Buffalo Sewer Authority Rain Check 2.0, Citywide Green Infrastructure

by David A. Barnes, Kevin Meindl and Oluwole McFoy

Introduction

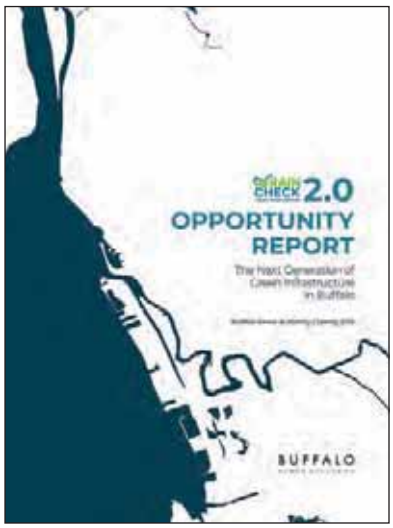
The Buffalo Sewer Authority (BSA) is moving forward to meet the Green Infrastructure (GI) commitments of their Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP). The LTCP was approved by state and federal regulatory agencies in 2014 and included implementing GI strategies for runoff control for impervious surfaces. BSA committed to GI as a practical solution to support traditional gray infrastructure projects and help reduce CSOs into local waterways.

New CSO abatement alternatives were developed and evaluated for comparison to the updated Preferred Alternative from the 2004 LTCP. The new alternatives included innovative and/or emerging technologies such as real-time control and GI. BSA provided additional detail on their GI program by developing a Green Infrastructure Master Plan which includes further refinement of GI impervious surface control targets in critical areas of the collection system. This included analysis at the more localized Sewer Patrol Point (SPP) level, to identify where the system would most benefit from GI technologies. The SPP-level GI allocation provides a more refined and cost-effective approach for BSA to work toward a 1,315-acre total GI program effort.

BSA remains committed to evaluating opportunities to maximize the use of additional cost-effective GI approaches. The target acreage is a minimum program commitment. Any additional GI acreage proposed, in conjunction with the optimization of gray projects, would be in addition to the 1,315-acre goal. This approach allows BSA to adaptively manage the GI program to incorporate lessons learned in each implementation program and take advantage of land use and infrastructure investments projected for each period to deliver the maximum public benefits to the City of Buffalo at the lowest cost.

Background

Officially launched by BSA in 2015, the Rain Check GI program has involved local, state and national water protection partners to plan and implement GI to reduce the frequency and impact of sewer overflows into local waterways.



Rain Check 1.0 Benchmark Report
Buffalo Sewer Authority

Rain Check 1.0 was the first generation of GI implementation in the City of Buffalo. This initiative included tackling the parts of the built environment that create the most runoff from stormwater, such as streets, parking lots and roofs. Projects included:

- Green streets along key transportation corridors with planted areas to collect and infiltrate stormwater and improve pedestrian safety.
- Green parking lots that collect and absorb stormwater.
- Demolitions and vacant lot restorations that created neighborhood green spaces to absorb stormwater.
- Rain barrels and downspout disconnections that enable homeowners to keep stormwater out of the system.

Rain Check 2.0 is a comprehensive, strategic plan that investigates GI projects within six priority sewer basins to reduce the stormwater runoff from approximately 500 acres of impervious surfaces. Community education and engagement are critical to the success of the program.

The Rain Check 2.0 work included the following major components:

- *Benchmark 1.0 Report* to document Phase 1 GI efforts.
- Rain Check 2.0 *Communication and Education* efforts including a new website, online tour and engagement materials.
- A *Technical Advisory Committee* (TAC) to provide guidance on technical and implementation challenges.
- Local *Government Engagement Meetings* to identify opportunities for collaboration.
- *Private Engagement Meetings* to identify partnerships for implementing GI projects.
- A *Stormwater Tree Analysis* and TAC to identify planting opportunities and crediting.
- *Retrofit Reconnaissance Inventory* including a desktop screening analysis to identify possible sites. Field investigations were then performed to determine feasible sites.
- *Rain Check 2.0 Opportunity Report and Equity Analysis.*

Rain Check 2.0 summarizes the preliminary effort to identify opportunities for GI on sites within the priority CSO basins ***(Figure 1)*** and includes recommendations for how GI can be

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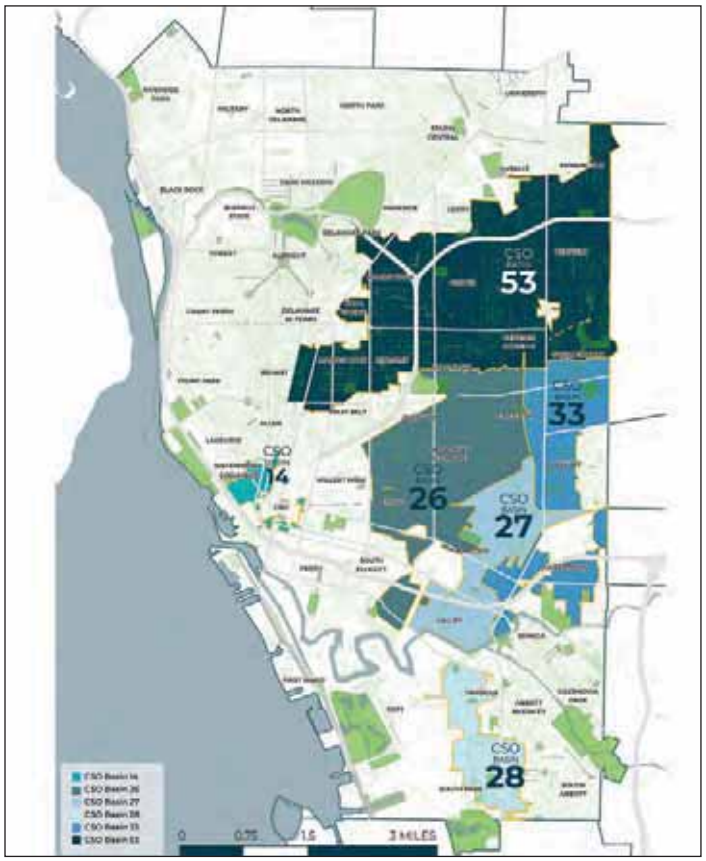

Figure 1. Map showing the six Rain Check 2.0 priority CSO basins.
Buffalo Sewer Authority/Arcadis

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deployed throughout the City of Buffalo.

The *Rain Check 2.0 Opportunity Report* describes efforts undertaken by BSA and identifies the need to create communities of action for implementation. Rain Check 2.0 includes a tool kit of GI technologies that can be deployed in Buffalo and identifies various strategies for structuring GI to maximize stormwater, environmental, equity and economic benefits.

Inclusive Outreach and Public Engagement

Public GI planning and projects can create venues for residents, community-based organizations, and other stakeholders to connect to and shape local decision-making processes. Robust outreach and engagement can provide mutual benefits to both BSA and community members by deepening understanding of community priorities; increasing legitimacy and support for public plans and projects; cultivating resident and community stewardship of projects; and improving government/community relations. Additionally, GI projects can initiate and facilitate community visioning in disinvested neighborhoods to help distribute these benefits to parts of the city that need it most. Outreach and engagement materials were developed to promote the benefits of GI ***(Figure 2)***.

CSO Basin Site Selection

BSA evaluated each of the priority CSO basins through the lenses of equity, environmental systems and site analysis. The opportunities identified in each CSO basin are an effort to balance these three priorities based on the specific conditions in the basin. For example, commercial properties and parking lots comprise much of the impervious area in the priority CSO basins. They are therefore some of the largest contributors of stormwater to the combined sewer system. Retrofitting these properties with GI will be critical to effectively manage the stormwater challenge. Institutions, such as schools and churches, may be smaller contributors of stormwater, but investments in GI on those properties may better support achieving equity goals, such as workforce development and neighborhood revitalization, than developments on private property alone. Improvements to corridors, including green streets and tree planting, address high levels of impervious surfaces and provide benefits such as reducing the urban heat island effect and increasing walkability of neighborhoods.

Based on this analysis, the *Rain Check 2.0 Opportunity Report* identifies types of GI opportunity sites. The opportunity sites were grouped by category, the key categories being corridors, commercial properties, parking lots, institutions, parks and vacant lots. These opportunity sites were identified in each CSO basin based on:

- Equity considerations citywide and within each CSO basin.
- Analysis of how GI would impact and improve environmental systems.
- Site analysis to determine the best opportunities to retrofit GI based on the highest impervious area and the highest feasibility.

Site Analysis

The total area in the six priority CSO basins is 6,827 acres. The target is the removal of 569 acres of impervious cover using GI. To understand the potential for managing large areas of impervious surface, detailed site analyses within the priority CSO basins were performed. These analyses involved two components:

1) A thorough desktop analysis utilizing advanced GIS and remote sensing techniques.
2) Detailed on-the-ground field surveys.

The initial desktop analysis identified potential parcels, property owners and land use. This included key community partners and property owners, such as Public Schools, Parks, Buffalo Urban Renewal Agency, Buffalo Urban Development Corporation, Buffalo

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Figure 2. Green infrastructure education and engagement materials. *Buffalo Sewer Authority/Arcadis*

Municipal Housing Authority, and religious centers. These community partners can act as catalysts for engagement and implementation. The analysis concluded that a significant portion of the impervious reduction targets could be achieved working with these partners.

BSA then conducted field surveys of properties identified through the desktop analysis. The objectives of the field surveys were to:

- Narrow the list of potential parcels to include only those where GI retrofits were feasible.
- Identify the impervious surface drainage area that could be captured on each site.
- Delineate areas within each site appropriate for GI.
- Propose potential GI solutions appropriate to each site.
- Identify implementation challenges at each site, such as parking and utility conflicts.

For each priority CSO basin, the *Rain Check 2.0 Opportunity Report* includes a map showing all the parcels surveyed, the drainage areas and possible GI location. A detailed description of different GI practices was developed.

Since many GI practices include plants, ensuring that possible GI sites have enough sun to grow plants is an important consideration. Therefore, the field surveys included an assessment of shading at each possible GI location. These finding are summarized for each CSO basin. An on-site evaluation was also made regarding how visible the potential GI practice would be from the public right of way. Visibility is important to the community and as a way for BSA to determine if there are any issues with a GI installation.

Site Field Evaluations

Several digital data collection and analysis applications were used to enhance project delivery and support production of the *Rain Check 2.0 Opportunity Report,* released in May 2019. Retrofit Reconnaissance Investigation (RRI) forms, developed by the Center for Watershed Protection and modified by BSA, were completed for over 400 private properties across the six priority sewer basins. Field data collection was conducted using Collector for ArcGIS, a mobile data collection app, to delineate drainage patterns and identify potential retrofit areas efficiently between office and field staff. Survey123, a form-centric data collection app, was used to complete the modified RRI form for each of the assessed areas. More than 10,000 data points were collected during the field investigations. These were summarized in Microsoft Power BI, a business analytics service, to build a library of information for future planning, engagement and implementation efforts ***(Figure 3)***. The team automated collected data into a series of site summary forms using ArcGIS Pro. Specifically, the map series functionality of ArcGIS Pro allows the team to produce hundreds of site layouts by iterating collected data over a series of mapping extents, from a single index layer.

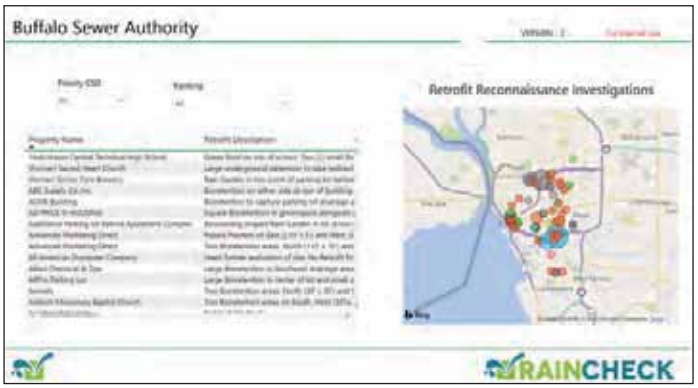

Figure 3. Microsoft Power BI output example. *Buffalo Sewer Authority/Arcadis*

An analysis of citywide tree canopy cover was also conducted to inform appropriate decision makers of current gaps in the urban forest to help prioritize future tree plantings at a higher level of accuracy. A custom workflow was built using Model Builder for ArcGIS to automate the processing of over 7 gigabytes of LiDAR data. The output of this workflow was further analyzed using standard geoprocessing tools to provide more focused insights.

The results of the field reconnaissance are summarized in ***Table 1.***

Table 1. RRI Field Results for Each CSO Area.

CSO	Target Reduction (Acres)	RRI Impervious Area (Acres)	Feasible Reduction (Acres)	Number of Sites Investigated	% Feasible vs Target
14	12.9	87	78	65	604%
26	63.6	244	115	96	179%
27	72.8	320	156	45	214%
28	27.4	68	58	38	211%
33	94	231	180	86	191%
53	298.9	560	485	133	162%

Opportunity Sites

Opportunity Sites were identified for each CSO basin. Workshops were held to review all field data and to discuss each CSO basin's characteristics, including:

- Tree canopy.
- Urban character.
- Equity considerations.
- Potential partners.
- Key neighborhood groups.
- Key corridors.
- Opportunities for clusters or networks.

Corridors

In several CSO basins, corridor GI is critical to meeting the stormwater goal. The predominance of large corridors allows for the organization of GI into larger networked system, increasing the overall potential effectiveness in the basin. For example, the Scajaquada Creek corridor also presents the opportunity to incorporate water history into GI and make underground infrastructure visible. Adding a park would provide an opportunity for both GI and neighborhood connectivity.

Sites

The sites inventoried for GI retrofits typically focused on businesses and large institutional campuses as well as community partner institutions. These sites are organized along many key corridors or grouped in industrial or commercial areas.

Clusters and Networks

Combining feasible retrofit sites, important institutional sites, and corridors reveals the existence of key clusters. The presence of community institutions provides the opportunity to have a programmatic focus, such as workforce development, community health or economic development.

Opportunity Report

The final deliverable is the *Rain Check 2.0 Green Infrastructure Opportunity Report and Equity Analysis.* The document describes the

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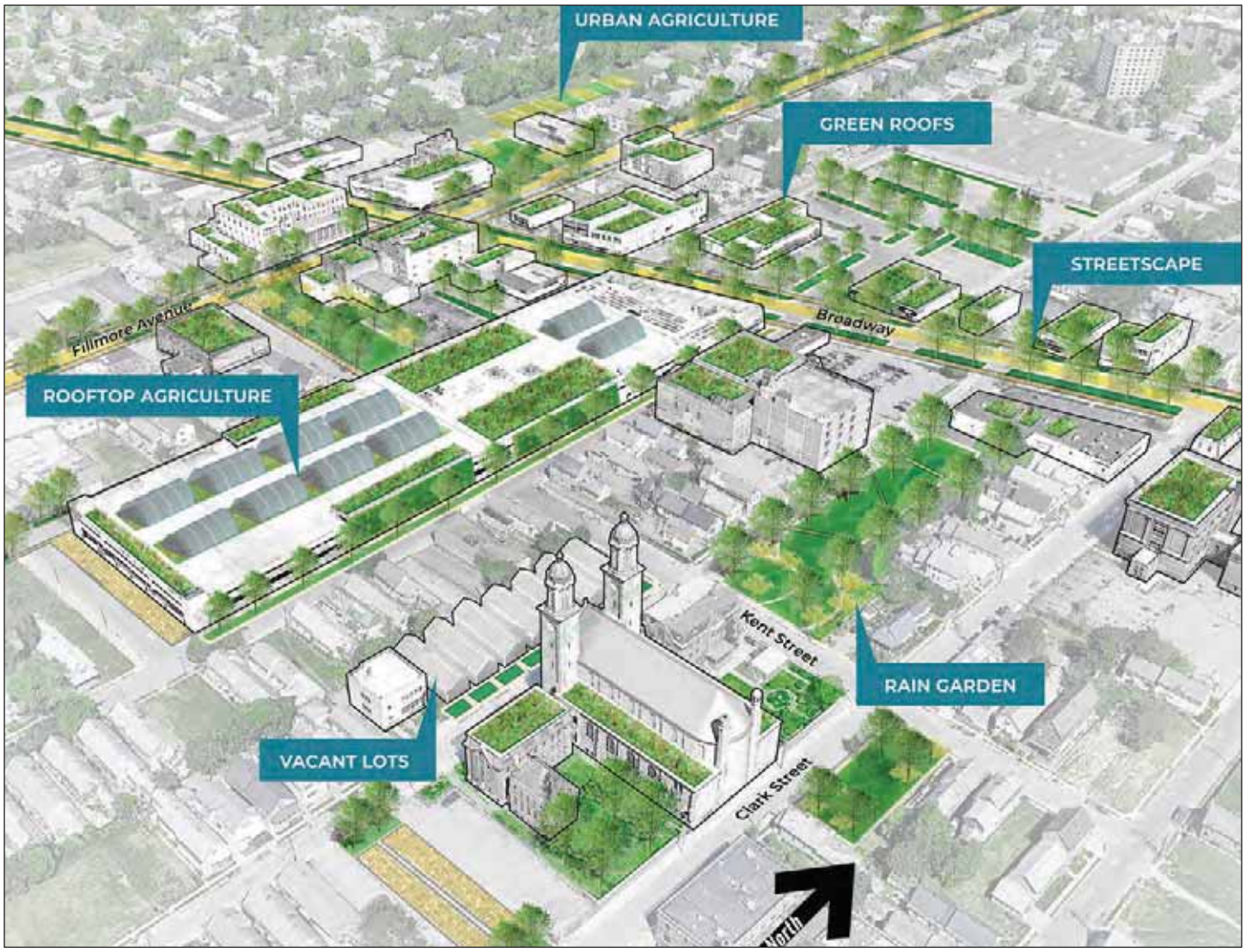

Figure 4. Potential GI for one neighborhood. *Buffalo Sewer Authority/Arcadis*

Figure 5. Location summary forms for stakeholder engagement meetings. *Buffalo Sewer Authority/Arcadis*

Buffalo Rain Check 2.0 Green Infrastructure efforts undertaken by BSA. The document was completed in spring 2019 and highlights opportunities in each priority sewer basin to meet CSO compliance requirements. The report includes green stormwater solutions located on both public and private property throughout the city to better manage stormwater, improve the health of waterways, and enhance and beautify the public land ***(Figure 4)***.

As a benchmark report, the document synthesizes some of BSA's research and outlines future initiatives. As a tool to facilitate future investment in GI, the document provides a unified framework and strategies to support planning and decision making. As an opportunity analysis, the document identifies potential partners and community benefits to engage stakeholders and property owners in planning and funding of GI projects across the City of Buffalo.

Successful GI requires a supportive culture in Buffalo that advocates for its implementation and maintenance. Rain Check 2.0 includes a robust strategy of engagement ***(Figure 5)*** and a balancing of priorities to ensure that stormwater goals are met and that the implementation of GI is informed by consideration of equity and the broader environmental context.

The work of Rain Check 2.0 confirmed that BSA can meet or exceed its stormwater goals in the priority CSO basins by employing GI. Meeting the goals requires investments in GI on both publicly owned and privately-owned properties. Ongoing planning and outreach to identify partners, engage stakeholders, and build trust and shared values is critical to success. *The Opportunity Report* is a first step in that larger planning effort.

The next steps in achieving BSA's stormwater goals include continuing communications and education, advancing private stakeholder engagement and developing the GI implementation program.

David A. Barnes is a Principal Engineer with Arcadis and may be reached at david.barnes@arcadis.com. Kevin Meindl is the Green Infrastructure Program Manager with the Buffalo Sewer Authority and may be reached at kmeindl@buffalosewer.org. Oluwole McFoy is the General Manager with the Buffalo Sewer Authority and may be reached at omcfoy@buffalosewer.org.

The reports cited in this article are available on the Rain Check Clean Water Buffalo website *https://raincheckbuffalo.org/*.

A bioretention cell, or rain garden, installed as part of Buffalo Sewer's CSO 060 Green Infrastructure Project. *Buffalo Sewer Authority*