCOSAN's Basin Planners in the WWP development process, which are the most recent projections available system-wide for every municipality. During the development of their municipal feasibility studies, some municipalities and authorities used a 2-year design storm as the design criteria for their separate systems, but others used a 10-year design storm. Some municipalities chose to simulate the design storm only during the summer period, some only during the winter period, and others considered both periods.

In ALCOSAN's WWP the proposed SSO control criteria is a long-term average of one overflow every two years. However, facilities in the WWP were conservatively sized to eliminate all overflows from a 2-year design storm simulated for both summer and winter periods. The summer period is in the month of August 2003 while the winter period is in the month of January 2003. To select a consistent design criterion for the ALCOSAN and municipal SSOs for this analysis, the two 2-year summer design storm selected by ALCOSAN was used. For calculations and presenting results, the reported overflow volumes reflect the larger of the two volumes. Since future flows are simulated without the municipal improvements to contain those flows, some flooding occurs in the models, so the reported untreated overflow volumes account for this by including flooded volumes at manholes along separate sewers. It is understood that some municipalities have proposed a higher level of service (e.g. meeting a summer and winter 10-year design storm) in their separate sanitary systems than is reflected in this analysis or may be seeking to address an objective other than just SSO elimination, so any opportunities identified below are less likely to be suitable options for those municipalities.

For the purpose of evaluating the cost-effectiveness of I/I only control, the rehabilitation costs were based on the same cost assumptions as described in Section 3.2.2 with one exception. As previously described, the cost estimates in Section 3.2.2 are conservative in that they assume 100% percent of the sewers in an area must be rehabilitated in order to achieve the assumed RDII reduction. In large areas, it is much more common to perform a SSES and find subareas with relatively low I/I and others with relatively high I/I. In this scenario, rehabilitation efforts would only target the subareas with relatively high I/I. Based on this reality, a more realistic cost assumption was used in the analysis, assuming that one-third of the public sewer in each target area would require complete rehabilitation to achieve the required reduction. As noted previously, additional detailed flow monitoring would be needed in any given area before the specific extent of rehabilitation in that area can be reasonably estimated.

The opportunities for elimination of grey infrastructure resulting from I/I reductions were evaluated by comparing I/I reduction costs to proposed project costs at three different scales, but only in those areas where separate sanitary improvements were proposed:

- For certain groupings of separate sanitary points of connections (POCs) to the ALCOSAN regional system that were analyzed by Basin Planners in the WWP development.
- For the entire area tributary to each separate sanitary point of connection to the ALCOSAN regional system.
- For the area upstream of each SSO outfall.

### Groups of Separate Sanitary Points of Connections

The results of the analysis by groups of separate sanitary POCs are shown in Figure 3-26. Each point represents results of the analysis for a single group. The vertical axis represents the ratio of the public sewer rehabilitation costs to the associated municipal and ALCOSAN Selected Plan costs, so a value less than one indicates an opportunity that is potentially cost-effective. The horizontal axis reflects the sum of all municipal and ALCOSAN SSO volumes associated with this group of POCs for the 2-year design storm, including separate sanitary sewer flooding, that remains after the aggressive I/I reduction is implemented in the models. The best opportunities for I/I reduction are those which have a very small design storm volume remaining, and a cost ratio less than one. The only group of POCs which meets this criterion is the upper portion of the Saw Mill Run planning basin, which is proposed to be served by an ALCOSAN sanitary relief interceptor. This would suggest that this group of POCs has a relatively low overflow volume to begin with, and that significant “wet area” is positioned upstream of the SSOs such that rehabilitation is effective at significantly reducing SSOs.

In all the other groups evaluated, the target areas of I/I reduction were not able to come close to eliminating SSOs for the 2-year design storm. This would suggest that either the SSO volumes are just too large to be impacted by rehabilitation, or that in inadequate amount of the “wet area” as defined by this analysis is positioned upstream of the SSOs such that rehabilitation is ineffective at significantly reducing SSOs.

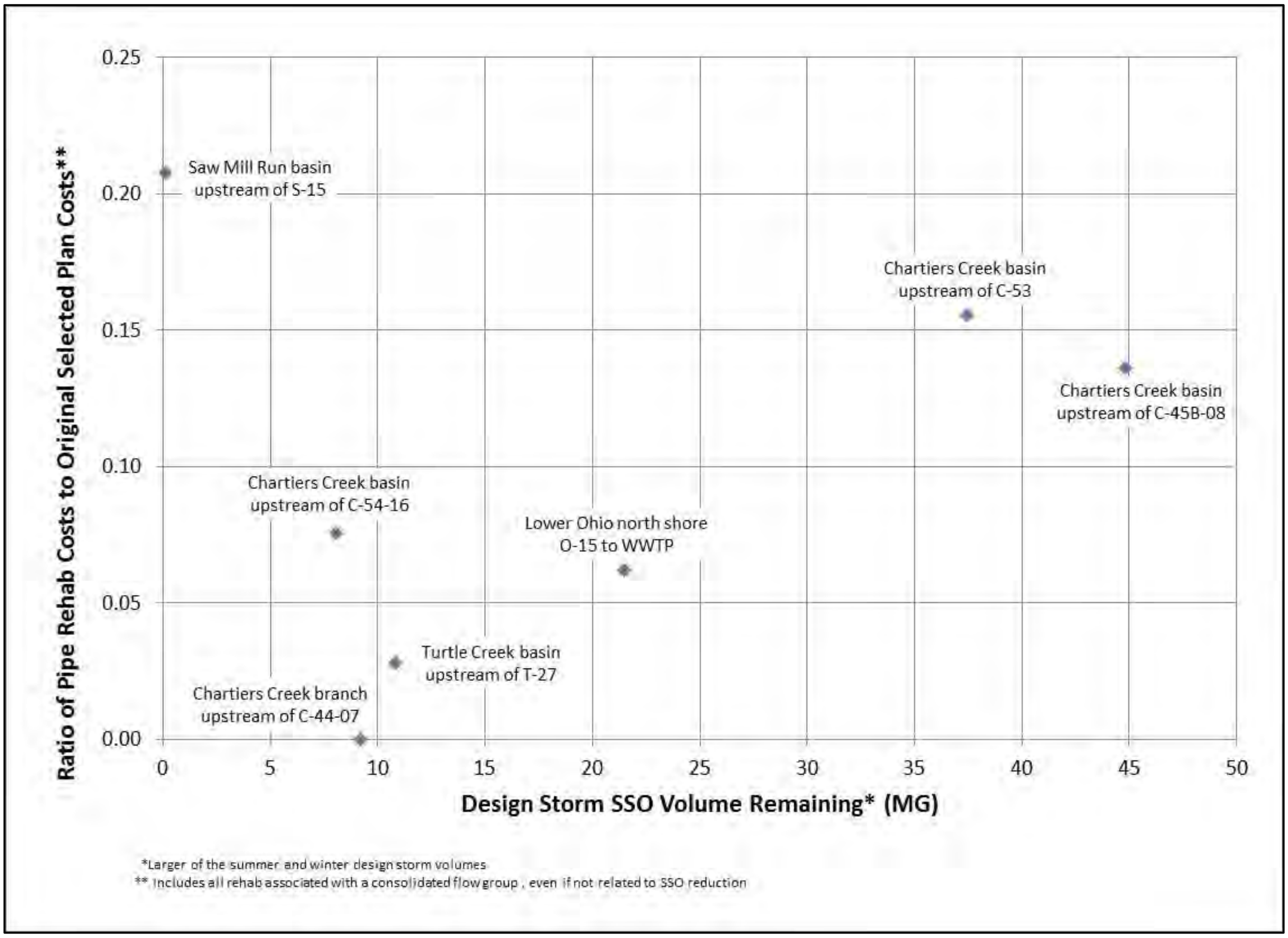



*Figure 3-26: Potential of I/I Reduction to Eliminate SSOs – Groups of Points of Connections*

## Point of Connection Sewersheds

Figure 3-27 and 3-28 shows the analysis results for each Point of Connection Sewershed using ALCOSAN's summer and winter 2-year design storms. The grey infrastructure costs for each POC include all municipal costs for the POC plus only those ALCOSAN costs which are specific to that POC. The best opportunities for I/I reduction are those POCs which have a very small design storm volume remaining, and cost ratios less than one. As shown in Figure 3-27, there are twenty-four POCs for which pipe rehabilitation to control SSOs might be cost-competitive with the combination of ALCOSAN and municipal grey solutions included in Selected Plan. Another ten POCs are less likely to be cost-effective as shown on Figure 3-28, while three more POCs are not shown on either plot. Given the uncertainty of the planning level cost estimates, the best opportunities worth exploring further are those POCs with less than 1 MG of overflow remaining for the 2-year design storm and a cost ratio of about two or less. The 21 POCs meeting these criteria are outlined in black in Figure 3-29, which also shows areas of high RDII as used in the H&H models for this analysis. The remaining POCs have relatively large overflow volumes remaining and/or high rehabilitation costs so they are less likely candidates for rehabilitation to eliminate all SSOs associated with these POCs.

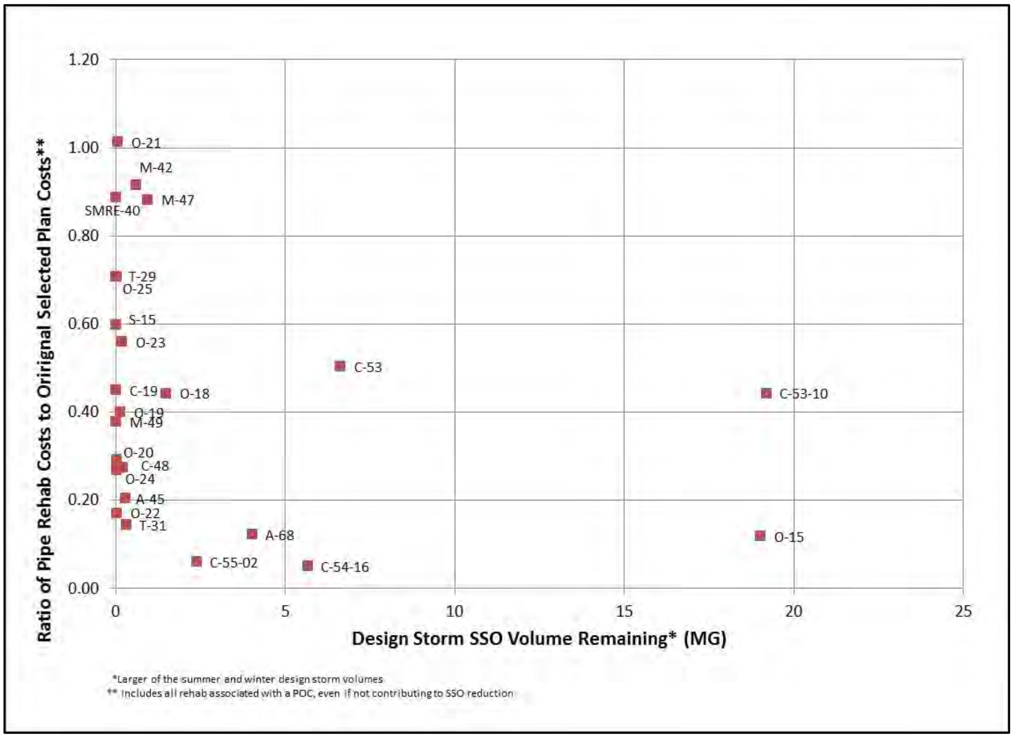



*Figure 3-27: Potential of I/I Reduction to Eliminate SSOs – Point of Connection Sewersheds – Cost Ratio of One or Less*

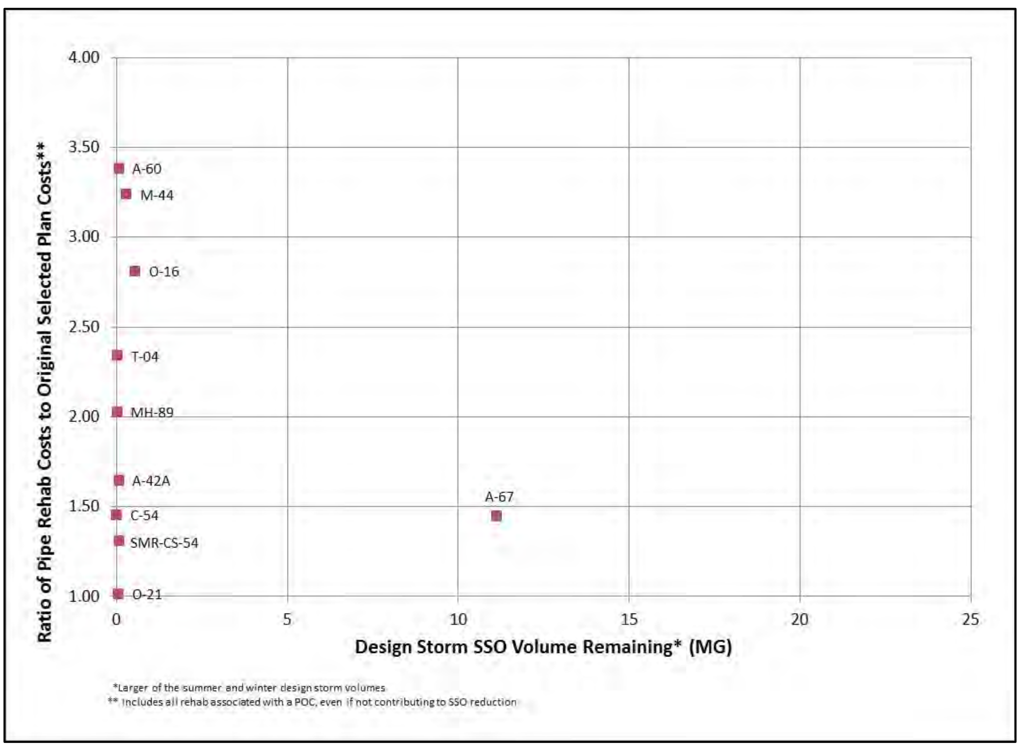



*Figure 3-28: Potential of I/I Reduction to Eliminate SSOs – Point of Connection Sewersheds– Cost Ratio of One or More*

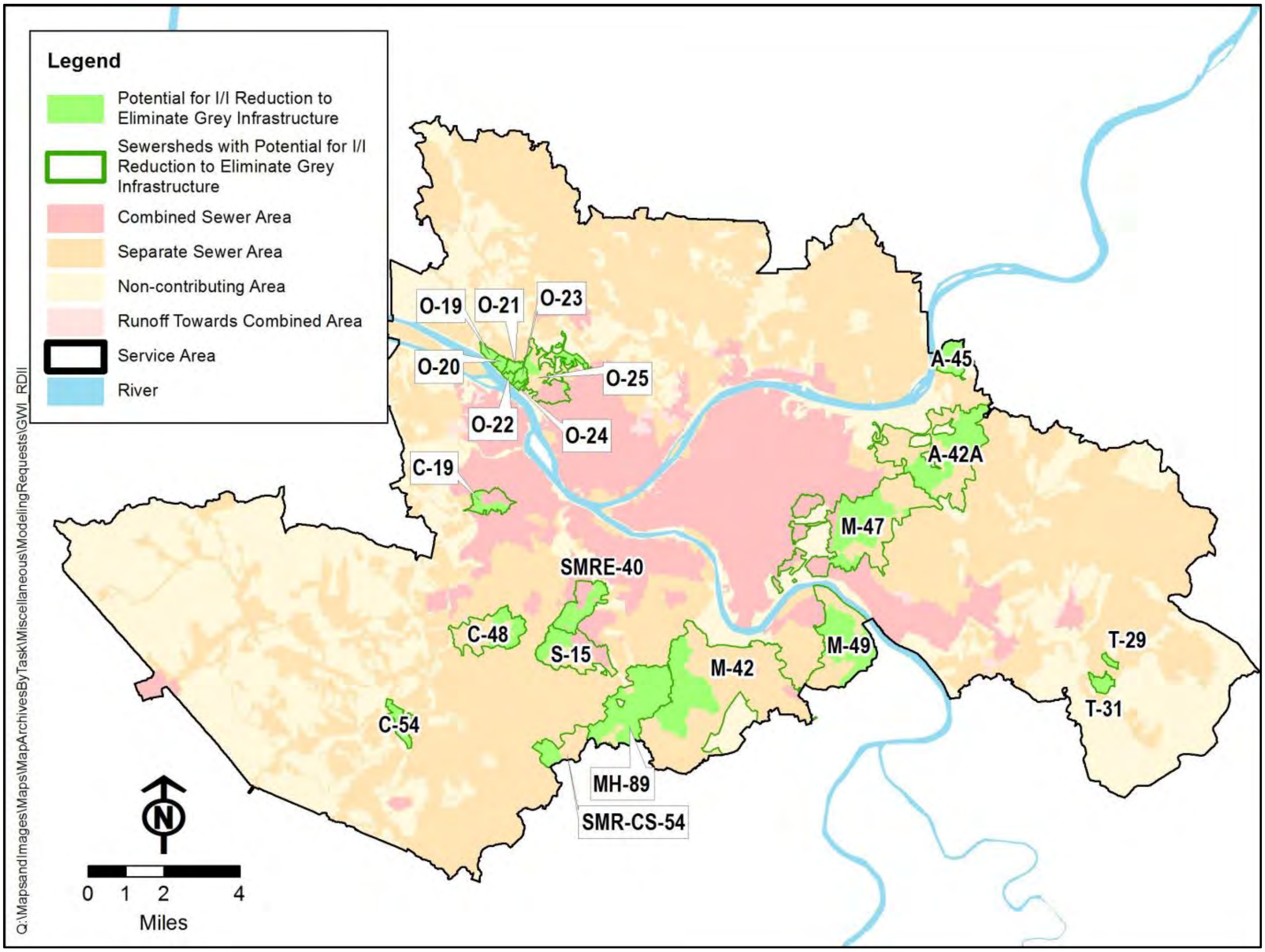



*Figure 3-29: Location of Point of Connection Sewersheds with Greatest Potentials for I/I Reduction to Eliminate SSOs for 2-Year Design Storm*

## Individual Outfalls

Opportunities were also evaluated based on overflow volumes for individual outfalls, but costs could not be factored into the analysis since many of the municipal feasibility studies do not have sufficient detail on the outfall-specific objectives, projects and costs for controlling SSOs. The impact of I/I reduction on SSO volume reduction was quantified in terms of SSO volume remaining at all ALCOSAN and municipal outfalls. Figure 3-30 shows the remaining SSO volume for the 2-year design storm at these outfalls. As shown in Table 3-16, a significant number of the nearly 100 ALCOSAN and municipal SSOs are not predicted to overflow during the 2-year design storm and many others have a relatively small overflow volume remaining. In some cases, this is a result of the I/I reduction reflected in the model, but in other cases it may be the case without any I/I reduction. Those outfalls with little or no overflow volume remaining for the 2-year design storm are likely the best opportunities for I/I reduction to eliminate a proposed project.

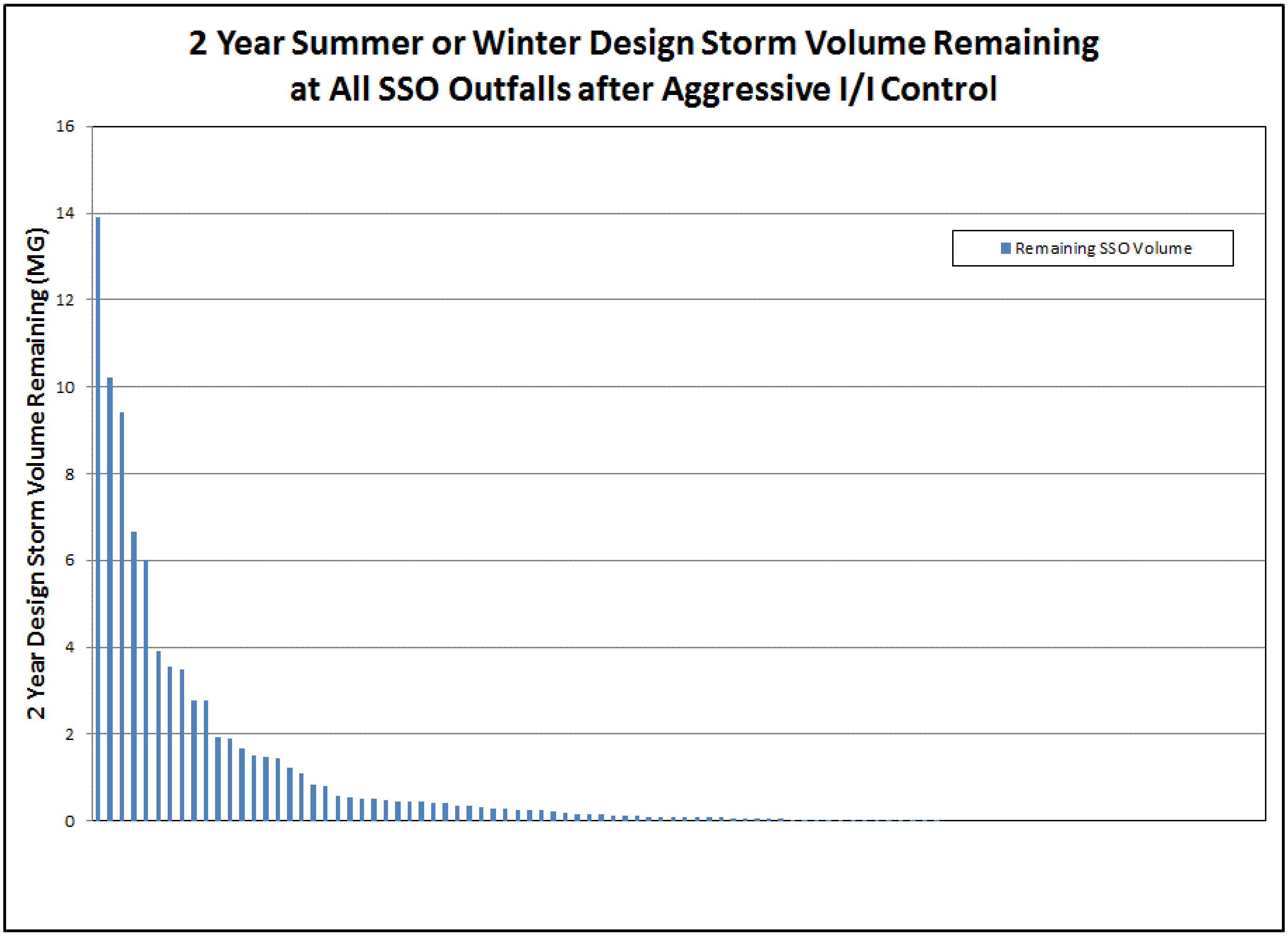



*Figure 3-30: Remaining SSO Volume After Aggressive I/I Reduction*

*Table 3-16: Count of SSO Outfalls by Category of Remaining SSO Volume after Aggressive I/I Reduction*

| Remaining SSO Volume After Aggressive I/I Reduction (MG) | Count of SSO Outfalls |
|---|---|
| 0 | 27 |
| 0 - 0.05 | 17 |
| 0.05 - 1 | 36 |
| >1 | 18 |

It is recommended that these opportunities be explored further in cooperation with the customer municipalities in order to also evaluate total present worth costs, and to consider the many other factors below that could change the cost comparison and possibly help identify additional opportunities for I/I reduction to eliminate the need for proposed separate sanitary sewer projects.

- The general ratepayer I/I reduction costs could be reduced if there are existing or new ordinance-driven reductions to I/I on private property.
- The I/I reduction cost could be reduced if grants or other supplemental funding sources become available to support source control efforts like I/I reduction.
- The municipal capital and total present worth cost of the I/I reduction alternative could differ if ALCOSAN were to institute some form of source control incentive, or were to institute some form of a wet weather charge system for its retail customers. This is discussed in detail in Section 5 of the report.
- The estimated I/I reduction costs are based on planning level costs and assumptions for addressing certain "wet areas" as reflected in the calibrated H&H models. The actual I/I reduction costs and the extent of rehabilitation needed to meet the specific project objectives will vary by location, and will need to rely on flow monitoring data directly for identifying "wet areas" to be targeted. In some cases, the aggressive I/I reduction scenario analyzed above provided a greater degree of control than is needed to eliminate an SSO and the I/I reduction costs would decrease accordingly. On the other hand, more extensive I/I reduction will be required in some areas where the results above showed some overflow remaining for the 2-year design storm.
- The municipality would need to provide updates for the proposed grey infrastructure improvements for each outfall including outfall-specific capital and annual O&M costs, and the specific objectives and/or level of control for each project. Additional sharing of flow monitoring data may also be required. In some cases, agency comments on the municipal feasibility studies, the EPA feedback provided in June 2014, and implications of a new flow reduction priority could significantly alter the projects proposed in the feasibility studies.
- Once the specific objectives for each separate sanitary sewer project are understood based on the latest information, the opportunities analysis identified above can be refined with more realistic estimates of the extent of rehabilitation and associated cost.
- As ALCOSAN proceeds into advanced facilities planning for grey infrastructure projects, refined cost estimates will be prepared for the ALCOSAN grey project costs associated with some of these outfalls based in part on additional field investigations, geotechnical borings, and analysis of alternative conveyance alignments and construction methods.
- Further discussion is needed regarding potential cost-sharing for the I/I reduction opportunities that could be regionally cost-effective, but that do not appear cost effective when viewed solely from the municipality perspective. Furthermore, if not already considered, municipalities should consider reduced O&M costs and reduced risk of structural failures in their cost-effectiveness analysis.
- The alternatives evaluated by municipalities frequently required making assumptions about the future hydraulic gradeline in ALCOSAN's interceptor during rare wet weather events that occur every 2 or 10 years. Once the initial phase of ALCOSAN grey infrastructure work is decided upon, which are expected to include a WWTP expansion and some initial tunnel segments

constructed to convey additional wet weather flow to the WWTP, the future ALCOSAN hydraulic gradelines and adjusted regulator settings can be predicted with more certainty. Depending on the hydraulic gradeline assumptions made by municipalities, the required municipal projects could be affected and thereby also affect I/I reduction opportunities.

- ALCOSAN and its customer municipalities are actively working towards regionalization of inter-municipal trunk sewers. This initiative is likely to create more opportunities for I/I reduction to eliminate the need for proposed conveyance improvements. First, municipalities could be incentivized to consider I/I reduction as a condition of transferring these sewers to ALCOSAN. Second, many of the proposed municipal wet weather improvement projects will become ALCOSAN's responsibility to implement, which will create an opportunity to revisit the preferred alternatives for these projects. This could involve re-examining the proposed level of control for SSO outfalls and ensuring that opportunities for I/I reduction alternatives have been fully evaluated.
- As noted earlier, the regulatory agencies have also indicated that flow reduction needs to become a high priority for the region. The full implications of this directive are not yet known, but they are expected to generate additional requirements for I/I reduction.

### 3.3.3 Sewer Separation

For purposes of this report, complete sewer separation refers to the practice of separating a combined sewer system into separate sewers/pipes for sanitary and storm water flows, both within the public right-of-way and on private property. The removed storm water flow would no longer be conveyed to the municipal or ALCOSAN wastewater collection system, and ideally most of the GWI and RDII would also be removed from the sanitary sewer that conveys the remaining flow to ALCOSAN. Complete sewer separation may involve converting the existing combined sewer to a sanitary sewer or a storm sewer, but in either case it includes reducing wet weather flow into the sanitary sewer to the extent needed to comply with standards for new sanitary sewer construction. On private property, this often involves disconnection of all foundation drains and roof leaders from the sanitary system (including verification testing), and redirection of those flows in a safe and responsible matter.

A closely related practice is removing a portion of the storm water flow from a combined sewer area where it is most cost-effective, and thereby often least disruptive to a neighborhood. For purposes of this report this will be referred to as an inflow reduction project, but some may also consider this partial sewer separation. An example would be to redirect existing road drainage (catch basins), yard drains and roof leaders (for those homes where this can be done in a safe and responsible manner) from the existing combined sewer to a newly constructed storm sewer system, but connections from the existing foundation drains and some residual roof leader connections would remain connected to the existing combined sewer system.

As noted in Section 3, large-scale sewer separation was not evaluated in this study as it was previously evaluated and presented in the WWP. At an estimated planning level cost of $10 billion, large-scale sewer separation of all combined areas was far more costly than the Selected Plan. Large-scale sewer separation is not common in other wet weather programs due its high costs and the major disruption required to almost every street and block in the area. Although there are some programs that still go this route for large areas due to special considerations that outweigh the high costs and disruption, such as: chronic basement flooding; inadequate conveyance capacity of the existing combined network to provide a desired level of service; or the possibility to integrate the construction with other major, disruptive infrastructure needs like road reconstruction or water main replacement.

As previously mentioned, only a few small areas of sewer separation were proposed in the municipal feasibility studies and separation alternatives did not even appear to be considered in some studies, so there appears to be limited municipal interest. Without that interest and the detailed records and local understanding of each unique municipal system, it is not possible to identify site-specific opportunities and costs for complete sewer separation or inflow reduction.  Nevertheless, a few general observations can be made as to where complete sewer separation or inflow reduction may be able to remove storm water from the system, at a lower cost than the municipal and ALCOSAN improvements in the Selected Plan.

## Complete Sewer Separation

In general, sewer separation is likely to be most viable for:

- Small, localized pockets of combined area;
- Areas where a significant portion of a combined sewer area has already been separated due to redevelopment projects and the requirement to provide separate storm and sanitary sewers for those projects;
- Outfalls where complete elimination is desired such as in sensitive areas;
- Areas where special municipal interest/objectives outweigh the cost and disruption of this approach;
- Areas within municipalities that have implemented some successful separation in the past or have made eventual separation a long-term objective; or
- Areas where municipalities have good records and knowledge of their system and past plumbing practices, and therefore have a good handle on sewer separation approaches and associated costs.

Localized sewer separation opportunities were evaluated by ALCOSAN's basin planners during WWP development, including upstream of each outfall where ALCOSAN was required to evaluate complete elimination of a CSO due to its location in a CD-defined sensitive area. Only a few sewer separation areas identified in the prior analysis appeared to be cost-effective opportunities to eliminate the need for other proposed improvements in the Selected Plan, but they could not be included in the Selected Plan as municipalities proposed to continue to convey all flows to ALCOSAN. They include outfalls A-47 and O-43. Additional sewer separation opportunities were identified by the basin planners but they would not reduce the Selected Plan costs.



## Inflow Reduction

Inflow reduction is likely to be a viable option in the same areas mentioned for complete sewer separation, but it is of particular interest for low frequency outfalls where removal of some inflow can achieve an overflow frequency target which approaches a level consistent with water quality objectives. From a screening level perspective, some of the best opportunities for inflow reduction to achieve such an overflow frequency target (and eliminate the need for a Selected Plan project and cost) are the same 19 outfalls identified earlier where GSI may cost-effectively eliminate the need for a Selected Plan project. Therefore, if 50 percent control of impervious area with GSI does not turn out to be a feasible option for some of these outfalls, inflow reduction may be another alternative worth exploring.

## 3.3.4 Direct Stream Inflows

In the mid-1990s, ALCOSAN identified suspected locations where surface watercourses discharged into municipal combined sewer systems. Based on field investigations in 2005, ALCOSAN and PaDEP determined that the streams at 11 of these locations exhibited perennial base flow; they were conveyed directly into the regional conveyance system; and, based on logistic complexity, there was a reasonable potential that they could be removed or re-routed. The combined drainage area of the 11 streams is approximately 2,400 acres. These streams are listed in Appendix J of the 2008 ALCOSAN CD. These direct stream inflow points are shown in Table 3-5 and Figure 3-7 in the WWP.

Over the years, ALCOSAN has worked with its municipal customers and other partners towards removing many of these direct stream inflows and several others, where cost effective. As result, there are few remaining opportunities where direct stream inflow removal is a cost-effective alternative to the proposed municipal and ALCOSAN projects in the Selected Plan. This section briefly summarizes ongoing ALCOSAN and municipal efforts to address direct stream inflows, and analyses performed by PWSA for four streams to determine if direct stream inflow removal was a cost-effective alternative. The ongoing ALCOSAN and municipal efforts include:

***Sheraden Park Direct Stream Inflow Removal*** – ALCOSAN, the City of Pittsburgh, the PWSA, and the U.S. Army Corps of Engineers have and continue to partner in the removal of direct stream inflows into PWSA's combined sewer system in Sheraden Park.

***Sheraden Park Stream Restoration*** – With the completion of the rerouting of the combined sewer system from the culverted stream flowing through Pittsburgh's Sheraden Park, the stream is being daylighted and will flow into Chartiers Creek. The meandering stream will flow into a constructed wetland at its confluence with Chartiers Creek.

***Dooker Hollow Direct Stream Inflow Removal*** – An acid mine drainage (AMD) stream discharges into the North Braddock Borough combined sewer system. ALCOSAN has investigated the treatment and re-use of the AMD as well as alternative energy methods to power pumping equipment.

***Millvale Industrial Park Direct Stream Inflow Removal*** – A stream along the State Route 28 Allegheny River Transportation Corridor is located above the former Millvale Industrial Park and is connected to the municipal sewers upstream of ALCOSAN Diversion Structure A-66. Construction of the Millvale project is underway as part of the PennDOT Route 28 widening project.

***Ravine Street Direct Stream Inflow Removal*** - Another stream along State Route 28 is located near Fifth Avenue in Sharpsburg and is connected to the municipal sewers upstream of ALCOSAN Diversion Structure A-69. Shaler Township, Sharpsburg Borough, and O'Hara Township have contributing sewers in this sewershed. The feasibility of removing this stream was previously studied, and the project has been on hold due to the need for additional funding. ALCOSAN is making a renewed effort to work with its partners to advance this project, and value engineering is currently underway.

## ALCOSAN Grit Trap Projects

While it is best to minimize the grit and sediment entering the municipal combined sewers by rerouting the streams from the sewers and to the rivers, rerouting in some cases would be cost prohibitive due to their distance from receiving streams. As an alternative, ALCOSAN is evaluating the feasibility of grit and sediment traps at the bottom (points of connection to ALCOSAN) of the trunk sewers into which the streams discharge. These simple structures allow sand, grit and debris to settle out as the wastewater slows slightly before continuing through the sewer. The sediment is removed with a vacuum truck or clamshell crane and trucked to disposal. ALCOSAN has identified several potential target locations for grit traps or other system modifications to enhance removal of grit and sediment:

***Spring Garden Run*** – Spring Garden Run was a narrow ravine that was filled by the City of Pittsburgh and Reserve Township to facilitate residential and commercial development. A large 8-foot by 9-foot City combined sewer has replaced the original streambed. Spring Garden Avenue was constructed over the fill. Dry and wet weather flow from a 520-acre watershed area is conveyed through the sewer and discharged into the north shore Allegheny interceptor through ALCOSAN's A-60 regulator. The design of this grit trap project has been completed. Due to property issues, construction of this project is not expected to proceed until ALCOSAN takes ownership of the Spring Garden trunk sewer, which is slated for regionalization.

***Four Mile Run / Panther Hollow*** – Surface streams in Schenley Park draining around 300 acres discharge directly into a Pittsburgh Water and Sewer Authority combined sewer that replaced the natural stream bed of Four Mile Run. This trunk sewer connects to the ALCOSAN system at regulator structure M-29 along the Monongahela River. There may be potential to enhance removal of grit and sediment as part of larger efforts to modify the existing diversion structure.

***Tassey Hollow*** - The lower half of the Tassey Hollow stream channel was piped and filled to facilitate residential, commercial, and industrial development. A 66-inch diameter combined sewer has replaced the original stream channel. The remaining surface stream portion of Tassey Hollow, located in Braddock Hills Borough north of Hawkins Avenue, discharges directly into the combined sewer. Dry and wet weather flow from the 356-acre surface stream inflow area is conveyed along the sewer and discharged into the Monongahela interceptor through the M-51 regulator. This grit trap project is currently in the design phase and the design is approximately 90% complete.

***Delafield Road*** - A stream source originating in Fox Chapel Borough flows via an Allegheny County storm sewer through the Township of O'Hara into the Borough of Aspinwall's combined sewer system. This combined sewer flows through the Borough of Aspinwall and ultimately connects to the ALCOSAN system at ALCOSAN A-78-00.

## PWSA Direct Stream Inflow Removal Analysis

As part of its municipal feasibility study, the PWSA completed an evaluation of the cost effectiveness of disconnecting direct stream inflow connections from their municipal sewage conveyance system. The evaluation was conducted in accordance with Paragraph 8.a.ii of the COA between the City of Pittsburgh, the PWSA, PaDEP, and the ACHD.

The general approach that was employed by PWSA in order to complete the cost-effectiveness analysis included the following steps:

- Stream inflow connections to the PWSA sewer system were identified.
- Potentially feasible methods of removing the identified stream flow connections were developed, along with the estimated cost of constructing and operating the facilities required to accomplish the stream removals.
- The amount of flow that would be removed through the elimination of the identified stream inflows was estimated, as was the potential cost that would be realized through the removal of the identified stream connections.
- The costs of stream removals were compared the resulting cost savings as the basis for assessing cost-effectiveness.

Available information regarding stream connections to the PWSA system was investigated for the purpose of identifying connection points to be evaluated. Sources of information included existing facilities mapping, institutional knowledge, stream connection information obtained from ALCOSAN from previous studies and its ongoing ALCOSAN Basin Facilities Planning Studies, investigations presented in the document entitled, *Stream Restoration and Daylighting: Opportunities in the Pittsburgh Region* (Studio for Creative Inquiry, Carnegie Mellon University, 2002), and field reconnaissance. PWSA completed a cost-effectiveness analysis for the locations listed below:

- Discharge from Panther Hollow Lake and the tributary stream in the Four Mile Run drainage area, tributary to ALCOSAN CSO structure M-29.
- Multiple locations in the Woods Run drainage area tributary to ALCOSAN CSO structure O-27.
- Stream inflow into the Spring Garden drainage area in Reserve Township, tributary to ALCOSAN CSO structure A-60.
- Stream inflow from the Corks Run drainage area, tributary to ALCOSAN CSO O-13.

The first three stream connections identified above are located within the ALCOSAN Main Rivers Basin. The Corks Run location lies within the ALCOSAN Chartiers Creek Basin Planning Area. The ALCOSAN Main Rivers Planning Basin and Chartiers Creek Planning Basin Storm Water



Management Models (SWMM) were used to estimate the reductions in peak overflow rates and volumes that would occur should the stream inflows be eliminated from the tributary sewers. This was accomplished by first running the SWMM models under the existing configuration conditions in order to establish a baseline.

The input files for the SWMM models were then modified to simulate the removal of the stream flow connections. This was done by editing the hydrologic properties of the subcatchment areas that drain to the stream inflow points of connection in order to reduce the areas of these subcatchments to near zero. This simulated the elimination of stream flows from the appropriate locations without otherwise affecting the baseline conditions. The typical year simulations were completed for these "stream disconnected" conditions and the resulting CSO statistics were compiled.

A total present worth cost was assigned to each flow reduction based on the ALCOSAN cost of treatment and a reduction in size of CSO control facilities as a result of the reduced volume and peak rates. This cost was compared to an estimate of the total present worth of disconnecting the direct stream inflow from the combined system. All four of the DSI projects investigated by PWSA were found to be not cost-effective.

## 3.4 Opportunities to Downsize Traditional Infrastructure in the Selected Plan

Section 3.3 identified where GSI and other source controls may be able to eliminate ALCOSAN and/or municipal grey infrastructure projects included in ALCOSAN's Selected Plan, at a comparable or lower cost to the region. While some potential opportunities for elimination were identified, most ALCOSAN and municipal elements of the Selected Plan cannot be eliminated.

Section 3.4 addresses a related question of whether the major elements of the Selected Plan, which cannot be eliminated, could be downsized as a result of aggressive application of source controls, at a comparable or lower cost to the region. Opportunities to downsize grey infrastructure needs were evaluated for the following elements of the Selected Plan:

- Regional tunnels;
- Primary treatment capacity at the Woods Run treatment plant;
- Pumping capacity for the tunnel de-watering pumping station;
- ALCOSAN relief interceptors, consolidation sewers and storage tanks; and
- Proposed municipal conveyance.

For the downsizing analysis extensive source controls were implemented in the Selected Plan systemwide model to evaluate a "Grey-Green" hybrid alternative that maximizes the use of source controls and consisted of:

- Managing 50% of impervious cover in combined area through GSI projects as previously described for Simulation 3 in Section 3.2.1.

- Aggressive Inflow/Infiltration reduction in both separate and combined areas as previously described for Simulation 9 in Section 3.2.2.

The implementation of GSI controls in the combined areas of the Selected Plan model was based on the following requirements and associated assumptions:

- Controls 50% of impervious area in combined sewer areas;
- Sized to capture first 1" of stormwater runoff;
- Manages runoff with infiltration and slow release to combined system; and
- Slow release generally occurs within 24 hours.

As with the elimination analysis, the downsizing analysis focused on capital costs as a way of prioritizing opportunities, but total present worth costs could be calculated in the future for the areas with the highest potential for cost savings when additional information becomes available.

### 3.4.1 Regional Tunnel and Pump Station Downsizing

The analysis approach to identifying opportunities for downsizing regional tunnel segments, primary treatment capacity, and de-watering pump station capacity was the same. It essentially consisted of simulating the Selected Plan systemwide model with extensive source controls and comparing the results to those of the Selected Plan as included in the Wet Weather Plan.

Figure 3-31 shows the extent of the regional tunnel, main pump station and the de-watering pump station as included in the Selected Plan, which provided the following level of service:

- Full control of sensitive area ALCOSAN CSOs with zero overflows during the Typical Year;
- 4-6 overflows during the Typical Year for significant ALCOSAN CSOs served by new regional conveyance;
- ALCOSAN CSOs controlled by the Regional Tunnel overflowed only during 6 pre-determined events during the Typical Year;
- At relatively small ALCOSAN CSO outfalls not served by new regional conveyance, minimize CSO discharges with regulator adjustment and system operational strategies;
- Reduce ALCOSAN SSOs to a long-term average of one overflow every two years
- The expanded treatment plant provided 600 MGD of primary treatment for wet weather flows with secondary bypass, and 295 MGD of secondary treatment, including core flow;
- The de-watering pump station has a maximum pumping capacity of 120 MGD to meet the 600 MGD capacity of the main pump station, and to empty the regional tunnel within 48 hours from the end of tunnel inflow.

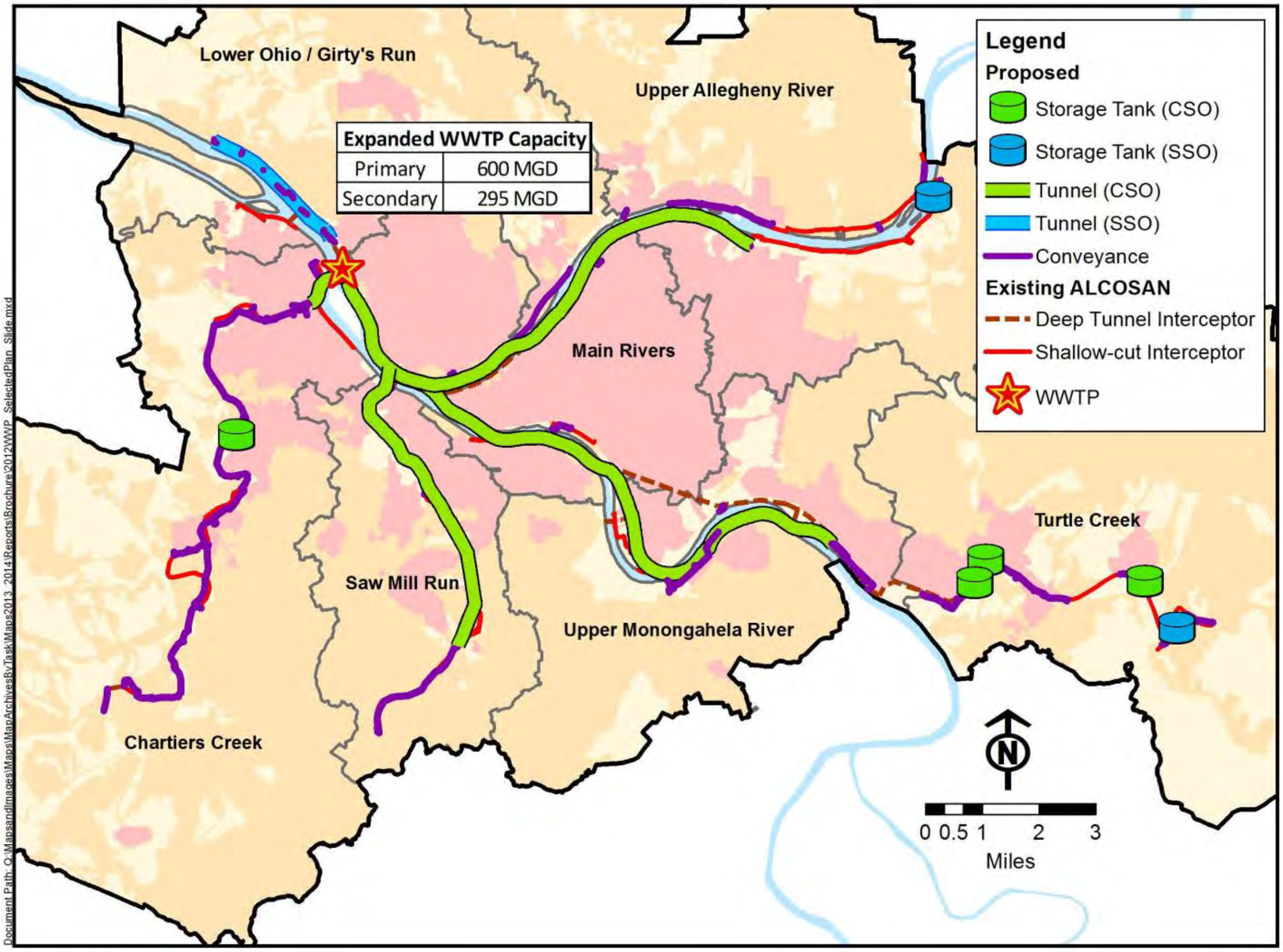



*Figure 3-31: Selected Plan*

Overflow volumes for the Grey-Green alternative were summarized on a planning basin level and receiving water level, and compared with similar summaries for the Selected Plan to judge performance equivalency. The regional tunnel segments were incrementally downsized until they provided comparable results in terms of CSO and SSO volumes in the analyzed receiving water segments, such that similar water quality impacts in the Grey-Green and Selected Plan alternatives would be expected.

The results of the Grey-Green alternative with down-sized regional tunnel segments indicated that none of the proposed regional tunnel segments can be eliminated. In terms of the possibility of downsizing any of these tunnel segments, and without consideration of cost implications, the Ohio and Allegheny River tunnel segments and the Chartiers Creek crossing could be marginally reduced in tunnel diameter and still meet equivalent water quality performance. For the Monongahela River, Saw Mill Run and Lower Ohio River segments, more appreciable tunnel diameter reductions were possible. Section 3.4.3 evaluates these possibilities further by considering the cost efficiency implications.



The Grey-Green alternative model with the down-sized regional tunnel extents was also used to evaluate opportunities for reducing the primary treatment capacity at the Woods Run Treatment Plant and reducing the size of the tunnel de-watering pump station. The secondary treatment capacity at the WWTP is expected to remain unchanged at 295 MGD to meet the core flow secondary treatment requirement. For this evaluation two downsized primary treatment and tunnel pump station capacity scenarios were developed:

- In the first scenario the main pump station capacity at the WWTP was reduced from 480 MGD to 450 MGD and the de-watering pump station capacity was reduced from 120 MGD to 90 MGD such that the total primary treatment capacity at the WWTP is reduced from 600 MGD to 540 MGD.
- In the second scenario the main pump station capacity at WWTP was reduced from 480 MGD to 390 MGD and the de-watering pump station capacity was reduced from 120 MGD to 90 MGD such that the total primary treatment capacity at the WWTP is reduced from 600 MGD to 480 MGD.

The performance of these scenarios was evaluated in terms of the remaining untreated overflow volume and the amount of time needed to de-water the regional tunnel. The results show that with extensive source controls the planned expansion of primary treatment capacity to 480 MGD might be adequate for ultimate compliance. The opportunity to reduce the pumping capacity of the regional tunnel de-watering pump station was evaluated by comparing the de-watering durations for the Grey-Green alternative (with 120 MGD maximum pumping capacity) to those of the two alternatives in which the maximum pumping capacity of the de-watering pump stations was limited to 90 MGD. Table 3-17 presents that comparison for three significant wet weather events of the Typical Year.

***Table 3-17: De-watering Time for Significant Events during the Typical Year Comparing Tunnel Pump Station Capacities***

| Event Date | Average Event Precip. (inches) | Regional Tunnel De-watering Duration (Hours) | | |
|---|---|---|---|---|
| | | 600 MGD Total Capacity<br>480 MGD Main Pump Station<br>120 MGD Tunnel Pump Station | 540 MGD Total Capacity<br>450 MGD Main Pump Station<br>90 MGD Tunnel Pump Station | 480 MGD Total Capacity<br>390 MGD Main Pump Station<br>90 MGD Tunnel Pump Station |
| **1/1/2003** | 1.5 | 48 | 66 | 65 |
| **7/21/2003** | 2.2 | 38 | 57 | 56 |
| **11/19/2003** | 2.1 | 46 | 62 | 61 |

The table shows that for the Grey-Green alternative, the 120 MGD capacity pump station is able to empty the regional tunnel in or within 48 hours of the end of inflow into the regional tunnel. With a reduced maximum pumping capacity of 90 MGD, the regional tunnel is emptied in 66 hours, which exceeds the 48 hour dewatering criteria established for all proposed storage facilities in the Selected

Plan. While downsizing is not recommended, it might be possible, but additional odor control facilities might then be required to meet standards. Furthermore, the cost-savings between 120MGD and 90 MGD would not be significant.

## 3.4.2 Regional Conveyance and Municipal Pipe Downsizing

The scope of the downsizing analysis was limited to identifying opportunities for cost savings. Due to the size and complexity of the models it was not practical to revisit the sizing of every part of the collection system at the same level of detail as the basin planners. The simplified standard that was applied was that conduits could be downsized if they were able to convey the design flow without being filled to more than 90% of their depth, as estimated using Manning's equation. In most cases the Basin Planners sized conduits such that they would not surcharge, and this method follows the same approach.

Design flows for each new or modified conduit were taken from the Green-Grey model applying GSI and I/I reductions to the Selected Plan. The design flows were compared to the estimated open channel capacity. For conduits where the design flow in the GSI model exceeded the capacity, no reduction was made. For conduits where there was excess capacity compared to the flows in the GSI model, revised capacities were tested for incrementally smaller conduits, and the smallest practical size was retained. Downsizing was considered for all new or modified conduits in the Selected Plan model, which included both proposed ALCOSAN consolidation sewers and municipal improvements.

Downsizing was considered for all new or modified conduits in the Selected Plan model, which included both proposed ALCOSAN consolidation sewers and municipal improvements. New capital cost estimates were developed for all downsized improvements using the ALCOSAN ACT. For comparison to the Selected Plan, estimates were calculated in 2010 dollars. Cost estimation of GSI and I/I source reduction in the downsizing analysis was calculated according to the costing assumptions described in Section 3 of this report.

## 3.4.3 Cost Analysis

For the purposes of the downsizing analysis, a "green:grey" ratio was calculated to evaluate the cost effectiveness of the Green-Grey alternative that maximizes GSI and other source controls. The "grey" portion of the ratio consisted of the capital cost of the ALCOSAN consolidation sewers and municipal improvements proposed in the Selected Plan. The "green" portion of the ratio consisted of the following capital costs:

1. the cost of the downsized ALCOSAN Selected Plan costs,
2. the cost of the downsized municipal improvements,
3. the GSI cost to capture 50% of the tributary impervious area within the combined portions of the system analyzed, and
4. the I/I source reduction efforts under Aggressive I/I conditions in both combined and separate portions of the system analyzed.

The systemwide costs of the Green-Grey alternative are compared to the original Selected Plan costs in Table 3-18. The estimated cost for the Green-Grey alternative is $5.1B, or $1.5B greater than the

Selected Plan. The GSI projects are all assumed to be ratepayer-funded retrofit projects located in the municipal ROW with a combination of porous pavement, bioretention and subsurface infiltration. For the purposes of comparison to the proposed ALCOSAN and municipal grey capital costs in the Selected Plan, capital GSI costs were assumed to be a municipal cost. If some additional GSI is also implemented via a redevelopment ordinance, as suggested in Section 3.1.1, this has the potential to provide some increased control at no direct cost to ratepayers.

*Table 3-18: System-Wide Green-Grey Downsized Alternative Comparison to Selected Plan*

| | Regional Tunnel De-watering Duration (Hours) | | |
|---|---|---|---|
| | **Component** | **Selected Plan Capital Cost ($Million)** | **Green-Grey Downsized Capital Cost ($Million)** |
| **ALCOSAN Costs** | WWTP | $378 | $334 |
| | Deep Tunnel Pump Station | $150 | $150 |
| | CSO Tunnel, Drop Shafts and Cross Connections | $1,054 | $808 |
| | SSO Tunnel and Drop Shafts | $127 | $95 |
| | Other Regional Conveyance and Facilities | $1,312 | $1,167 |
| **Municipal Costs** | Wet Weather Improvements | $530 | $443 |
| | Green Stormwater Infrastructure (to manage 50% of impervious combined area) | $0 | $1,507 |
| | I/I Control | $0 | $607 |
| **TOTAL** | | **$3,551** | **$5,111** |

While the Green-Grey alternative is a significantly higher capital cost from a system-wide perspective, the downsizing analysis also gives insight into which portions of the proposed improvements might be most impacted by extensive source control implementation, and have the most potential to be cost-effectively downsized in the future. A green:grey ratio was calculated for various portions of the systems, with each portion of the system represented by all improvements within each "loop" in Figure 3-32. For example, for the largest red loop along the Allegheny River, the green:grey ratio reflects the ratio calculated using all gray and source control costs upstream of where the Allegheny tunnel meets the Ohio tunnel.

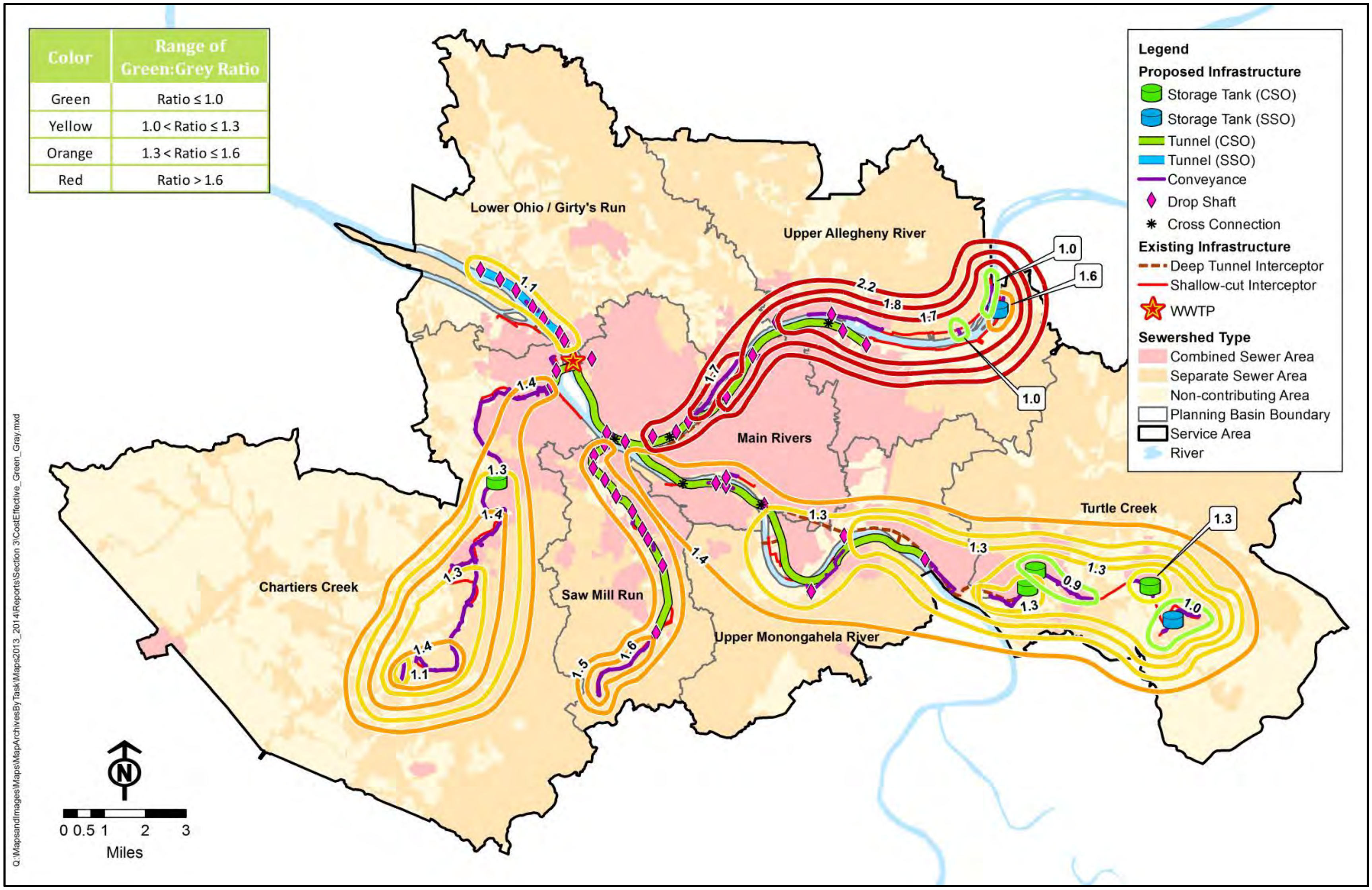



*Figure 3-32: Summary of Downsizing Analysis "Loops" Depicting Portions of Downsizing Analysis with Selected Plan Cost Ratio Comparison Values*

The depicted results of the downsizing analysis of ALCOSAN regional conveyance and municipal improvements shows areas in green where extensive GSI and I/I reduction may have the most potential to downsize proposed grey infrastructure in a cost-effective manner. These include:

- Some of the proposed storage tanks and consolidation sewers in the Turtle Creek basin
- Two small separate sanitary conveyance projects in the Upper Allegheny basin

The remainder of the proposed improvements have less potential for cost-effective downsizing, and the green:grey ratios generally increase for portions of the system that get closer to the WWTP, with the exception of the Lower Ohio SSO tunnel.



# 4.0 MUNICIPAL OPPORTUNITY ASSESSMENT & POTENTIAL PROJECTS

## Section Summary

In parallel with the regional analysis of the potential of source controls, ALCOSAN analyzed green stormwater infrastructure (GSI) project opportunities at a local site level and engaged community members in identifying their preferred source control opportunities. These efforts served as a continuation of ALCOSAN's role in providing technical and administrative support to municipalities to implement green stormwater infrastructure projects. The involvement of the local community forged effective partnerships between ALCOSAN, and community stakeholder groups to facilitate concepts for future GSI implementation. ALCOSAN also took initial steps toward engaging municipalities on inflow and infiltration (I/I) reduction opportunities for future consideration and potential to eliminate proposed grey infrastructure.

**SECTION OVERVIEW:**

- **ALCOSAN worked with 3RWW to identify over 14,000 potential GSI locations**
- **A Lawrenceville area pilot study identified the top 5 highest potential sites for reducing CSO volume using GSI**
- **Over 80 meetings were held with municipalities and stakeholders to discuss potential GSI project opportunities and led to over 200 suggested project locations**
- **Over 75 site visits were conducted to assess GSI project potential**
- **GSI concepts were developed at eleven locations with significant municipal interest**
- **ALCOSAN continues to meet with municipalities and stakeholders to build partnerships that will advance GSI and I/I reduction projects**

To evaluate GSI projects at a site level, ALCOSAN conducted two different analyses. In the first analysis, ALCOSAN, with the assistance of 3 Rivers Wet Weather (3RWW), identified potential GSI project locations based on the United States Environmental Protection Agency (USEPA) SUSTAIN (System for Urban Stormwater Treatment and Analysis Integration) software and local engineering judgment. This was done in 29 different study areas throughout the combined sewer service area and resulted in identifying 14,000 locations for potential GSI implementation.

The second analysis approach focused on a pilot sewershed and evaluated the best sites for implementing GSI technologies based on stormwater runoff volume reduction. This evaluation was completed in the combined sewersheds in the Lawrenceville area within the City of Pittsburgh and identified the top 5 feasible sites for further evaluation.

Community feedback played a large role in identifying sites for GSI as ALCOSAN and 3RWW conducted over 80 meetings with municipal officials and other stakeholders to discuss the source control study (SCS) evaluation and broaden the perspective of how GSI can be implemented in the region. Through these meetings, over 200 preferred locations for GSI projects were identified by municipalities and stakeholders. Additionally, these meetings enabled ALCOSAN to directly discuss the results of 13 independent GSI evaluations led by municipalities and stakeholders and integrate the recommended GSI project concepts for future consideration.

ALCOSAN visited over 75 suggested GSI sites to evaluate concept projects for future consideration. Site visits were prioritized based on GSI project concepts that are currently the furthest advanced by municipalities and stakeholders. ALCOSAN also conducted site visits for GSI projects that could have the most significant combined sewer overflow (CSO) volume reductions even if the potential for project implementation is still years away. Preliminary GSI project concepts were also developed for feasible sites where no initial concept existed. ALCOSAN shared these results with municipalities and stakeholders for their consideration and continues to work with potential partners as individual project development continues. Working together, opportunities were identified to implement GSI as a sewer overflow control measure while also providing co-benefits to the community. ALCOSAN developed specific renderings and layouts for the most advanced projects to aid in visualizing these potential gains and advancing the project design.

ALCOSAN also initiated meetings with municipalities on I/I reduction opportunities. As part of ALCOSAN's ongoing role in providing technical and administrative support to municipalities to implement source controls, ALCOSAN will continue to advance the evaluation of selected I/I reduction opportunities in order to refine the scope and costs of these projects

Overall, the analysis reported in Section 4:

- Provides a more detailed look at sites where GSI could be implemented based on two different analysis methods;
- Provides a contemporary impression of the potential sites where community members are seeking to implement GSI projects; and
- Reflects upon the importance of coordinating future implementations together through effective partnerships.

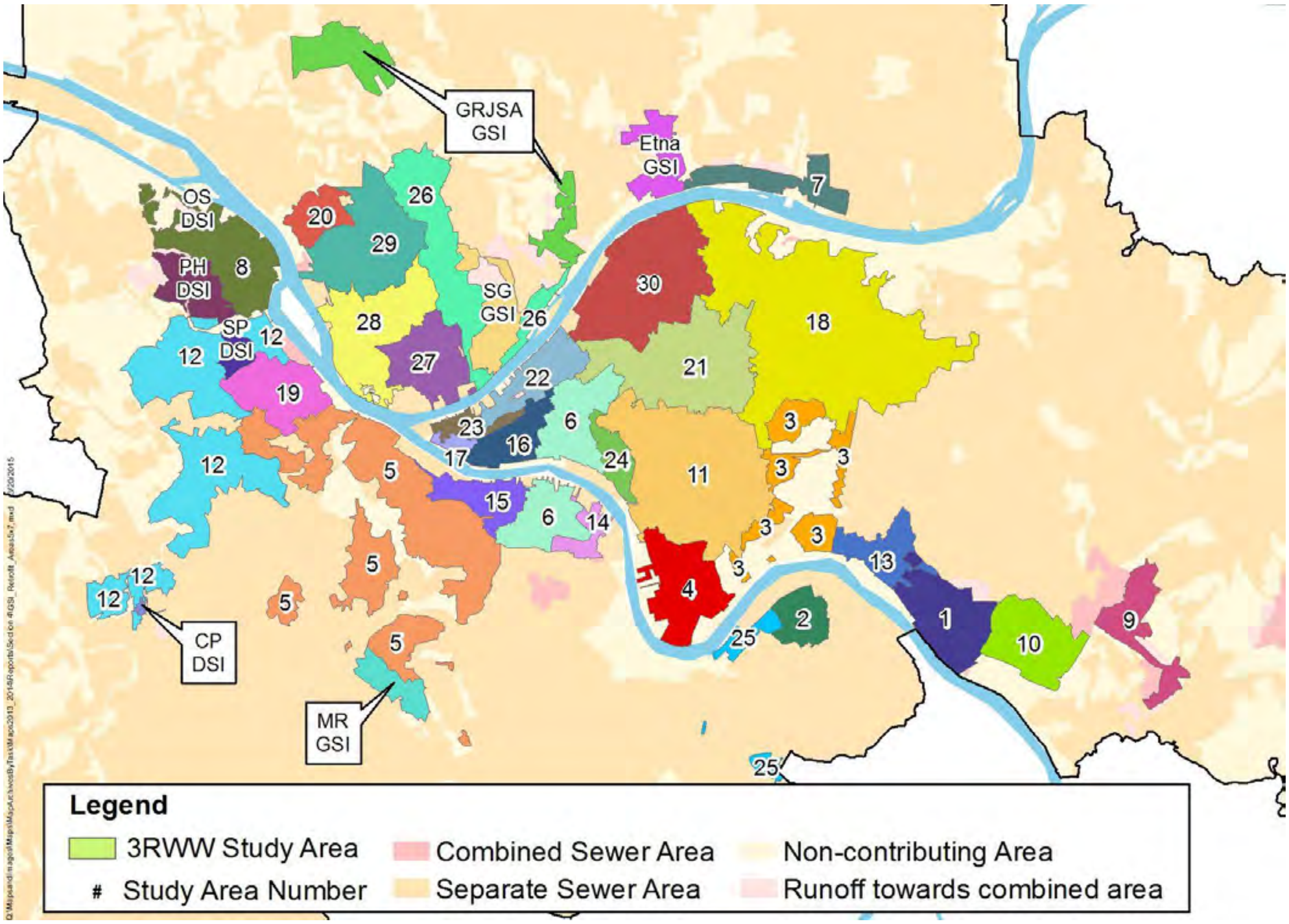
## 4.1 Municipal Green Infrastructure Analyses

### 4.1.1 ALCOSAN Regional Source Control Analysis

Detailed in Section 3.3.1 of this report, ALCOSAN's regional analysis of source controls offered initial insights into which areas might be best suited for implementing GSI that could be cost competitive with proposed grey improvements. ALCOSAN identified 19 outfalls where intensive application of upstream GSI has the potential to replace previously proposed grey infrastructure solutions. As ALCOSAN further investigates these areas, ALCOSAN is following up with each municipality involved to discuss how GSI can be sited throughout a sewershed to achieve the level of control needed to replace the proposed grey infrastructure.

### 4.1.2 3RWW Green Stormwater Infrastructure Project Identification

ALCOSAN partnered with 3RWW to identify potential sites suitable for GSI projects throughout the combined service area. In 2013, 3RWW developed a process for identifying and evaluating potential GSI sites in the Nine Mile Run, Girty's Run, and McNeilly Run sewersheds culminating in a report titled *Evaluation of the Feasibility of Green Infrastructure Implementation*. This evaluation process was subsequently applied with some refinements in the ALCOSAN SCS to identify potential GSI retrofit projects for municipal and commercial implementation. These projects serve as a starting point for discussions with municipalities to consider areas for GSI implementation, as detailed in Section 4.2 of this report.




| | | | | |
|---|---|---|---|---|
| 1. Braddock | 2. Homestead | 3. Nine Mile Run | 4. Hazelwood | 5. Saw Mill Run |
| 6. Central Southside | 7. Sharpsburg/Aspinwall | 8. Sto-Rox | 9. Turtle Creek/ Wilmerding | 10. Turtle Creek/ East Pittsburgh |
| 11. Four Mile Run | 12. Chartiers Creek | 13. Swissvale/Rankin | 14. Upper Southside | 15. Lower Southside |
| 16. Lower Hill/ Duquesne | 17. Downtown Monongahela | 18. Highland Park | 19. Corliss | 20. Brighton Heights |
| 21. Shadyside/Friendship | 22. Strip District | 23. Downtown Allegheny | 24. Bates Street | 25. West Homestead |
| 26. Lower Northern Allegheny | 27. North Shore | 28. Upper Ohio | 29. Woods Run | 30. Lawrenceville |

***Figure 4-1: Green Stormwater Infrastructure Study Areas in ALCOSAN source control study and other local analyses***

The GSI evaluation process began with the application of the USEPA's SUSTAIN software to twenty-nine specific study areas in the ALCOSAN service area. These study areas comprise most of the combined sewer areas within the ALCOSAN service area and are displayed in Figure 4-1. Most of the remaining combined sewer area was analyzed as a part of studies initiated through other efforts such as the Etna Borough Green Infrastructure Master Plan or the ongoing Pittsburgh Water and Sewer Authority (PWSA) GSI Evaluation in Saw Mill Run. Study Area 30, Lawrenceville area, was part of a separate pilot study within the SCS, and is described in Section 4.1.3.

For the GSI evaluation in the SCS, the SUSTAIN Best Management Practice (BMP) siting module was used to identify the locations best suited to implement the following BMPs:

- Permeable pavement;
- Bioretention basin;
- Infiltration basin/trench;
- Grassed swale/bioswale;
- Vegetated filter strip; and
- Constructed wetlands.

**United States EPA describes SUSTAIN as:**

***A decision support system that assists stormwater management professionals with developing and implementing plans for flow and pollution control measures to protect source waters and meet water quality goals. SUSTAIN allows watershed and stormwater practitioners to develop, evaluate, and select optimal best management practice (BMP) combinations at various watershed scales based on cost and effectiveness[4-1].***

SUSTAIN compares publicly available databases of the following site characteristics: a) drainage area, b) drainage area slope, c) imperviousness, d) hydrological soil group, e) water table depth, f) road buffer distance, g) stream buffer distance, and h) building buffer distance against criteria established for each of the selected BMPs. The national default siting criteria from these databases were revised to better reflect conditions in Western Pennsylvania. The output from the SUSTAIN BMP siting module is a Geographical Information System (GIS) Shapefile that identifies locations meeting all of the "revised" siting criteria applicable to the BMP.

***Figure 4-2: Sample SUSTAIN Output***

Following identification of the BMP features using SUSTAIN, 3RWW analyzed the results to identify potential GSI projects. This was facilitated using GIS software and engineering judgment to identify three classes of Concept GSI Projects:

[4-1] http://www2.epa.gov/water-research/system-urban-stormwater-treatment-and-analysis-integration-sustain

1. ***Potential Municipal GSI Projects*** – projects within the public right-of way or on public land that offer the potential to be owned, operated, and maintained by a municipal entity. Potential projects included all of the BMP types;
2. ***Potential Commercial / Institutional GSI Projects*** – projects located on private parcels that would be owned, operated, and maintained by a commercial/private land owner. Projects were limited to Permeable Pavement and Green Roofs;
3. ***Potential Special Case GSI Projects*** – this class of projects is comprised of undertakings with unclear or complicated ownership. Potential projects included Permeable Pavement on State or County Roadways, GSI projects along the Port Authority Transit (PAT) of Allegheny County Busways, and GSI projects with access limitations along railroads.

Details of the GIS facilitated, engineering-judgment based, post-processing screening methodology are presented in Appendix E. The GSI evaluation process estimated the maximum possible drainage area that could become tributary to each project if all upstream inlets were modified. Once any given GSI project becomes further defined, the project-specific drainage area would need to be determined and verified in the field to reflect the proposed scope of the project and the actual drainage paths that would bring flow to the project site. For example, the project scope may or may not include modification of upstream inlets to route additional flows to the proposed project site. As a result of these type of considerations, the drainage areas tributary to further refined project concepts will likely be smaller than the estimates of maximum possible area reported here-in. Additionally, Appendix E includes a series of materials for each Study Area including: a map of BMP features identified with SUSTAIN, aerial photos with identified municipal GSI projects for each technology, a master table of all identified projects and corresponding drainage areas and summary tables for the identified SUSTAIN BMP features and concept municipal GSI projects.

## SUSTAIN BMP Output

The output from the SUSTAIN BMP siting module identified 561,372 features covering 43,260 acres as shown in Table 4-1. Note that in many cases, multiple BMP features were identified for the same area, so the total area of BMP features in Table 4-1 is higher than the available impervious area of the combined system. The post processing effort removed these overlapping areas to identify a single BMP feature at a given location, and led to the municipal GSI projects identified in Table 4-2.

***Table 4-1: TOTAL SUSTAIN BMP Features Output for ALCOSAN Service Area***

| SUSTAIN BMP Feature | Number of Features | Area of BMP Features (Acres) |
|---|---|---|
| **Permeable Pavement** | 108,953 | 7,742 |
| **Bioretention** | 177,273 | 14,585 |
| **Infiltration Basin/Trenches** | 44,271 | 6,951 |
| **Vegetated Filter Strips** | 98,416 | 8,597 |
| **Grass Swales** | 123,917 | 5,191 |
| **Constructed Wetlands** | 8,542 | 194 |
| **Totals** | **561,372** | **43,260** |

## Concept Municipal GSI Projects

Based on the BMP features, 8,998 concept municipal GSI projects were identified covering 1,014 total acres as shown in Table 4-2.

*Table 4-2: Summary of Identified Concept Municipal GSI Projects within ALCOSAN Service Area*

| Concept GSI Technology | Number of Projects | GSI Project Area (Acres) |
|---|---|---|
| **Permeable Pavement** | 2,696 | 803 |
| **Bioretention** | 5,970 | 188 |
| **Infiltration Basin/Trenches** | 259 | 16 |
| **Vegetated Filter Strips** | 62 | 5 |
| **Grass Swales** | 7 | 1 |
| **Constructed Wetlands** | 4 | 1 |
| **Totals** | **8,998** | **1,014** |

The concept municipal GSI projects are also shown for all 29 Study Areas on Figure 4-3. Detailed, full-size maps of each study area can be found in Appendix E of this document.

## Concept Commercial/Institutional and Special Case GSI Projects

Based on the BMP features, 4,890 concept commercial/institutional and special case GSI projects were identified covering 2,245 total acres as shown in Table 4-3. In special cases on private property, it is up to the property owner to determine whether GSI technologies are appropriate for the site. This analysis was conducted to determine the relative scale at which GSI projects would be identified on these special case properties using the same inputs and post-processing that was applied in identifying municipal GSI opportunities. It is acknowledged that certain limitations exist in applying any GSI technology, and these special cases also have additional limitations due to existing land use that would need to be considered in more detail before pursuing any project opportunity.

*Table 4-3: Summary of Identified Concept Commercial/Institutional GSI Projects in ALCOSAN Service Area*

| Concept GSI Technology or Special Case Project Category | Number of Projects | GSI Project Area (Acres) |
|---|---|---|
| **Commercial Permeable Pavement** | 1,939 | 723 |
| **Commercial/Institutional Green Roofs** | 2,014 | 845 |
| **State Route Permeable Pavement** | 913 | 666 |
| **Busway Permeable Pavement** | 12 | 9 |
| **Busway Bioretention** | 12 | 2 |
| **Totals** | **4,890** | **2,245** |

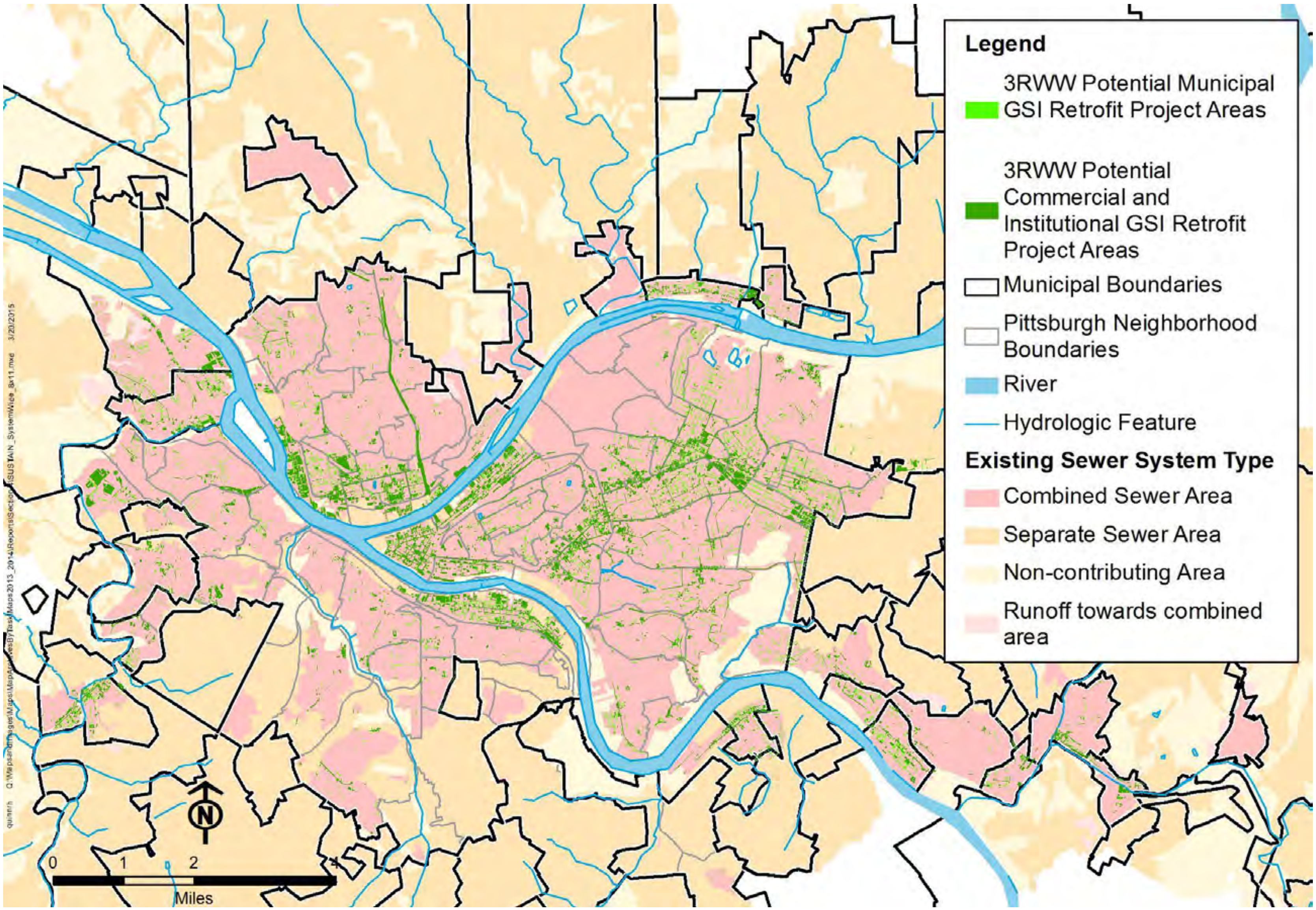



*Figure 4-3: Potential Green Stormwater Infrastructure Municipal Retrofit Project Locations identified by 3RWW*

### 4.1.3 Lawrenceville Green Stormwater Infrastructure Pilot Study Area

In addition to the 3RWW SUSTAIN-based analysis of potential GSI sites, ALCOSAN performed a separate pilot study in Study Area 30 (Lawrenceville) as shown in Figure 4-4. This study area encompasses sewersheds A-22 through A-35. The pilot study involved identifying municipal green stormwater infrastructure retrofit opportunities utilizing a proprietary approach developed by Landbase Systems. The pilot was conducted in part to evaluate the methodology and assess how this approach might support future ALCOSAN flow reduction efforts. The following activities were part of the pilot study:

- For all stormwater inlets contained in Landbase Systems mapping, rank the inlets and drainage areas based on annual runoff volume, gross impervious area and net impervious area. Net impervious area assumes that all upstream inlets are functioning properly and capturing all upstream runoff, while gross impervious area assumes that all upstream runoff is conveyed to that particular inlet. These assumptions bound the varying degrees to which upstream inlets can become clogged and runoff be conveyed to the next downstream inlets;
- Rank each sewershed based on the potential runoff volume intercepted and the potential net impervious area controlled by each potential site;
- Select two sewersheds from within the pilot study area that have the best potential for GSI implementation;
- Identify potential sites for GSI implementation within the two selected sewersheds including the drainage areas, estimated annual runoff volume and the net impervious area controlled by each site; and
- Evaluate GSI strategies at five sites within the selected sewersheds that have the highest potential runoff reduction, and provide a summary of overflow reduction and estimated installation costs.

The ranking analysis of each stormwater inlet enabled ALCOSAN to evaluate potential 'high-yield' sites, i.e. the sites that have the highest predicted volume of runoff tributary to an existing storm water inlet. While many factors must be considered in siting GSI, this desktop analysis can aid by focusing efforts in locations that are likely to be more cost-effective in reducing combined sewer overflows. Inlets within the Lawrenceville study were ranked based on their net annual runoff and net acres of impervious surfaces. Based upon the analysis, the top 13% of the storm water inlets receive 50% of the runoff tributary to the mapped inlets

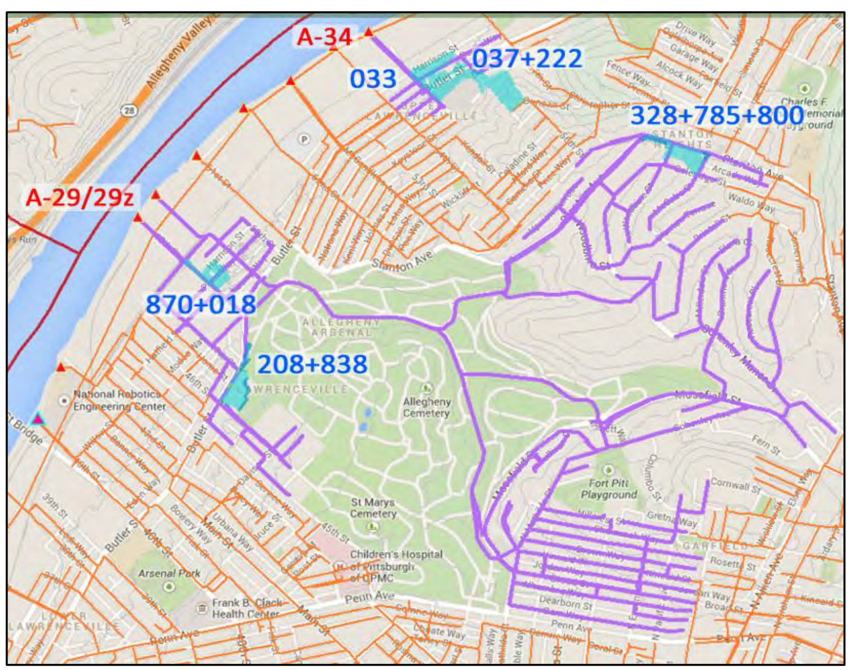



*Figure 4-4: Locations of Selected GSI Sites in Lawrenceville Pilot Study*

within the sewershed. Also, the top 13% of the inlets contain 50% of the tributary impervious area within the sewershed.

The sewersheds within this study were also ranked based on the potential net runoff volume and potential net impervious area. Each sewershed, A-22 through A-35, contains high ranking runoff and net impervious surface locations that can use source reduction strategies, but two of the higher ranked sewersheds were selected for the purpose of identifying opportunities for early implementation projects: A-29/29z and A-34. Potential GSI project sites within these two sheds were then ranked based on several criteria including net tributary runoff volume and net tributary impervious area. Approximately ten of the higher ranked sites were selected for site visits to assess project visibility, general site characteristics and the specific locations where GSI might be installed. Based on the field visits, ALCOSAN then selected five sites for further evaluation as potential GSI installations.

The five sites evaluated as potential GSI installation sites are listed in Table 4-4 below. Field visits were made at all sites in both dry and wet weather to confirm the viability of the location to support a GSI retrofit technology.

***Table 4-4: Potential GSI Implementation Sites Evaluated in Lawrenceville Pilot Study***

| Site ID | Sewershed | GSI Strategy | Location |
|---|---|---|---|
| **870+018** | A-29/29z | Remove | 48th & Harrison Streets |
| **328+785+800** | A-29/29z | Return | Stanton Ave & Woodbine St |
| **208+838** | A-29/29z | Infiltration Only | Butler St & Allegheny Cemetery |
| **033** | A-34 | Return | 55th St |
| **037+222** | A-34 | Infiltration Only | Butler St & 55th St & 56th St |

GSI strategies were evaluated using one of three approaches below for managing stormwater runoff in combined systems:

1. ***Return GSI:*** a GSI technology captures and infiltrates a designed amount of stormwater runoff and for volumes of runoff above the design capacity, stormwater is slowly released back into the nearest downstream combined sewer connection
2. ***Remove GSI:*** captures stormwater runoff like "Return GSI," with runoff volumes above the design capacity being slowly released through a new storm sewer or a natural outlet for infiltration
3. ***Infiltration Only GSI:*** designed to capture and infiltrate all of the anticipated runoff in the Typical Year precipitation record without contributing to localized flooding and without a connection to the nearest downstream combined sewer. Sites evaluated for infiltration only will require extensive infiltration testing prior to implementation.

Landbase Systems methodology was used to approximate the performance of the GSI strategies at the 5 sites using ALCOSAN's typical year precipitation and sewershed properties from ALCOSAN's regional existing conditions hydrologic and hydraulic (H&H) models. These models do not reflect future flow conditions, future regulator adjustments, or proposed municipal and ALCOSAN improvements as reflected in the Wet Weather Plan (WWP). The GSI characteristics, costs, and estimated performance are summarized in Table 4-5, with extrapolated unit costs based on the estimated performance and construction costs displayed in Table 4-6. The average GSI storage provided is 0.6 inches over the tributary impervious area, which is less than the 1 to 1.5 inches typically used in other wet weather programs.

*Table 4-5: Lawrenceville GSI Implementation Sites Performance Statistics*

| | Site 870+018 Shed A-29/29z Remove GSI | Site 328+785+800 Shed A-29/29z Return GSI | Site 208+838 Shed A-29/29z Infiltrate GSI | Site 033 Shed A-34 Return GSI | Site 037+222 Shed A-34 Infiltrate GSI |
|---|---|---|---|---|---|
| **Drainage Area (ac)** | 2.05 | 2.16 | 10.02 | 1.72 | 4.61 |
| **Impervious Area (ac)** | 1.73 | 0.89 | 1.14 | 1.57 | 1.25 |
| **Percent Impervious (%)** | 84.5% | 41.0% | 11.4% | 91.2% | 27.2% |
| **GSI Area (sf)** | 1,600 | 3,000 | 3,000 | 1,500 | 5,000 |
| **GSI Storage (cf)** | 3,500 | 3,000 | 1,625 | 3,600 | 2,000 |
| **GSI Storage (inches over impervious area)** | 0.56 | 0.93 | 0.39 | 0.63 | 0.44 |
| **Annual Stormwater Runoff Removed (MG)** | 1.25 | 0.37 | 0.72 | 0.25 | 0.80 |
| **Annual Stormwater Runoff Delayed and Returned to Combined Sewer (MG)** | 0 | 0.42 | 0 | 0.62 | 0 |
| **Estimated Construction Cost** | $278,000 | $158,000 | $87,000 | $190,000 | $117,000 |

*Table 4-6: Lawrenceville GSI Estimated Performance Unit Costs*

| | Site 870+018 Shed A-29/29z | Site 328+785+800 Shed A-29/29z | Site 208+838 Shed A-29/29z | Site 033 Shed A-34 | Site 037+222 Shed A-34 |
|---|---|---|---|---|---|
| **Cost per Gallon of Runoff Removed ($)** | $0.22 | $0.42 | $0.12 | $0.76 | $0.15 |
| **Cost per Impervious Acre Managed ($)** | $161,000 | $177,000 | $76,000 | $121,000 | $94,000 |
| **Cost per Square Foot of GSI Area ($)** | $174 | $53 | $29 | $127 | $24 |

The construction cost estimates developed for the Lawrenceville Pilot Study were estimated using recent bid and construction price information in Western Pennsylvania, and were not based on the ALCOSAN Alternatives Costing Tool (ACT). The average estimated construction cost is $58 per square foot. This cost is generally higher than the unit costs from other cities as presented in

Section 3.1, which are sized to provide a greater amount of storage per impervious than provided for the 5 sites in this analysis.

The full report of the Lawrenceville GSI analysis is included in Appendix F.

### 4.1.4 Other Green Stormwater Infrastructure Analyses in the ALCOSAN Service Area

In addition to the ALCOSAN SCS, individual municipalities and stakeholder groups have produced reports, or are in the process of developing GSI studies, within specific areas of ALCOSAN's combined sewer service area. This section contains summaries of the most significant known reports that have developed concept designs for potential GSI projects or have recommendations for implementation of specific projects.

#### Green Stormwater Infrastructure Feasibility Assessment for the Spring Garden Watershed

Separate from the source control study, ALCOSAN examined the potential for GSI projects to be implemented in the area surrounding the Spring Garden neighborhood of Pittsburgh. The goal of this effort was to examine an entire sewershed for GSI project opportunities that could be implemented by local municipalities to serve as a guide for future efforts.

The Spring Garden sewershed (ALCOSAN POC A-60) is broken down into nine separate areas of study with a total of nine GSI project recommendation proposed, along with cost and performance estimates. An example of a project concept design is located in Figure 4-5. The Spring Garden Report emphasizes the importance of carefully selecting early stage GSI demonstration projects that are most likely to be cost effective in terms of stormwater runoff reduction. The report concludes that these demonstration projects can help build a body of knowledge that will eliminate the risks and concerns associated with implementing GSI. Finally the report goes on to suggest a number of possible public and private sources for potential


*Figure 4-5: Spring Garden Green Stormwater Infrastructure Concept Design*

funding and recommends the use of non-monetary incentives to encourage additional GSI implementation.

### Pittsburgh Water and Sewer Authority Wet Weather Feasibility Study Section 9: Adaptive Management, Green Infrastructure, and Integrated Watershed Planning

In July of 2013, PWSA submitted its municipal feasibility study with a recommendation to examine the feasibility of replacing certain previously planned grey infrastructure improvements intended to address the CSO problem with potential GSI installations. The PWSA Study discusses integrated watershed management and the need to identify additional sources of pollution that may not be eliminated by the proposed grey infrastructure improvements. The study also emphasizes consideration for an Adaptive Management Implementation Plan that calls for continual reevaluation of the effectiveness and affordability of each of the controls implemented or proposed for implementation. Some of the ideas for the feasibility study were based on recommendations of the PWSA-led Greening the Pittsburgh Wet Weather Plan Charrette project of 2013.


*Figure 4-6: ALCOSAN and PWSA Partnered for GSI projects in Pittsburgh's Schenley Park*

One of the projects included in the PWSA Study and Adaptive Management Implementation Plan (AMIP) is the Integrated Watershed Management (IWM) demonstration project in the Saw Mill Run sewershed. There, PWSA is looking to find the optimal mix of gray and green infrastructure to control combined sewer overflows as part of a larger pollution control strategy aimed at meeting broader water quality standards. PWSA has proposed a three-stage process to guide the implementation and assessment of initial GSI and IWM activities. Each stage is accompanied by a decision point for which PWSA will assess progress and determine the most appropriate means for compliance with the Consent Order and Agreement to include IWM and GSI or continue with the baseline approach as is. The three decision points are to be spread out over a 4-year period and if the requirements of each point are not met, PWSA will revert back to the baseline approach.

Decision Point 1 pivots on gathering regional and regulatory support for GSI and IWM. If this is not achieved by the end of Year 1, PWSA will revert back to the baseline approach. The second phase of the project and accompanying Decision Point 2 require the demonstration of technical justification that GSI and/or IWM can cost-effectively help meet CSO control or broader water quality standards. Finally, Decision Point 3 requires that early demonstration activities show effectiveness in controlling runoff and the potential for managing CSOs or improving water quality. If PWSA is able meet requirements of the three decision points, at the conclusion of this process it may submit a Revised Feasibility Study for review and approval by the Pennsylvania Department of Environmental Protection (PaDEP) and Allegheny County Health Department (ACHD) or a formal proposal to utilize an integrated planning framework.

As with the Saw Mill Run sewershed demonstration project, the PWSA study proposes a four-year, three-phased AMIP. The AMIP seeks to achieve the optimal balance between green and gray solutions to meet compliance objectives in a more cost-effective manner. The decision points mirror those outlined for the Saw Mill Run sewershed demonstration project. Decision Point 1 turns on regional and regulatory support, Decision Point 2 focuses on a demonstration of technical justification and cost-effectiveness in meeting compliance objectives and Decision Point 3 rests on a need to demonstrate effectiveness at controlling runoff and the potential for managing CSOs or improving water quality. As with the Saw Mill Run project, PWSA may submit a Revised Feasibility Study depending on the outcome of the AMIP. PWSA has budgeted $9,600,000 to be spent over the course of the AMIP.

## Etna Green Infrastructure Master Plan Demonstration Projects


*Figure 4-7: Etna Borough Green Infrastructure Installation at Walnut and School Street*

The Etna Green Infrastructure Master Plan (Etna Plan), completed in June of 2014, was authored by the Borough of Etna and financed in part through a grant administered by the Pennsylvania Environmental Council. The objective of the Etna Plan was to assess the feasibility of reducing or eliminating the use of previously proposed gray infrastructure through the implementation of green stormwater infrastructure solutions in Etna.

The Etna Plan included 23 projects that manage a total drainage area of 33.6 acres, of which 13.4 acres are impervious area. The Etna Plan generally prioritizes projects into phases with respect to stormwater runoff reduction potential, benefits in meeting compliance goals such as CSO reduction, and their relationship to ongoing programs such as Green Streetscape. A number of projects under the Etna Plan which make up Phase I of Green Streetscape were implemented in the summer of 2014. Figure 4-7 displays one of the GSI installations in a parking lot at the corner of Walnut Street and School Street in Etna Borough. Etna continues to study and implement phases of their Master Plan. Etna is within the Pine Creek Sewershed, and as mentioned in both the Pine Creek Sewershed Joint Municipal Feasibility Study and the Etna Borough Municipal Feasibility Study, the Borough will continue to pursue GSI and other measures to prevent stormwater from entering the combined sewer system in parallel to meeting the CSO control objectives identified in their municipal feasibility study.

## 3RWW Conceptual GSI Design in the Brookline, Point Breeze and Swisshelm Park Neighborhoods of Pittsburgh

Using the USEPA's SUSTAIN BMP siting tool as well its own RainWays® tool, 3RWW conducted a study assessing the feasibility of using GSI within the City of Pittsburgh. Potential projects for the Brookline, Point Breeze and Swisshelm Park neighborhoods of Pittsburgh were developed as GSI conceptual design sites as part of the 2012 EPA Green Infrastructure Community Partners Program and is the subject of three separate reports, drafts of each released in October of 2013.

The Brookline report provided concept design of GSI in specific areas along Sussex Avenue and reported on the potential usefulness of GSI in these areas to reduce combined sewer overflows and provide other additional co-benefits.

3RWW selected multiple sites around the Frick Museum in the Point Breeze neighborhood for conceptual GSI design projects, with one potential layout displayed in Figure 4-8. The conceptual designs included permeable pavement in the Frick Museum parking lot, bioretention in curb extensions and a traffic circle along South Homewood Avenue, a bioretention median and permeable parking lanes along Le Roi Road, permeable parking strips on three other streets and an entire alley resurfaced with permeable pavement along Osage Lane.

The proposed design for Swisshelm Park included permeable pavement and bioretention in a traffic circle, curb-extension bioretention in three locations and permeable parking strips, all of which are to be incorporated along multiple blocks of Windermere Drive.

All three reports concluded that the proposed design for the project sites demonstrates that GSI can be retrofitted into urban neighborhoods to assist in efforts to reduce combined sewer overflows while providing a number of other benefits to the community including an increased sense of well-being for residents and increased property values.

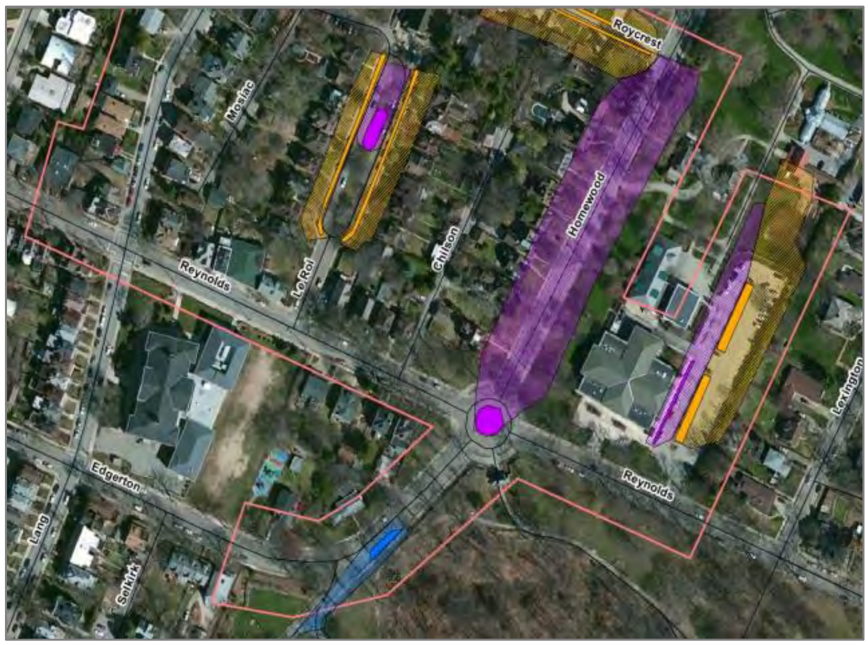



*Figure 4-8: Layout of Conceptual GSI Projects in Frick Museum Area, Point Breeze*

*Source: http://www.3riverswetweather.org/sites/default/files/GI%20Neighborhood%20Design%20Report-Point%20Breeze.pdf*

## Southside Green Infrastructure Charrette

Over a three-day period from April 10 to April 12, 2014, a number of stakeholders, hosted by the Pittsburgh Green Infrastructure Network, convened to draft a design for a demonstration district for green infrastructure along 21st Street in the City of Pittsburgh's South Side. The goal was to create a green street that would serve as a community link between the Three Rivers Heritage Trail along the Monongahela River and South Side Park along the Southside "slopes" area. This meeting of designers intent on developing a plan, known as a charrette, brought together attendees from environmental groups, engineering firms, academic institutions and governmental agencies and included representatives from ALCOSAN, PWSA, 3RWW and the University of Pittsburgh, among other stakeholder groups and volunteers. 21st Street would be redesigned to be used as a demonstration project for GSI that can reliably remove stormwater while also serving a multi-modal transportation options and create a new community aesthetic.

Participants were broken up into six design teams and each team was assigned to one of three study areas representing three different sections of the 21st Street corridor. An example of one of the design renderings is included in Figure 4-9. Each team produced a design package and gave a presentation that included an overall plan for their assigned study area as well as specifics about the types of GSI and other design elements used. Detailed sketches showing the locations of the GSI as well as conceptual renderings of photos of the renovated areas were also a part of each design package and provided a comprehensive vision of what the designers hoped to achieve. All designs can be found at: http://www.southsidegreen.com/


*Figure 4-9: Conceptual Rendering of 21st Street in Pittsburgh's Southside*

*Source: Southside Green Infrastructure Charrette, http://www.southsidegreen.com/*

## Carnegie Borough Green Scan Report

Carnegie Borough, along with the Western Pennsylvania Conservancy (WPC), developed a Green Scan of its community in 2013. The Green Scan is a process developed by WPC to help communities identify the best options for supporting community revitalization through "greening," i.e., the softening or replacement of hard surfaces with living plants which provide a variety of benefits.

The Carnegie Green Scan resulted in the recommendation of a number of projects including targeting several areas of interest with respect to stormwater management. The first of these projects involved the Carnegie Free Public Library Grounds. There, it was recommended to redesign the landscaping to serve as GSI by redirecting runoff from the roof and parking lot into a swath of bioswale. A second GSI site recommendation was made with regard to Carnegie Borough Municipal Parking Lot 10, which is slated for renovation in the near future. GSI options there include planting healthy trees in the existing tree pits, reconfiguring the lot to add more tree pits, repurposing an adjacent side street to add curb cuts and a rain garden and incorporating permeable pavement on all or part of the lot. Finally, the third opportunity to add GSI in Carnegie occurs in Seventh Avenue Park. The park provides the space for multiple potential bioswales which could be built on-site to manage stormwater runoff.

## Allegheny Riverfront Vision Plan

The Allegheny Riverfront Vision Plan was a cooperative effort of the Urban Redevelopment Authority of Pittsburgh, City of Pittsburgh, and Riverlife, released in 2010. The vision laid out in this report is currently in progress as part of the Allegheny Riverfront Green Boulevard effort. The plan was developed with the intent to revitalize, enhance and redefine the Allegheny riverfront to increase economic vitality, improve connections to the river, restore ecological character, develop complimentary uses and amenities, create beautiful and memorable places with present resources and plan for sustainable development. The plan covers the Allegheny riverfront area from Pittsburgh's Strip District to Highland Park neighborhoods. A sample rendering of how the Green Boulevard concept could be applied is included in Figure 4-10.

***Figure 4-10: Existing Area of Potential Green Infrastructure Project within Allegheny Green Boulevard***

The Vision Plan addresses a wide range of issues related to riverfront development and redevelopment, and addresses a larger set of ecological principles within planning of stormwater management including GSI. By encouraging development that will restore a more natural hydrologic cycle through GSI capture and treatment, the Allegheny Riverfront Green Boulevard vision hopes to achieve associated gains in economic development and quality of urban life. Among the stormwater management strategies discussed in the report were:

- Consideration of requirements for new development to include GSI;
- Granting credits to existing properties that implement GSI;
- Narrowing all impervious surfaces where possible
- Constructing all parking spaces and driveways with pervious systems; and
- Encouraging the disconnection of downspouts and allowing clean roof drainage to discharge directly into the rivers.

Current information on the development of this plan can be found at:
http://www.greenboulevardpgh.com/

## Western PA Conservancy Analysis of Garden Sites

The Western Pennsylvania Conservancy (WPC) and its volunteer network maintains numerous seasonal gardens in parcels within the public right-of-way throughout the ALCOSAN service area. WPC is interested in retrofitting some of these sites to incorporate green stormwater infrastructure where appropriate. In the *Analysis of Garden Sites* report, WPC evaluated three sites within the City of Pittsburgh that have among the highest potential of all garden sites to capture stormwater runoff from upstream impervious area. These sites are in Greenfield, Oakland and Southside neighborhoods of Pittsburgh. Preliminarily design concepts were developed and performance evaluated at these sites for their potential to be retrofit to function as stormwater infrastructure in addition to their existing use as an aesthetical garden.

# 4.2 Municipal Coordination and Identification of Potential Green Infrastructure Projects

## 4.2.1 Municipality and Stakeholder Meetings

Shortly after the initial results of the 3RWW SUSTAIN analysis were drafted, ALCOSAN initiated a series of SCS status meetings with municipalities, GSI stakeholder groups, and specific government agencies. These coordination efforts covered technical, institutional, and implementation aspects of GSI planning and were conducted throughout 2013-2014. The major goals of these meetings were to:

- Discuss unique needs of the municipality/organization and its vision for implementing GSI and other source controls;
- Share findings to date of the 3RWW GSI project analysis and ALCOSAN regional source control opportunities assessment;
- Discuss funding sources and grant opportunities; and
- Generate ideas and encourage implementation of GSI retrofit projects, as well as incorporation of GSI into redevelopment projects.

Municipal officials that participated in meetings included mayors, council members, managers, and engineering staff. At the request of some municipalities, follow-up meetings were held with other stakeholders including community development corporations, neighborhood organizations, foundations, land developers, and other government agencies.

A full listing of meetings ALCOSAN held with municipalities and similar details of meetings held with outside stakeholder organizations is included in Appendix G-2. ALCOSAN continues to conduct regular meetings and discussions with municipal officials and with other regional stakeholders and developers who have interest in building GSI. Further discussion on potential partners in implementation of GSI projects is included in Section 4.6.

## 4.2.2 Identification of Potential GSI Opportunities

Each meeting with municipalities and stakeholders resulted in the identification of potential GSI project locations and ideas on how to partner with ALCOSAN to implement the projects. These locations were generated after discussing the results of one or more of the following GSI analyses discussed in previous sections:

- Regional Source Control Analysis (Section 3);
- 3RWW Green Infrastructure Project Identification (Section 4.1.2);
- Lawrenceville Green Infrastructure Pilot Study (Section 4.1.3); and
- Area identified by other green infrastructure studies in the county (Section 4.1.4).

Approximately 14,000 potential GSI project locations emerged from the 3RWW analysis and about another 200 from other efforts, including coordination of municipal and stakeholder visioning for the communities they serve including:

- Municipal road reconstruction sites
- Planned municipal public works sites or publicly-funded redevelopments
- Existing/planned streetscape improvements
- Areas of prominent visibility, such as business districts
- Areas thought to provide an aesthetical amenity to community in addition to the essential stormwater capture functionality
- Sites at parks or existing green space
- Private redevelopment sites with potential for partnerships.

Among the potential locations that were discussed at meetings, ALCOSAN developed a database of ideas for potential GSI projects at the locations that municipalities and stakeholders were interested in pursuing in the next few years. Figure 4-11 displays these projects throughout the combined sewer service area. This database of potential projects is a living document, with additions made as they are provided to ALCOSAN. In some instances, projects that were recommended early on have already been implemented by municipalities or slated for construction at the date of this publication. A complete listing of projects ideas developed to date is listed in Section 5 as well as Appendix G-1.

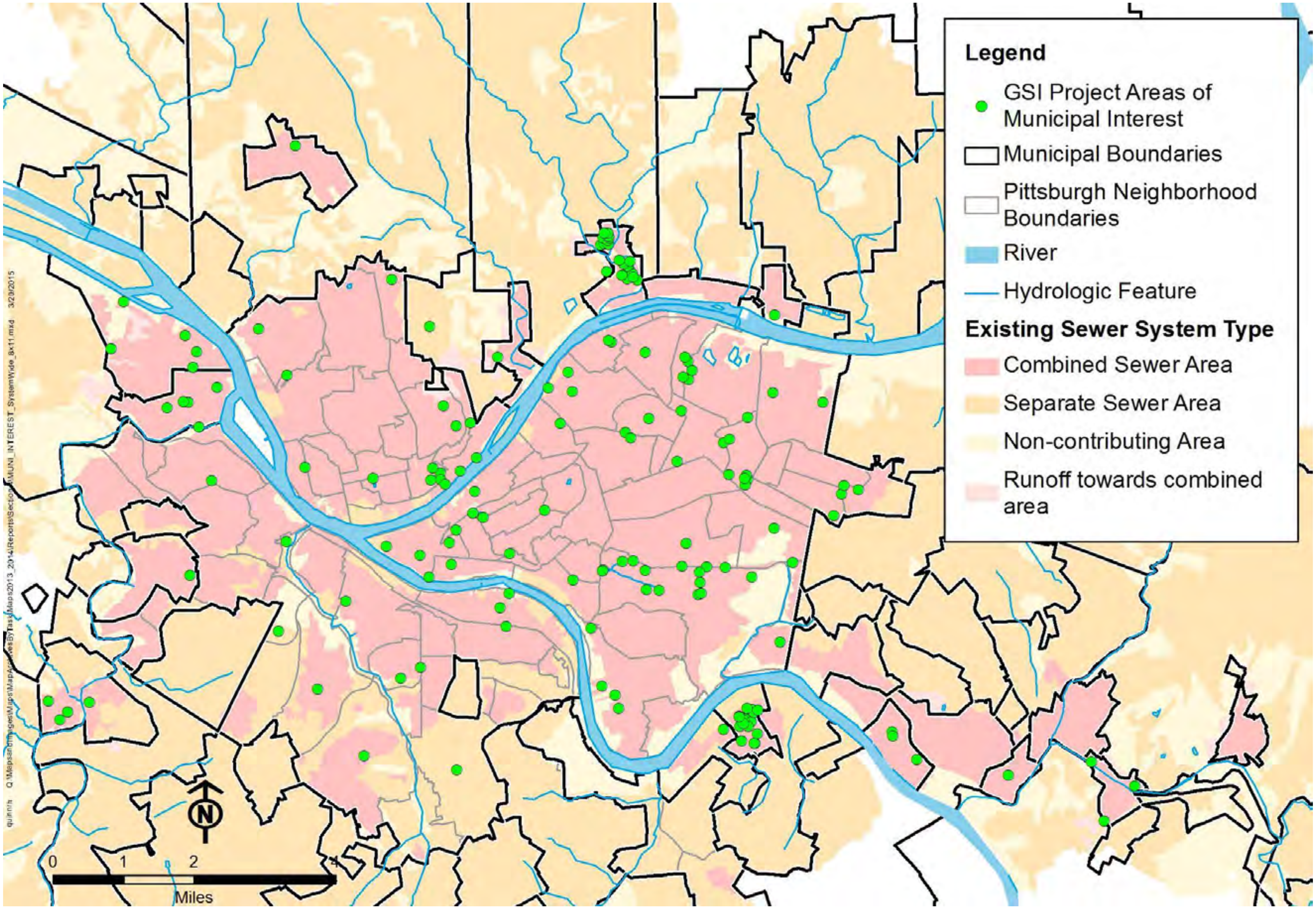
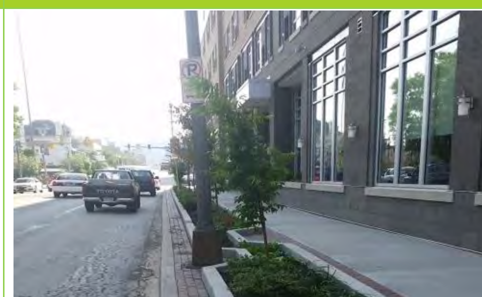



*Figure 4-11: Municipal and Stakeholder Identified Green Infrastructure Projects*

Potential municipal green infrastructure projects identified were either retrofit projects that would be built into the existing public right-of-way or public land, or redevelopment projects that would integrate GSI elements within planned municipal infrastructure projects such as road reconstructions or municipal park projects. In some cases, a municipality would identify a prominent private development or redevelopment effort in their community and discussed how they were working with the private property owner to include GSI components. Examples of local GSI retrofit and redevelopment projects are included in Table 4-7.

*Table 4-7: Examples of Green Infrastructure Retrofit and Redevelopment Projects*

| Land Owner | Type of Land | Retrofit GSI Project Examples | Development / Redevelopment GSI Projects Examples |
|---|---|---|---|
| **Public** | Right-of-way |  Example: West View Rain Garden |  Example: Hyatt Hotel, Baum Boulevard |
| | Publicly-owned Property |  Example: County Office Building Green Roof |  Example: Etna Parking Lot |
| **Private** | Parcels |  Example: East Liberty Presbyterian Church on-site bioretention |  Example: Bakery Square 2.0 |

Integrating GSI into land redevelopment is a significant opportunity to improve the hydrologic response to typical rainfall events in our region through routing more runoff from impervious surfaces to properly designed GSI and other on-site stormwater management techniques. It is often desirable to integrate GSI into redevelopment efforts or in parallel with planned municipal right-of-way construction as the added cost to include GSI within planned construction is often less expensive than constructing a GSI retrofit project of similar performance into existing land uses. Furthermore, if the land development requirements are incorporated into ordinances, the GSI cost can be borne by land developers and property owners rather than sewer system ratepayers.

Some municipalities in the ALCOSAN combined sewer area, including the City of Pittsburgh, have developed on-site stormwater management ordinances for redevelopment and development projects. The single most cost-effective means of implementing GSI from a ratepayer perspective would be implementation of a stormwater management ordinance in all combined sewer areas, preferably based on a common design standard selected to help achieve municipal and ALCOSAN CSO compliance obligations. The current Act 167 planning efforts being led by Allegheny County present an ideal opportunity to establish such ordinances. As the region continues to evolve policy on issuing stormwater management standards for all land development and redevelopment efforts, ALCOSAN will continue to aid municipalities and development communities with incorporating GSI and other source controls as feasible.

## 4.3 Assessment of Potential Green Infrastructure Project Opportunities

Numerous opportunities for potential GSI projects were identified through the technical analysis and public outreach efforts of the SCS. Meetings with municipalities and stakeholders resulted in the development of over 200 project location suggestions, shown in Figure 4-12. Due to the high degree of municipal and stakeholder interest, ALCOSAN evaluated suggested site locations for their feasibility to implement GSI projects. ALCOSAN wanted to evaluate the sites where GSI project concepts which were furthest advanced by municipalities and stakeholders and also those of high potential CSO impact in an effort to continue municipal and stakeholder momentum and promote GSI implementation in the near term. Using the information gathered in field evaluations, ALCOSAN developed conceptual design materials on behalf of the municipalities and stakeholders, as described in Sections 4.4. For the most promising projects, ALCOSAN is working with municipalities to advance the technical evaluation and build partnerships for implementation.

In order to determine which projects to evaluate, ALCOSAN developed an initial screening process with the understanding that all suggested project sites have potential for future consideration, but only a portion could be evaluated as part of the SCS. It is important to stress that this process was used as a means of prioritizing attention, not as a means of ruling out possibilities. While ALCOSAN has identified a select number of sites that advanced through the screening, field evaluation and concept design stages, this does not preclude any of the suggested project sites from future consideration.

Thus far, ALCOSAN has visited more than 75 sites and conducted formal field assessments for the most promising near-term projects. Project summaries were prepared for those projects that were deemed viable after conducting a field assessment. Once the drainage area to a particular site was estimated in the field, initial project sizing estimates were made based on capturing the first 1.5 inches of runoff, which closely approximates the 95th percentile storm for the region. An example graphic of the site drainage area and potential concept after a field visit is displayed in Figure 4-13. The site summaries, with sizing information and initial field assessment reconnaissance forms, can be found in Appendix H.


*Figure 4-12: ALCOSAN Officials Conducting a GSI Field Assessment*


*Figure 4-13: Example Summary of a GSI Concept post-Site Visit*

## 4.4 Concepts for Example Green Infrastructure Projects

As ALCOSAN went through the process of collecting field data on suggested GSI sites, conceptualizing the potential for GSI technologies to be implemented at those sites was a part of the overall evaluation. Developing a preliminary layout of how potential GSI technologies can be built into a site is an essential consideration, and essential to estimating the cost of an urban GSI retrofit.

As a means of helping municipalities and stakeholders consider how GSI could be implemented at the suggested sites, ALCOSAN developed visual renderings and conceptual layouts of GSI projects for consideration at sites where no initial concept existed or for sites which did have initial technical analysis but where visual representation would aid the community in understanding the potential of the site. These conceptual designs are a starting point that requires additional community input, further engineering analysis and site testing to advance to a complete design. ALCOSAN has advanced five preliminary concepts which are described below and will continue to work with the project partners as these individual projects advance toward final design. These concepts include preliminary renderings and layouts that are included in Appendix I.

Through the municipal coordination effort, these five projects are among the most advanced by the municipalities and project stakeholders and reinforce the importance of continued outreach to aid the proactive efforts of the ALCOSAN communities. If municipalities are interested in continuing to pursue these projects, ALCOSAN will continue to coordinate with the partners to help ensure that the technical, institutional, and financial matters for each of the projects can be successful. Municipal coordination was a success of the source control study, and ALCOSAN will continue to work with GSI project partners on the projects they received feedback on. It is important to acknowledge the many proactive efforts within the region that have focused on potential GSI concept designs, and ALCOSAN hopes to enhance more efforts through to implementation in the future.

### 4.4.1 Braddock Borough Community Plaza

Braddock Borough has teamed with the Mon Valley Initiative and The Design Center of Pittsburgh to integrate green infrastructure for the planned redevelopment of a new community plaza along Braddock Avenue between 4th and 5th Streets. The Braddock Community Plaza was designed to retain stormwater runoff of the on-site impervious area by integrating GSI into the design. The project stakeholders are working with ALCOSAN to capture runoff from surrounding roads and expand the potential impact of green infrastructure for this project. The project concept, with a rendering displayed in Figure 4-14, proposes the use of infiltration channels, rain gardens and an underground infiltration bed designed to collect runoff from surrounding streets and sidewalks and

*Figure 4-14: Braddock Community Plaza Rendering*

infiltrate into groundwater, with a connection to the existing combined system for storm events above the designed capacity. The plaza would provide the community with a gathering place for events and add vegetation to the block while providing an essential stormwater management function.

The infiltration channels are shallow, depressions can be planted with a variety of trees, shrubs or grasses with underlying soils and porous media designed to aid infiltration into groundwater. The Braddock concept would have stormwater runoff routed into the channel flow down the natural slope through a series of check dams connecting at the bottom to the underground infiltration bed where the majority of runoff is designed to infiltrate.

The proposed underground infiltration bed along the length of the plaza adjacent to Braddock Avenue will provide temporary storage and infiltration of stormwater runoff by placing various types of media beneath the surface. This technology typically consists of a highly pervious soil underlain by a uniformly graded aggregate for storage and infiltration. In some designs, specific stormwater infiltration chambers are used to increase the volume of storage able to be captured. Testing the infiltration capacity of this site will determine the final design and configuration of the underground infiltration bed. A full layout of the proposed redevelopment with a preliminary GSI configuration is displayed in Figure 4-15.

By pairing this GSI concept with a planned redevelopment, Braddock Borough is demonstrating the ability to reduce certain costs to build a GSI project. Final design and construction of the Braddock Community Plaza is planned for 2015.


*Figure 4-15: Braddock Plaza GSI Concept Plan*

## 4.4.2 Homestead Borough Frick Park Infiltration Trenches

Municipal leaders representing Homestead Borough have expressed an interest in exploring the installation of GSI strategies to address stormwater issues throughout the Borough. A concept plan has been developed which proposes storm sewer disconnection, subsurface infiltration beds and infiltration trenches in Homestead's Frick Park and along Amity Street, Ann Street and E. 11th Avenue. These technologies are designed to direct street and sidewalk runoff into vegetated areas and allow for infiltration into groundwater.

The proposed infiltration trenches located along Amity and Ann Streets would capture and infiltrate small storm events, and are placed to intercept flow runoff before it reaches the existing catch basins, as seen in Figure 4-16.

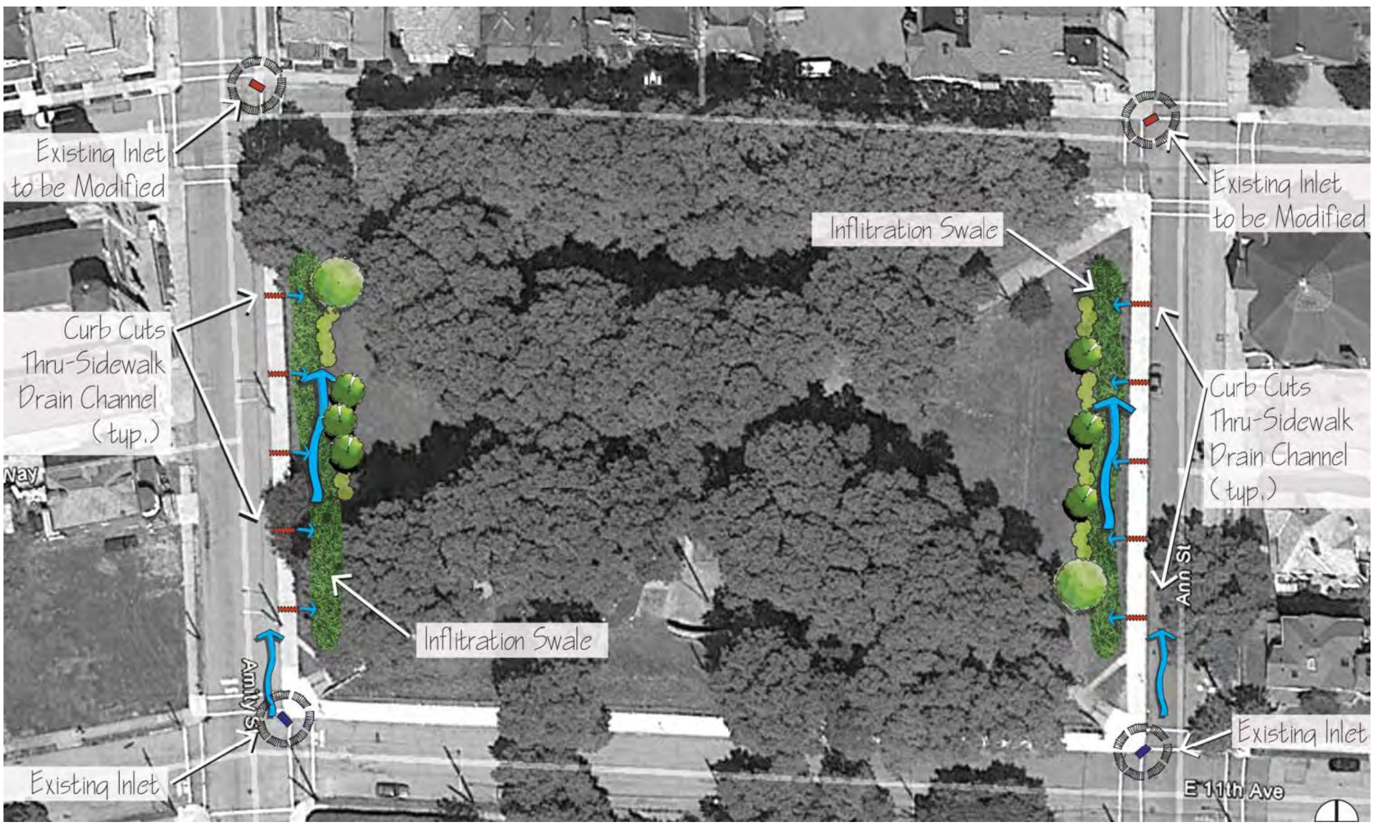



*Figure 4-16: Homestead Borough GSI Concept Layout*

Large storm events would be conveyed through underground perforated pipe and into infiltration beds within Frick Park. There is flexibility to make these infiltration beds have surface, native vegetation features or buried infiltration media to keep the existing lawn area open. Sizing of the infiltration beds can vary and are dependent on factors such as constructability, volume controls, utility locations, and impervious surface drainage area. A cross-sectional rendering of a potential layout of the GSI technologies is included in Figure 4-17.

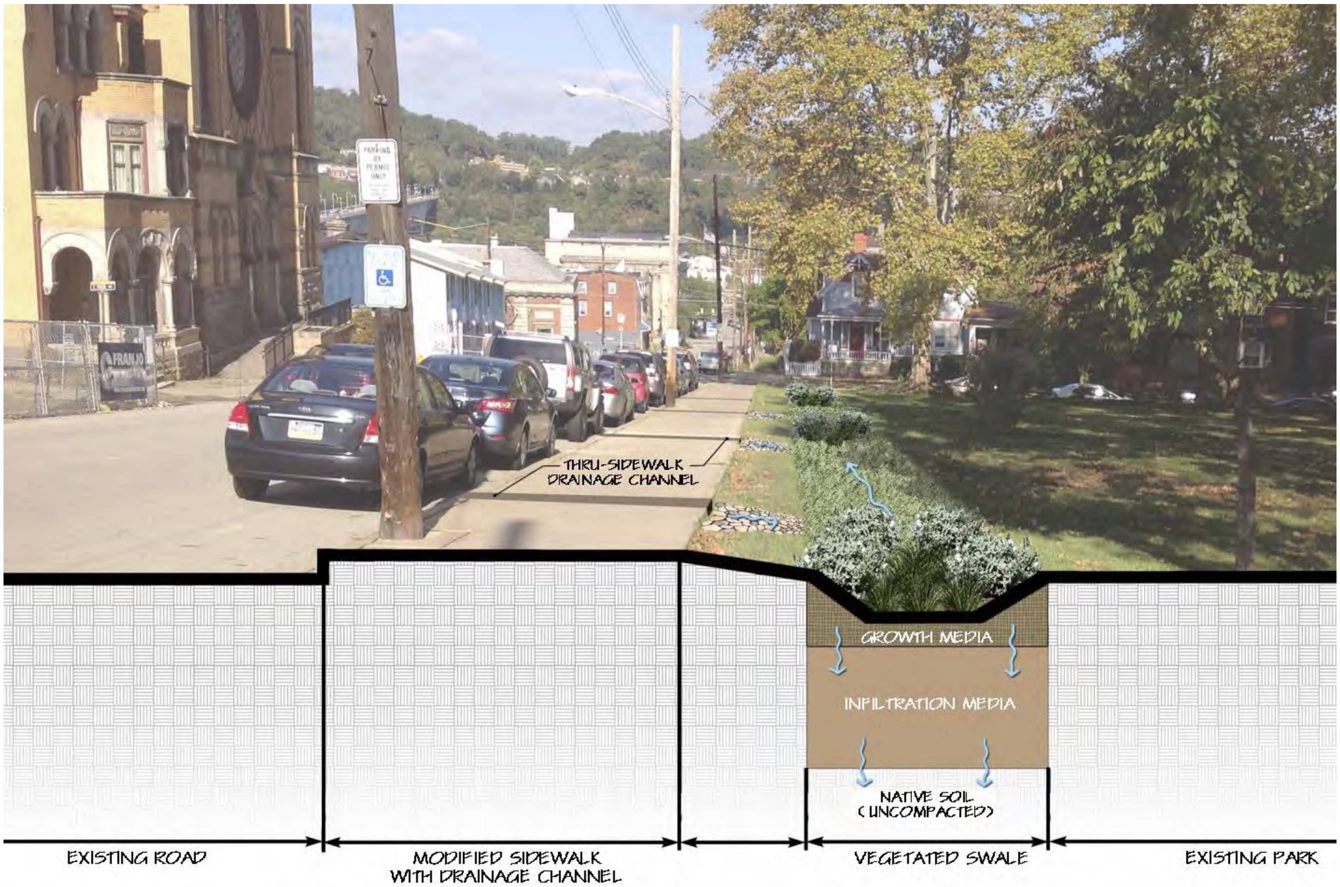



*Figure 4-17: Homestead Borough Frick Park GSI Cross-Sectional Rendering*

## 4.4.3 City of Pittsburgh Beltzhoover Neighborhood - McKinley Park GSI

The Pittsburgh Parks Conservancy is working with ALCOSAN on potential GSI projects throughout McKinley Park, in the Beltzhoover neighborhood of Pittsburgh. Beltzhoover residents have also expressed ideas to improve neighborhood access and connections to the park through the incorporation of GSI technologies within the existing green space of the park. Recent GSI installations have been

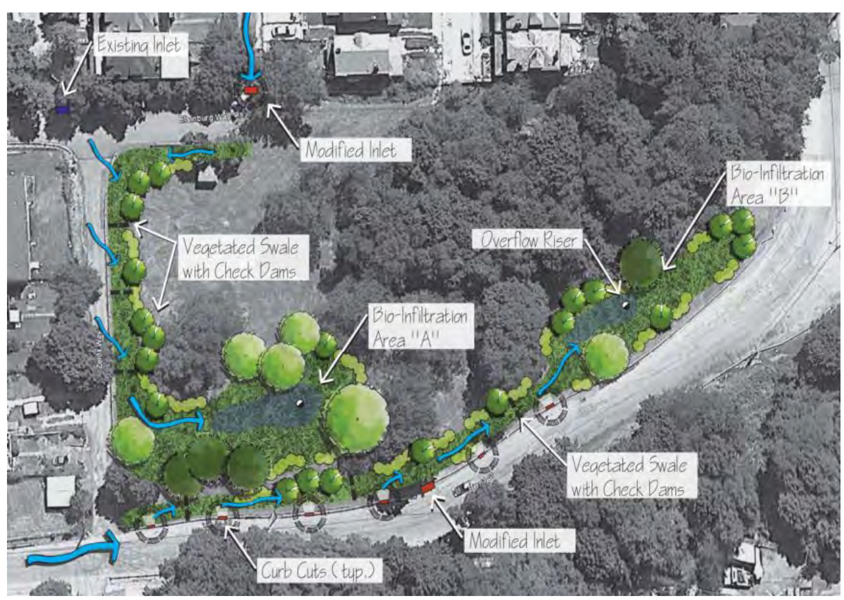



*Figure 4-18: McKinley Park Bernd Street Green Infrastructure Concept Layout*

incorporated into McKinley Park in a parking lot off of Amesbury Street and the adjacent recreation center.

There are two areas where concept GSI designs have been developed in McKinley Park as part of the source control study. The first is the northeastern portion of the park adjacent to Bernd Street, as displayed in Figure 4-18. The second design concept would incorporate GSI along Michigan Avenue perimeter of McKinley Park, as displayed in Figure 4-19.

Both concepts propose the use of vegetated swales and rain garden/bioretention areas designed to collect and infiltrate runoff from impervious areas. Vegetated swales are shallow channels intended to be a green alternative to curb and gutter conveyance systems and would include a dense selection of native, salt-resilient plants with a high pollutant removal potential. The dense vegetation is underlain by a permeable soil or aggregate layer for infiltration into the groundwater.

Since the park area along Bernd Street has a steeper slope, check dams have been included in the concept to enhance the capture and infiltration capabilities by decreasing velocity of stormwater runoff within the trench and provide additional opportunity for filtering and settling of pollutants. The dams will create a series of small pools along the length of the swale. The vegetated swales will be used as pre-treatment for the proposed rain garden/bioretention areas onsite. The configuration of the concept is illustrated in a cross-sectional rendering of the site, as displayed in Figure 4-20.

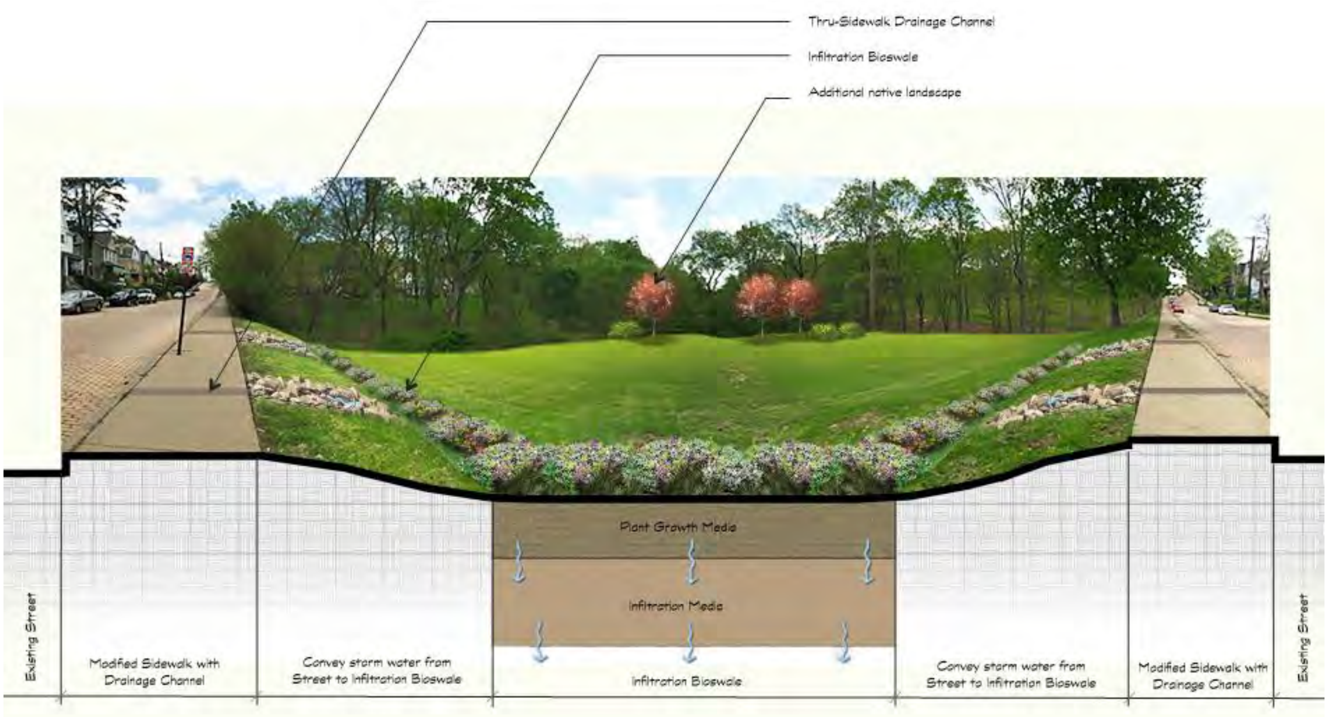



*Figure 4-19: McKinley Park, Michigan Street GSI Concept Rendering*

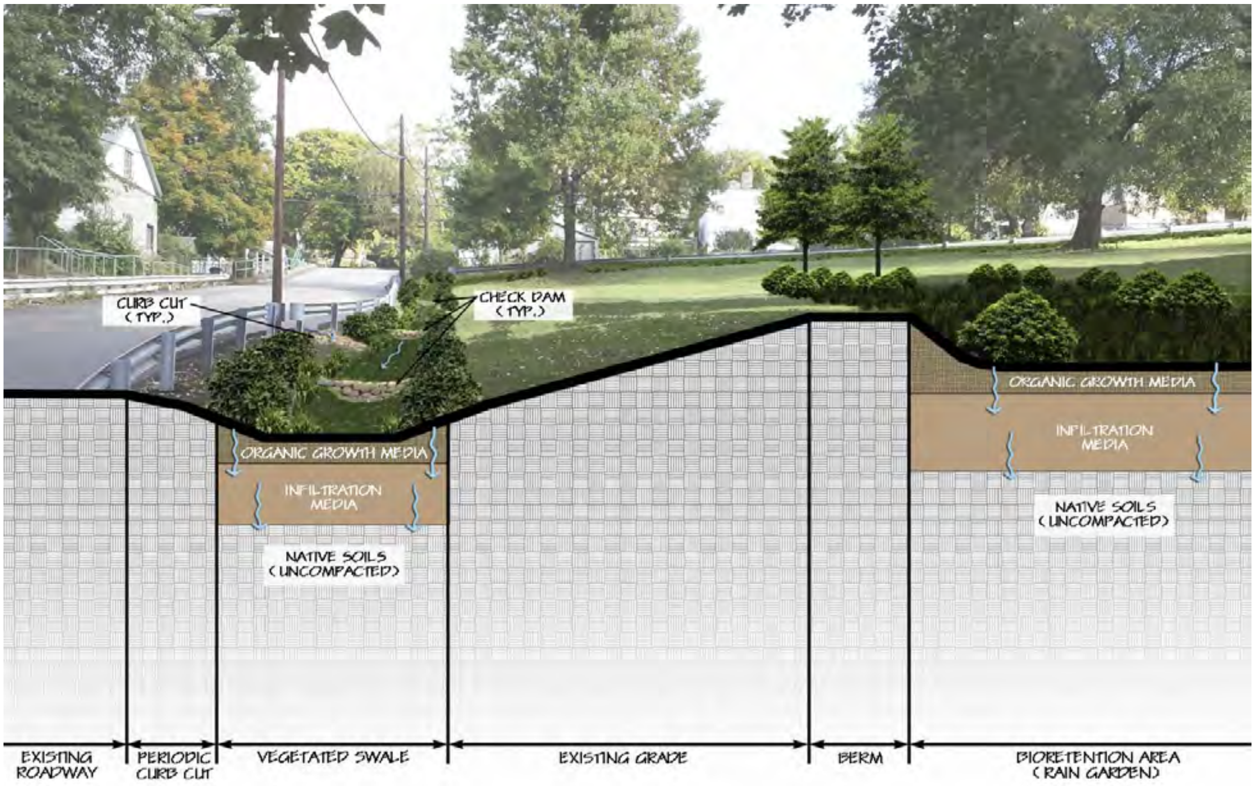



*Figure 4-20: McKinley Park Rendering*

## 4.4.4 Etna Borough GSI Concept from *Etna Green Infrastructure Master Plan*

The Etna Borough *Green Infrastructure Master Plan* outlines a program for the borough consisting of GSI projects, downspout disconnection, tree planting, and vacant property projects that would be both beneficial to the community and address stormwater regulatory issues. A concept plan was developed using various technologies such as rooftop disconnection, infiltration trenches, rain gardens, pervious concrete, subsurface infiltration beds, and enhancement of riparian buffer areas along Pine Creek. These strategies will reduce stormwater runoff volumes and promote infiltration and groundwater recharge. ALCOSAN worked with the Borough to develop a conceptual rendering and layout of their proposed GSI solutions for projects 056, 056A and 057 from the *Green Infrastructure Master Plan*.


*Figure 4-21: Etna Borough GSI Rendering*

The Etna *Green Infrastructure Master Plan* can be accessed publicly online at: http://www.etnaborough.org/files/Etna-GI-Masterplan-COMPLETE-REPORT.pdf. The Master Plan provides an approach to managing the drainage areas upstream of the three separate project areas for Projects 056, 056A and 057 through implementation of GSI technologies in the vicinity of the intersection of Bridge Street and Freeport Street in Etna. The Master Plan also discusses a preferred concept that would convey flow from these three drainage areas and integrate a subsurface infiltration facility within an existing gravel parking lot located across Bridge Street. Figures 4-21 and 4-22 display a rendering and layout of this preferred concept. The concept for Etna is to include both surface and subsurface GSI technologies proposed in the Master Plan which will be integrated to convey stormwater runoff from the streets and into the infiltration basin in the parking lot area. The concept shows a centralized GSI approach to stormwater management in that the concept takes runoff that currently flows to three distinct drainage areas and reroutes the stormwater to one central location through the application of GSI technologies.


*Figure 4-22: Etna Borough GSI Concept Plan*

The proposed subsurface infiltration bed located within the gravel parking lot will provide temporary storage and infiltration of stormwater runoff by placing various types of storage media beneath the surface. Additional considerations of vegetation plantings could be placed along Pine Creek to better enhance the buffer area between the gravel parking lot and the stream, and can be considered as the project design is advanced. Given the advanced preliminary siting and engineering effort of Etna, the concept has flexibility in its configuration and final design.

ALCOSAN intends to work with all parties involved for this innovative approach to controlling stormwater through a centralized GSI approach.

### 4.4.5 Project 15206 GSI Concept in the City of Pittsburgh, Morningside Neighborhood


*Figure 4-23: Morningside Infiltration Trench Rendering*

Project 15206 is an initiative started out of then - Pennsylvania State Senator Jim Ferlo's office with the goal to improve water quality and stormwater management in that area within the 15206 zip code. Organizers of this effort looked for opportunities to implement GSI to aid in the region's need to reduce CSOs. Several GSI concept projects have been developed that are exploring the implementation of GSI in the East Liberty, Highland Park, Larimer, Lincoln-Lemington-Belmar and Morningside neighborhoods of the City of Pittsburgh. ALCOSAN is working with Project 15206 and Pittsburgh City Council Member Deb Gross for a proposed concept plan in the vicinity of Vetter and Chislett Streets of Morningside. The concept is a decentralized approach of GSI using grass-lined infiltration swales along the public rights-of-way of Bryant, Vetter and Vilsack Streets to collect and infiltrate stormwater runoff. Preliminary analysis of the stormwater within the surrounding area indicates the potential for a much larger effort to modify stormwater catch basins and reroute stormwater flow to an area below Chislett Street that would discharge stormwater into Heth's Run. Given the complexity, permitting and coordination of other Heth's Run restoration efforts, this ambitious concept warrants extensive evaluation and community feedback to determine the feasibility of such a project. As a means of developing a surface GSI approach that could ultimately be integrated into the more ambitious effort, ALCOSAN developed the concept layout and rendering displayed in Figures 4-23 and 4-24.

Grass-lined infiltration swales would be placed to capture stormwater runoff from the streets and have the ability to retain and infiltrate to a design storm event and slowly release flows to the existing catch basins for larger storm events. This concept could be modified and scaled to fit the desired community design, but would have the ability to mitigate stormwater runoff from entering directly into the combined sewers. ALCOSAN will continue to advance this concept in partnership with Project 15206 officials and community members as well as participate in the planned urban stream restoration of Heth's Run.

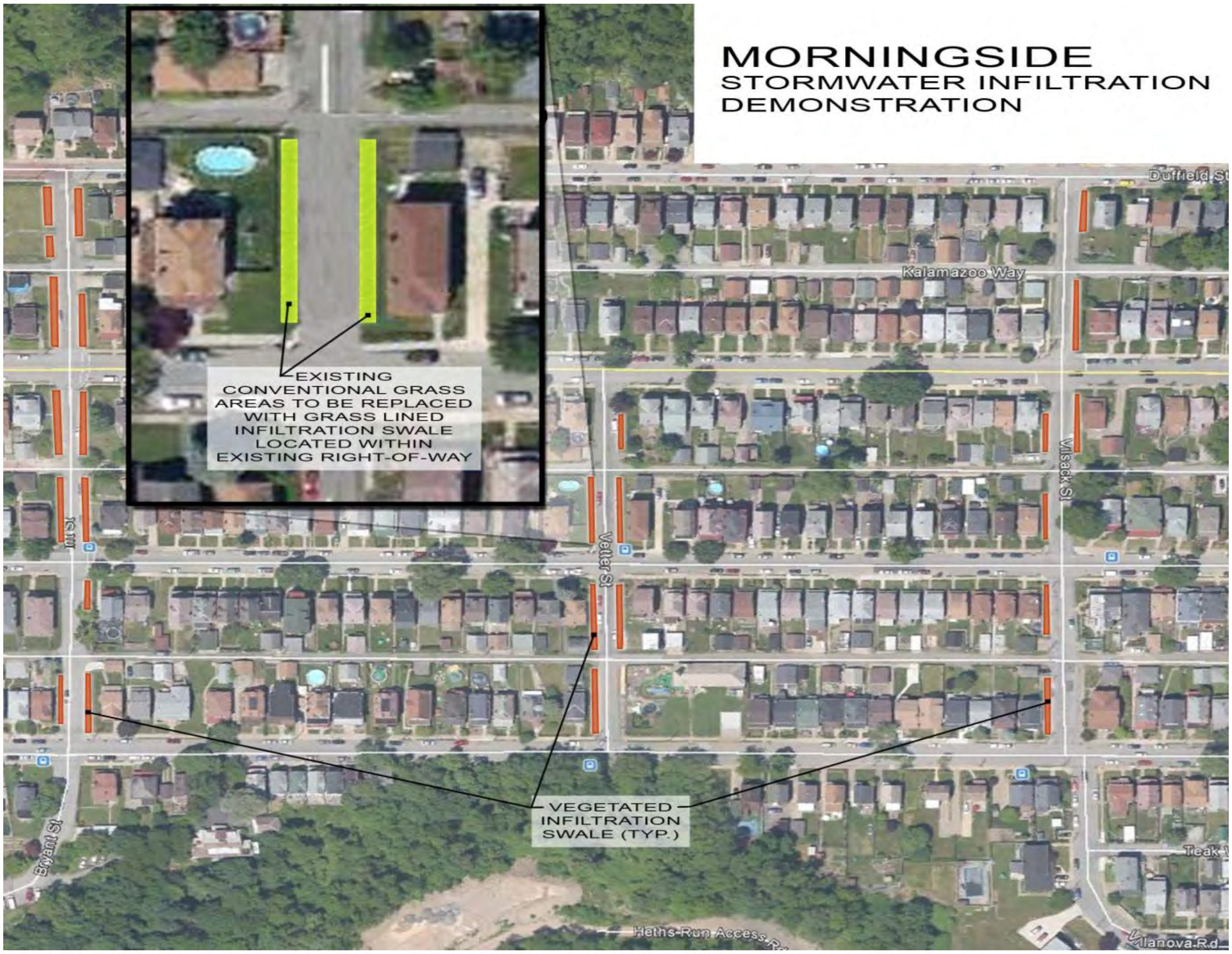



*Figure 4-24: Morningside GSI Concept Plan*

## 4.4.6 East Pittsburgh Grandview Avenue Park, East Pittsburgh Borough

East Pittsburgh Borough has expressed interest in redeveloping vacant land for reuse as a GSI site that would also include a playground and picnic area for the community. The site is located along Grandview Avenue and would collect runoff from several blocks in the surrounding residential neighborhood via gravity flow and modification of existing stormwater catch basins. This project would reduce the volume of stormwater runoff that enters the combined sewer system and subsequent volume of combined sewer overflow into Turtle Creek.

A concept layout of the project is displayed in Figure 4-25. Property acquisition and one abandoned building demolition would enable three parcels to be converted into the community playground with GSI surrounding the site. Potential exists to add more land via an easement agreement with an adjoining apartment building to the north of the site. Due to the proximity to PA Route 30, the playground would be buffered via a landscaped berm, fence, or other physical barrier. The site also has potential to include a "Welcome to East Pittsburgh" sign facing PA Route 30 or other signage to highlight the community redevelopment.

The proposed site layout includes a rain garden intended to infiltrate runoff and slowly release flows above capacity to an existing stormwater catch basin located along PA Route 30. Additionally, if infiltration capacity at the site is limited, or for flexibility in design of the playground, potential exists to use underground detention to manage stormwater. To optimize utility coordination and planning, the borough has asked that road resurfacing of Grandview Ave could coincide with construction of this GSI project which could reduce construction costs.

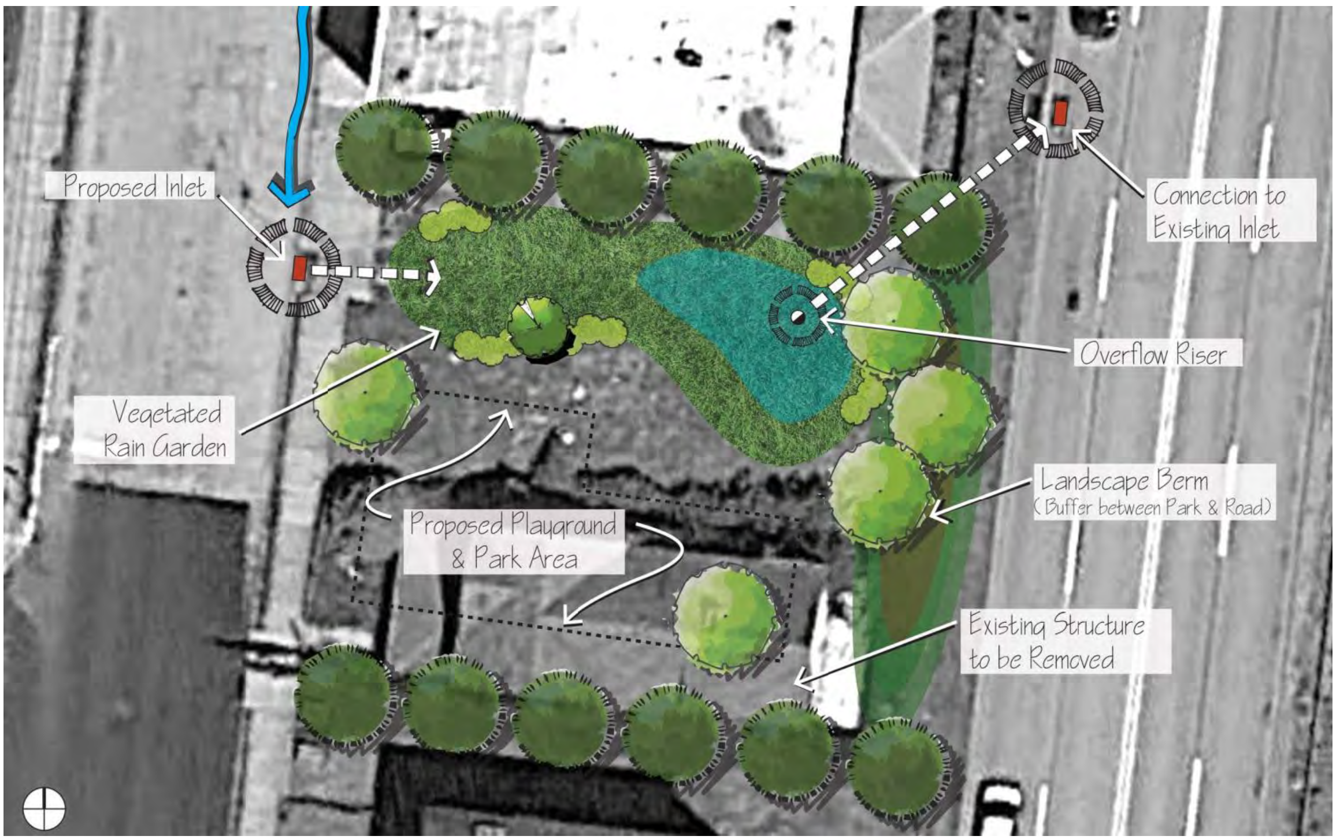



*Figure 4-25: East Pittsburgh GSI Concept Plan*

## 4.4.7 ALCOSAN Access Shaft M-30 Property, City of Pittsburgh Greenfield Neighborhood

ALCOSAN's deep tunnel access shaft M-30 is located in the City of Pittsburgh on a property at the intersection of Greenfield Avenue and Irvine Street. The site is owned by ALCOSAN, and a portion of the site currently serves as a seasonal flower planting bed maintained by the Western Pennsylvania Conservancy (WPC). This concept proposes to transform the existing planting area into a native-vegetation rain garden to collect runoff from surrounding streets and reduce the volume of water entering the combined sewer within M-29 sewershed. WPC has expressed an interest in partnering in a project at the site and continuing to provide maintenance. The concept layout for this project is displayed in Figure 4-26.

The proposed rain garden would collect runoff via modifications to existing stormwater inlet structures. Runoff would then absorb into the surrounding soil and vegetation and infiltrate into the ground. For larger, more intense storm events, a perforated underdrain would collect water that does not infiltrate and a riser structure would convey runoff back to the existing combined system.


*Figure 4-26: ALCOSAN Access Shaft M-30 GSI Concept Plan*

## 4.4.8 Fleming Avenue GSI and Community Park, Stowe Township

Within Stowe Township there are two neighboring sites that have the potential to build GSI and reuse the land for community purposes. The first location is a triangular open lawn area along Fleming Avenue currently owned by the Township and serves as a de facto traffic triangle. The second location is a series of adjacent vacant parcels across the street from the first location. The township has expressed interest in obtaining the properties to build GSI and use the rest of the land for a neighborhood park. These two sites can function in tandem within a single GSI design as displayed in the layout in Figure 4-27.

Both locations are configured to have bioretention/infiltration collect stormwater runoff via curb cuts and connect to the existing combined sewer via modifications to existing storm structures. The vacant parcels have enough land to use the perimeter for GSI and retain the interior land for a community amenity such as a park. There is also the potential to use the vacant parcels for subsurface stormwater storage cells.


*Figure 4-27: Fleming Avenue GSI Concept Plan*

## 4.4.9 Allegheny Commons North Avenue GSI Concept, City of Pittsburgh

Allegheny Commons Park on Pittsburgh's North Side is an existing green space with potential to retrofit areas with green stormwater infrastructure to add to the park's aesthetics and manage stormwater runoff. ALCOSAN has explored potential areas for implementing vegetated swales along the park's perimeter on North Avenue. The swales would collect runoff from either curb cuts or new stormwater inlets and infiltrate it into the groundwater within the existing lawn areas of the park. Figure 4-28 displays one potential GSI retrofit of a vegetated bioswale configuration along North Avenue. Placement of swales will need to account for existing mature tree canopy and root structure as well as existing uses for recreation and events. Infiltration swales will contain an overflow riser structure to return runoff over the capacity of the design storm to the combined sewer system. Future opportunities exist to retrofit GSI in other areas of the park and enhance the existing native vegetation within Pittsburgh's oldest public park. Potential partners to this effort include the Allegheny Commons Initiative, the City of Pittsburgh, and the Pittsburgh Parks Conservancy.

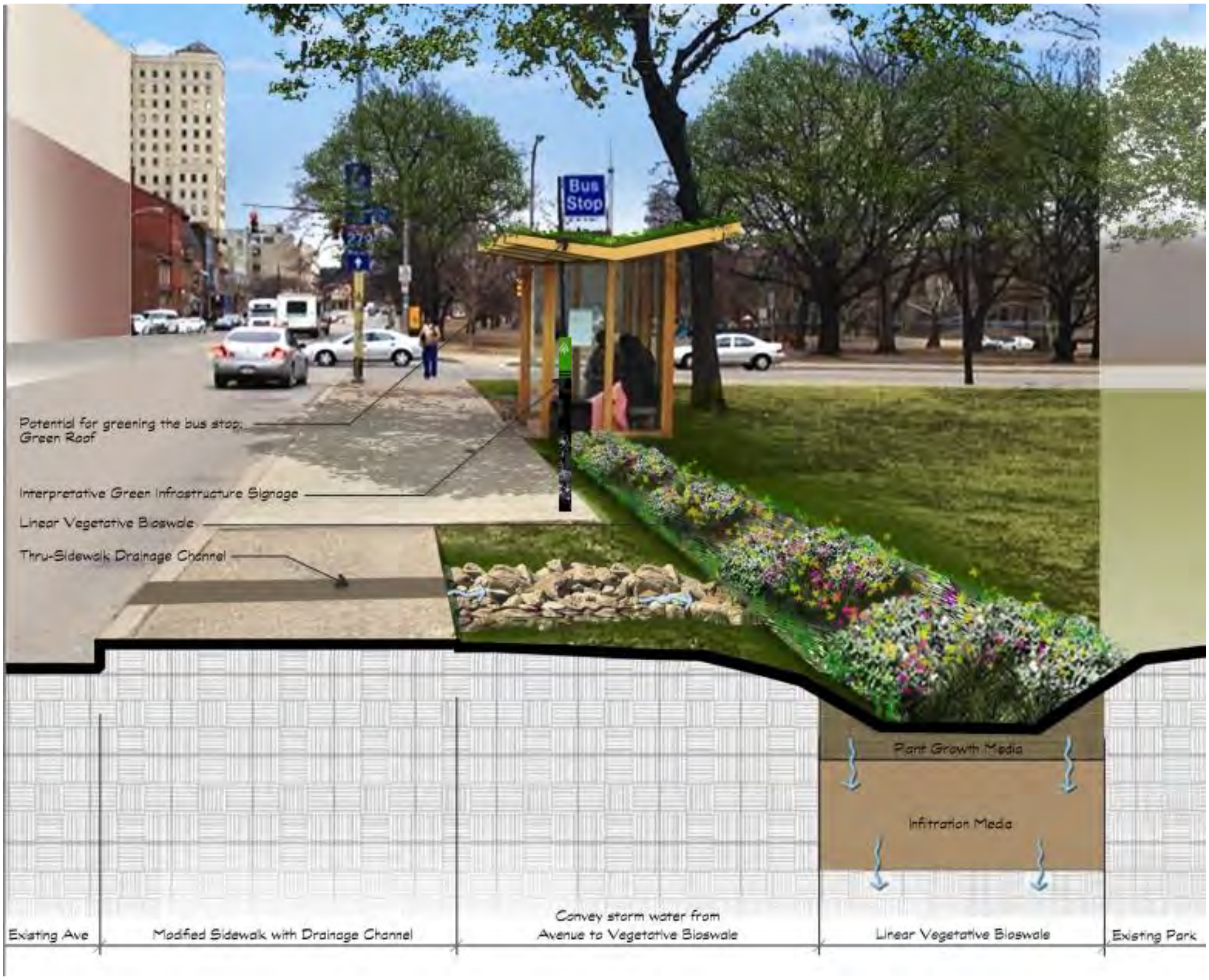



*Figure 4-28: Allegheny Commons GSI Concept Rendering*

## 4.4.10 Airbrake Avenue Trail GSI Concept, Wilmerding Borough

ALCOSAN and Wilmerding Borough officials are seeking ways to incorporate GSI into the existing walking trails and recreation area along Airbrake Avenue in Wilmerding. The area spans four blocks along Turtle Creek and contains areas of mature tree growth, lawn area open for recreation, existing playground areas, and a recent extension to include a walking trail. The concept design, displayed in Figure 4-29, would retrofit GSI into the existing park through a series of rain gardens and infiltration bioswales while maintaining the current land use. A series of curb cuts and inlet modifications would convey runoff to the GSI and reduce the potential for overflow into Turtle Creek. The addition of native vegetation would reduce maintenance of lawn areas and provide added slope stability along the walking trail.

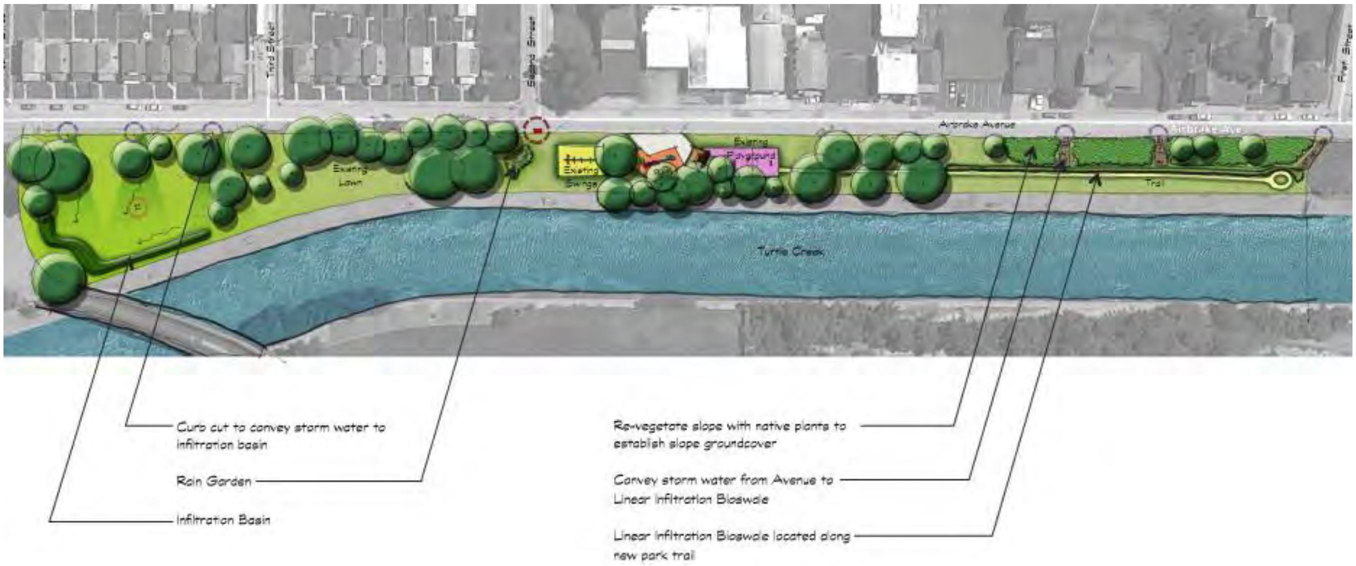



*Figure 4-29: Airbrake Avenue GSI Concept Layout, Wilmerding Borough*

## 4.5 Potential Municipal I/I Reduction Projects

While ALCOSAN's primary focus for engaging community members and municipalities was in relation to GSI opportunities, ALCOSAN also took initial steps toward engaging municipalities on I/I reduction opportunities. This effort is a continuation of ALCOSAN's role in providing technical and administrative support to municipalities to implement source controls, and will continue beyond what is described in this report. As part of that ongoing effort, ALCOSAN will continue to advance the evaluation of selected I/I reduction opportunities in order to refine the scope and costs of these projects.

### 4.5.1 Municipal Meetings

ALCOSAN recently initiated SCS status meetings with municipalities that have expressed interest in I/I reduction as a potential approach to achieving wet weather compliance. These meetings covered technical, institutional and implementation aspects of I/I reduction. The major goals of these meetings were to:

- Discuss past I/I reduction projects;
- Discuss I/I reduction alternatives evaluated in the municipal feasibility studies;
- Discuss unique needs of the municipality and their future vision for addressing I/I reduction opportunities;
- Share findings to date of the ALCOSAN regional source control opportunities assessment;
- Discuss funding sources and grant opportunities;
- Discuss the potential implications of the new regional emphasis on flow reduction efforts per the direction given by EPA at a meeting in June, 2014; and
- Generate ideas and encourage implementation of I/I reduction projects.



Municipal officials that participated in meetings included council members, managers, and engineering staff. The meetings held to date are included Appendix G-2. ALCOSAN continues to conduct meetings and discussions with municipal officials who have interest in pursuing I/I reduction.

### 4.5.2 Identification of Potential I/I Reduction Opportunities

Each meeting with municipalities resulted in the discussion of future I/I reduction opportunities and ideas on how to partner with ALCOSAN to implement the projects. The discussions covered opportunities to rehabilitate portions of the municipal collection systems, as well as the opportunities and challenges of addressing I/I on private property. The discussion also covered preliminary observations from the opportunities assessment presented in Section 3.

As these meetings continue, ALCOSAN will develop a database of ideas for potential I/I reduction projects where there is municipal interest. As with the GSI opportunities, this database of potential projects will be a living document, with additions made as projects with municipal interest are identified by or provided to ALCOSAN.

## 4.6 ALCOSAN Partnership Opportunities

Given the rapidly growing number of diverse public and private organizations that are embracing GSI and other source reduction, ALCOSAN has developed a broad range of current and potential future partners in source reduction as a means to organize its efforts.

### Municipal Partnerships

Since 1998, ALCOSAN has partnered with its customer municipalities, authorities and other public agencies on green source reduction projects. These include eight direct stream inflow removal projects, three stream daylighting and restoration projects and recent GSI projects in West View Borough and Schenley Park. As detailed in this section, ALCOSAN has been working with its customer municipalities to identify municipal GSI and I/I reduction projects. As of September 30, 2014 ALCOSAN has held:

- Forty meetings with elected officials, municipal officials, public authorities and other public agencies
- Seven meetings with private developers;
- Thirty-one meetings with other stakeholders; and
- More than fifty visits to potential GSI sites that were suggested by municipalities.

### Private and Non-Profit Partners

#### Categories of Private and Non-Profit Partners

Most of the land on which rain and snow fall in the ALCOSAN service area is private property and offer opportunities for managing stormwater on private property with GSI technologies. Additionally, there are several non-profit organizations within the ALCOSAN service area that have an interest in implementing GSI as part of a vision for greener, sustainable and enhanced communities. As part of the SCS, ALCOSAN has continually reached out to diverse private and non-profit organizations towards identifying and implementing GSI opportunities to suit the needs of these stakeholders.

An initial step in working with private and non-profit partners is identifying which groups are out there and their potential interests and roles. ALCOSAN has identified and worked with three broad categories of private and non-profit groups.

**Environmental Organizations** – Groups whose primary focus is on the stewardship within the natural and built areas of ALCOSAN's service area. Examples include:

- Watershed Associations (e.g. Nine Mile Run Watershed Association)
- Nature Conservancies (e.g. Pittsburgh Parks Conservancy)
- Ecological Sustainability/Green Advocacy Groups (e.g. Sustainable Pittsburgh, Tree Pittsburgh)

**Regional Improvement Organizations** – Groups whose primary focus is on community economic development and/or the funding of community enhancing projects. Examples include:

- Local Foundations (e.g. Richard King Mellon Foundation, COLCOM Foundation)
- Economic Development Organizations:
  - Regional Development (e.g. Allegheny Conference, Regional Industrial Development Corporation)
  - Community Development (e.g. Economic Development South, Urban Redevelopment Authority)
  - Business District Associations (e.g. South Side Chamber of Commerce)
  - Community Organizations/Neighborhood Associations (e.g. East Liberty Development Corporation, Brighton Heights Citizen Federation)

**Private Property Owners & Developers** – Long term, the greatest potential for green stormwater management will come through the group that owns most of the land. Long term, most if not all of the developed land within the ALCOSAN service area will be redeveloped – buildings will be replaced or refurbished, parking areas will be repurposed, plumbing and private sewers will be replaced. To maximize the benefits of GSI, ALCOSAN, the municipalities, and Allegheny County will need to partner with the private property owners, private developers, and non-profit property owners and groups to integrate GSI into the changes in property usage. Examples of groups whose primary focus is on land utilization and development and/or who have significant parcels within the service area include:

- Significant Regional Private Landowners (e.g. UPMC, Giant Eagle)
- Industrial (e.g. Colteryahn Dairy, Calgon Carbon)
- Real Estate Developers (e.g. Walnut Capital, Trek Development)
- Universities (e.g. CCAC, University of Pittsburgh)
- Faith-Based Organizations (e.g. PA Interfaith Impact Network)

ALCOSAN realizes that this taxonomy is imprecise and overlapping and is intended solely to help organize partnering efforts.

It is anticipated that environmental organizations and regional improvement organizations will initially be the primary focus in aiding municipalities with implementing GSI. Interactions with these partners will also aid ALCOSAN in understanding and navigating regional institutional issues and make recommendations for future GSI implementation policies for the region.

Private property owners and developers represent significant land ownership within the service area and could significantly aid or supplement municipal GSI efforts. Additionally, commercial and industrial properties have some of the highest concentrations of impervious surface area outside of public right-of-ways. Their owners can offer perspectives on how potential ordinance changes to promote GSI would affect existing and future private developments efforts.

## Levels of Partnerships

In addition to identifying broad categories of potential private and non-profit groups to work with, ALCOSAN has identified broad levels of involvement that the different types of groups could have in identifying and implementing GSI projects.

**Programmatic Partners** - Programmatic partners can provide regional-level support and influence for the ALCOSAN source control study and any subsequent implementation programs and facilitate getting the county, the municipalities, community groups, and private property owners to work together towards broad programmatic and policy consensus on issues such as municipal code revisions and stormwater management. Examples would include the Allegheny Conference on Economic Development and the Allegheny League of Municipalities. The programmatic partners can also assist in strategic program development and implementation, working with ALCOSAN towards a series of projects which might be developed by local groups (e.g. Western Pennsylvania Conservancy)

**Project Partners** - Project partners are individual property owners or groups that would own and implement GSI or other flow reduction projects on their property or would construct and/or maintain the projects under agreement with the property owners.

**Advisory Partners** - Advisory partners would be consulted in specific instances to aid in GSI planning and implementation to tap their expertise and resources. Examples include the Southwestern Pennsylvania Planning Commission and the Bidwell Training Center. These groups might or might not be directly involved in project implementation.

## Partner Roles in GSI Implementation

The roles that a given partner can play will vary in level of commitment and scope, and in some instances a partner could provide multiple roles within a partnership. Project funding will be a key role that some partners could play. For example, foundations, private property owners and non-profit organizations could provide matching or challenge grant funding to organizations implementing GSI projects.



GSI partners can also play critical roles in public information and institutional capacity development. For example, job training organizations could develop the workforce necessary for GSI project long term operation and maintenance.

Volunteer efforts by community, faith-based, neighborhood, and environmental groups will continue to be vital in the implementation and long-term maintenance of GSI projects. For example, the volunteer efforts coordinated by the Pittsburgh Parks Conservancy have been invaluable in the restoration and maintenance of the natural areas within the City's park system.



# 5.0 A GREENER WET WEATHER STRATEGY

## Section Summary

There are abundant opportunities for green stormwater infrastructure (GSI) and inflow and infiltration (I/I) reduction within the ALCOSAN service area. ALCOSAN, 3 Rivers Wet Weather (3RWW), the City of Pittsburgh (including Pittsburgh Water and Sewer Authority - PWSA), smaller municipalities, and numerous neighborhood groups have identified thousands of potential locations and applications for green stormwater management and I/I reduction. While some of the project opportunities may not prove to be feasible, other opportunities will certainly emerge.

**ALCOSAN'S GREENER STRATEGY**

- **ALCOSAN has identified locations where GSI and I/I reduction could replace ALCOSAN and municipal grey facilities and save nearly $100 million regionally.**
- **Combining green and grey solutions can lead to greater environmental and community benefits.**
- **ALCOSAN will leverage its leadership role and resources to foster the implementation of GSI and I/I reduction projects.**

The analyses documented in Sections 3 and 4 of this study show that a greener alternative to the Wet Weather Plan (WWP) can add water quality and community benefits without additional cost to ALCOSAN's rate payers. To demonstrate, this section presents a conceptual Greener Alternative that saves $37 million in ALCOSAN and municipal costs using GSI and $61 million in ALCOSAN and municipal costs using I/I removal in place of corresponding grey infrastructure leading to a combined regional cost savings of $98 million. In addition, the conceptual Greener Alternative provides a higher level of overflow reduction (by approximately 220 MG) compared to the Selected Plan option identified in ALCOSAN's 2013 WWP.

While the additional community benefits of GSI described in Section 2 are real, this analysis does not attempt to monetize benefits beyond overflow reduction since their financial value is dependent on individual and community-specific preferences and perceptions. ALCOSAN suggests that municipalities and other GSI implementers incorporate these additional benefits into their own assessment and decision-making processes. ALCOSAN will leverage its regional leadership role and resources to foster the translation of GSI and I/I projects from concepts to reality through a comprehensive flow reduction program, its GROW Program, as outlined in Section 7 of this document.

## 5.1 Abundant Opportunities

ALCOSAN, 3RWW, the City of Pittsburgh (including PWSA), smaller municipalities, and numerous neighborhood groups have identified thousands of potential locations and applications for green stormwater management, sewer separation, and I/I reduction:

- Working with ALCOSAN, 3RWW identified more than 14,000 potential GSI application locations whose feasibility could be explored further.
- In meetings with ALCOSAN, forty municipalities have identified 200 potential GSI projects of municipal interest.
- ALCOSAN has identified locations throughout the service area where the use of GSI and I/I reduction could replace grey facilities and save nearly $100 million in regional costs.
- The PWSA is implementing a five-year, $9.6 million Adaptive Management Implementation Plan as part of its wet weather strategy.
- Municipalities such as Etna, Millvale, Bellevue, and West View Boroughs have implemented innovative and community enhancing GSI projects.
- Flow removal via sewer separation is being proposed by PWSA ($8.9M), Wilkins Township ($1.6M) and Pitcairn, while the Pennsylvania Department of Transportation (PennDOT) is also funding sewer separation for three sewersheds in cooperation PWSA, ALCOSAN and the City of Pittsburgh.
- Other municipalities such as Braddock and McKees Rocks Boroughs are actively pursuing GSI projects as a part of their economic revitalization efforts.
- Neighborhood, economic development and environmental groups are actively envisioning and incorporating GSI into their efforts, e.g. the Project 15206 stormwater management initiative.
- Private and private / public partnership redevelopment projects such as the ALMONO Hazelwood Flats are integrating GSI into their designs.

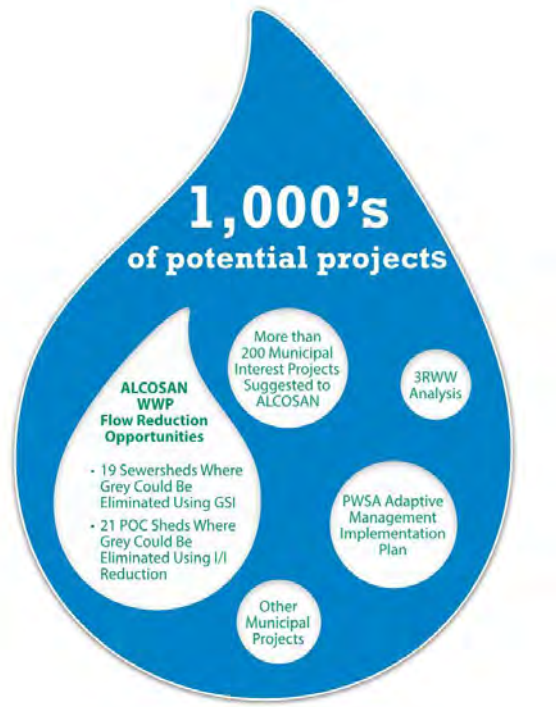



***Figure 5-1: The ALCOSAN Service Area Provides Abundant Opportunities for GSI and I/I Projects.***

The areas in which the identified project opportunities are located are shown on Figure 5-2, including source control projects that are already planned or underway. The opportunities and planned projects are also included in Table 5-1, with the exception of the 14,000 locations identified by 3RWW. While some of the project opportunities may not prove to be feasible, other opportunities will emerge. The translation of all GSI and I/I reduction projects from concept to reality will occur within the respective legal and institutional contexts of their locations and proponents.

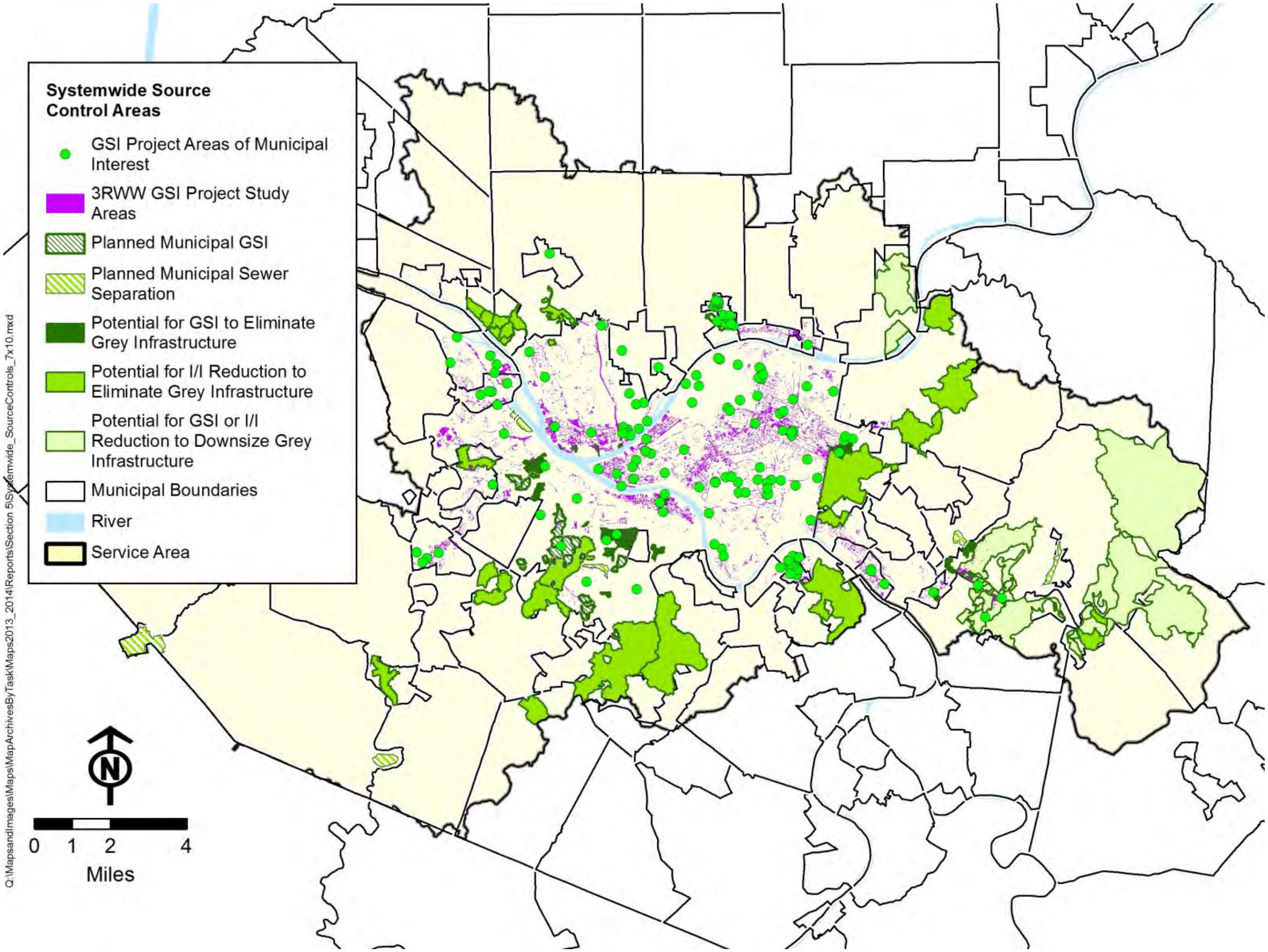



*Figure 5-2: Areas of Identified Project Opportunities*

***Table 5-1: Areas of Identified Project Opportunities***

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 1 | A | Braddock | Community Plaza at former UPMC hospital site |
| 2 | A | Braddock | Braddock Ave at the intersections of $4^{th}$, $5^{th}$ and $6^{th}$ Streets |
| 3 | A | Braddock | Future Redevelopment at Braddock Ave and Quarry St (site of former bakery) |
| 4 | A | Braddock | Vacant Lots |
| 5 | A | PWSA - Hazelwood | 4800 Block of 2nd Ave |
| 6 | A | PWSA - Hazelwood | Hazelwood Carnegie Library Second Avenue and Tecumseh |
| 7 | A | PWSA - Hazelwood | ALMONO Development |
| 8 | A | PWSA - Squirrel Hill | Business District - along Forbes Avenue business district (between Murray Ave and Shady Ave) |
| 9 | A | PWSA - Squirrel Hill | Near O'Connor's Corner (Murray Ave and Phillips Ave) |
| 10 | A | PWSA - Squirrel Hill | Squirrel Hill Post Office |
| 11 | A | PWSA - Southside | S. $21^{st}$ Street from Southside Park to the riverfront trail |
| 12 | A | PWSA - Saw Mill Run Watershed | Projects TBD |
| 13 | A | Project 15206 - Morningside | Heth's Run, Chislett St & Vetter St |
| 14 | A | PWSA - Beechview | Broadway Ave Streetscape |
| 15 | A | PWSA - Carrick | Brownsville Road Streetscape |
| 16 | A | PWSA - Strip District | Smallman Street - Road reconfiguration and resurfacing between $16^{th}$ and $21^{st}$ streets |
| 17 | A | PWSA - Chateau | Beaver Ave - Road reconfiguration |
| 18 | A | PWSA - Lawrenceville | $43^{rd}$ Street Overlook |
| 19 | A | PWSA - Highland Park | Heth’s Run - Pittsburgh Zoo Parking Lot |
| 20 | A | PWSA - Hill District | Hill District Master Plan |
| 21 | A | Bakery Square Redevelopment | Bakery Square 2.0 |
| 22 | A | PWSA - McDonough's Run | McDonough’s Run GSI Evaluation |
| 23 | A | PWSA - Nine Mile Run | Nine Mile Run GSI Evaluation |
| 24 | A | PWSA - McNeilly Run | McNeilly Road Concept Projects |
| 25 | A | PWSA - Point Breeze | Frick Park Area Concept Projects |
| 26 | A | PWSA - Swisshelm Park | Swisshelm Park Concept Projects |
| 27 | A | PWSA - Brookline | Brookline Area Concept Projects |
| 28 | A | PWSA - Southside | Birmingham Bridge Grassy Areas (Southside End) |
| 29 | A | PWSA - Point Breeze | Forbes Ave between Beechwood Blvd and Braddock Ave |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 30 | A | PWSA - Regent Square | Frick Park playground area at intersection of Forbes Ave and Braddock Ave |
| 31 | A | PWSA - Hill District | Lower Hill District, Cliffside Park |
| 32 | A | PWSA - Allegheny West | W North Ave near Allegheny Commons Park |
| 33 | A | PWSA - South Oakland | Bates Street Corridor in conjunction with removal of invasive species |
| 34 | A | PWSA - Lawrenceville | (A-29/A-29Z) Site 037+222 - Lawrenceville Shop n' Save |
| 35 | A | PWSA - Lawrenceville | (A-29/29Z) Site 0870 - Inlet at 48$^{th}$ and Harrison Street |
| 36 | A | PWSA - Lawrenceville | (A-29/29Z) Site 208+838 – In front of Allegheny Cemetery along Butler St between 46$^{th}$ and 47$^{th}$ St |
| 37 | A | PWSA - Lawrenceville | (A-29/29Z) Site 328+735+800 – Stanton Avenue between McCabe Street and McCandless Ave |
| 38 | A | PWSA - Lawrenceville | (A-34) Site 0033 – Butler Street between 55$^{th}$ and 56$^{th}$ Street, river side ROW. |
| 39 | A | McKees Rocks | Chartiers Ave Renovations |
| 40 | A | McKees Rocks | Third Street Park |
| 41 | A | McKees Rocks | Etna and Sefler Street area |
| 42 | A | McKees Rocks | Miller Street |
| 43 | A | McKees Rocks | Furnace St parking lot |
| 44 | A | McKees Rocks | P&LE Complex "McKees Rocks Flats" |
| 45 | A | PWSA - Hill District | Energy Innovation Center |
| 46 | A | PWSA - Hill District | Duquesne University |
| 47 | A | PWSA - Hill District | Former Civic Arena Site, within ROW of new roads. |
| 48 | A | PWSA - Hill District | Hill House |
| 49 | A | PWSA - Crafton Heights | Clearview Ave |
| 50 | A | PWSA | Green Alleyways throughout District 2 |
| 51 | A | Parkway Center Mall Redevelopment | Projects TBD |
| 52 | A | Wilmerding | Patton Street |
| 53 | A | Wilmerding | Airbrake Ave Walking Trails |
| 54 | A | Wilmerding | Ice Plant Hill Road, Westinghouse Ave and YMCA Parking Lot |
| 55 | A | Aspinwall | Business District |
| 56 | A | PWSA - Garfield | Hillcrest Street |
| 57 | A | Homestead | Renovation of Hazel Way between McClure and West Street to incorporate stormwater collection pipe and redirect stormwater flow into a bioretention pond between railroad tracks in vicinity of E 6$^{th}$ Ave and McClure Street. |
| 58 | A | Homestead | Municipal Parking Lot at West Street and 9$^{th}$ Ave |
| 59 | A | Homestead | Bumpouts along Ann Street |
| 60 | A | Homestead | Bumpouts along West Street |
| 61 | A | Homestead | Parking lot next to Citizen's Bank at 8$^{th}$ Ave and McClure St |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 62 | A | Homestead | Triangular grass island property between Sarah and West Street, near 15th Ave |
| 63 | A | Homestead | Property at Glenn and 13th Street |
| 64 | A | Homestead | Small parking area at Hazel Way and McClure Street |
| 65 | A | Homestead | Tree wells with curb cutouts along Amity Street |
| 66 | A | Homestead | 11th Avenue side of Frick Park between Ann St and Amity Street |
| 67 | A | Homestead | Playground at Sarah and 12th Street |
| 68 | A | Homestead | Parklet at site of Harry's Suit Shop along 8th Ave (210 E 8th Ave) |
| 69 | A | Homestead | Allegheny County Department of Human Services Homestead Complex |
| 70 | A | Homestead | Townhouse development along Amity Street |
| 71 | A | West Homestead | Redevelopment of former Keystone Plumbing site for rehabilitation center |
| 72 | A | Homestead | Voodoo Brewing redevelopment of former municipal building at Amity and 9th Avenue |
| 73 | A | Homestead | Stormwater ponding issues: Runoff from West St collects on 8th Ave; Runoff from Ann and McClure St collects on 6th Ave |
| 74 | A | Carnegie | Carnegie Library and Music Hall |
| 75 | A | Carnegie | Municipal Parking lot 10 |
| 76 | A | PWSA - Oakland | Schenley Park - Panther Hollow Watershed Restoration |
| 77 | A | PWSA - Hill District | Hill District Master Plan |
| 78 | A | East Pittsburgh | Bioretention with community park near the vicinity of Grandview Ave and Christina Alley |
| 79 | A | PWSA - Downtown | Grass Triangle areas along Commonwealth Place and Liberty Avenue near the off-ramp from the Fort Pitt Bridge. |
| 80 | A | Millvale | Girty's Run GSI Evaluation |
| 81 | A | Millvale | Investigate CSO Impacts |
| 82 | A | West View | Girty's Run GSI Evaluation |
| 83 | A | PWSA - McKinley Park | McKinley Park - Perimeter roads Delmont Ave, Michigan Street, and Eldora Place. |
| 84 | A | PWSA - Hill District | Lower Hill District, Cliffside Park - Driveway |
| 85 | A | PWSA - Squirrel Hill | Schenley Park – Beacon Street |
| 86 | A | PWSA - Squirrel Hill | Schenley Park – Bob O'Connor Golf Course |
| 87 | A | PWSA - Squirrel Hill | Schenley Park – Westinghouse Memorial |
| 88 | A | PWSA - Squirrel Hill | Frick Park – Environmental Center at Frick Park |
| 89 | A | PWSA - Squirrel Hill | Schenley Park – Schenley Drive |
| 90 | A | PWSA - Highland Park | Highland Park – Heth's Run Stream Daylighting |
| 91 | A | PWSA - Hill District | MLK Field off of Kirkpatrick Street (Warren K Branch Park) |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 92 | A | PWSA - Lawrenceville | Arsenal Park |
| 93 | A | PWSA - Oakland | Schenley Park – Panther Hollow Lake Restoration |
| 94 | A | PWSA - Oakland | Schenley Park – Daylighting Panther Hollow Lake Outfall |
| 95 | A | Stowe | Preston Park Area (Ohio Street and Center Street in Stowe Twp.) |
| 96 | A | Stowe | Parking lot and triangular traffic island at the intersection of Nicol Ave and Graham St |
| 97 | A | Stowe | Corner of Main St and Hillcrest |
| 98 | A | Stowe | Corner of Fleming and Davis Ave |
| 99 | A, B | Etna | Butler St & Bridge St - 060 |
| 100 | A, B | Etna | Butler St & Bridge St - 374 |
| 101 | A, B | Etna | Butler St & Bridge St - 234 |
| 102 | A, B | Etna | Butler St & Bridge St - 047 |
| 103 | A, B | Etna | Butler St & Freeport St - 196 |
| 104 | A, B | Etna | Bridge St - 057 |
| 105 | A, B | Shaler/Etna | James St - 209 |
| 106 | A, B | Etna | Walnut St & High St - 225 |
| 107 | A, B | Etna | Union Alley, Bridge & Freeport - 056 |
| 108 | A, B | Etna | Union Alley, Bridge & Freeport - 056a |
| 109 | A, B | Etna | Butler St - 067 |
| 110 | A, B | Etna | Butler St - 372 |
| 111 | A, B | Etna | Maplewood & Pine St - 243 |
| 112 | A, B | Etna | Maplewood & Pine St - 238 |
| 113 | A, B | Etna | Dewey St - 163 |
| 114 | A, B | Etna | Dewey St - 164 |
| 115 | A, B | Etna | Dewey St - 168 |
| 116 | A, B | Etna | Vilsack St - 173 |
| 117 | A, B | Etna | Church St & Wilson St - 011 |
| 118 | A, B | Etna | Weible St & Angle Alley - 014 |
| 119 | A, B | Etna | Highland St & Angle Alley - 014a |
| 120 | A, B | Etna | East side of Grant Ave - 099 |
| 121 | A, B | Etna | West side of Grant Ave - 172 |
| 122 | A | PWSA - Spring Garden | Spring Garden Ave - 1 |
| 123 | A | PWSA - Spring Garden | Romanhoff St & South Side Ave - 2 |
| 124 | A | PWSA - Spring Garden | Spring Garden Ave - 3 |
| 125 | A | PWSA - Spring Garden | Damas St - 4 |
| 126 | A | PWSA - Spring Garden | Phineas St, Perata St, Troy Hill Rd - 5 |
| 127 | A | PWSA - Spring Garden | Tripoli St, Suismon St, Turtle Way - 6 |
| 128 | A | PWSA - Spring Garden | Heinz St - 7 |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 129 | A | PWSA - Spring Garden | River Ave - 8 |
| 130 | A | PWSA - Spring Garden | River Ave - 9 |
| 131 | A | McKees Rocks | Sproul Street |
| 132 | A | Carnegie | Borough Building Entryway and Parking Lot |
| 133 | A | Carnegie | Seventh Avenue Park |
| 134 | A | PWSA - Brighton Heights | McClure Ave at Woods Run |
| 135 | A | PWSA - Brighton Heights | Marmaduke Parklet and surrounding area to Jack's Run |
| 136 | A | PWSA - Garfield/Bloomfield | Penn Avenue between Mathilda St and Evaline St (Phase 1) |
| 137 | A | PWSA - West End | Main at Alexander, PPA lot |
| 138 | A | PWSA - Lincoln-Lemington and Larimer | Entire length of Lincoln Avenue |
| 139 | A | PWSA - Larimer | Larimer Ave on either side of E Liberty Boulevard |
| 140 | A | PWSA - Bloomfield | S. Winebiddle St. - Waldorf School of Pittsburgh |
| 141 | A | PWSA - Mt. Washington | Chatham Village |
| 142 | A | PWSA - Summer Hill | Zane Ave (north tip of Summer Hill) |
| 143 | A | PWSA - North Shore | River Ave from Heinz Lofts to Washington's Landing |
| 144 | A | PWSA - Squirrel Hill | Douglas/Phillips parking lot |
| 145 | A | PWSA - Larimer | Living Waters of Larimer will partner with current development or existing projects |
| 146 | A | PWSA - Larimer | Larimer Community Garden at the Village Green, Larimer Ave/Mayflower St |
| 147 | A | PWSA - Homewood | Rosedale area near Susquehanna - above culvert of NMR |
| 148 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall A-56-OF |
| 149 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall S-34-OF |
| 150 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall M-17-OF |
| 151 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall A-47-OF or sewer separation |
| 152 | D | Turtle Creek Borough | Control up to 50% of combined area upstream of outfall T-11-OF |
| 153 | D | Turtle Creek Borough | Control up to 50% of combined area upstream of outfall TR-01-OF |
| 154 | D | Turtle Creek Borough | Control up to 50% of combined area upstream of outfall T-13-OF |
| 155 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall CSO_032N001 |
| 156 | D | Pittsburgh/ Wilkinsburg | Control up to 50% of combined area upstream of outfall 1071-OF |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 157 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall M-18-OF |
| 158 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall M-20-OF |
| 159 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall S-46-OF |
| 160 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall S-29-OF |
| 161 | D | East Pittsburgh | Control up to 50% of combined area upstream of outfall T-03-OF |
| 162 | D | Turtle Creek Borough | Control up to 50% of combined area upstream of outfall TR-02-OF |
| 163 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall O-43-OF or sewer separation |
| 164 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall S-28-OF |
| 165 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall O-40-OF |
| 166 | D | Pittsburgh | Control up to 50% of combined area upstream of outfall S-42-OF |
| 167 | A | PWSA - McKinley Park | McKinley Park - Perimeter roads Zelda Way, Bernd St |
| 168 | A | Project 15206 - Highland Park | Hampton to Heths Park - 15206 |
| 169 | A | Project 15206 - Highland Park | Bryant King to Lower Heths Park |
| 170 | A | Project 15206 - East Liberty | Penn Circle West |
| 171 | A | Project 15206 - Highland Park | Negley Run North |
| 172 | A | Project 15206 - Lincoln Lemington | Highland Dr & Lemington Ave |
| 173 | A | Project 15206 - Larimer | PAT_01 Parking |
| 174 | A | Project 15206 - Larimer | PAT_02 Parking |
| 175 | A | Project 15206 - Larimer | Washington Blvd Chatham Entry Bus Shelter |
| 176 | A | Project 15206 - Larimer | Rainbow St Chatham Parking & PAT property |
| 177 | A | Western PA Conservancy - Southside | Josephine & Greeley |
| 178 | A | Western PA Conservancy - Terrace Village | Centre & Herron |
| 179 | A | Western PA Conservancy - Greenfield | Greenfield & Irvine |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 180 | A | 3RWW – Swisshelm Park | Project located within the 1300 block of Windermere Dr. in Swisshelm - Permeable Parking |
| 181 | A | 3RWW – Swisshelm Park | Project located within the 1300 block of Windermere Dr. in Swisshelm - Bioretention |
| 182 | A | 3RWW – Swisshelm Park | Project located within the 1200 block of Windermere Dr. in Swisshelm - Bioretention #1 |
| 183 | A | 3RWW – Swisshelm Park | Project located within the 1200 block of Windermere Dr. in Swisshelm - Bioretention #2 |
| 184 | A | 3RWW – Swisshelm Park | Project located within the 1200 block of Windermere Dr. in Swisshelm - Bioretention #3 |
| 185 | A | 3RWW – Swisshelm Park | Project located within the 1100 block of Windermere Dr. in Swisshelm - Permeable Parking |
| 186 | A | 3RWW - Point Breeze | Frick Museum - Private parking lot - Bioretention |
| 187 | A | 3RWW - Point Breeze | Frick Museum - Private parking lot - Permeable Parking |
| 188 | A | 3RWW - Point Breeze | S. Homewood Ave - Bioretention |
| 189 | A | 3RWW - Point Breeze | S. Homewood Ave - Traffic Island Bioretention |
| 190 | A | 3RWW - Point Breeze | Le Roi Road - Bioretention |
| 191 | A | 3RWW - Point Breeze | Le Roi Road - Permeable Parking |
| 192 | A | 3RWW - Point Breeze | Osage Lane - Permeable Alley |
| 193 | A | 3RWW - Point Breeze | Roycrest Place - Permeable Parking |
| 194 | A | 3RWW - Point Breeze | Card Lane - Permeable Parking |
| 195 | A | 3RWW - Point Breeze | Lang Court - Permeable Parking |
| 196 | A | 3RWW - Brookline | Sussex Ave North of Sageman Ave |
| 197 | A | 3RWW - Brookline | Sussex Ave South of Sageman Ave |
| 198 | A | PennDOT - Northside | East Ohio Street between East and Chestnut |
| 199 | A | PennDOT - Downtown | Forbes Ave Between Smithfield St & Grant |
| 200 | A | Nine Mile Run Watershed Association - Crescent Elementary | Bennett Street and Tokay Street in City of Pittsburgh |
| 201 | A | Nine Mile Run Watershed Association - Oakwood & Batavia Streets | Oakwood and Batavia Streets in City of Pittsburgh |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 202 | A | Nine Mile Run Watershed Association - Frankstown & Wheeler Streets | Frankstown & Wheeler Streets in City of Pittsburgh |
| 203 | A | PWSA - East Liberty | Samoan Way |
| 204 | A | PWSA - Squirrel Hill | Forbes Avenue & Wightman Street |
| 205 | A | PWSA - Squirrel Hill | Beacon Street & Murray Avenue |
| 206 | A | PWSA - Squirrel Hill | Wightman School Community Building |
| 207 | A | PWSA - Downtown | East of Municipal Courts Drive and the First Ave Parking Garage |
| 208 | B | PWSA | $9.6M in GSI in City of Pittsburgh combined portions of Saw Mill Run with proposed projects. (Specific locations unknown, but Figure 5-2 assumes the areas could fall within sheds MH-11, MH-18, MH-77, MH-80, MH-89, S-15, S-23 and SMRE-40. |
| 209 | C | PWSA | Sewer separation of all combined area in MH-55 |
| 210 | C | PWSA | Sewer separation of selected combined areas in A-58 |
| 211 | C | PWSA | Sewer separation of selected combined areas in SMRE-40 |
| 212 | C | Pitcairn | Sewer separation of selected combined sewer area in T-26 |
| 213 | C | Wilkins Township | Sewer separation of all combined sewer area in TR-02-04 |
| 214 | C | Wilkins Township | Sewer separation of all combined sewer area in TR-03 |
| 215 | C | South Fayette / MATSF | Sewer separation of all combined sewer area in C-54-16 |
| 216 | C | McDonald Borough | Sewer separation of all combined area in C-45B-04 |
| 217 | C | PWSA / PennDOT / ALCOSAN | Sewer separation of all combined area in O-09 |
| 218 | C | PWSA / PennDOT / ALCOSAN | Sewer separation of all combined area in O-10 |
| 219 | C | PWSA / PennDOT / ALCOSAN | Sewer separation of all combined area in O-11 |
| 220 | E | Penn Hills | I/I reduction in separate sanitary portions of A-42A shed with high rainfall dependent inflow and infiltration (RDII). |
| 221 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of A-45 shed with high RDII |
| 222 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of C-19 shed with high RDII |
| 223 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of C-48 shed with high RDII |
| 224 | E | Bridgeville | I/I reduction in separate sanitary portions of C-54 shed with high RDII |
| 225 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of M-42 shed with high RDII |

| Project ID | Project Category[1] | Municipality / Authority / Stakeholder | Suggested Project Location |
|---|---|---|---|
| 226 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of M-47 shed with high RDII |
| 227 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of M-49 shed with high RDII |
| 228 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of MH-89 shed with high RDII |
| 229 | E | Avalon | I/I reduction in separate sanitary portions of O-19 shed with high RDII |
| 230 | E | Avalon | I/I reduction in separate sanitary portions of O-20 shed with high RDII |
| 231 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of O-21 shed with high RDII |
| 232 | E | Bellevue | I/I reduction in separate sanitary portions of O-22 shed with high RDII |
| 233 | E | Bellevue | I/I reduction in separate sanitary portions of O-23 shed with high RDII |
| 234 | E | Bellevue | I/I reduction in separate sanitary portions of O-24 shed with high RDII |
| 235 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of O-25 shed with high RDII |
| 236 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of S-15 shed with high RDII |
| 237 | E | Bethel Park | I/I reduction in separate sanitary portions of SMR-CS-54 with high RDII |
| 238 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of SMRE-40 shed with high RDII |
| 239 | E | Trafford | I/I reduction in separate sanitary portions of T-29 shed with high RDII |
| 240 | E | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of T-31 shed with high RDII |
| 241 | F | TBD – Multiple municipalities | I/I reduction in separate sanitary portions of A-82 shed with high RDII |
| 242 | F | O'Hara | I/I reduction in separate sanitary portions of A-85 shed with high RDII |
| 243 | F | TBD – Multiple municipalities | GSI and I/I reduction in selected areas tributary to Selected Plan storage tank near T-10. |
| 244 | F | TBD – Multiple municipalities | I/I reduction in separate sanitary areas with high RDII and tributary to Selected Plan storage tank near T-27. |

[1]Project categories per Figure 5-2:
A – GSI Project Areas of Municipal Interest
B – Planned Municipal GSI
C – Planned Municipal Sewer Separation
D – Potential for GSI to Eliminate Grey Infrastructure
E – Potential for I/I Reduction to Eliminate Grey Infrastructure
F – Potential for GSI or I/I Reduction to Downsize Grey Infrastructure

## 5.2 A Greener Alternative

One of the objectives of this Source Controls Study (SCS) was to evaluate the feasibility and cost-effectiveness of incorporating more GSI into the WWP. Previous sections of this report evaluated this objective from technical, institutional, financial and municipal coordination perspectives, and led to the identification of numerous opportunities to control sewer overflows with GSI and other source controls, while also providing additional community benefits. Drawing on the opportunities identified, this section presents a Greener Alternative to the Selected Plan which can add water quality and community benefits without additional cost to ALCOSAN's rate payers compared to the Selected Plan. To accomplish this, the most cost-efficient opportunities identified in Sections 3 and 4 were paired with planned municipal GSI projects and modified Selected Plan facilities, which were downsized or eliminated in favor of GSI and other source control practices, where applicable.

While the additional community benefits of GSI described in Section 2 are real, this analysis does not attempt to monetize benefits beyond overflow reduction since their financial value is dependent on individual and community-specific preferences and perceptions. Municipalities and other GSI implementers will incorporate these additional benefits into their own assessment and decision-making processes. To support this suggestion, this source control study includes GSI opportunities that may cost more than equivalently performing grey infrastructure alternatives for the purpose of providing municipal officials and other decision makers with a wide range of GSI project possibilities that can accommodate a range of additional community benefits.

Table 5-2 summarizes the source control projects or programs included in the Greener Alternative, along with a summary of the assessment approach. In Figure 5-3, the locations of the source control projects are shown, with the exception of those generated through stormwater management and sewer lateral repair ordinances. Using planning-level assumptions, by 2046, these ordinances may affect approximately 1,100 acres of impervious cover in the combined sewered areas. In the separate sewered areas, lateral inspection and repair ordinances may ultimately affect over 70% of properties representing more than 13,000 acres of impervious cover. Those projects are assumed to occur through development and re-development and property transfers equally distributed throughout the combined and sanitary sewered areas, respectively, at the rates described in Table 5-2.

*Table 5-2: Summary of Source Controls Included in the Greener Alternative*

| Category | Type of Source Control | Description | Quantity of Source Controls | Assessment Approach[1] |
|---|---|---|---|---|
| **Ordinances** | Stormwater Management | Would require on–site stormwater management for new development and redevelopment, preferably using GSI techniques | 1,100 Acres<br><br>1,100-2,200 potential projects | In combined areas, 10% of impervious areas become controlled by GSI based on an average re-development rate of 0.3% of each per year through 2046 |
| | Lateral Inspection/Repair Ordinance | Would require repairs at time of sale, if needed, to address infiltration and inflow | Potential for 70% of all laterals to be affected by 2046 | In separate areas, RDII volumes are reduced by 7% based on a 2.3% average annual property transfer rate through 2046[2] |
| **Planned Projects** | City of Pittsburgh GSI | Manage runoff from selected areas in the Saw Mill Run basin | Assumed to manage runoff from 33 acres of impervious area | Distributed GSI evenly between selected sewersheds[3] |
| | Etna GSI | Manage runoff from 11 subcatchments in the Upper Allegheny basin | 13 acres of impervious area managed<br>29 projects proposed by Etna | Distributed GSI evenly between selected sewersheds |
| | Bellevue I/I Reduction | I/I reduction projects are proposed for six sewersheds in the Lower Ohio basin | *Included with cost effective I/I total below* | Improvements in these areas are included in the cost effective I/I reduction below |
| | Sewer Separation | Remove stormwater from selected combined sewer areas in several municipalities, in addition to some separation already reflected in Selected Plan model. | 163 acres of separation | Runoff from separated areas is directed to stormwater outfalls. |
| **Cost-Effective Projects** | Cost-Effective GSI | Construct GSI to control an additional 50% of combined impervious area tributary to 19 outfalls | 155 acres of impervious area managed<br><br>150-300 potential projects | Distributed GSI evenly between selected sewersheds. No overlap with Pittsburgh or Etna GSI projects. |
| | Cost-Effective I/I Reduction | Complete rehabilitation of a portion of the municipal sewers in 19 POC sewersheds | 90 miles of pipe rehab<br><br>2,100 manholes rehabbed | In separate areas, RDII volume reduced to reflect lateral inspection/repair ordinance |

[1]All GSI projects were assumed to be designed in accordance with the higher performing assumptions described in Simulation HP as discussed in Section 3. Beyond RDII reductions listed in the table, I/I reduction projects will also provide additional benefit in terms of GWI reductions which is not quantified.
[2]Estimates of I/I reduction due to lateral repairs vary widely, but a typical range in the literature is 10 to 30% by volume (e.g. WERF. 2006. Methods for Cost-Effective Rehabilitation of Private Sewer Laterals). With an assumed rate of 2.3% of laterals inspected per year, 70% of laterals will be inspected by 2046. It is assumed that half of these (35%) will be repaired, and that the I/I reduction from each repair will be 20% of previous inflow volume. This results in an assumed reduction in total I/I volume entering sanitary sewers of 7%.
[3]Per the PWSA Wet Weather Feasibility Study, the proposed GSI is primarily intended for POCs where PWSA has uncontrolled CSOs with a need for improvements, so GSI was assumed to be located in subcatchments of those combined POCs with planned improvements that were located entirely within the City of Pittsburgh (MH-11, MH-18, MH-77, MH-89, S-15, S-23, SMRE-40).

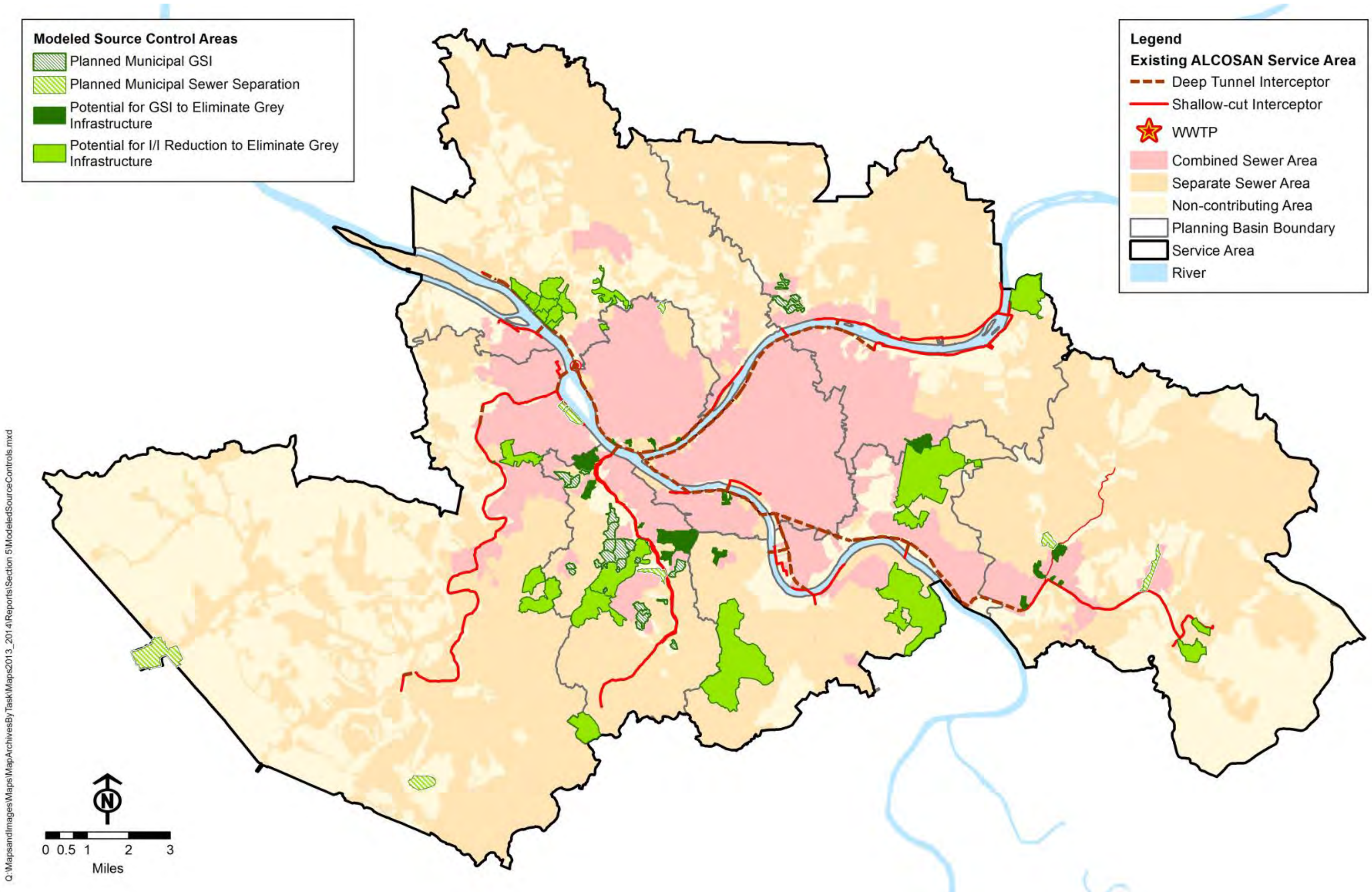



*Figure 5-3: Source Control Areas Included in Greener Alternative*

Figures 5-4 and 5-5 provide additional information about the cost-effective source control projects identified in Figure 5-3. For each of the areas where GSI has the potential to cost-effectively replace grey infrastructure with 50 percent of the impervious area managed by GSI, Figure 5-4 indicates the point of connection (POC) sewershed in which the area is located, the acres of impervious area that will need to be managed by green infrastructure, the estimated number of GSI projects required, and the total estimated cost of those projects. In total, it is estimated that between 150 and 300 GSI projects will be required. For each of the areas where aggressive I/I reduction has the potential to cost-effectively replace grey infrastructure, Figure 5-5 indicates the POC sewersheds in which the area is located, the miles of municipal sewer to be rehabilitated, and the number of municipal manholes to be rehabilitated. In total, it is estimated that 120 miles of sewer rehabilitation will be required, and that 3,100 manholes will need to be rehabilitated.

Table 5-3 summarizes the estimated capital cost savings to ALCOSAN and the municipalities for the source controls included in the Greener Alternative that have been identified to potentially eliminate grey projects. As with all grey infrastructure planning level cost estimates, these cost estimates have an uncertainty range of +50/-30%. The costs estimates also rely on aggressive (optimistic) assumptions about the extent of pipe rehabilitation that will be required to achieve a certain flow reduction. In total, the addition of $105M in GSI and other source control projects could replace $203M in ALCOSAN and municipal grey infrastructure costs, resulting in about $100M in regional cost savings. Based on the downsizing opportunities evaluated, another $20M in regional cost savings may be possible by reducing the size of one storage tank and associated consolidation sewers in the Turtle Creek planning basin. However, this was not included in the Greener Alternative as it would require further investigation and is very dependent on the evolving issues of flow reduction and regionalization.

***Table 5-3: Regional Capital Cost Savings for Source Controls Identified to Potentially Eliminate Grey Projects***

| Type of Source Control | Added Source Controls in Greener Alternative ($ millions)[1] | ALCOSAN/Municipal Grey Projects Eliminated ($ millions)[1] | Regional Capital Cost Savings ($ millions)[1] |
|---|---|---|---|
| **Cost-effective GSI** | $44 | $81 | $37 |
| **Cost-effective I/I Reduction** | $61 | $122 | $61 |
| **TOTAL** | $105 | $203 | $98 |

***[1]All costs are capital costs in $Millions, 2010 Dollars***

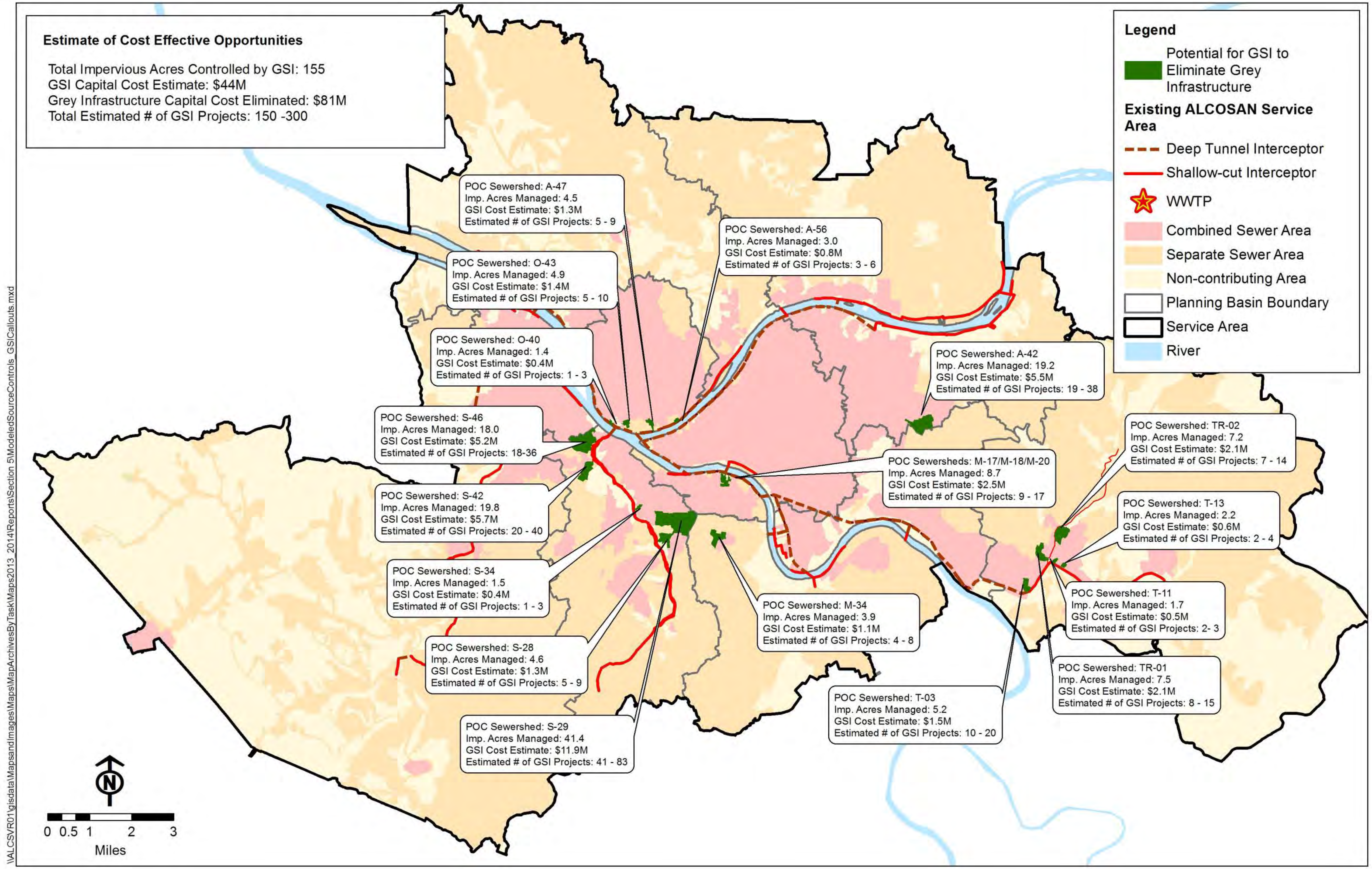



*Figure 5-4: GSI Opportunities Included in Greener Alternative*

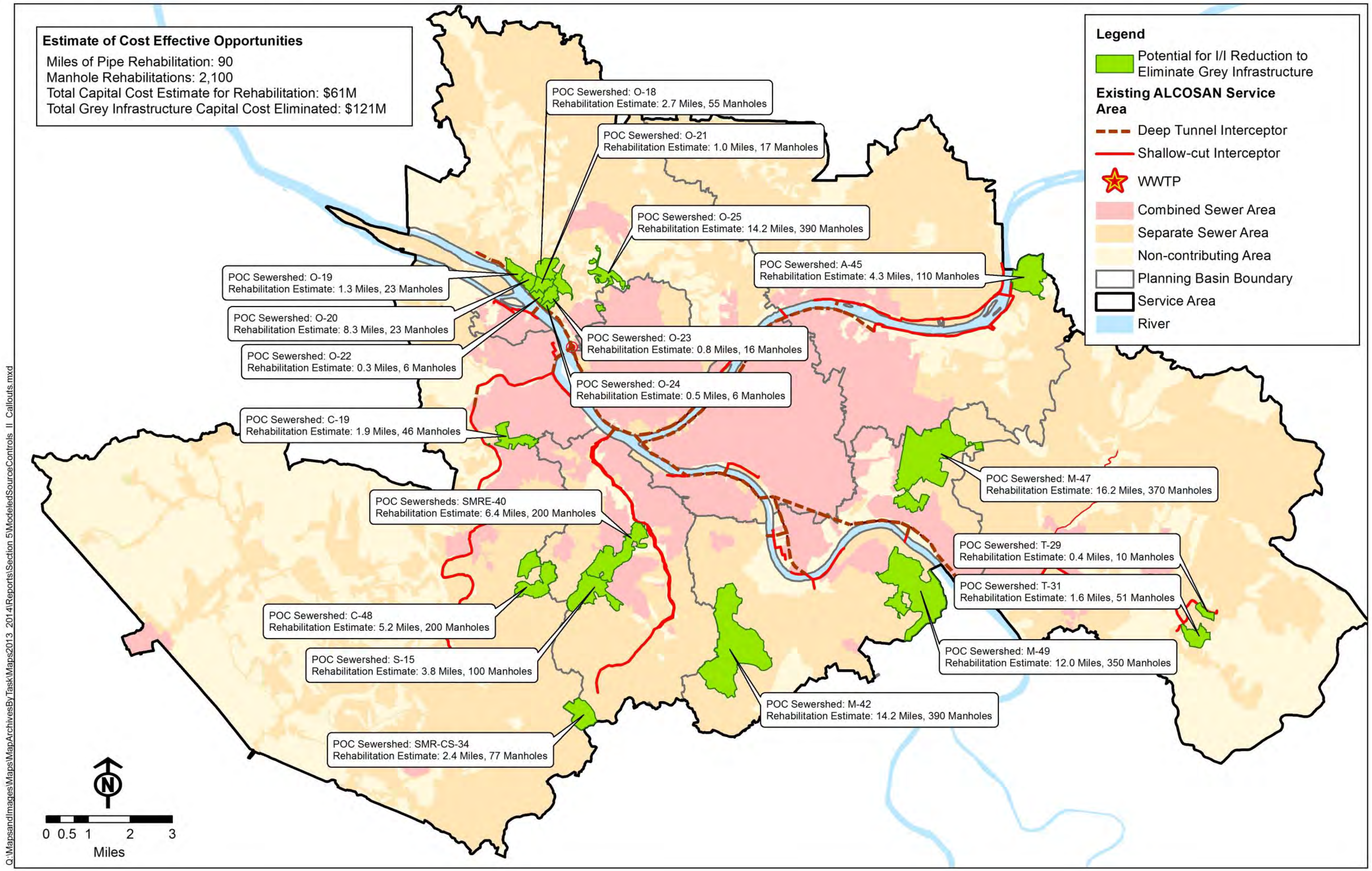



*Figure 5-5: I/I Reduction Opportunities Included in Greener Alternative*

Table 5-4 summarizes performance statistics for the Greener Alternative, which provides a higher level of overflow reduction (by approximately 220 MG) compared to the Selected Plan. The chosen source controls targeted cost-effective controls that provide significant performance gains and cost savings. The performance gains in Table 5-3 are reductions from the already high level of control in the Selected Plan. Surface runoff to combined sewers and I/I to sanitary sewers are both reduced on the order of 10%. These results suggest that the source controls are effective in further reducing wet weather overflows beyond the Selected Plan reductions.

**ALCOSAN'S GREENER STRATEGY**

**ALCOSAN has identified locations throughout the service area where GSI and I/I reduction could replace grey facilities and save nearly $100 million in regional costs.**

The simulation results in Table 5-4 demonstrate that the Greener Alternative achieves better performance than the Selected Plan, while the capital cost estimates in Table 5-3 suggest a regional savings of $37 million using GSI and $61 million using I/I removal in place of corresponding grey infrastructure leading to a combined regional cost savings of nearly $100 million.

*Table 5-4: Estimated Performance of Greener Alternative Compared to the Selected Plan*

| Performance Metric | Annual Improvement Relative to the Selected Plan (MG) |
|---|---|
| **Stormwater Runoff Removed (due to GSI projects and sewer separation)** | 710 |
| **Inflow Reduction (due to I/I controls)** | 770 |
| **Overflow Reduction (ALCOSAN & Municipal)** | 220 |
| **Treated Flow Reduction** | 1,170 |

These results indicate that a Greener Alternative to the Selected Plan has the potential to provide improved overflow reduction performance and the community benefits associated with GSI at a lower cost to ALCOSAN rate payers. This conceptual Greener Alternative demonstrates that if municipalities work together with ALCOSAN to strategically implement GSI and other source controls which can replace or downsize select grey infrastructure improvements, cost savings and/or improved water quality benefits can be realized.

The policies and projects discussed in this section are meant to be illustrative of options available to government and civic leaders at the municipal level and will require additional evaluation in coordination with municipal feasibility studies and flow reduction plans. However, these findings provide confidence that GSI and other source controls can be cost effectively incorporated into a long-term compliance strategy. Towards this end, ALCOSAN will leverage its regional leadership role and resources to foster the translation of GSI and I/I projects from concepts to reality through a its GROW Program, as outlined in Section 7 of this document.



# 6.0 SOURCE REDUCTION INCENTIVES

## Section Summary

This section looks at incentives to encourage municipalities and property owners to reduce wet weather flows. Flow reduction incentives can be in the form of wet weather charges that are intended to encourage wet weather flow reduction and to partially recover wet weather control costs. Wet weather charges can be applied at the "retail" level by municipalities and wastewater authorities to individual properties. Twenty-two of the fifty largest municipalities with combined or mixed sewers already have a wet weather charge. These can be variously named, ranging from "stormwater fee" to "Clean River Surcharge" (Columbus, Ohio). The charges are typically based on a property's ability to generate stormwater and use impervious area as a proxy for runoff potential. Sanitary or mixed sewer system wet weather charges can take the form of a standard additional fee that is intended to help pay for wet weather compliance costs, e.g. Louisville Metropolitan Sewer District's (MSD's) Consent Decree (CD) Charge.

Wastewater charges can also be applied at a wholesale level by a regional wastewater authority to its customer municipalities. For example, the Massachusetts Water Resources Authority includes peak monthly flows in their rate calculations for member municipalities.

It appears that ALCOSAN, its 83 customer municipalities and their affiliated municipal authorities could impose wet weather charges under current state statute but may face restrictions under their articles of incorporation and service agreements.

The majority of municipalities or authorities who have a wet weather charge encourage green stormwater infrastructure (GSI) or

**KEY FINDINGS**

**Wet Weather Charges:**

- **Are becoming widespread nationally**
- **Encourage flow reduction and partially offset compliance costs**
- **ALCOSAN and the customer municipalities appear to have the statutory authority to implement, but could face other restrictions**

**ALCOSAN Funding:**

- **ALCOSAN could fund municipal GSI and I/I reduction projects, or**
- **Could directly implement GSI projects as appropriate.**
- **Funded projects would need to demonstrably support ALCOSAN's core services of wastewater conveyance and treatment.**

**ALCOSAN Technical and Institutional Support:**

- **More than 15 years of ALCOSAN GSI and flow reduction support**
- **ALCOSAN provides technical and outside funding procurement (more than $40 million in Federal and state funding since 1997)**

**ALCOSAN / Municipal / County Cooperative Options:**

- **Flow Reduction Plans**
- **Voluntary transfer of intermunicipal trunk sewers to ALCOSAN**
- **Integration of GSI and I/I reduction into redevelopment and stormwater management.**

other flow reduction by providing fee credits for implementing GSI or other source reduction steps. A number of sanitary sewer municipalities have adopted surcharges on users whose properties can contribute excessive inflow or infiltration as determined through mandatory inspections. East Norriton, PA provides one example.

Positive incentive programs that offer grants, rebates, low cost financing, etc., for GSI or inflow and infiltration (I/I) reduction source control are less common than credit programs. Onondaga County's Green Improvement Fund is an example of a large-scale program. Smaller programs tend to focus on assisting homeowners with lateral replacement such as Brookfield Wisconsin. ALCOSAN funding of GSI or I/I reduction projects would need to demonstrably relate to services that ALCOSAN provides under its articles of incorporation, i.e. the conveyance and treatment of wastewater from the customer municipalities. Therefore, GSI and I/I reduction projects funded by ALCOSAN would need to demonstrably support this mission through cost savings or operational efficiencies. ALCOSAN's ability to directly fund projects on private property appears to be quite limited. ALCOSAN funding assistance for municipal flow reduction projects could come in the form of a source reduction funding agreement or as may better fit some conditions, through direct ALCOSAN project implementation.

Beyond project funding, ALCOSAN could provide technical and institutional support for GSI and I/I reduction projects. ALCOSAN has been helping municipalities with flow reduction for more than 15 years. This help has included project facilitation and technical support. ALCOSAN has provided engineering, technical, and construction services totaling nearly $11 million and, through the diligent support of the Pittsburgh region's Congressional delegation, more than $40 million in federal and state funding for municipal flow reduction projects since 1997 has been realized.

*Table 6-1: Example Wet Weather Charges in Combined Sewer Systems*

| Example Wet Weather Charges in Combined Sewer Systems | | |
|---|---|---|
| City / Regional Authority | | Typical Residential Annual Cost |
| 1 | Sacramento | NA |
| 2 | DC Water | $147 |
| 3 | Des Moines | $110 |
| 4 | Indianapolis | $27 |
| 5 | Fort Wayne | $44 |
| 6 | Louisville MSD | $191 |
| 7 | Detroit | $192 |
| 8 | Minneapolis | $137 |
| 9 | St. Paul | $80 |
| 10 | Kansas City | $24 |
| 11 | Columbus | $195 |
| 12 | Cleveland/NEORSD | $61 |
| 13 | Cincinnati/MSDGC | $42 |
| 14 | Toledo | $46 |
| 15 | Portland | $287 |
| 16 | Philadelphia | $126 |
| 17 | Nashville | $36 |
| 18 | Chattanooga | $115 |
| 19 | Richmond | $45 |
| 20 | Seattle/King County | $151 |
| 21 | Spokane | $45 |
| 22 | Milwaukee/MMSD | $60 |



ALCOSAN has identified opportunities to partner with the municipalities, Allegheny County, and other stakeholders to implement institutional changes that would reduce wet weather flows. ALCOSAN and the municipalities could cooperatively establish flow reduction plans intended to reduce the size and scope of grey wet weather facilities. ALCOSAN is also working with the municipalities towards the voluntary conveyance of inter-municipal trunk sewers to ALCOSAN. The integration of GSI into municipal property development and redevelopment via stormwater management ordinances could provide additional opportunities for flow reduction that would occur organically as properties are developed and/or redeveloped.

## 6.1 Wet Weather Charges

The control of sewer overflows provides a new and enhanced level of public service. Traditional sewer user charges that are based on billed water consumption or the measurement of sewage flows through a meter do not reflect the costs of capturing and treating the large volumes and high peaks of wastewater experienced during wet weather (Figure 6-1).

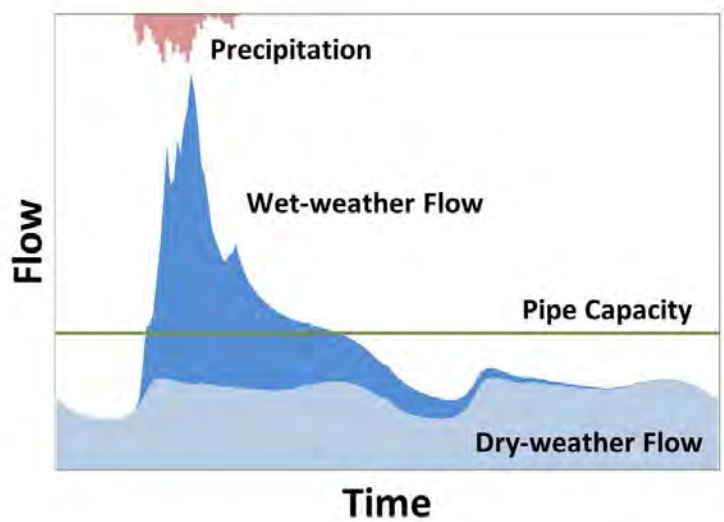



*Figure 6-1: Controlling sewer overflows requires the capture and treatment of large amounts of wastewater which frequently exceeds current system capacities*

Many wastewater authorities and municipalities have implemented some form of wet weather charge. Wet weather user charges are intended to partially recover the costs for wet weather compliance. These charges include both charges to individual rate payers and to customer municipalities at the wholesale level. Wet weather charges can also be imposed to encourage source reduction, thereby reducing the need for future capital expenditures by the regional wastewater agency.

The terminology used by various wastewater utilities on this topic is not standardized. Cities or regional authorities serving combined or mixed collection systems (partially combined and sanitary systems) often use the term “stormwater fee” or something similar. Others use more descriptive terminology, e.g. the Louisville MSD imposes an “EPA Consent Decree Charge” and Columbus, Ohio has a “Clean Rivers Surcharge”.  The term “stormwater utility” is often used in discussions about a wet weather user charge somewhat interchangeably with “stormwater fee”.

For most of ALCOSAN’s customer municipalities, sewer service charges for conveyance and treatment follow the traditional sewer use charges model that is based on billed water consumption and does not include a wet weather charge. ALCOSAN does, however, have a limited number of agreements with newer communities that incentivize management of peak wet weather flows. Communities that connected to the ALCOSAN system after 1987 have modified “Z” agreements with ALCOSAN that



specify allowable quantities of I/I with charges for I/I in excess of those allowable quantities. Many, if not all, of these agreements have been amended to allow municipalities to create internal municipal escrow accounts for excess I/I penalties. This escrow concept replaced direct payments to ALCOSAN for excess I/I in mid-1996 and the funds are now utilized by the respective communities for studies, investigations, and projects related to I/I reduction.

## Retail Wet Weather Charges

Twenty-two of the fifty largest municipal or regional wastewater authorities with combined or mixed collection systems have some form of a wet weather charge beyond the basic service charge. The annual costs per typical residential connection range from $24 (Kansas City) to $287 (Portland) with the average (non-weighted) being $95 per year. The fees are typically based upon impervious area with a standard residential equivalency serving as the basis of charges for non-residential properties. Examples include:

> **DC Water** – the DC Water Authority's Clean Rivers Impervious Area charge is based on an equivalent residential unit (ERU). An ERU is defined as the impervious area in square feet of a statistically median single family residential property.
>
> **Columbus, Ohio** – Columbus Ohio implemented its "Clean Rivers Surcharge" to support its 40-year, $2.5 billion Wet Weather Management Plan. Columbus residential properties are assigned one ERU and are charged around $3.04 per month. An ERU is based on an average residential property having 2,000 square feet of impervious area. A charge of $1.80 per month per residential account is applied to suburban users in sanitary sewer municipalities.
>
> **Louisville Metropolitan Sanitary District (MSD)** – MSD's "EPA Consent Decree Surcharge" provides a source of revenue towards the estimated $800 million cost of compliance with MSD's CD. The current rate for the surcharge is the greater of $8.94 per month or $1.07 per thousand gallons of billed consumption for residential users. There is also a stormwater fee that is called the "Drainage Service Charge" which goes towards the stormwater and flood protection facilities within the service area.

## Sanitary Sewer Surcharges

Nationally, a number of sanitary sewer municipalities have adopted mandatory private sewer inspection programs coupled with surcharges applied to property owners that do not repair leaks or remove inflow sources:

> **East Norriton Township, PA** – inspects properties for illicit connections and to inspect the building laterals. Property owners are required to repair laterals found to have structural defects. The modified sewer use ordinance includes an "Untimely Repairs Surcharge".[6-1]
>
> **Old Lycoming Township, PA** – The sewer use ordinance enables the township to enter private property to inspect building sewers. Leaks and inflow sources are required to be

6-1 http://www.eastnorritontwp.org/Uploads/FileManager/Resolutions%20&%20Ordinances/ord%20456.pdf

repaired or removed within 30 days. After 30 days, a surcharge equal to three times the sewer rates is imposed.[6-2]

**Indianola, IA** – access to private property is mandatory for purposes of I/I inspection. Property owners denying access are categorized as non-compliant and assessed a monthly surcharge of $50-70. Property owners implementing repairs within 90 days of notification of problems are eligible for financial incentives that include a 25% reimbursement or up to a 10-year loan.[6-3]

## Wholesale Wet Weather Charges

There are relatively few regional wastewater authorities that are directly analogous to ALCOSAN. Most regional authorities have far fewer points of connection with far fewer municipalities. Nevertheless, at least three regional wastewater agencies have implemented wholesale wet weather charges to their customer municipalities that are intended to encourage wet weather source reduction at the municipal level:

**Massachusetts Water Resources Authority (MWRA)** – Wet weather control facilities are sized based upon peak flow rates and peak flow volumes. MWRA modified its municipal service agreements to include both average daily and peak monthly flows in the rate methodology to provide a direct financial incentive for flow reduction.[6-4]

**Twin Cities Metropolitan Council Environmental Services (MCES)** – provides wastewater interceptor conveyance and treatment to all or portions of the seven county Minneapolis – St. Paul metropolitan region. MCES' 2030 Water Resources Management Policy Plan projected a need for $3.7 billion in conveyance interceptor and treatment plant upgrades and expansions. To reduce future capital costs, MCES implemented an inflow and infiltration reduction program in 2007. I/I goals are distributed to each municipality, expressed in terms of peak hourly flow (PHF) rates. MCES charges for I/I mitigation costs at a rate of $380,000 per million gallons per day (mgd) of capacity over the target. The municipality can choose to pay the surcharge or to perform I/I mitigation.

**Peak Flow Rate Charges**

- **Wet weather facility sizes are driven by peak flow rates.**
- **MWRA captures peak monthly flows in its user charge system.**
- **Twin Cities Metro Council uses a Peak Hourly Flow rate metric as a metric for peak capacity demands.**

**Northeast Ohio Regional Sewer District (NEORSD)** – NEORSD provides wastewater conveyance and treatment services to the City of Cleveland and 61 suburban communities across northeast Ohio. A four-tiered stormwater fee was implemented based upon impervious surface areas in both combined and sanitary sewer areas. The fee for a typical residential property with 2,000 to 4,000 square feet of impervious area is $7.00 per month. Residential

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6-2 As described at a presentation by the PWEA Collection System Committee at PennTEC 2012. http://www.oldlycomingtwp.org/Documents/Ordinance%20Sewers%20and%20Sewage%20Disposal.pdf

6-3 http://www.indianolaiowa.gov/Portals/0/Documents/city/I&I%20Policy.pdf

6-4 MWRA Infiltration/Inflow Task Force Report – A Guidance Document for MWRA Member Sewer Communities and Regional Stakeholders. March, 2001.

and non-residential users can qualify for stormwater quality and stormwater quantity credits on the fees of up to 100%.[6-5] Twenty-five percent of the revenue is used to fund a Community Cost-Share Account for distribution to the municipalities for projects that reduce the volume, flow rate or pollutant load to the stormwater system, for sanitary sewer overflow (SSO) controls or for National Pollutant Discharge Elimination System (NPDES) Phase II compliance. As of September 30, 2013, the Ohio Eighth District Court of Appeals ruled against the NEORSD in finding that, among other things, the NEORSD does not have the authority to enact and implement the Regional Stormwater Management Program or to collect its stormwater fee. As a result of this ruling, the NEORSD is suspending Regional Stormwater Management Program activities and the collection of stormwater fees for the program while it pursues an appeal of the Court's ruling to the Ohio Supreme Court. The Ohio Supreme Court heard arguments regarding the NEORSD's appeal from both sides on September 9, 2014 but has not yet issued a ruling.

## 6.2 Green Stormwater Incentive Programs

### Property Incentives

In 2009, the United States Environmental Protection Agency (USEPA) catalogued types of GSI incentives[6-6] that have or can have financial incentives components, nicely framing the array of programs that have been developed nationally. USEPA identified forty-three municipalities and regional authorities who had implemented one or more of these incentives programs, including combined and sanitary sewer systems (Figure 6-2). Twenty-eight of the systems offered a stormwater fee discount. Seven offered development incentives and/or grants and thirteen provided rebates or installation financing to homeowners. Examples of these incentives are described below. Some offer more than one type of incentive.

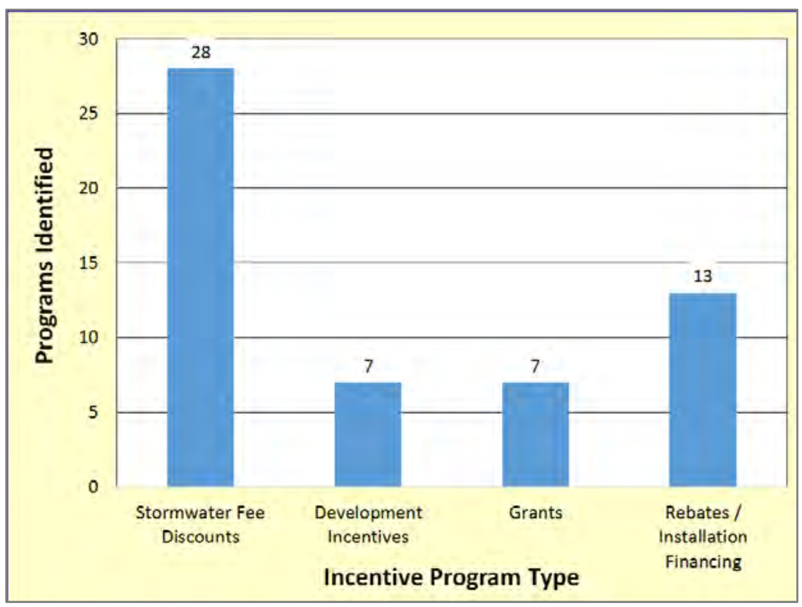


***Figure 6-2: Types of Green Stormwater Infrastructure Incentives Programs***
*Source: USEPA Municipal Handbook – Incentives Programs*

6-5 NEORSD Stormwater Fee Credit Manual, 2012 pg. 3
6-6 Managing Wet Weather with Green Infrastructure Municipal Handbook – Incentives Mechanisms, June 2009 EPA-833-F-09-001 page 1

## Stormwater Fee Discounts and Credits

Municipalities or municipal authorities that impose stormwater fees often offer incentives to property owners in the form of fee credits. These credits may be based upon one or more of the following factors:

- Stormwater quantity reductions, e.g. Louisville MSD and others;
- Stormwater water quality impacts, e.g. Portland, Oregon and others;
- Reductions to contributing impervious areas, e.g. Philadelphia Water Department and others; and/or
- Specific controls, e.g. rain barrels in Mt. Lebanon.

- **Sixteen of the twenty two largest combined wastewater systems offer credits for GSI**
- **The average maximum credit is around 50% of the annual wet weather fee.**

## Development Incentives

Incentives are offered to private developers and redevelopers to include GSI features. For example, Portland Oregon allows increases in the allowable areas of buildings in exchange for GSI features such as green roofs. EPA reported $225 million in additional investments and the construction of 120 green roofs within Portland under this program.[6-7]

## Grants

A number of municipalities and regional authorities provide grants to property owners, non-profit organizations, or customer municipalities in support of GSI projects. For example, Onondaga's County New York's Department of Water Environment Protection (WEP) established its Green Improvement Fund (GIF) in 2010 to provide financial incentives for the installation of Green Infrastructure (GI) Technologies.

Eligible GSI projects include: [6-8]

- Rain Gardens
- Bioretention
- Dry Wells
- Underground Infiltration Systems
- Green Roofs
- Porous Pavement
- Tree Plantings
- Tree Trenches
- Planter Boxes
- Cistern Systems

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6-7 Managing Wet Weather with Green Infrastructure Municipal Handbook – Incentives Mechanisms, June 2009 EPA-833-F-09-001. Page 4.

6-8 The information that follows was excerpted from the Green Improvement Fund Program Description and Application, Onondaga County Department of Water Environment Protection, revised July 2012.

The geographic eligibility area was originally all unmitigated combined sewer areas but was limited to specific priority combined sewer overflow (CSO) basins within Onondaga County program area.

## Rebates & Installation Financing

Some utilities offer rebates to property owners who install source controls. For example, the (Washington) DC Water Authority (formerly DCWASA) will provide homeowners up to $1,200 to adopt one or more landscape enhancements such as shade trees, rain barrels, and permeable pavement. Home owners and small commercial building owners in Chicago can qualify for up to $5,000 towards green roof installations.

The City of Maplewood Minnesota offered to construct rain gardens in the public rights of way on the front edge of residential properties if the homeowners planted and maintained the gardens. This was done as a part of an otherwise scheduled street repaving and improvement project.

## Large Combined & Mixed Sewer Systems Financial Incentives

Of the twenty-two large combined and mixed sewer systems that have a wet weather charge, sixteen offer some form of wet weather charge reduction credit for controlling the volume of wet weather flows entering the combined sewer systems. These credits provide incentives for the installation of GSI and other means of reducing wet weather flows.

The financial incentives offered by the sixteen large combined and mixed wastewater systems are summarized on Figure 6-3. The percentage of the wet weather charge that can be credited to the property owner tends to be limited. The maximum credit percentages range from 25% to 100% of the wet weather charge. The average credit is about 60%. A few (Indianapolis and Minneapolis) have upper limits of 100%. However, to qualify for a 100% credit, the property must control runoff up through the 100-year storm event. Excluding the 100-year event options, the average maximum credit is around 50%. It should be noted that the various systems' incentives are highly individualized and much detail is lost in attempts to generalize.

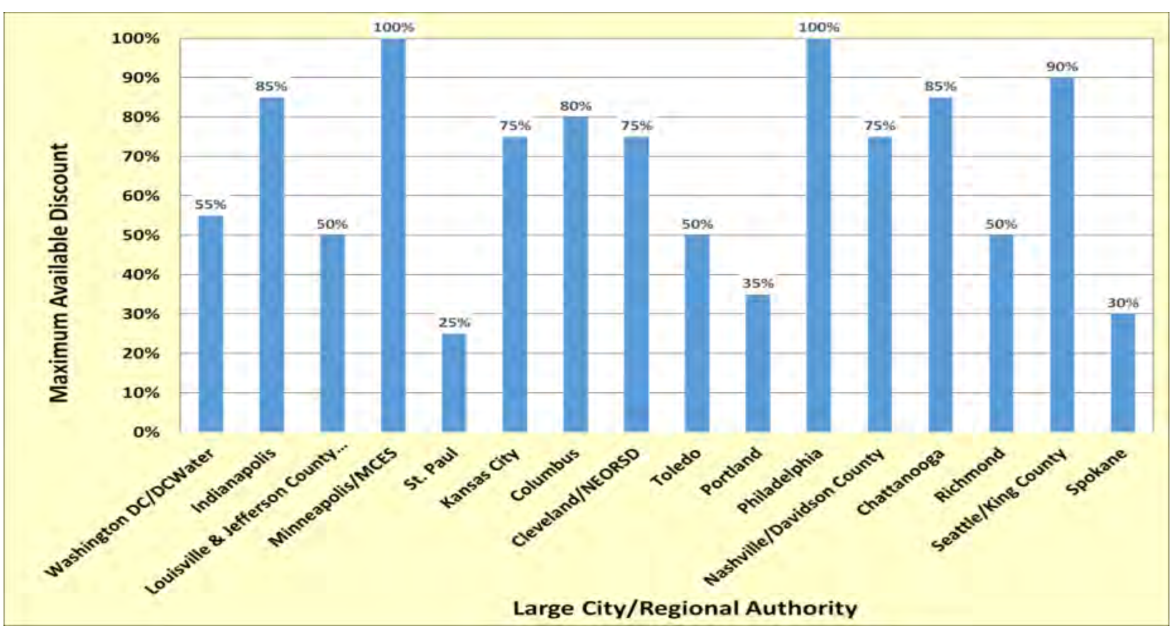


*Figure 6-3: Wet Weather Fees and Discounts for Large Systems*

# 6.3 Inflow and Infiltration Source Reduction Incentives

## Types of Private Source Reduction Incentives

Nationally, municipal incentives towards private property source reduction vary widely, but can be broadly described as fitting into the following categories:

- ***Punitive*** – property owners are assessed an excessive flow charge (e.g. East Norriton, PA);
- ***Financial assistance*** – the municipality or municipal sewage authority provides rebates, loans at favorable terms, or grants to property owners who repair or replace defective portions of their laterals or plumbing that are contributing excessive I/I.; or
- ***Municipal funding*** – the municipality or municipal sewage authority pays the contractors directly or reimburses property owners for the repairs to private laterals, etc., based upon the systemwide cost-effectiveness and benefits of reducing the I/I from the private sources.

*Figure 6-4: Deteriorated Building Lateral Sewer*

These incentive options are not mutually exclusive as implemented by municipalities. Examples of private source reduction incentives programs include:

***Ann Arbor, Michigan*** - Property owners are required to disconnect footing drains within 90 days of receiving notice from the City of Ann Arbor to do so. Ann Arbor will inspect properties to determine if footing drains are connected and to assess site drainage options, including the installation and discharge of sump pumps. The City will provide funding of up to $4,100 for a typical household and provides a list of qualified contractors. If the work is not completed within 90 days, the homeowner may lose City funding and a $100 per month surcharge for the discharge of unmetered sewage may be imposed.

*Figure 6-5: Sump pump disconnection from sanitary sewer*

***Brookfield, Wisconsin*** – Brookfield is a satellite community in the Metropolitan Milwaukee Sanitation District (MMSD). Brookfield has enforced ordinance provisions for maintenance of privately owned sanitary sewer systems since 1999. Using funds from the MMSD Private Property Inflow/Infiltration Reduction Program and from Brookfield, the program consists of inspections of residential properties and private sewer laterals on a voluntary basis. A reimbursement program was also established. Property owners completing repairs within one year of the inspection date are eligible for a 75% reimbursement (maximum $8,000 reimbursement).

***Portland, Oregon*** – In 2013, Portland implemented a pilot project that offers to repair or replace eligible privately-owned laterals at no cost to the property owner in a specific neighborhood. The City is targeting neighborhoods with high I/I and has evaluated this as the most cost effective approach to improving system performance. Participation is voluntary.

***City of Windsor Heights, Iowa*** - Windsor Heights encourages residents to repair and replace their private sewer laterals through improvement loans. The loans are offered through a neighborhood financing corporation. A portion of the loan (up to 50%, depending on income level) is eligible for forgiveness after 5 years.

## Summary of National Wet Weather Charges and Incentives

- Wet weather charges are intended to provide a revenue stream to partially recover wet weather control costs.
- Wet weather charges also provide a revenue stream for the funding of positive source reduction incentives such as grants and rebates.
- Stormwater fees (variously named) are the most common form of wet weather charges.
- Stormwater fees are typically based on a parcel of property's ability to generate stormwater runoff that must be controlled. The impervious area of parcels is used as a proxy to estimate this potential.
- More than one-half of the stormwater fees have a related program that provides fee credits to property owners for implementing GSI or other source reduction steps. The credits vary by program from around 25% to 100% of the stormwater fees.
- Sanitary sewer system wet weather charges can take the form of a standard additional fee that is intended to help pay for wet weather compliance costs. Columbus Ohio's Clean River Surcharge and Louisville MSD's CD Charge are examples.
- Wet weather charges in sanitary sewer areas can motivate property owners with faulty laterals or drainage to correct problems through punitive surcharges. East Norriton Township provides an example of this strategy.
- Positive incentive programs that offer grants, rebates, low cost financing, etc., for GSI or I/I reduction source control are less common than credit programs. Onondaga County's Green Improvement Fund is an example of a large-scale program. Smaller programs tend to focus on assisting homeowners with lateral replacement such as Brookfield Wisconsin.
- To date, relatively few wholesale wet weather charges by regional authorities on customer municipalities have been identified. The MWRA's peak flow charge and the Twin Cities MCES program provide interesting examples.



# 6.4 ALCOSAN Legal and Institutional Context

## Wet Weather/Stormwater Fees in the ALCOSAN Service Area

It appears that ALCOSAN, its 83 customer municipalities, and their affiliated municipal authorities could impose wet weather fees on property owners and/or wastewater utility accounts under current state statute. ALCOSAN and the municipalities could however face restrictions under their respective articles of incorporation, bond covenants, or service agreements.

Currently there are at least four municipalities with stormwater fees in Pennsylvania: the cities of Philadelphia, Lancaster, and Meadville and the municipality of Mount Lebanon. In addition, the Pittsburgh Water and Sewer Authority (PWSA) announced its intent to implement a stormwater fee.[6-9]

Until July 2013, municipal authorities organized under the Municipality Authorities Act ("MAA") did not have explicit authority to manage stormwater. Nonetheless, a few small municipal authorities (e.g., Coraopolis, Sunbury) have been managing municipal stormwater permitting obligations and undertaking flood control projects by broadly interpreting the MAA as granting such authority. The Pennsylvania legislature in July 2013 amended the MAA, through the enactment of Act 68 of 2013, to expressly include the authority to manage stormwater. Now, existing municipal authorities may manage stormwater if their articles of incorporation include all the powers and authority to undertake projects authorized by the MAA. However, if a municipal authority's articles of incorporation do not contain such all-inclusive language, the articles must be amended to include the function of stormwater management.

- **ALCOSAN, its 83 customer municipalities, and their affiliated municipal authorities could impose wet weather fees under current statute.**
- **This flexibility may be limited by existing contractual or fiduciary arrangements.**
- **Currently, there are at least four municipal stormwater fees in Pennsylvania.**

ALCOSAN currently has no authority to provide stormwater management services under its articles of incorporation. However, two original ALCOSAN's incorporating municipalities—the City of Pittsburgh and Allegheny County—may amend the articles to expressly authorize stormwater management services. The amendment of the MAA in July 2013 (Act 68) settled the question of whether the MAA authorizes stormwater management.

ALCOSAN provides wholesale wastewater conveyance and treatment to its 83 customer municipalities. Each municipality pays ALCOSAN the aggregate of all municipal users' bills within its jurisdiction on a quarterly basis. Any wet weather fee imposed by ALCOSAN would likely parallel this mechanism, i.e. the wholesale municipal charges would be based on the aggregated characteristics of the individual properties or sewer users.

6-9 http://aps.pittsburgh.gov/pwsa_WWFS_Section_9.pdf

## Mechanisms for ALCOSAN Funding Support of Source Reduction

ALCOSAN's current abilities to provide financial support for GSI and I/I reduction from municipal and private sources appear to be limited by the following:

- Any funded source reduction projects would need to demonstrably relate to the services that ALCOSAN provides under its Articles of Incorporation;
- ALCOSAN's ability to directly incentivize GSI on private properties is very limited due to legal and institutional constraints;
- The options for ALCOSAN funding of municipal collection system I/I reduction appears to be limited to ALCOSAN supporting projects based upon potential regional cost savings; and
- The "Public Purpose Doctrine"[6-10] holds that the use of public funds must be for a public benefit. In the context of private laterals, public expenditures would need to be based on public benefit, e.g. through cost savings or operational efficiencies relating to ALCOSAN's provision of wastewater conveyance and treatment services.

# 6.5 ALCOSAN Incentives Program Options

## Overview

Based upon analysis of programs across the United States and a review of the legal and institutional framework within Pennsylvania, eight source reduction program options that would fit within the current legal and institutional structures with manageable modifications have been identified. The group includes programs that could be implemented by ALCOSAN as well as programs that ALCOSAN could support but would be led by others.

**ALCOSAN Incentives – the Past 15 Years:**

- **Eight stream inflow projects completed;**
- **Three stream restoration projects completed;**
- **$40 million in federal and state funding; and**
- **$11 million in ALCOSAN funding.**

Some of the programs' features may overlap or contradict each other. Each program description includes the following as applicable:

1. Program goals;
2. Program description;
3. Logistics;
4. Potential Funding Sources (as applicable);
5. Issues and actions required for implementation; and
6. Pros and Cons.

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6-10 Legal and Funding Issues during Private Lateral Foundation Water Environment Research Foundation research project 02-CTS-5d page 10.

## OPTION 1 – PROJECT FACILITIATION & TECHNICAL SERVICES

***Lead Agency:*** ALCOSAN

***Target Group:*** ALCOSAN Customer Municipalities, Partnering Non-Profit Groups

***Goals:***

- To identify and facilitate municipal and non-profit group GSI and I/I reduction projects.
- To provide technical leadership and services in the planning, design and construction of  projects

***Description:***

Since 1998, ALCOSAN has provided technical services necessary for GSI project planning, design and construction management. ALCOSAN uses in-house engineering and other professional resources or procures as necessary architectural/engineering services for the design, resident inspection and construction management of municipal projects. The value of these services could potentially be used as in-kind matches for federal and state grant programs that require local cost sharing.

***Figure 6-6: Jack's Run stream was re-routed out of the combined sewer system and restored***

This program has been used successfully by ALCOSAN in its direct stream removal and stream restoration projects. ALCOSAN has obtained approximately $40 million in federal and state funding for municipal projects since 1998. ALCOSAN's direct contributions have totaled nearly $11 million through 2013.


***Figure 6-7: ALCOSAN Officials Evaluating Locations for GSI Projects***

***Logistics:***

- ALCOSAN identifies potential project sites;
- ALCOSAN meets with the municipalities and other project partners;
- ALCOSAN provides, as appropriate, technical (e.g. site planning or cost estimation) and funding (e.g. grant writing) assistance;
- ALCOSAN provides design and construction management and other technical services;
- ALCOSAN applies for state and federal grants on behalf of the municipalities (e.g. EPA grant funding for the West View Borough GSI project); and

- Municipality or non-profit project advocate will own, operate, and maintain the facilities.

***Potential Funding Sources:***

- ALCOSAN can provide direct funding for municipal engineering services and/or in-kind services by the ALCOSAN professional staff or ALCOSAN consultants; and
- The cost of these activities is typically charged to an ALCOSAN capital improvement program (CIP) project account and/or ALCOSAN's operating budget.

***Issues and Actions Required to Implement:***

- Limited issues – current ALCOSAN activities; and
- May require additional ALCOSAN staff and consultant resources depending upon levels of engagement.

| EXAMPLES | | |
|---|---|---|
| Carnegie Borough Green Stormwater Management | East Pittsburgh GSI | Economic Development South |
| Schenley Park Green Street | Nine Mile Run Stream Restoration | Sheraden Park Stream Restoration |
| Jack's Run Stream Restoration | Nine Mile Run Watershed Rain Barrel Project | |

## OPTION 2 – STORMWATER MANAGEMENT AND SEWER USE ORDINANCES

***Lead Agency:*** Municipalities, County Health Department, ALCOSAN

***Target Group:*** Private Property Owners

***Goals:***

- Promote the use of sustainable GSI practices in new development and redevelopment
- Generate widespread organic implementation of GSI as properties and neighborhoods develop or redevelop over time;
- Shift wet weather costs from the general rate base to large impervious properties;
- Reduce inflow and infiltration from private property including lateral sewers; and
- Reduce the volume and water quality impacts of stormwater run-off from properties subject to ALCOSAN's industrial pretreatment program (IPP) requirements.

***Description:***

- Property development and redevelopment (over a specified size) would be required to incorporate on-site stormwater management using GSI, where feasible;
- Private property sewer laterals would be periodically inspected and structural repairs made; and

- Property owners in combined sewer areas that are subject to ALCOSAN's IPP and all other properties exceeding a trigger size would implement stormwater best management practices.

***Logistics:***

- Municipal and County codes would be modified to require on-site management of stormwater runoff for new property development and redevelopment (over a specified size) using GSI where feasible;
- Municipal sewer use ordinances (SUO) would be modified to require periodic inspection of building laterals for structural soundness and excessive I/I. Property owners would be required to repair laterals within a set time period or face a significant municipal surcharge;
- Municipalities could provide funding assistance to property owners as permitted by evolving state law;
- ALCOSAN would integrate stormwater management requirements, for combined areas, and property conformance with municipal sewer use ordinance requirements for lateral sewer maintenance and extraneous flow controls into its existing Chapter 94 planning module review and approval process;
- Should be integrated into County Act 167 and municipal ordinance conformance efforts; and
- A working group of municipal, ALCOSAN, county, developers, property owners and industrial sewer users would develop:
  - Property size and characteristics triggering requirements
  - Technical design, operation and maintenance standards
  - Model municipal ordinances or ordinance amendments

***Potential Funding Sources:***

- Existing tax, municipal fees, and user charge sources; and
- Potentially from wet weather charges.

***Issues and Actions Required for Implementation:***

- Coordination of municipal, municipal authority (including ALCOSAN,) and county agencies;
- Analysis of legal impediments would be required; and
- Uniform municipal ordinances across the ALCOSAN service area could be required.

| EXAMPLES | | |
|---|---|---|
| City of Philadelphia | City of Pittsburgh | City of Lancaster, PA |
| New York City | North Hills COG Act 167 Plan | |

## OPTION 3 – FLOW REDUCTION PLANS

***Lead Agency:*** ALCOSAN, PaDEP, and/or ACHD

***Target Group:*** Allegheny County Municipalities

***Goals:***

- Reduction in the volumes and peak rates of wet weather flows, thereby reducing the size and scope of required regional (ALCOSAN) wet weather conveyance and treatment facilities; and
- To prevent future increases in dry and wet weather flows due to further deterioration of municipal collection systems.

***Description:***

A minimum operation and maintenance standard could be uniformly imposed on all municipalities to promote sustainable practices that reduce infiltration and contain further deterioration of municipal collection system sewers. In addition, more aggressive flow reduction plans could be imposed for areas where source controls could more cost effectively address sewer overflows than alternative grey infrastructure alternatives.

***Figure 6-8: Sanitary Sewer Overflow Caused by Excessive Inflow and Infiltration***

***Logistics:***

ALCOSAN could assist in using available monitoring and modeling data and the results of this source controls study to support the development of flow reduction plans;

- ALCOSAN could work with customer municipalities and 3RWW to review the potential options and discuss the pros and cons of alternative approaches;

***Potential Funding Sources:***

Not applicable for ALCOSAN. However, the municipal costs of compliance could be considerable and may fall disproportionately on some municipalities. Some form of funding assistance through county, state, federal or ALCOSAN might need to be considered.

***Issues and Actions Required to Implement:***

PaDEP and ACHD, with the potential participation of EPA, would need to approve municipal flow reduction plans.

| EXAMPLES (Analogues) | | |
|---|---|---|
| PA Chapter 94 (25 Pa. Code 4):<br>▪ Sewer bans and corrective action plans;<br>▪ PaDEP and ACHD municipal orders; and<br>▪ 94:32 relating to public health hazards or pollution. | Massachusetts:<br>▪ Design standards include 1 year six-hour storm; and<br>▪ Cost effectiveness I/I study is required if infiltration exceeds 4,000 gallons/inch-mile per day. | New Jersey:<br>▪ 80% permitted treatment capacity triggers development of I/I plan. |

# OPTION 4 – SOURCE REDUCTION INCENTIVES PROGRAM

***Lead Agency***: ALCOSAN

***Target Group:*** Municipalities, Non-Profit Groups, Small Property Owners

***Goals:***

- A stable and user-friendly funding source for GSI and I/I reduction projects;
- Provide a source of matching funds to access county, state and federal grant programs;
- Provide a basis for regional prioritization of projects based on overflow control impacts; and
- Provide a basis for technical design and performance standards for projects.

***Description:***

- ALCOSAN could offer funding to municipalities for GSI and I/I reduction projects;
- Funding could be competitive based on technical standards, source reduction potential, community benefit, etc.; and
- Funding conditions could include ALCOSAN access and project owner's O&M responsibilities for the funded facilities.

***Figure 6-9: Infiltration trenches and berms have been installed to reduce hillside erosion, converting lawns to meadows, and vegetative buffers in Pittsburgh's Schenley Park.***

***This demonstration project was partially funded through $400,000 in fiscal 2010 Clean Water Act appropriations and through support by ALCOSAN, PWSA and the Pittsburgh Parks Conservancy.***

***Potential Funding Sources:***

- ALCOSAN could fund all or portions of the program as a self-capitalized project;
- New revenues from an ALCOSAN or other (e.g. municipal or County-wide) wet weather (stormwater) fee; and/or
- New revenues from an Excessive Capacity Demand Charge.

***Issues and Actions Required to Implement:***

- Amendment of ALCOSAN's Articles of Incorporation to include addressing stormwater;
- Identification and resolution of legal issues;
- Establishment of a funding program administration; and
- Exploring tax implications (and bond covenants, if bond proceeds are used) of potential funding mechanisms.

| EXAMPLES | | |
|---|---|---|
| Milwaukee Sanitary District | City of Chicago | Seattle (King County) |
| Onondaga County | Philadelphia Water Department | DC Water |

# OPTION 5 – ALCOSAN CONSTRUCTS, OPERATES AND MAINTAINS FACILITIES

***Lead Agency:*** ALCOSAN

***Target Group:*** ALCOSAN Customer Municipalities

***Goals:***

- Efficient and direct implementation of GSI projects;
- Funding source for supporting GSI; and
- Basis for design and performance standardization.

***Figure 6-10: ALCOSAN's CS&T Building parking lot uses a rain garden and bio-swale to capture and infiltrate stormwater***

***Description:***

Rather than being a source of project funding, ALCOSAN would directly construct, operate, and maintain green stormwater facilities to be located on municipal public properties and potentially on private properties. This would be a green analogue to ALCOSAN acquiring property or easements and installing a new pump station.

***Logistics:***

- ALCOSAN acquires property or utility easements (as applicable);
- ALCOSAN installs the GSI facility (as applicable); and
- ALCOSAN or the municipality or non-profit would operate and maintain the facilities to ALCOSAN standards for the useful life of the facilities.

***Potential Funding Sources:***

- ALCOSAN could fund all or portions of the program as a self-capitalized project;
- A portion of ALCOSAN's annual capital improvements budgets (funded through bonds);
- New revenues from an ALCOSAN or other (e.g. County-wide) wet weather (stormwater) fee; and
- New revenues from an Excessive Capacity Demand Charge.

***Issues and Actions Required to Implement:***

- Amendment of ALCOSAN's Articles of Incorporation may be required to include addressing stormwater; and
- Legal determination that funded projects or classes of projects are providing services to the general rate base, e.g. by providing stormwater storage in lieu of regional conveyance and treatment.

| EXAMPLES | | |
|---|---|---|
| Philadelphia (Facility Owner) | Hampton Road Sanitary District – Payment of municipal improvement costs | Other municipalities implementing GSI (Facility Owners) |



## OPTION 6 – WET WEATHER CHARGES

***Lead Agency:*** ALCOSAN or Allegheny County or the Municipalities

***Target Group:*** ALCOSAN Customer Municipalities, Municipal Retail Wastewater System Users

***Goals:***

- Incentivize source reduction;
- Provide a stable funding source for GSI and I/I reduction projects;
- Shift WWP cost burdens from the residential user class to the larger generators of stormwater runoff and excessive I/I, including commercial properties with large impervious areas; and
- Recover costs attributable to disproportionately high wet weather flow rates or volumes.

***Description:***

- ALCOSAN or Allegheny County or the municipalities could establish a wet weather charge (analogous to stormwater fees) which would be applicable to all properties served by municipal collection systems based on impervious areas in combined sewersheds and I/I characteristics in sanitary sewersheds;
- Alternatively, system-wide performance standards for combined and sanitary sewer areas could be established, and the municipalities would be assessed a surcharge for wet weather flows that exceed the system-wide performance standard for their system type;
- Municipalities could receive credits for GSI implemented on public properties and for collection system repairs resulting in I/I reductions; and property owners would receive credits for implementing GSI and/or building lateral inspections and repairs from their municipalities;
- Some or all of the excessive capacity demand charges levied could be rebated to the municipalities for the implementation of GSI and I/I reduction; and
- Charges could be set to generate a targeted annual revenue stream (not to recover all WWP program costs).

**A WET WEATHER CHARGE COULD:**

- **Shift cost burdens from residential users to property owners with large impervious areas such as parking lots**
- **Provide dedicated funding for source reduction incentives**
- **Stimulate repairs and replacements of excessively leaky sewer pipes.**

***Logistics:***

- ALCOSAN or Allegheny County could apply a wholesale charge to the municipalities based on impervious area in combined sewersheds and on I/I characteristics in sanitary sewersheds;
- Excessive Capacity demand charges could be assigned to the municipalities as applicable;
- The municipalities could be given time to implement and quantify source reductions before the payment is due;

- Residential charges could be based on one or more "equivalent dwelling units" to simplify implementation; and
- ALCOSAN could establish design and performance standards for credit-eligible projects.

***Issues and Actions Required to Implement:***

- Amendment of ALCOSAN's Articles of Incorporation to include addressing stormwater;
- "Overlay Agreement" or other legal mechanism would be required for ALCOSAN to impose a wet weather charge on the municipalities;
- Coordination with proposed stormwater fees in Pittsburgh and other combined sewered areas. (Mount Lebanon's and other sanitary sewer municipalities that implement stormwater fees should not be an issue); and
- Development of a reliable impervious area database for use in implementing an impervious area based charge is a significant undertaking.

| EXAMPLES | | |
|---|---|---|
| DC Water | Indianapolis | Louisville/Jefferson County |
| Columbus, OH | Toledo | NEORSD |
| MWRA | Philadelphia | Mount Lebanon, PA |
| Meadville, PA | Twin Cities Metropolitan Council Environmental Services | |

## OPTION 7 – REGIONALIZATION OF INTERMUNICIPAL TRUNK SEWERS

***Lead Agency:*** ALCOSAN

***Target Group:*** ALCOSAN Customer Municipalities

***Goals:***

- To identify regional cost reduction opportunities using GSI and I/I in lieu of expanding wet weather trunk sewer conveyance capacities called for in the Municipal Feasibility Studies;
- To redirect scarce municipal resources from wet weather conveyance capacity projects to GSI and collection sewer rehabilitation; and
- To achieve economies of scale by leveraging ALCOSAN's technical and financial resources into efficient trunk sewer rehabilitation (including I/I reduction) and capacity upgrades, if necessary.

***Description:***

- The ownership of intermunicipal trunk sewers of 10" diameter or more would be voluntarily transferred from the municipalities to ALCOSAN;
- ALCOSAN would operate and maintain the transferred trunk sewer as a part of its regional conveyance interceptor sewer system;
- The municipalities would receive no payment for the transferred sewers and would retain any municipal debt related to the sewers; and

- ALCOSAN would re-evaluate any conveyance capacity upgrades that were proposed in the Municipal Feasibility Study covering the trunk sewer. The analysis would determine whether GSI and I/I source reduction in the contributing municipalities' collection systems could reduce the need for the conveyance capacity expansions.

***Logistics:***

- ALCOSAN and the customer municipalities would finalize the identification of intermunicipal trunk sewers that could be subject to voluntary transfer to ALCOSAN;
- ALCOSAN and the customer municipalities would finalize a model Transfer Agreement for use in individual agreements between ALCOSAN and the municipalities;
- The customer municipalities would determine if they want to convey the trunk sewers and enact appropriate local ordinances authorizing the entering into a transfer agreement with ALCOSAN.
- The transferring municipalities would need to agree to cooperate on the establishment of flow reduction plans for the collection sewers contributing to the regionalized trunk sewer.

***Issues and Actions Required to Implement:***

- After an 18-month collaborative process to establish mutual goals, the scope of the pipes to be transferred, and a draft legal agreement, ALCOSAN is meeting individually with the impacted municipalities to begin the transfer process;
- The required physical condition of the intermunicipal trunk sewers as a condition of ALCOSAN's acceptance must be determined; e.g. documentation of conformance with the inspection and spot repair requirements under the PaDEP and ACHD municipal compliance orders;
- The resolution of any outstanding inter-municipal cost, liability or responsibility issues under existing inter-municipal trunk sewer agreements that could materially affect the transfer or operation of the sewers;
- A regulatory determination of the responsibility for, and as applicable, the transference of any NPDES discharge permits associated with overflow outfalls within the municipal collection system;
- The integration of the transferred trunk sewers into ALCOSAN's Wet Weather Plan, federal consent decree (as applicable) and NPDES permit (as applicable).

| EXAMPLES | | |
|---|---|---|
| ALCOSAN (Saw Mill Run Interceptor circa 1990) | Girty's Run Joint Sewer Authority | McCandless Twp. Sanitary Authority – Franklin Park Borough |
| Municipal Authority of the City of McKeesport – Dravosburg, etc. | Sanitary District 1 of Northern Kentucky | Louisville-Jefferson County Metropolitan Sewer District |

## OPTION 8 – SUPPORT RELATED PROGRAMS

***Lead Agency:*** Varied

***Target Group:*** Private Property Owners, Municipalities

***Goal:*** For ALCOSAN to leverage large and small-scale neighborhood redevelopment projects to include GSI and environmental/aesthetic enhancements.

***Overview:***

The following are potential programs that could support GSI and source reduction. These programs would be implemented by other organizations; however, ALCOSAN could provide financial and technical support and would be involved in the setting of their policies and program scopes as applicable to GSI and source reduction.

***Land Banking Description***:

The Pittsburgh Land Bank or a non-profit organization would aggregate abandoned or derelict properties within the ALCOSAN service area for redevelopment, GSI facilities and community amenities such as parklets. The GSI facilities would be sized to handle flows from adjacent properties that may be developed. To allay community concerns, GSI facilities could be eliminated in the future if the space is needed for tax generation or needed community development (e.g. future construction of a grocery store within a food desert neighborhood). It is assumed that the redevelopment would include GSI. Although this contingency could be inefficient, it is analogous to relocating utilities for a redevelopment project.

***Potential ALCOSAN Roles***

- Technical support;
- Construction of GSI features (e.g. rain gardens or simply replacing impervious areas with grass or garden space); and
- Seed capital for land acquisitions (ALCOSAN would be reimbursed when properties are sold).

***Examples and Analogues***

- Dauphin County;
- Under consideration by:
  - Allegheny County;
  - Berks County;
  - Philadelphia County; and
  - Allegheny Land Trust.

***Green Credits Banking Description***:

A third party (e.g. the county, a non-profit agency, or limited purpose financial authority) would serve as a market place and clearing house for the buying and selling of source reduction credits. Property owners (including tax-exempt) would pay stormwater/impervious area fees established by

ALCOSAN or the municipalities, and would receive credits for source control from the establishing agency. The property owners could sell or trade these credits to other property owners using the green credits bank. Residential property owners could install small scale GSI (e.g. rain gardens) and sell their credit to the bank. The value of credits could vary by the stormwater and overflow impacts on the affected receiving streams.

### *Potential ALCOSAN Roles*

- Technical support for the identification and valuation of credits; and
- Purchase of credits as an incentive to GSI (subject to same legal considerations.)

### *Examples and Analogues*

- PennVEST Nutrient Credit Program;
- Wetland mitigations banking; and
- Carbon emissions reduction trading.

### *Green Crowd Sourcing and Green Micro-Loans Description*:

A small scale "green bank" would be established as a non-profit corporation to provide small, low cost loans to residential; small non-profit e.g. a church; and small commercial properties for GSI or lateral repairs.

Green crowd sourcing could be used to accumulate private donations to GSI projects. Moreover, a portion of municipal or county stormwater fees could be diverted at the direction of the property owner (or a voluntary additional amount added to stormwater fee payments) for a GSI project fund.

### *Potential ALCOSAN Roles*

- Technical and institutional support e.g. design and performance standards; and
- Seed capital.

### *Examples and Analogues*

- Gateway Green crowd funding program in Portland, Oregon; and
- Voluntary add-on to utility bills for low income heating support.

# 6.6 Analysis of Options

## Pros and Cons

The positive and negative aspects of the various source reduction incentives programs detailed above are presented in Table 6-2. The lists are intended to frame policy discussion and should not be considered as necessarily exhaustive.

*Table 6-2: Incentive Program Options Pros and Cons*

| OPTION | PROS AND CONS |
| --- | --- |
| Option 1<br><br>Project Facilitation and Technical Services | **Pro**<br>▪ Current ALCOSAN incentives/support program;<br>▪ No legal or political challenges of projects to date; and<br>▪ Provides maximum flexibility.<br><br>**Con**<br>▪ Difficulties in obtaining and maintaining municipal commitments to projects;<br>▪ No written guide to the process or eligibility for ALCOSAN assistance;<br>▪ Could open ALCOSAN up to criticism by municipalities or groups who are not assisted; and<br>▪ Ad-hoc project development may pose work load issues and budgeting issues for ALCOSAN |
| Option 2<br><br>Redevelopment and Related Municipal Ordinances | **Pro**<br>▪ Long term incremental progress in utilizing more sustainable stormwater management practices;<br>▪ Gradual shifting of wet weather program costs from rate payer to large private property owners as redevelopment occurs;<br>▪ Standardization across the service area reduces the potential municipal perception that such ordinances would be a cost competitive disadvantage;<br>▪ Assists with municipal stormwater compliance in sanitary sewer areas;<br>▪ Can lead to significant and more cost effective long-term flow reduction benefit by taking advantage of lower re-development GSI costs over retrofit;<br>▪ May result in property value, aesthetic and environmental benefits; and<br>▪ Requires property owners to control I/I originating on private property.<br><br>**Con**<br>▪ Financial burden on property owners;<br>▪ Ordinance updating and coordination would generate municipal costs for legal and related services; and<br>▪ Increased administrative costs and burdens for the municipalities and for ALCOSAN. |
| Option 3<br><br>Flow Reduction Plans | **Pro**<br>▪ Fosters long term reinvestment in wastewater infrastructure;<br>▪ Establishes equitable minimum standards for all municipalities;<br>▪ Can motivate municipalities to implement source reduction measures when more cost effective than traditional grey infrastructure alternatives for controlling overflows; and<br>▪ Protects ALCOSAN from the risk of future CSO and SSO compliance issues brought on by the continued degradation of municipal collection systems and private lateral sewers.<br><br>**Con**<br>▪ Compliance burdens could fall disproportionately on some municipalities, particularly those that have not maintained their system, or for reasons beyond their control;<br>▪ Administration and enforcement costs; and<br>▪ Regulatory framework in Pennsylvania (and other states) is not well structured for satellite municipalities. The regulatory focus includes an implicit assumption that the end-of-the-system POTW and NPDES holder and the collection system owner/operators are the same entity. |



| OPTION | PROS AND CONS |
|---|---|
| Option 4<br><br>ALCOSAN Funding Program for GSI and I/I Reduction Projects | **Pro**<br>▪ Provides direct, targeted funding for source reduction projects;<br>▪ Stable funding source; and<br>▪ ALCOSAN could establish design, O&M, and maintenance standards.<br><br>**Con**<br>▪ Program administration costs and attention; and<br>▪ Annual program costs (ideally would be revenue neutral). |
| Option 5<br><br>ALCOSAN Construction, Operation and Maintenance of GSI Facilities | **Pro**<br>▪ Enhanced project controls and efficiencies;<br>▪ Provides direct, targeted funding for source reduction projects;<br>▪ Stable funding source; and<br>▪ ALCOSAN could establish design, O&M, and maintenance standards.<br><br>**Con**<br>▪ Program administration costs and attention;<br>▪ Annual program costs (ideally would be revenue neutral).<br>▪ ALCOSAN would need to develop in-house resources for the development and execution of projects and subsequent maintenance or contract for these services;<br>▪ Potential ALCOSAN liability exposure for problems relating to GSI structures; and<br>▪ Logistical complexity for small parcels. |
| Option 6<br><br>Wet Weather Charges | **Pro**<br>▪ Would provide a stable funding source for source reduction;<br>▪ Incentivizes municipal source reduction, including I/I reduction from public and private sources;<br>▪ Wet weather costs would be shifted from the residential class to the larger generators of stormwater and groundwater entering the municipal sewer systems;<br>▪ Quantification of the bases for the charges can be accomplished using calibrated hydrologic-hydraulic models (permanent flow meters at points of connection with the ALCOSAN system is not required;) and<br>▪ Charges could be deferred to allow time for municipal implementation of source reduction programs.<br><br>**Con**<br>▪ Overlap with municipal stormwater charges (in combined sewer areas) would need to be addressed;<br>▪ Inter-municipal allocation of responsibilities for excessive capacity demands could be contentious; and<br>▪ Wet weather flow characteristics may be beyond the control of certain municipalities due to topography or other factors. |
| Option 7<br><br>Regionalization of Intermunicipal Trunk Sewers | **Pro**<br>▪ Rehabilitation of regionalized trunk sewers;<br>▪ Opportunity to identify regional cost reductions using GSI and I/I in lieu of expanding wet weather trunk sewer conveyance capacities; and<br>▪ Frees municipal funding for GSI and collection system rehabilitation.<br>**Con**<br>▪ Increases ALCOSAN costs and responsibilities; and<br>▪ Municipal benefits would be focused on the directly affected municipalities, although regional benefits would accrue to all. |

| OPTION | PROS AND CONS |
|---|---|
| Option 8-A<br><br>Land Banking | **Pro**<br>▪ Low cost to ALCOSAN;<br>▪ Opportunities for partnership building with municipalities and non-profit groups;<br>▪ ALCOSAN could influence project selection and technical standards; and<br>▪ Flexibility –small scale GSI facilities could be redeveloped as community needs and opportunities arise.<br><br>**Con**<br>▪ Small and diffuse properties may have limited source reduction benefit as locations may not be cost effective; and<br>▪ Not applicable for I/I reduction. |
| Option 8-B<br><br>Green Credit Banking | **Pro**<br>▪ Property owners with property that is not amenable to GSI could support GSI;<br>▪ Property owners with property not in high GSI impact potential areas could support projects in more favorable areas; and<br>▪ Opportunity for the funding of small neighborhood enhancements, e.g. parklets or community gardens.<br><br>**Con**<br>▪ No local analogies;<br>▪ A non-profit organization would be needed to establish and implement the program; and<br>▪ Legal impediments have not been evaluated. |
| Option 8-C<br><br>Green Crowd Sourcing and Green Micro-Loans | **Pro**<br>▪ Provides low cost and accessible funding for small neighborhood GSI projects;<br>▪ Projects would tend to provide community aesthetic and recreational benefits; and<br>▪ Opportunities for partnership building with municipalities and non-profit groups.<br><br>**Con**<br>▪ A non-profit organization with sufficient legal, financial, and technical capabilities would be needed to establish and administer such a program; and<br>▪ Could be difficult to target projects to high source reduction potential areas. |

## Qualitative Scoring

The differing natures of the potential incentives programs preclude meaningful quantitative comparative scoring between the options. The options are not mutually exclusive; moving forward ALCOSAN, the municipalities, and other stakeholders are likely to overlap variations of the options. Moreover, some of the options are mutually supportive, e.g. a wet weather charge would provide a funding source for an ALCOSAN funding program. Each alternative can be evaluated qualitatively in terms of:

- Implementation difficulty;
- Program costs;
- Timeframe – to get the program up and running; and
- Program impact.

The incentives program options are evaluated qualitatively against these metrics in Table 6-3.

***Table 6-3: Qualitative Scoring of the Incentive Alternatives***

| Implementation Scorecard | | | |
|---|---|---|---|
| Option | Metric | Score | Notes |
| Option 1<br>Project Facilitation and Technical Services | Difficulty | Low | Current ALCOSAN activities |
| | Cost | Low | To date have been relatively low and controllable |
| | Timeframe | Now | Current |
| | Impact | Low | Impact limited to a relatively few interested municipal participants |
| Option 2<br>Redevelopment and Related Municipal Ordinances | Difficulty | High | Would require considerable County and municipal coordination and consensus building. |
| | Cost | Moderate | Would require ongoing municipal resources to implement |
| | Timeframe | Long | Slow process dependent on development and redevelopment rates |
| | Impact | High | Significant long-term impacts |
| Option 3<br>Flow Reduction Plans | Difficulty | High | Appears workable under current statute, would require political support and negotiating individual agreements with municipalities |
| | Cost | Moderate | Expect moderate development and administration cost for ALCOSAN |
| | Timeframe | Moderate | Full implementation expected to take multiple years |
| | Impact | High | Would result in long term source reduction and system reinvestment |
| Option 4<br>Source Reduction Funding Programs | Difficulty | Moderate | Would require ongoing ALCOSAN program management staff and support |
| | Cost | High | Cost a function of program scope |
| | Timeframe | Moderate | Could likely take a year to establish a workable program |
| | Impact | High | Could result in numerous projects, depending on funding scope. |
| Option 5<br>ALCOSAN Constructs, Operates and Maintains | Difficulty | Moderate | Would require ongoing ALCOSAN program management staff and support |
| | Cost | High | Cost a function of program scope |
| | Timeframe | Moderate | Could likely take a year establish a workable program |
| | Impact | High | Could result in numerous projects, depending on funding scope. |
| Option 6<br>System-Wide Wet Weather Charges and/or Excessive Capacity Demand Charge | Difficulty | High | Potentially significant legal and political hurdles |
| | Cost | Moderate | Low to moderate aggregate costs depending on rate structure and levels |
| | Timeframe | Moderate | Would likely take at least one year to implement. |
| | Impact | High | Could motivate source reduction and would provide a revenue source for GSI and I/I control projects. |
| Option 7 | Difficulty | Moderate | Will require individual transfer agreements with each affected municipality. |

| Implementation Scorecard | | | |
|---|---|---|---|
| Option | Metric | Score | Notes |
| Regionalization of Intermunicipal Trunk Sewers | Cost | High | A significant portion of the estimated $530 million in municipal wet weather costs that was included in ALCOSAN's Wet Weather Plan is likely to be attributable to intermunicipal trunk sewer rehabilitation and capacity upgrades. |
| | Timeframe | Moderate | ALCOSAN anticipates that initial transfer agreements could be entered into during 2016, with at least an additional five years for significant implementation. |
| | Impact | High | Could provide substantial opportunities to identify cost-effective municipal GSI and I/I reduction along with significant I/I reduction within the regionalized trunk sewers. |
| Option 8: ALCOSAN Support for Related Programs (by Others) | | | |
| Land Banking | Difficulty | Low | ALCOSAN technical or financial support |
| | Cost | Low | Limited ALCOSAN commitment |
| | Timeframe | Near | Dependent upon groups establishing the land bank(s) |
| | Impact | Low | Depending on number and size of lots, likely limited aggregate source reduction impact |
| Green Credit Banking | Difficulty | High | Would require various new institutional structures |
| | Cost | Low | Limited ALCOSAN commitment |
| | Timeframe | Moderate | Would likely take years to establish |
| | Impact | Unknown | Impacts would depend on the number, source and GSI value of projects |
| Green Crowd Sourcing and Green Micro-Loans | Difficulty | Moderate | Would require an implementing non-profit |
| | Cost | Low | Limited ALCOSAN commitment |
| | Timeframe | Moderate | One to two years |
| | Impact | Unknown | Impacts would depend on the number, source and GSI value of projects |

ALCOSAN's proposal to select and integrate the various source reduction incentive options discussed in this section is outlined in Section 7 of this document.

# 7.0 ALCOSAN's FLOW REDUCTION PROGRAM

While green stormwater infrastructure (GSI) and inflow and infiltration (I/I) reduction can't completely eliminate the need for traditional grey facilities, they can lead to significant reductions in sewer overflows, cost savings and community benefits. ALCOSAN is committed to help lead Allegheny County into a future with sustainably clean water and green communities. Towards this goal, ALCOSAN is proposing the following Green Initiatives including a Green Revitalization of Our Waterways (GROW) program which is already underway providing financial assistance to municipal green partnership projects;

**ALCOSAN's GREEN INITIATIVES**

1. **Green Revitalization of Our Waterways (GROW) Program**
   - **Commitment of funding to municipal flow reduction partnership projects**
   - **Flow reduction project development support**
   - **Expand search for funding for municipalities and encourage partnerships**
2. **Collaborative development of municipal flow reduction plans**
3. **Flow reduction ordinance support**
4. **Long term flow monitoring program**
5. **Regionalization of inter-municipal trunk sewers**
6. **Green enhancements for ALCOSAN-owned wet weather facilities**

1. Green Revitalization of Our Waterways
   - ALCOSAN is providing financial support towards municipal flow reduction partnership projects.
   - ALCOSAN will provide municipalities with technical support resources for developing and implementing municipal GSI, direct stream inflow removal, and sewer rehabilitation projects.
   - ALCOSAN will expand its pursuit of outside funding on behalf of interested municipalities and facilitate partnering opportunities between municipalities and key stakeholders, including public-private partnerships.
2. Work cooperatively with customer municipalities to develop flow reduction plans.
3. Collaborate with the municipalities, the County and other stakeholders towards developing service-area wide model stormwater management, planning and development ordinances, procedures and regional utility coordination efforts.
4. Expand its long-standing program of sewer flow monitoring to assist the municipalities in identifying and confirming GSI and I/I project locations and in evaluating the efficacy of flow reduction projects.
5. Accept ownership of and responsibility for inter-municipal trunk sewers transferred from municipalities to ALCOSAN. ALCOSAN anticipates that regionalization will support flow reduction initiatives, including the prioritization of sewer rehabilitation projects to reduce I/I along transferred trunk sewers.

6. Include GSI, community enhancements and public education at ALCOSAN wet weather control facilities, wherever feasible.

The goal of ALCOSAN's Flow Reduction Program is to capitalize on the benefits that GSI, flow reduction and regionalization can bring to the region. Success will require intensive and on-going coordination amongst many regional stakeholders; including ALCOSAN, its customer municipalities, the regulatory agencies, community and neighborhood groups, and regional planning and governmental agencies.

ALCOSAN is committed to seizing the opportunities identified in this study to make a greener wet weather strategy a reality. More specifically, ALCOSAN will accelerate its ongoing efforts and take the following actions:

- Continue implementation of its GROW municipal partnership program;
- Participate in municipal coordination forums for mutually developing flow reduction plans;
- Use the findings of this source control study to work with the municipalities, community groups and regulatory agencies to design and implement GSI and other flow reduction projects;
- Ramp up its flow reduction technical support efforts, building on its 15-year tradition of partnering with municipalities on projects; and
- Continue the implementation of voluntary intermunicipal trunk sewer regionalization.

The Green Initiatives will evolve as ALCOSAN works with the customer municipalities and other stakeholders to craft a structure that meets the region's diverse needs and circumstances.


*Figure 7-1 ALCOSAN's Green Initiatives*

Regionalization is also expected to prompt flow reduction projects. ALCOSAN plans to evaluate the potential for GSI and sewer rehabilitation to replace the need for some grey infrastructure improvements proposed in municipal feasibility studies. As cost savings and community benefit opportunities present themselves, ALCOSAN plans to leverage GROW program resources to motivate green solutions to sewer overflow control. Public education, outreach, and promotion are also expected to motivate flow reduction projects by building community interest, facilitating information exchange, and promoting success stories.

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