

Appendix 3 Green Infrastructure Anticipated Co-Benefits Analysis

FINAL REPORT

Northeast Ohio Regional Sewer District

October 7, 2015



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Executive Summary

The Northeast Ohio Regional Sewer District (District), as part of its Combined Sewer Overflow (CSO) Consent Decree with the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (Ohio EPA), is required to report on ten different categories of co-benefits for its Appendix 3 Green Infrastructure (GI) projects. The District's Appendix 3 GI Anticipated Co-Benefits Analysis (Anticipated Co-Benefits Analysis) includes calculations of specific community, environmental and financial co-benefit indicators to fulfill this requirement.

This report describes the methods applied to develop co-benefits information and analysis results representing a range of anticipated community, environmental and financial co-benefits. These co-benefits, shown in Figure ES1, are examined at the site and neighborhood scales. The report also discusses the impact of certain co-benefits collectively across the District's Appendix 3 GI Projects and refers to this cumulative impact as the program-wide scale.

Figure ES1: Anticipated Co-Benefits



Community Benefits

Recreational Benefits
Aesthetics Improvements
Socioeconomic/
Quality of Life Benefits
Potential Property Value Increases
Community Engagement



Environmental Benefits

Ecological Benefits
Air Quality Benefits
Climate Change Mitigation



Financial Benefits

Energy Savings
Job and Economic Development
Life Cycle-Cost Savings

Appendix 3 GI Projects

Since 2011, the District completed the GI Plan, construction of two Appendix 3 GI Projects and advanced planning and design on an additional seven projects. The District expects to spend a total of \$58.7 million to design and construct the Appendix 3 GI Projects by 2019. The Appendix 3 GI Projects analyzed for co-benefits include:

- University Circle Demonstration Project
- Green Ambassador – Slavic Village Demonstration Projects
- Fleet Avenue Green Infrastructure
- Green Ambassador – Urban Agriculture
- Green Ambassador – Fairhill/MLK
- East 140th Street Consolidation & Relief Sewer Project
- Woodland/Central Green Infrastructure Project
- Union Avenue Green Infrastructure
- Buckeye Road Green Infrastructure

It is important to note the District has a range of other green infrastructure efforts outside of its Consent Decree. These efforts were not analyzed as part of this report and are not included in this document. As a result, this document does not represent the District's full green infrastructure effort.

Anticipated Co-Benefits

The analysis of anticipated co-benefits focuses on the ten required co-benefits plus community engagement, as defined by the District with feedback from the District's External Advisory Committee (EAC). The Anticipated Co-Benefits Analysis discreetly analyzes indicators for each co-benefit. The analysis approach compares pre- and post-construction conditions to calculate different co-benefit indicators.



Green Ambassador – Slavic Village Demonstration Site (East 75th Street)

Analysis Approach

The Co-Benefits Model serves as the primary analysis tool to calculate anticipated co-benefit indicators. The model was constructed to compare different data inputs and add specific calculation parameters to produce co-benefits information. The model serves as a data repository as well as a tool to graphically illustrate the model results.

The co-benefits were measured with indicators developed by the District to provide measurable and quantitative information about the anticipated impact of the Appendix 3GI projects. The analysis uses the co-benefit indicators to produce non-monetary and monetary values and express anticipated impacts of Appendix 3 GI in ways that are most meaningful to the District and its stakeholders.

The analysis starts with the collection and review of existing data supplemented by site visits. Data inputs focused on:

- Appendix 3 GI Project Design Features: Key design features that influence co-benefit indicators for each category ;
- Current Project Area Conditions: The existing GI Feature Site and its connectivity to existing areas; and
- Calculation Parameters: Parameters derived from existing practices such as life-cycle wastewater treatment cost per gallon, or environmental or engineering literature such as carbon sequestration rates, and applied in computations to estimate GI system performance and co-benefit indicators.

Data collection and review also considered the population groups directly affected by the Appendix 3 GI Projects in terms of socio-economic conditions and environmental justice indicators. The analysis inputs and outputs, and analysis results and evaluation findings are described in terms of the populations who

live on parcels and in households immediately adjacent to or within a 5-minute walking distance to the Appendix 3 GI Feature Site, and for the neighborhoods shown in Figure ES2.

Figure ES2: Project Locations by Neighborhood

Neighborhood*	Appendix 3 GI Project
Broadway – Slavic Village	Green Ambassador – Slavic Village Demonstration Projects Fleet Avenue Green Infrastructure Union Avenue Green Infrastructure
University Circle	University Circle Demonstration Project
Kinsman	Green Ambassador – Urban Agriculture
Buckeye Shaker Square	Green Ambassador – Fairhill/MLK
East Cleveland	East 140 th Street Consolidation & Relief Sewer Project
Central	Woodland/Central Green Infrastructure Project
Buckeye – Woodhill	Buckeye Road Green Infrastructure

Source: Northeast Ohio Data Collaborative, 2012.

Results and Evaluation

The District developed the co-benefit indicators to ensure results from the analysis were responsive to Appendix 3 of the Consent Decree. It is also important that the results were clear, project specific and related to the issues of highest priority within the affected communities. Results and evaluation findings are presented in this report as follows:

- Appendix 3 GI Project Specific Results
- Program-wide Summary
- Comparison of Appendix 3 GI Projects
- Green vs. Gray Infrastructure Comparisons

The co-benefits anticipated for Appendix 3 GI Projects are proportional to the size of the GI Feature Sites and their respective drainage areas. Only two of the Appendix 3 GI Projects do not include sewer separation: University Circle and Slavic Village Demonstration. Investments by the District in additional Appendix 3 features and amenities including landscaping, hardscapes and gathering spaces at the GI Feature Site, provide significant community and financial co-benefits. Environmental co-benefits all projects are modest in terms of air pollutant and greenhouse gas emissions reductions. Detailed findings from the Anticipated Co-Benefits Analysis are presented in Section 5.

Program-wide results are presented in Figure ES3 on the next page as the sum of key indicator values across all nine Appendix 3 GI Projects. Overall performance and benefits of these projects are linked in various ways to the 209 MG of stormwater that these projects manage and the projects' total footprint, including 10 miles of new sewers within respective drainage areas and 63 acres of land improvements at the GI Feature Sites. These results are further described in this Appendix 3 GI Anticipated Co-Benefits Analysis Final Report.

It is important to specifically note the findings of this analysis related to life-cycle costs of GI versus traditional gray infrastructure. At the volumes of CSO which the District is controlling, and the specific parameters of the District's combined sewer system, GI has a higher life-cycle cost than gray infrastructure.

Figure ES3: Program-wide Results

Key Indicators			Program Totals
Community Benefits	Community Engagement	Number of People within Walking Distance to Site	10,261
	Recreational Benefits	Acres of New Public Space	39
	Potential Property Value Increases	Number of Existing Parcels Adjacent to the GI Site	231
	Aesthetic Improvements	Acres of Distressed Properties Repurposed	29
	Quality of Life Benefits	Number of Households with New Local Infrastructure	2,812
Environmental Benefits	Ecological Benefits	Number of New Trees	1,508
	Ecological Benefits	Acres of Natural Areas	18
	Climate Change Mitigation	Acres of Shaded and Pervious Surface Area	39
	Climate Change Mitigation	Metric Tons of Potentially Reduced Greenhouse Gas at WWTP	187
	Air Quality Benefits	Kilograms of Potentially Reduced Air Pollutants	3,022
Financial Benefits	Energy Savings	Annual Energy Cost Savings at WWTP	\$156,328
	Jobs and Economic Development	Annual Economic Impact (indirect)	\$654,466

"The District's GI project is some of the first investment we have seen going in the Buckeye area in awhile. It's a big investment that is visible to the public so it presents an opportunity to improve the neighborhood. Both communities are interested because we have a mass of GI there and the question is whether it is a critical mass or not and how we achieve that. The work the District is doing is exciting and it's interesting to be a part of the External Advisory Committee and see the evolution of their thinking about GI as they move through the process."

— Cleveland Botanical Gardens (CBG): Sandra Alba, Director of Research

1. Introduction

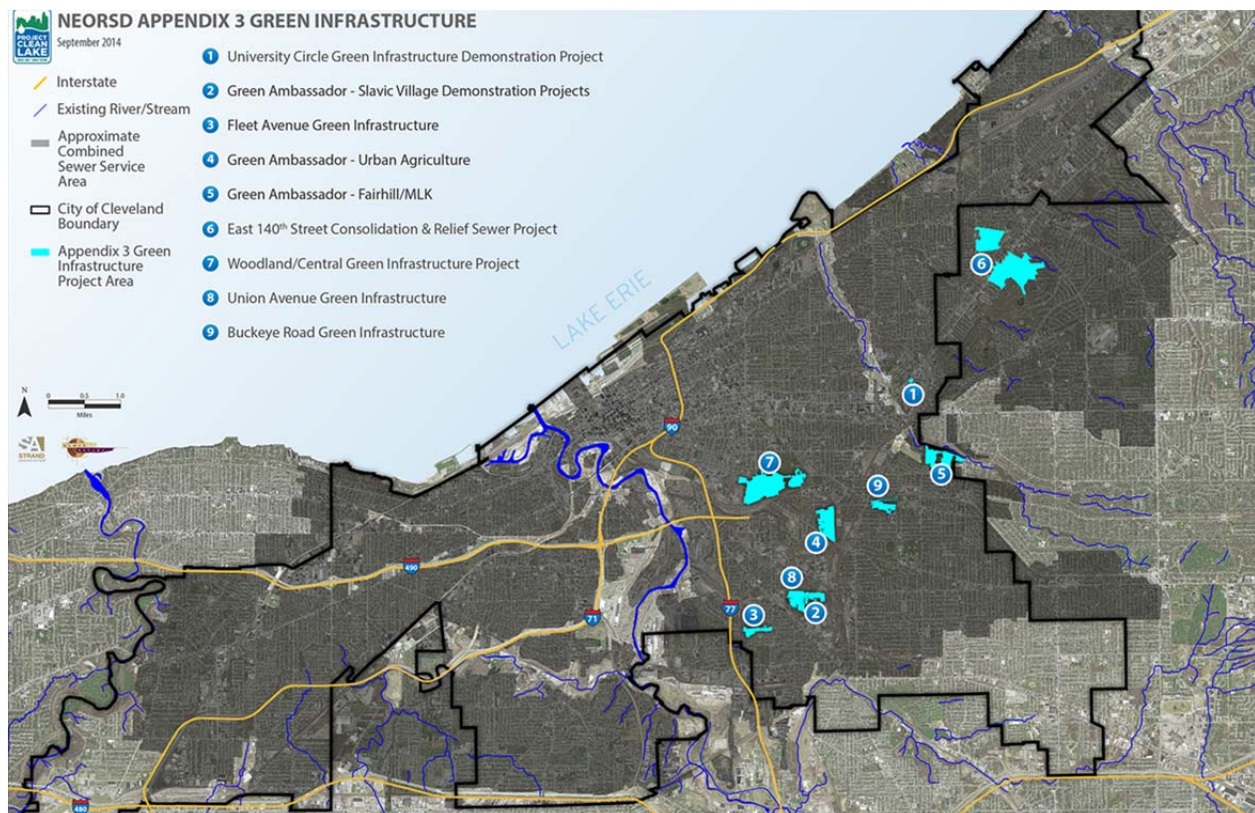
The Northeast Ohio Regional Sewer District (District), as part of its Combined Sewer Overflow (CSO) Consent Decree with the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (Ohio EPA), is required to report on ten different categories of co-benefits for its Appendix 3 Green Infrastructure (GI) Projects. The District's Appendix 3 GI Anticipated Co-Benefits Analysis (Anticipated Co-Benefits Analysis) includes calculations of specific community, environmental and financial co-benefit indicators to fulfill this requirement.

The co-benefit indicators developed by the District provide measurable or quantitative information about the anticipated impact of GI projects for specific co-benefits. This analysis produces non-monetary and monetary values supplemented by qualitative information to express anticipated impacts of Appendix 3 GI in ways that are most meaningful to the District and its stakeholders.

This report describes the methods applied to develop co-benefits information as well as the analysis results for co-benefit indicators representing a range of anticipated community, environmental and financial impacts at the site, neighborhood and program-wide scales.

It is important to note the District has a range of other green infrastructure efforts outside of its Consent Decree. These efforts were not analyzed as part of this report and are not included in this document. As a result, this document does not represent the District's full green infrastructure effort.

Figure 1.1: District Appendix 3 GI Projects within the Combined Sewer Area





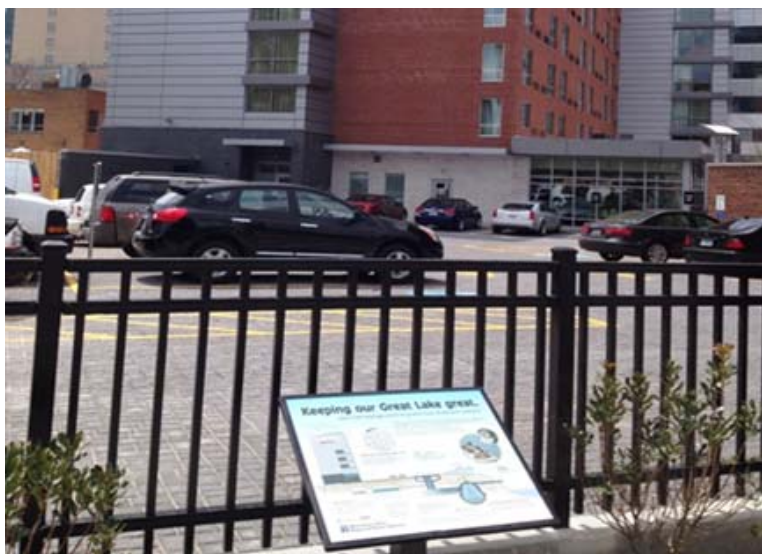
Appendix 3 GI Projects Background

The CSO Consent Decree includes Appendix 3, which requires the District to develop and implement a GI Plan. The GI Plan describes how the District will control an additional 44 million gallons (MG) of wet weather CSO volume through GI. This additional control is to be achieved through Appendix 3 GI Projects at a minimum cost of \$42 million, and completed within 8 years from the date of entry of the Consent Decree (July 7, 2011).

Since 2011, the District completed the GI Plan, construction of two Appendix 3 GI Projects and advanced planning and design on an additional seven projects. Figure 1.1 provides locations of the Appendix 3 GI Projects. The District expects to spend a total of \$58.7 million to design and construct Appendix 3 GI by 2019. A summary of each GI project, including design and construction schedules, the estimated CSO volume reductions with and without gray infrastructure implemented, pre- and post-gray, respectively are is below:

University Circle Demonstration

The project is located in the University Circle neighborhood close to downtown Cleveland and adjacent to Case Western Reserve University, the Museum of Contemporary Art, and University Hospitals. It is designed to manage 1 MG of stormwater in a typical year. GI at this site will reduce CSO volume by an estimated 400,000 gallons pre-gray and 100,000 gallons post-gray. The primary design includes underground storm chambers and pervious interlocking concrete pavers, taking advantage of existing sandy soils, in a hotel parking lot. Construction was completed in July 2013.



Pervious Interlocking Concrete Paver Parking Lot - University Circle

The University Circle Demonstration project resulted in a strong relationship between the District and the local community development corporation, University Circle Incorporated (UCI). Together the District and UCI are promoting GI in the University Circle neighborhood and highlighting efforts to incorporate GI practices into redevelopment projects in the combined sewer area. The District is also focusing on the type and intensity of maintenance necessary to ensure such practices continue to function properly. In addition to fostering community partnerships and the high visibility of this project, the University Circle Demonstration has performed well in its first years of installation. District monitoring shows no runoff from the site up to the 100-year storm event.

Key Terms Defined

Pre-Gray: District modeling and/or engineering calculation of baseline conditions to estimate CSO capture for each GI project without gray infrastructure i.e., current tunnel.

Post-Gray: District modeling and/or engineering calculation of Consent Decree conditions to estimate CSO capture for each GI project with gray infrastructure i.e., current tunnel.

Typical Year: A synthetic typical year rainfall time series was developed in 1995 as part of the District's CSO facilities planning effort. This synthetic typical year consists of 121 representative events compiled predominately from recorded rainfall that occurred in 1991 and 1993.

Green Ambassador - Slavic Village Demonstration

The project is located in the Broadway-Slavic Village neighborhood of the City of Cleveland. It is designed to manage 200,000 gallons of stormwater in a typical year. GI at this site will reduce CSO volume by an estimated 100,000 gallons for pre-gray and post-gray conditions. The primary design includes three bioretention basins which receive surface runoff from adjacent land and streets via curb cuts. Construction was completed in November 2014.



Complete Bioretention Basin on East 78th Street - Slavic Village Demonstration

The Green Ambassador – Slavic Village Demonstration project was built on vacant land. This project compliments reuse efforts advanced by the Slavic Village Development Corporation and other neighborhood partners including the Cleveland Botanical Gardens, the U.S. EPA Office of Research and Development and U.S. Geological Survey. The project repurposes vacant, land banked parcels adjacent to the Morgana Run bike trail and adds a neighborhood amenity that the District will permanently maintain.

Fleet Avenue

The project is located in the Broadway-Slavic Village neighborhood. It is designed to manage 4.7 MG of stormwater in a typical year. GI at this site will reduce CSO volume by an estimated 3.6 MG pre-gray, and 500,000 gallons post-gray. The primary design is an infiltration basin which receives flow from new separate storm sewers along Fleet Avenue. The design is complete and substantial construction completion is scheduled for the first quarter of 2016.



Design Rendering of the Infiltration Basin on Fleet Avenue

The Fleet Avenue project facilitated the implementation of the larger Fleet Avenue Rehabilitation Project, a long-planned complete and green street by the City of Cleveland and the Slavic Village Development Corporation. It takes advantage of the existing sandy soils on-site and the ability to infiltrate stormwater, permanently removing it from the combined sewer system. This project also repurposed vacant property at a highly visible location along Fleet Avenue and ensures its on-going functionality through the District's maintenance.

Green Ambassador - Urban Agriculture

The project is located in the Kinsman neighborhood on Cleveland's east side. It is designed to manage 7 MG of stormwater in a typical year. GI at this site will reduce CSO volume by an estimated 6.6 MG pre-gray, and 1.6 MG post-gray. The primary design includes four bioretention basins which receive flows from new separate storm sewers and adjacent surface runoff. Construction will begin second quarter of 2015 with substantial completion scheduled for the last quarter of 2016.

The Green Ambassador – Urban Agriculture project built on several years of work done by the Burten Bell Carr Community Development Corporation and its partners, including the Rid-All Green Partnership and Kinsman Farms, a project of The Ohio State University Extension. The project takes advantage of these strong site anchors and catalyzed the removal of legacy illegal dumping that has plagued this area. It also provided an essential entry feature to the Urban Agricultural Innovation Zone.

The project will permanently repurpose vacant properties, improve a neighborhood park, and provide an outdoor classroom for educational programming.



Design Renderings of Two Bioretention Basins - Urban Agriculture

Green Ambassador - Fairhill/MLK

The project is located in the Buckeye-Shaker neighborhood of the City of Cleveland. It is designed to manage 17 MG of stormwater in a typical year. GI at this site will reduce CSO volume by an estimated 9.6 MG pre-gray, and 2.4 MG post-gray. The primary design is a bioretention basin which receives flows from new separate storm sewers. Construction will commence first quarter of 2015 with substantial completion scheduled for the last quarter of 2016.



Design Rendering of the Gateway and Energy Dissipater - Fairhill/MLK

The Green Ambassador – Fairhill/MLK project is located at a highly visible intersection on Cleveland's east side and within a historic and well-used City park. Throughout the development of the project, the District worked closely with the Buckeye Shaker Square Area Development Corporation and other project partners, including adjacent residents and local businesses, to ensure the project is an amenity to the neighborhood. In addition, the District partnered with the Regional Transit Authority to add amenities and improve aesthetics at an existing bus stop adjacent to the project.

East 140th Street Consolidation & Relief Sewer

GI is to be constructed as part of this sewer improvement project located in the City of East Cleveland on Page Avenue, Scioto Avenue and Second Avenue to manage up to 117.8 MG of stormwater in a typical year. GI at this site has the potential to reduce CSO volume by an estimated 25.3 MG pre-gray, and 5.8 MG post-gray. The preliminary design includes three detention basins which receive flows from new separate storm sewers. The design is underway and substantial construction completion is scheduled for the first quarter of 2019.



Design Rendering of Detention Basin - E 140th Street Consolidation & Relief Sewer

The East 140th Street Consolidation and Relief Sewer project repurposes vacant properties along severely blighted areas. The project replaces abandoned structures with neighborhood amenities, including public open space that will be maintained by the District.

Woodland Central

The project is located in the City of Cleveland's Central neighborhood. If associated environmental issues are resolved, the project could manage up to an estimated 41 MG of stormwater in a typical year and reduce CSO volume by an estimated 14.3 MG pre-gray, and 5.7 MG post-gray. However, this site has substantial environmental issues that may impact its viability. The primary design includes two large bioretention basins which receive flows from new separate storm sewers as well as adjacent surface runoff. The design is to commence in April 2015 and substantial construction completion is scheduled for third quarter of 2019.

The Woodland Central project has the potential for significant community benefits, if the District can cost-effectively deal with the legacy of illegal dumping that has resulted in significant brownfields issues. Located in the historic Kingsbury Run watershed, the Woodland Central project will remediate and repurpose vacant properties, add two large scale open space features for the community, and build on other community redevelopment efforts being lead by the City of Cleveland and Burten Bell Carr Community Development Corporation.



Design Renderings of Bioretention Basins - Woodland Central

Union

The project is located in the City's Broadway-Slavic Village neighborhood. As currently planned the project will manage an estimated 10 MG of stormwater in a typical year and reduce CSO volume by an estimated 4.2 MG pre-gray, and 1.2 MG post-gray. The primary design is a bioretention basin which receives flows from new separate storm sewers. The design is underway and substantial construction completion is scheduled for last quarter of 2018.



Design Rendering of Bioretention Basin - Union

As with the other Appendix 3 GI Projects in the Broadway-Slavic Village neighborhood, the Slavic Village Development Corporation (SVD) has been an essential partner to the District in the implementation of the Union project. This project repurposes a large vacant industrial site adjacent to the Morgana Run trail and nearby is new residential development being lead by SVD.

Buckeye

The project is located in the Buckeye-Woodhill neighborhood on Cleveland's east side. As currently planned the project will manage an estimated 10 MG of stormwater in a typical year and reduce CSO volume by an estimated 3.7 MG pre-gray, and 1.1 MG post-gray. The primary design includes bioretention basins which receive flows from new separate storm sewers. The design is underway and substantial construction completion is scheduled for last quarter of 2018.



Design Rendering of Bioretention Basins - Buckeye

Like the Fairhill/MLK project, the Buckeye project is well supported by the Buckeye Shaker Square Area Development Corporation. It meets a longstanding community need for removal of abandoned structures along Buckeye Road and the construction of a gateway to the commercial corridor of Buckeye above Woodhill Road. The project will build multiple, cascading bioretention basins along the corridor and repurposes blighted properties with new public open space to be maintained by the District.

Analysis Goals and Guiding Principles

The District's primary goals in developing the Anticipated Co-Benefits Analysis are to produce meaningful results for the communities most affected and to advance the national dialogue about the benefits of GI beyond CSO control. To accomplish these goals, the District's approach was driven by the following guiding principles:

- The analysis should be specific to the Districts' Appendix 3 GI Projects and sites, while balanced with credible existing environmental, social and economic data;
- Input from diverse stakeholders throughout the analysis will ensure results speak to the issues of highest priority in the affected communities including environmental justice concerns;
- Considerations beyond costs must be accounted for to ensure a balanced GI strategy in the combined sewer area moving forward and, therefore, triple bottom line (TBL) values or one monetary cost summing all Appendix 3 GI projects versus other CSO control projects should not be forced; and
- The information developed can be used to improve Appendix 3 GI projects and designs throughout the combined sewer area and Northeast Ohio going forward as it relates to co-benefits, and support plans for neighborhood revitalization and redevelopment to the greatest extent feasible.

The District intends to use the results of this analysis to enhance completed and remaining Appendix 3 GI Project designs.

External Advisory Committee Involvement

The District's External Advisory Committee (EAC) serves as a discussion forum for the District to engage with interested community members on the impacts of the District's Appendix 3 GI decisions and projects. The EAC includes a comprehensive representation of community organizations within the District's combined sewer area.

During the development of the Anticipated Co-Benefits Analysis, the EAC had several opportunities to provide feedback including meetings and follow-up surveys conducted by the District. The first meeting focused on the anticipated co-benefits and related indicators. The second meeting was formatted similar to a workshop with a presentation about the Anticipated Co-Benefits Model and small breakout group discussions focused on the best way to present results to the community including preliminary indicator values.

All feedback from these meetings as well as interim communications between members and the District were evaluated to determine how best to integrate into the Anticipated Co-Benefits Analysis. In particular,

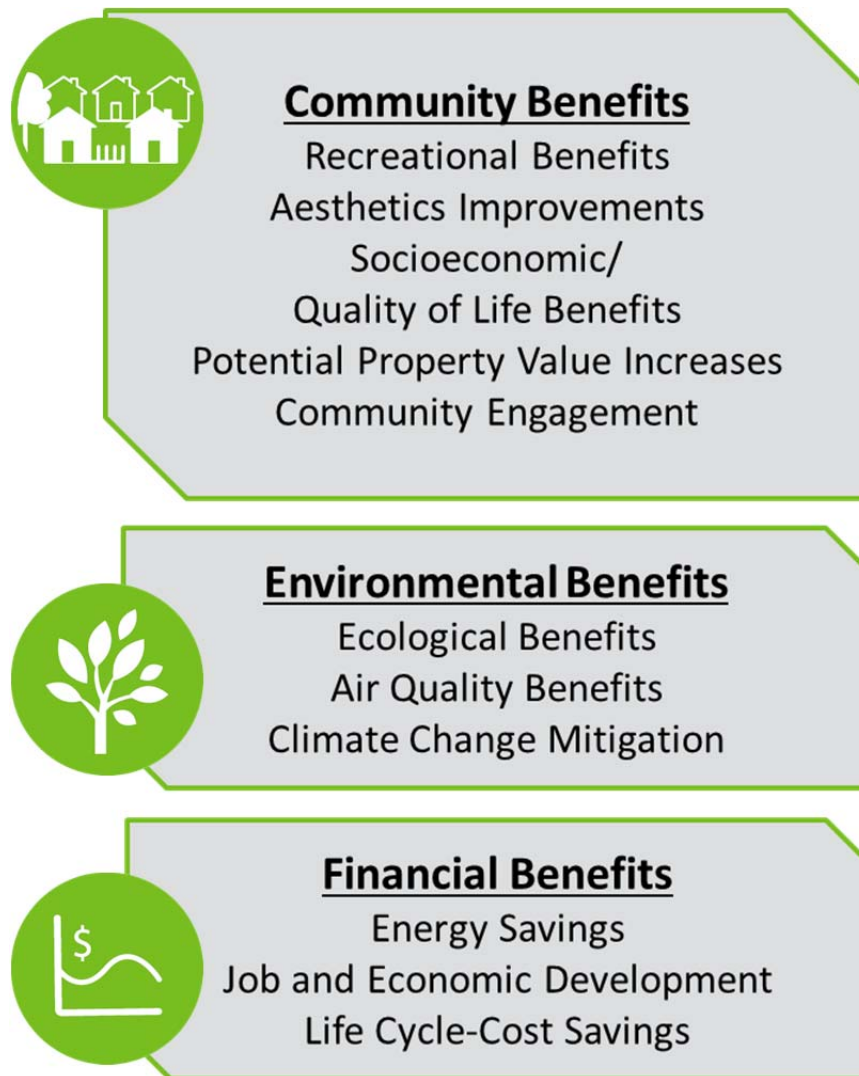
Participating EAC Members

- Burten Bell Carr Community Development Corporation
- City of Cleveland Council – Ward 1
- City of Cleveland Council – Ward 15
- City of Cleveland, Planning Commission
- City of Cleveland, Mayor's Office of Capital Projects
- Cleveland Botanical Gardens
- Cleveland Foundation
- Cleveland Urban Design Collaborative
- Cleveland Water Alliance
- Cuyahoga County Landbank
- Cuyahoga County Planning Commission
- Environmental Health Watch
- Greater Cleveland Partnership
- GreenCityBlueLake Institute
- Lakewood Alive
- LandStudio
- Neighborhood Progress Inc.
- Northeast Ohio Areawide Coordinating Agency
- St. Luke's Foundation

the following feedback from the EAC helped to frame the analysis approach and reporting of results herein:

- The different co-benefits and related indicators should be organized into categories for easier communication (as shown in Figure 1.2);
- Qualitative information about the types of community partners and types of engagement specific to each Appendix 3 GI Project should be described as part of the Anticipated Co-Benefits Analysis (see summary of community benefit indicators and stakeholder interviews in Section 5, GI Project Specific Results); and
- The presentation of co-benefit indicators should compare impacts across the different Appendix 3 GI Projects and program-wide impacts as improvements over baseline conditions of concern within the community (see Section 5 and findings and conclusions in Sections 6 and 7).

Figure 1.2: Categories of Anticipated Co-Benefits Suggested by the EAC



2. Analysis Approach

The analysis of anticipated co-benefits relies upon a qualitative and quantitative evaluation approach that includes data collection, internal and external feedback and a calculator tool. The flow chart in Figure 2.1 shows the complete approach used to develop the Anticipated Co-Benefits Analysis. This approach allows for the measuring of anticipated co-benefits to be updated in the future as projects are constructed and data is refined, if desired. Each of the analysis steps are described in more detail in this section of the report.

Figure 2.1: Appendix 3 Anticipated Co-Benefits Analysis Approach



Pre-Analysis

Each of the District's Appendix 3 GI Projects was visited by a multi-disciplinary analysis team that included engineers, an economist and an urban planner and District staff to initiate pre-analysis data collection. Examples of existing site conditions are shown in Figure 2.2. In addition to photo-documentation, observations noted included land uses surrounding the Appendix 3 GI Feature Site, conditions of adjacent properties, pedestrian traffic, and access to public transportation.

For each site, background information on proposed GI project design features, existing site conditions and uses, and current project area or neighborhood conditions were provided by the District. Initial data included basis of design and design option evaluation reports, community impact assessments, public participation plans, design plans and costing data specific to each Appendix 3 GI Project. The data were reviewed to extract information about GI project areas and site conditions, design features and planting plans, and estimated stormwater managed and CSO reduction volumes. These data sources are listed in Appendix D of this report.

Figure 2.2: Current Conditions at Representative GI Feature Sites



Union



East 140th Street Consolidation & Relief Sewer



Woodland Central



Buckeye

Reviewing potential geographic areas of impact was essential to the identification of population groups expected to benefit from Appendix 3 GI Projects. This step began during the pre-analysis phase and was continuously refined throughout the Anticipated Co-Benefits Analysis. The different levels of impact

considered the GI Feature Site, surrounding community, larger neighborhood and drainage area, and the City.

Desktop analyses using geographic information systems (GIS) were completed to evaluate areas within a ¼- and ½-mile radius and representative of the 5- and 10-minute walk, respectively, to the GI Feature Site. An example is shown in Figure 2.3 where a ¼-mile radius around the Green Ambassador Fairhill/MLK site is shown in orange and a 5-minute walk is shown in blue to reflect actual pedestrian connections in the surrounding community.

The District reflected potential walking routes or patterns of current residents to delineate the 5-minute walk. For this reason, as show in Figure 2.3, the 5-minute walk is irregularly shaped and extends short distances beyond the ¼-mile radius. For all Appendix 3 GI Projects, these scales were applied to begin to measure ecological, climate change, air quality, recreational, aesthetic, potential property value increase and socioeconomic/quality of life co-benefit indicators.

Figure 2.3: Pedestrian Connections within a 5-minute Walk to GI Feature Site



Larger geographic areas of potential impact were also evaluated to assess socioeconomic/quality of life co-benefit indicators. The analysis was expanded to include the drainage areas where separate storm sewers are to be constructed and the defined neighborhoods for comparative statistics of direct benefits. Finally, program-wide areas of influence were used to measure the anticipated co-benefit indicators associated with jobs and economic development, the impacts of reduced flows to the District's wastewater treatment plants on air quality and energy savings, and green versus gray infrastructure comparisons of life-cycle cost savings and climate change mitigation.

Data collection and review, started during the pre-analysis and refined throughout the analysis, provided the 'inputs' into the Anticipated Co-Benefits Model described in more detail below.

Defining Co-Benefits and Related Indicators

The anticipated co-benefits analyzed and presented in this report align with the co-benefits identified in Appendix 3 of the District's Consent Decree. The co-benefits were expanded to include community engagement and capture the level of community partnerships needed to develop each project and

integrate into the neighborhood. As described in Sections 3 and 4 of this report, a majority of anticipated co-benefits include two or more indicators and different areas of impact. The indicators are used in the Anticipated Co-Benefits Model to capture the values used to measure the anticipated co-benefits.

Anticipated Co-Benefits Model

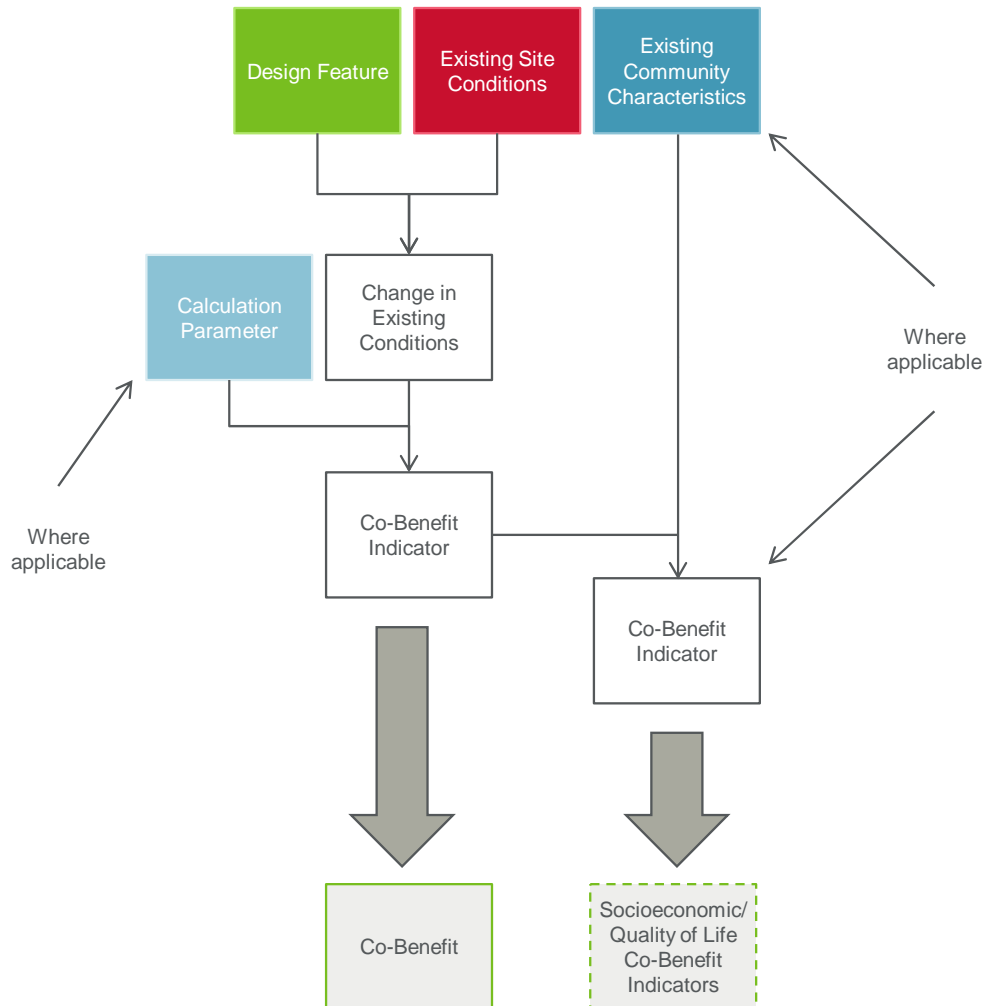
The Anticipated Co-Benefits Model is an Excel based tool and workbook. This model allows the input of information about the design features of Appendix 3 GI Projects and existing site conditions and surrounding community characteristics to produce anticipated co-benefit indicator values.

The model is a series of linked worksheets, including data banks, data sources, and project specific input and output summaries, to calculate anticipated co-benefit indicators and to describe related co-benefits. The mapping diagram in Figure 2.4 shows how the measurement of co-benefit indicators is based on determining the incremental difference between existing conditions and the anticipated future conditions after the Appendix 3 GI Project is built. The data used to determine the change between the existing conditions and future effects of the project includes various factors to determine the co-benefit indicator values or change in existing conditions, such as site-specific design features of each project, the existing site conditions, and existing community characteristics surrounding the Appendix 3 GI project site.

For some co-benefits, the impact of an Appendix 3 GI Project requires computation based on various calculation parameters to transform a change in existing conditions into meaningful indicators of potential future impacts. For example, the gallons of treatment avoided at wastewater treatment plants (WWTPs) as a result of stormwater managed by an Appendix 3 GI Project is multiplied by the kilowatt per hour (kWh) of energy used to treat a gallon of flow at the Southerly and Easterly WWTPs. This amount of energy in kWh is converted to a reduction of carbon dioxide (CO₂) emissions using a multiplier of 0.0007 metric tons of CO₂ per kWh based on the US EPA - Emissions & Generation Resource Integrated Database (eGRID). This multiplier represents a calculation parameter used to determine reduced greenhouse gas (GHG) emissions and the related climate change mitigation co-benefits.

In other instances, the impact on existing condition is the same as the co-benefit indicator and no such calculation parameter is needed. In some cases, the change in existing condition or calculated indicator is evaluated with socioeconomic and quality of life co-benefit indicators to identify specific benefits for selected population groups.

Detailed information about calculating anticipated co-benefit indicators based on the combining of inputs and calculation parameters is presented in Section 4 and additional information about the creation of the Anticipated Co-Benefits Model is in Appendix C.

Figure 2.4: Framework for Calculating Anticipated Co-Benefits

Preliminary Anticipated Co-Benefit Results Review

Preliminary analysis results and indicator values were calculated within the Anticipated Co-Benefits Model and reviewed by the District and EAC. Reviews focused on the presentation of the information to ensure it was clear and comprehensive yet specific to the indicators most important to the community. These were identified by the EAC and included those indicators related to recreational benefits, jobs and economic development, ecological benefits, energy savings and climate change mitigation.

GI Project Specific Results and Evaluation

This report presents final results and findings from the Anticipated Co-Benefits Analysis in several different formats as described below.

Appendix 3 GI Project Specific Results

The results from the calculation of co-benefits indicators in the Anticipated Co-Benefits Model are organized by community, environmental and financial benefits, and accompanied by socio-demographics data for the surrounding community and larger neighborhood where each GI project is located. Values for all co-benefit indicators are described in Section 5 of this report along with summaries of GI project details and stakeholder feedback about integrating Appendix 3 GI into the community through engagement and partnerships.

Evaluation

Section 6 of this report begins with a program-wide summary of the anticipated co-benefits of the Appendix 3 GI Projects. The values for select co-benefit indicators are totaled across all of the Appendix 3 GI Projects to describe expected outcomes program-wide and across seven different neighborhoods in Cleveland and East Cleveland. Key findings from the GI Project Specific Results including quantitative and qualitative information are next described as GI project-by-project comparisons.

Lastly, two co-benefits and related indicators are compared for Appendix 3 GI Projects and the avoided upsized gray infrastructure identified to achieve the 44 MG of equivalent additional CSO control (Avoided Gray Infrastructure). This comparison is consistent with the approach identified in the District's GI Plan. Specifically, life cycle costs for both are presented as well as co-benefit indicators for climate change mitigation. Several of these indicators are calculated based on the impacts on wastewater pumping and/or treatment at the Districts' wastewater treatment plants.

3. Anticipated Co-Benefits of Appendix 3 GI Projects

Appendix 3 of the District's Consent Decree identified specific co-benefits beyond CSO control anticipated with the District's GI projects and required the development of a report to quantify these co-benefits. These co-benefits were also expanded to include a specific co-benefit for community engagement and to reflect education and partnership opportunities as part of the analysis. The District's analysis began with defining these co-benefits to identify measurement methods and metrics for each.

CSO Consent Decree Appendix 3 Language

Evaluating the co-benefits of Green Infrastructure control measures. Within three years following EPA approval of the Plan, NEORSD shall submit a report to EPA and Ohio EPA quantifying the anticipated co-benefits of NEORSD's Green Infrastructure control measures. Co-benefits, for the purposes of this Consent Decree, mean the benefits, in addition to mitigating wet weather flow, that are achieved by NEORSD's CSO Program in Appendix 1. In the report, NEORSD shall describe the methods to be used to identify/analyze co-benefits. The co-benefits to be evaluated and quantified include, at a minimum, the following categories:

- Life-cycle costs
- Ecological benefits (ecosystem services)
- Socio-economic and/or quality of life benefits to low-income or minority populations
- Provision of recreational benefits
- Climate change-related effects, including change in carbon footprint
- Energy savings
- Air quality
- Aesthetics
- Jobs
- Property values

NEORSD may engage with research and development organizations to access expertise or advice on how to conduct assessments, or may also collaborate or enter into memoranda of understanding to improve the quality of monitoring and reporting.

The analysis of co-benefits begins with specifying one or more quantifiable indicators per type of co-benefit that represent the impact of a project on that type. In some cases, the co-benefits overlap or are linked based on common indicator values. For example, the potential for a project to impact property values would largely stem from improvements in aesthetics or recreational opportunities at the site – all three of which are separate types of co-benefits for the purposes of this analysis and the analysis discreetly analyzes indicators for each. The below descriptions for each type of co-benefit further elaborates on these linkages, while Section 4 presents the indicators selected to describe each co-benefit.



Community Benefits

Recreational Benefits: A GI project can be designed to provide opportunities for recreational activities within an urban environment including walking or biking as well as passive use by providing access to amenities such as trails or benches and places to rest. These amenities can improve quality of life and health benefits for people who use the space for physical activity.

Aesthetic Improvements: Separate from ecological or recreational components of a GI project, the amount of new or improved open space to be maintained in perpetuity for public use or as neighborhood views is an aesthetic improvement particularly when it replaces a blighted or distressed parcel.

Socioeconomic/Quality of Life Benefits: While jobs and economic development, community engagement and potential property value increases are identified as separate co-benefits, a GI project can have an impact on residents if viewed as a positive repurposing of a parcel or investment in community infrastructure.

On the infrastructure side, the reconstruction of road surfaces in poor condition provide a visible improvement in the neighborhood while the provision of new local storm sewers increase the level of service to address rainfall events that may cause localized flooding of sewer back-ups in homes.

At the parcel-level, replacing abandoned or blighted structures, illegal dumping areas, unstable or eroded ground cover, and brownfield sites with attractive, maintained landscaping and other amenities with the construction of the District's Appendix 3 GI Projects provide visible improvements in the neighborhood. These direct improvements are particularly important in neighborhoods where blight or debris presents a potential safety or security risk or where the establishment of vegetated ground cover may stabilize sites exposed to erosion and reduce the release of lead or other sediment attached contaminants. Similarly, co-benefit indicators for air quality, climate change mitigation, and recreation positively affecting public health in the community also positively influence overall socioeconomic conditions and quality of life.

Potential Property Value Increases: The potential for increases in individual property values adjacent to a GI project will depend on a number of factors including other co-benefits and related indicators, such as aesthetic improvements and socioeconomic/quality of life indicators. While these other co-benefit indicators will be considered, documenting baseline property information for parcels adjacent to GI Feature Sites will allow for tracking real estate following the construction of GI projects to measure potential property value increases associated with GI if so desired.

Community Engagement: The design, construction, and operation of GI projects provide opportunities for collaboration with community partners including local government and organizations responsible for the stewardship or redevelopment of the project area and its surroundings. In addition, the surrounding community may be afforded educational opportunities from the presence of gathering spaces and interpretive signage at a GI Feature Site. For example, specific GI Feature Sites provide space on site for field visits to learn about the water cycle and support stormwater related curriculum for school children.



Environmental Benefits

Ecological Benefits: These benefits are derived from the creation and protection of natural areas that include native plant species and the diverse mix of flora and fauna these areas support. These benefits can be created by GI itself and the selection of planted material at the site along with any enhanced connectivity to larger natural area corridors.

Air Quality Benefits: The direct improvement in air quality due to an increase in trees, shrubs, and other vegetation (or biomass) and its ability to trap air pollutants (NO₂, SO₂, O₃, and PM 10) from the atmosphere.

This co-benefit also reflects the potential reduced level of pollutant emissions that could occur if a GI system resulted in avoided wastewater flows to a treatment plant and would therefore reduce the plant's energy demand. Lower energy demand would in turn lead to less air pollutant emissions.

Climate Change Mitigation: Climate change mitigation can occur if a GI system includes a net increase in biomass as described above for air quality benefits. An increase in biomass would increase the rate of carbon sequestration from the atmosphere. Impervious surface reduction and an increase in shaded area can create a cooling effect on site. This is considered a benefit for the surrounding community given the localized impacts of "urban heat island" such as higher ambient temperatures.

This co-benefit also reflects the potential reduction in carbon emissions that could occur as a result of reduced embodied energy requirements for construction materials and avoided wastewater flows to a treatment plant. Carbon emissions associated with embodied energy and wastewater flows will be computed for the District's GI program. Embodied energy requirements for GI will be compared to the Avoided Gray Infrastructure, per the District's GI Plan.



Financial Benefits

Energy Savings: The avoided cost in electricity and gas usage for the pumping and treatment of water at wastewater facilities as a result of the avoided conveyance of flow for treatment and expressed as a cost savings.

Jobs and Economic Development: Operations and maintenance (O&M) expenditures for GI can lead to job support (direct impact). Economic benefits of job support affect those who are employed, as well as the communities where the jobs are located. This can include changes in income, gross regional product, and sales and property tax revenue (indirect impact).

Life Cycle Cost Savings: Potential cost savings reflect the difference in capital, O&M costs between a GI project and the Avoided Gray Infrastructure. In cases when a GI system has higher life cycle costs, the "savings" would be negative and not be a benefit. These comparative results are reported herein.

4. Calculating Co-Benefit Indicators

This chapter discusses a series of indicators that provide quantitative measures of the anticipated impact of the Appendix 3 GI Feature Site and drainage area improvements for each co-benefit discussed in the previous chapter. The selection of indicators is based on the feasibility of quantifying the anticipated impact of the project in a way that is relevant to the co-benefit. For example, one of the recreational co-benefit indicators is the size of the GI Feature Site that permits recreational activity, such as walking and biking. Another recreational co-benefit indicator quantifies the number of amenities, such as park benches.

The co-benefit, potential property value increases, aims to account for any market-based influence of the project on the value of nearby properties. Proper estimation of property value changes depends on having site-specific studies or other research that closely match the context around these sites. Some data exists on property value increases due to GI installed on private property (e.g. green roofs) improvements. However, there are no known studies that can be used to estimate the changes in values for properties that are adjacent to GI sites on public property. As such, this indicator is limited to quantifying only the numbers of properties that would most likely observe property value increases that could occur over time. The purpose of this indicator is to provide baseline information for future measurement. The District recognizes that there is substantial information on the positive property value impacts of proximity to parks and large public open spaces. However, given the significant difference between the Appendix 3 GI projects and typical parks, the District did not want to rely on this existing data.

Overall, the indicators include quantitative metrics (e.g. acres of distressed property repurposed) and monetary metrics (e.g. economic impact of O&M job creation) to express GI project impacts in ways that are most meaningful to the District and its stakeholders. These complete set of co-benefit indicators provide measurable information about the impact of GI projects for the anticipated co-benefits described in Section 3.

Most of the indicators related to community and environmental co-benefits are determined as a net change from the project relative to existing site conditions. For example, if an existing site already permits recreational activity and the design increases this area, only the net change in acreage is reported as the indicator.

As identified in Section 2, a select set of indicators for Appendix 3 GI Projects were compared to the Avoided Gray Infrastructure. These indicators are related to the potential differences in wastewater flows to the District's wastewater treatment plants. For example, an indicator reflecting the energy savings at the plant would be computed from the energy use per unit of treatment volume and the millions of gallons per year retained at the bioretention facility.

Data on Anticipated Co-Benefit Indicators

Quantitative values of indicators have been estimated from a variety of data sources describing GI design features, existing site conditions, community characteristics, and calculation parameters. The different types of inputs and data sources used in the Anticipated Co-Benefits Model are described below.

- **GI Project Design Features:** Key design features that influence co-benefit indicators for each category are varied. In some cases, a design feature relates to multiple co-benefit indicators, such as the number of trees on a site, or the volume of water retained. Since many of these sites have not been built yet, data that can be used to determine co-benefit indicator values will come from: (a) design documents, including basis of design (BOD) and design option evaluations (DOE) reports and 100% design documents; (b) ArcGIS analysis – District data and analysis, Parcel Maps, Land Bank Parcels; and GIS Analysis; and (c) Site Visits.
- **Current Project Area Conditions:** Several types of variables or data relate to the existing GI Feature Site and its connectivity to existing areas. All data regarding existing site conditions is collected from the individual project's BOD or DOE reports, GIS Analysis, and site visits.
- **Calculation Parameters:** This section presents parameters that are derived from existing practices (e.g. life-cycle wastewater treatment cost per gallon) and environmental or engineering literature (e.g. carbon sequestration rates) and applied in computations to estimate GI system performance and co-benefit indicators.

It is important to note that inputs for the University Circle Demonstration, Fleet Avenue, and the Green Ambassador Projects of Slavic Village Demonstration, Urban Agriculture and Fairhill/MLK are based on complete designs, with few design assumptions needed to model the anticipated co-benefits as compared to the other Appendix 3 GI Projects where the District had to make assumptions not on final design plans. Table 4.1 identifies the status of each GI project and the data used, such 100% design documents, to calculate co-benefit indicators for GI Project Design Features.

Figure 4.1: Appendix 3 GI Project Information Status

Appendix 3 GI Project	Design Document Status
University Circle Demonstration	Design and Construction Documents
Green Ambassador Slavic Village Demonstration	Design and Construction Documents
Fleet Avenue	Design Documents
Green Ambassador Urban Agriculture	Design Documents
Green Ambassador Fairhill/MLK	Design Documents
E. 140th St. Consolidation & Relief Sewer	50% Design
Woodland Central	Design Options Evaluation
Union	Design Options Evaluation
Buckeye	Design Options Evaluation

Characteristics of Communities

The type of co-benefit that may be created at a site is relevant to assess who is affected or who may benefit from the District's Appendix 3 GI Projects. As such, various socio-economic and demographic data have been analyzed using GIS for the community surrounding the GI Feature Site – including the 5-minute walking distance as defined by this analysis and neighborhood as defined by the Northeast Ohio Data Collaborative. These local community characteristics provide information on how a project may be aligned with the environmental justice concerns of the larger neighborhood within which the project is located or City of Cleveland. Socio-economic and demographic data that have been compiled from the 2010 US Census and other local sources (e.g. Northeast Ohio Community and neighborhood Data for Organizing (NEO CANDO) and Northeast Ohio Data Collaborative) include: (a) total population and proportions of the population who are (b) minorities, (c) low income, (d) youth population under 18 and (e) over 65 years old.

Detailed Descriptions of Co-Benefit Indicators

The following information describes the indicators selected to reflect anticipated impacts for each of the co-benefits. The indicators are organized by category as in the previous section. For each indicator, a description of what the indicator is measuring is included, along with the unit of measure, scale of impact and any calculation parameters being used. As part of the analysis, indicator values calculated to be zero or a negative value indicate no change from existing or future without the GI project conditions or in some cases a worse condition and, therefore, would not be considered a community, environmental or financial benefit in this report. Selected indicators are described in later sections of this report, while all indicator values--positive, neutral and negative--are recorded in the Anticipated Co-Benefits Model which is available in Appendix C.



Community Benefits

Recreational Benefits

- **Increase in recreational area**
 - Description: Some sites create opportunities for recreational activity within an urban context including maintained lawns for walking, gathering and sitting. This indicator measures the total change in acreage between new and existing recreational space.
 - Unit of measure: Acres
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents, BOD Reports, DOE Reports
 - Calculation Parameter: Not Required; Direct Data Source
- **New amenities on the GI project area**
 - Description: A variety of amenities will be included on the site, such as benches and other facilities. This indicator quantifies the number and type of these amenities in the project area.
 - Unit of measure: Number and Type of Amenity
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents, BOD Reports, DOE Reports
 - Calculation Parameter: Not Required; Direct Data Source
- **New trails/paths in the GI project area**
 - Description: For sites that include walking paths, this indicator accounts for the net increase in length of the new path (relative to any existing public path).

- Unit of measure: Linear feet
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents, BOD Reports, DOE Reports
- Calculation Parameter: Not Required; Direct Data Source

Aesthetic Improvements

▪ Increase in public space area

- Description: Some sites are designed for open access that allow for public gathering. This indicator quantifies the net increase in acreage of open space.
- Unit of measure: Acres
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents, BOD Reports, DOE Reports
- Calculation Parameter: Not Required; Direct Data Source

Quality of Life Benefits

▪ Length of improved roadway

- Description: In the drainage area, new sewers will be installed and as a result, portions of roadways along this street will be resurfaced. This indicator measures the length of resurfacing.
- Unit of measure: Miles
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents, BOD Reports, DOE Reports
- Calculation Parameter: Not Required; Direct Data Source

▪ Increase in local sewer capacity

- Description: New sewers will be installed that will provide additional capacity and may potentially reduce flooding and basement backups..
- Unit of measure: Miles
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents, BOD Reports, DOE Reports
- Calculation Parameter: Not Required; Direct Data Source

▪ Management of brownfields

- Description: Some sites are currently designated as brownfields. If the design includes the management of these brownfields, the areage of this management activity will be indicated.
- Unit of measure: Acres
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents and Reports, BOD Reports, DOE Reports
- Calculation Parameter: Not Required; Direct Data Source

▪ Repurpose / removal of distressed properties

- Description: Some sites currently include distressed properties which are properties and areas which consist of land bank properties, abandoned or blighted structures, illegal dumping areas, and unstable or eroded ground cover. If the design includes the removal of distressed properties, the acreage of this management activity will be indicated.
- Unit of measure: Acres
- Scale of Impact: Surrounding Community
- Data Sources: Land Bank Data, Site Visits, Aerial Desktop Analysis
- Calculation Parameter: Not Required; Direct Data Source

Potential Property Value Increases

- **Parcels with property value enhancement potential**
 - Description: Property value increases are highly uncertain for the types of improvements at a project site. The potential for property value improvements is instead indicated by the number of adjacent parcels that would be most likely to benefit from project impacts, including the on-going ownership and maintenance of these projects by the District. .
 - Unit of measure: Number
 - Scale of Impact: Surrounding Community
 - Data Sources: County Parcel Data
 - Calculation Parameter: Not Required; Direct Data Source

Community Engagement

- **Provision of Interpretative signs**
 - Description: The District plans to install interpretive signs to provide information about how the project works and its overall impact. This indicator quantifies the number of such signs.
 - Unit of measure: Number
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents, BOD Reports, DOE Reports
 - Calculation Parameter: Not Required; Direct Data Source
- **Design of gathering spaces**
 - Description: Sites designed with seating areas are quantified based on the number of actual seats gathering activities at the site.
 - Unit of measure: Number
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents, BOD Reports, DOE Reports
 - Calculation Parameter: Not Required; Direct Data Source
- **Enhanced community partnerships**
 - Description: Sites have various numbers of local partners who will be involved with integrating the site and its environmental and community value into their activities and on-going engagement of their communities. This indicator quantifies this number of partners.
 - Unit of measure: Number
 - Scale of Impact: Surrounding Community
 - Data Sources: District and EAC Communications
 - Calculation Parameter: Not Required; Direct Data Source



Environmental Benefits

Ecological Benefits

- **Increase in diverse natural area at the GI project area**
 - Description: Sites that are designed with natural areas (as distinct from recreational areas, and other site uses) will have an indicator that measures the net change in this acreage.
 - Unit of measure: Acres
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents, BOD Reports, DOE Reports
 - Calculation Parameter: Not Required; Direct Data Source
- **Introduction of blooming species to attract pollinators**

- Description: Newly created natural areas based on diverse planting plans include blooming species, which are important for attracting pollinators. Within the overall acreage of natural areas, this indicator measures the acreage of blooming species.
- Unit of measure: Acres
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents
- Calculation Parameter: Not Required; Direct Data Source

Air Quality Benefits

▪ Reduced air pollutants in the project area

- Description: Additional coverage of biomass at the GI Feature Site may increase the volume of particles trapped on leaves and other vegetation. This indicator represents the total net change in tonnage of NO₂, SO₂, O₃, and PM 10 that can be removed from the atmosphere.
- Unit of measure: Tons
- Scale of Impact: Surrounding Community
- Data Sources: USDA Forest Service - iTrees Street
- Calculation Parameter: Entrainment Rates

▪ Avoided air pollutant emissions at Wastewater Treatment Plant (WWTP)

- Description: Avoided wastewater flows to the plant because of sewer separation and treatment with GI leads to a potential reduction in energy consumption at the plant. This indicator estimates the potential reduction in tons of pollutants emitted from lower energy demand.
- Unit of measure: Tons
- Scale of Impact: Program-wide
- Data Sources: District Communication
- Calculation Parameter: Energy Usage per Gallon of Treatment (Southerly and Easterly WWTPs); Emission Rates per kWh

Climate Change Mitigation

▪ Reduced greenhouse gas (GHG) emissions

- Description: Avoided wastewater flows to the plant because of sewer separation and treatment at the GI Feature Site leads to a potential reduction in energy consumption at the plant. This indicator estimates the potential reduction in tons of GHG emitted from lower energy demand.
- Unit of measure: Tons
- Scale of Impact: Program-wide
- Data Sources: US EPA - Emissions & Generation Resource Integrated Database
- Calculation Parameters: CO₂ Tons per kWh and kWh per stormwater volume at District treatment facilities (Southerly and Easterly WWTPs)

▪ Reduced atmospheric carbon

- Description: Additional coverage of biomass can lead to higher levels of carbon sequestration. This indicator uses standard sequestration rates to estimate levels of GHG removed from the atmosphere.
- Unit of measure: Tons
- Scale of Impact: Program-wide
- Data Sources: USDA Forest Service - iTrees Street
- Calculation Parameter: Sequestration Rates

▪ Impervious surface reduction

- Description: The net acreage of reduced impervious surface at the GI Feature Site, will be quantified as a measure of reduced runoff and lower urban heat island influence in the area.
- Unit of measure: Acres
- Scale of Impact: Surrounding Community
- Data Sources: Design Documents, BOD Reports, DOE Reports, Aerial Desktop Analysis
- Calculation Parameter: Not Required; Direct Data Source
- **Increase in shade based on trees**
 - Description: The net increase in shaded area based on tree canopy will be an indicator of reduced ambient temperatures for GI Feature Site visitors.
 - Unit of measure: Acres
 - Scale of Impact: Surrounding Community
 - Data Sources: Design Documents BOD Reports, DOE Reports, Aerial Desktop Analysis
 - Calculation Parameter: Not Required; Direct Data Source



Financial Benefits

Energy Savings

- **Avoided energy consumption**
 - Description: Avoided wastewater treatment activity due to sewer separation and treatment at the GI Feature Site would generate energy savings. This indicator is computed by multiplying the total volume of wastewater avoided by the amount of energy and cost required for treating one gallon.
 - Unit of measure: Dollars
 - Scale of Impact: Program-wide
 - Data Sources: District Communication
 - Calculation Parameter: Energy Use per Volume of Wastewater treatment (Southerly and Easterly WWTPs)

Jobs & Economic Development

- **O&M jobs**
 - Description: The overall GI program will support jobs for inspecting, operating and maintaining the GI and separated sewers. Using a job creation multiplier (Calculation Parameter) and the total amount spent on O&M, the total number of jobs supported by the program is calculated. This will be reported as full time equivalents (FTE).
 - Unit of measure: FTE
 - Scale of Impact: Program-wide
 - Data Sources: District Communication
 - Calculation Parameter: Labor Person/Crew per Square Foot of GI Project
- **Total regional economic impact**
 - Description: The overall economic impact of total Appendix 3 GI Program O&M jobs is estimated and reported using standard economic multipliers (Calculation Parameter) based on the total number of jobs supported (Design Feature).
 - Unit of measure: Dollars
 - Scale of Impact: Program-wide
 - Data Sources: District Communication
 - Calculation Parameter: \$ of Impact per Job

Life-Cycle Cost Savings

- **Reduced life-cycle costs (District)**
 - Description: The life cycle cost of a project includes capital, operation and maintenance (O&M), and repair and replacement (R&R) costs. This is a benefit if there is a reduction in any of these costs as a result of the Appendix 3 GI project.
 - Unit of measure: Dollars
 - Scale of Impact: Green vs. Gray Comparison
 - Data Sources: District Communication
 - Calculation Parameter: Life-cycle Cost Analysis Factors

5. GI Project Specific Results

This section presents selected results from the Anticipated Co-Benefits Model and stakeholder interviews to describe the potential impacts of each of the Appendix 3 GI Projects post-construction. The values bolded below denote values directly from the Model that are different for each GI project described.

University Circle Demonstration

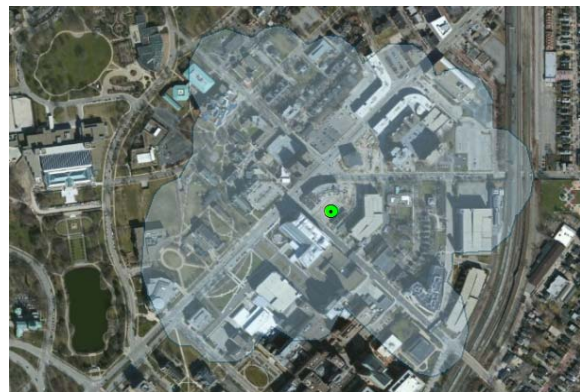


GI Project Details

- **1.0** MG of stormwater managed in typical year
- **0.4** MG of CSO volume reduced pre-gray
- **0.1** MG of CSO volume reduced post-gray
- **1.0** acres of drainage area managed
- **0.5** acres is the size of the GI Feature Site
- **\$540,089** in total net present value life cycle costs, including maintenance, over 30 years
- **1,134** people live within a 5-minute walk to this site, which is **14.3%** of the University neighborhood population (see also Figure 5.1)

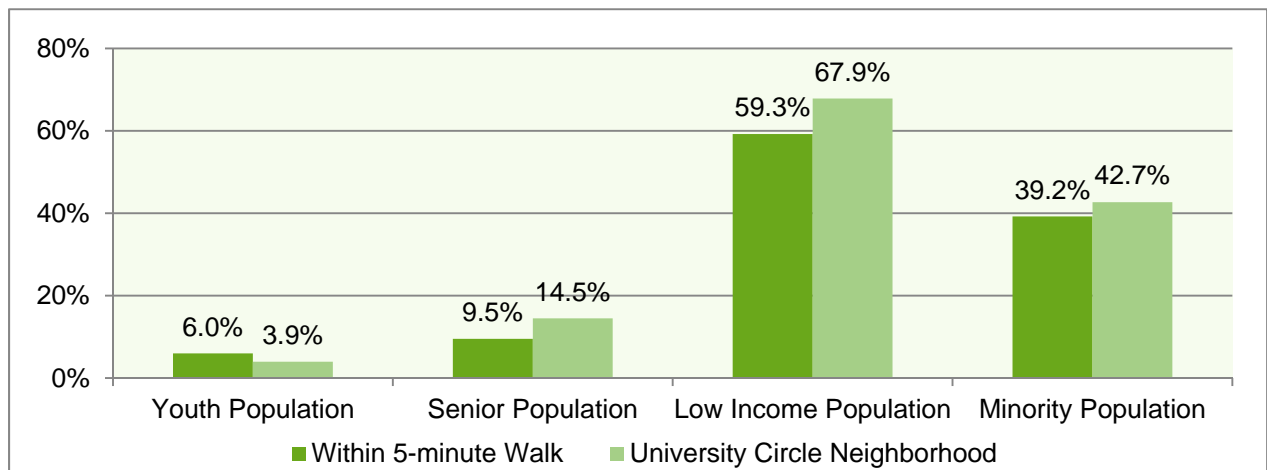


Pervious Interlocking Concrete Paver Parking Lot



5-minute Walk to Site

Figure 5.1: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **0.5** acre of improved public space represents a **0.4%** increase in improved public space in the University Circle neighborhood.
- Recreational Benefits: **2** bike racks will be added at the GI Feature Site.
- Potential Property Value Increase: **7** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **1.6%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **3** community partners including University Circle, Inc.; GPD Group, and Snavelly Group to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **3.4** kilograms less health impacting air pollutants and **0.6** tons less GHG emissions. The avoided WWTP flow leads to **4.8** kilograms less health impacting air pollutants and **0.6** tons less GHG emissions.



Financial Benefits

- Energy Savings: **\$520** in annual energy savings from avoided wastewater treatment which represents a **1.2%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: This project may support **0.5** FTEs for green jobs (direct impact). The share of employment associated with this GI project leads to **\$3,136** in annual economic development (indirect impact) which represents 0.5% of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

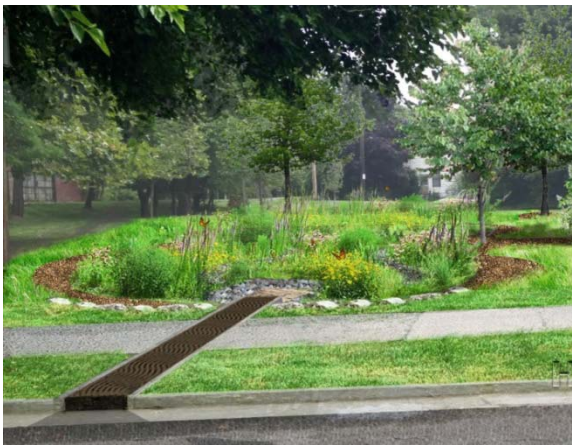
The University Circle Demonstration GI project enhances the visitor experience because it is located at the hotel and a retail center where a lot of people are coming in from out of town. The NEORSD does the general maintenance for the site, and in the winter, the permeable pavement has less required maintenance from a snow removal stand point. The signage on site educates people about the permeable pavers and stormwater management. University Circle Inc. is incorporating stormwater education as part of its community programming activities and they plan to incorporate stormwater management practices on existing and future construction at the Circle.

Green Ambassador - Slavic Village Demonstration



GI Project Details

- **0.2** MG of stormwater managed in typical year
- **0.1** MG of CSO volume reduced pre-gray
- **0.1** MG of CSO volume reduced post-gray
- **3.0** acres of drainage area managed
- **1.1** acres is the size of the GI Feature Site
- **\$1,164,792** in total net present value life cycle costs, including maintenance, over 30 years
- **575** people live within a 5-minute walk to this site, which is **2.6%** of the Broadway-Slavic Village neighborhood population (see also Figure 5.2)

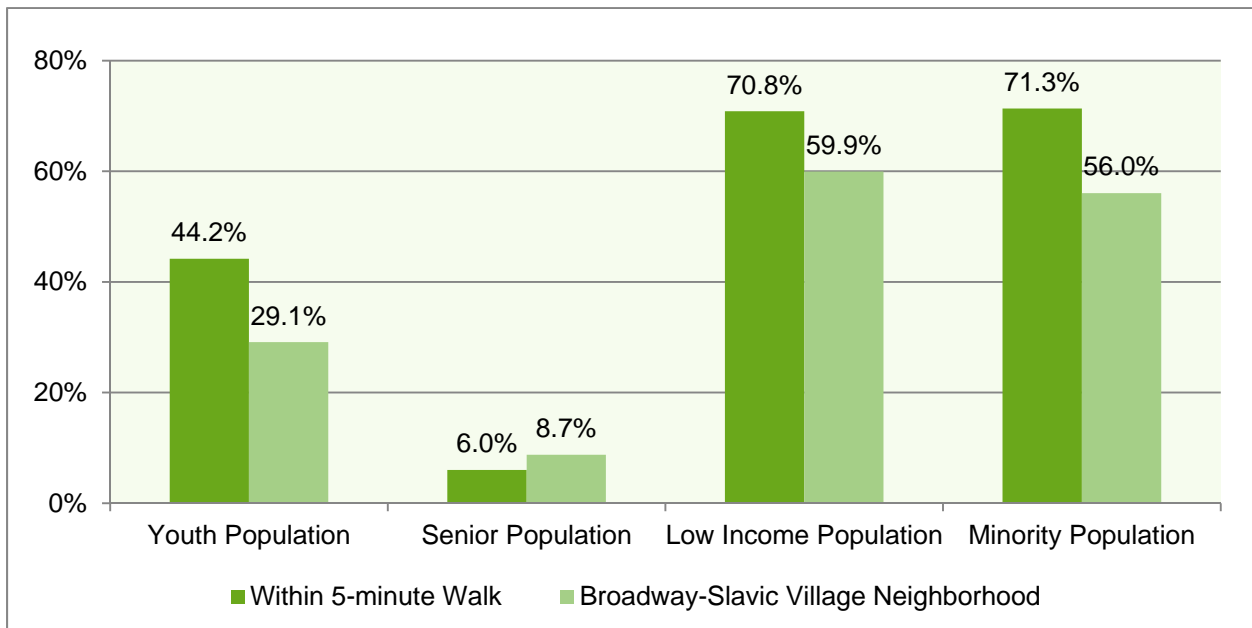


One of Three Bioretention Basins



5-minute Walk to Site

Figure 5.2: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **1.1** acres of new public space represents a **0.9%** increase in new public space in the Broadway-Slavic Village neighborhood.
- Recreational Benefits: **0.1** acre of new recreational area will be added at the GI Feature Site.
- Quality of Life Benefits: There are **1.1** acres of distressed properties repurposed to support neighborhood revitalization. This represents a **0.8%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **20** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **6%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **5** community partners including Cleveland Botanical Gardens (CBG), Slavic Village Development (SVD), EPA, United States Geological Services (USGS), and the Ohio State University Extension (OSU) to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **0.9** acre of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **1.6** kilograms less health impacting air pollutants and **2.9** tons less GHG emissions. The avoided WWTP flow leads to **1.9** kilograms less health impacting air pollutants and **0.3** tons less GHG emissions.
- Climate Change Mitigation: **14** more trees and their respective combined shaded area, along with **0.1** acre of less impervious surfaces, represents a **36%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$256** in annual energy savings from avoided wastewater treatment which represents a **0.1%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.11** FTEs for green jobs (direct impact). The share of employment associated with this GI project leads to **\$627** in annual economic development (indirect impact) which represents **0.1%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

Slavic Village Demonstration is part of the Model Block Area and “Rails to Trails” project which was created to target additional improvements in the neighborhood. The project runs directly adjacent the Morgana Run Trail which is part of a plan to create more greenway and places along the trail that can be bumped out and widen as time goes on. The trail connects to Metro Park facilities and their towpath and parks. The increased usage of these facilities presents educational opportunities for the community to see the benefits of stormwater reduction and the beautification provided by the GI projects. It increases people confidence in the community and it also creates an impact of safety perceptions. These are some reasons why people can stop leaving and start moving into the neighborhood. The GI project fits perfectly with SVD’s vision to create a community that is sustainable, incorporates active living, and also creates economic opportunities and investment.

Fleet Avenue

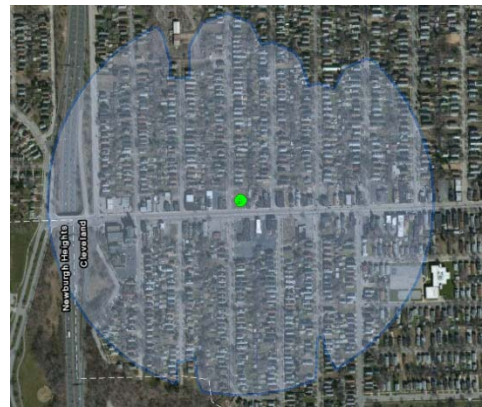


GI Project Details

- 4.7 MG of stormwater managed in typical year
- 3.6 MG of CSO volume reduced pre-gray
- 0.5 MG of CSO volume reduced post-gray
- 15.0 acres of drainage area managed
- 0.3 acres is the size of the GI Feature Site
- \$3,050,751 in total net present value life cycle costs, including maintenance, over 30 years
- 1,516 people live within a 5-minute walk to this site, which is 6.8% of the Broadway-Slavic Village neighborhood population (see also Figure 5.3)

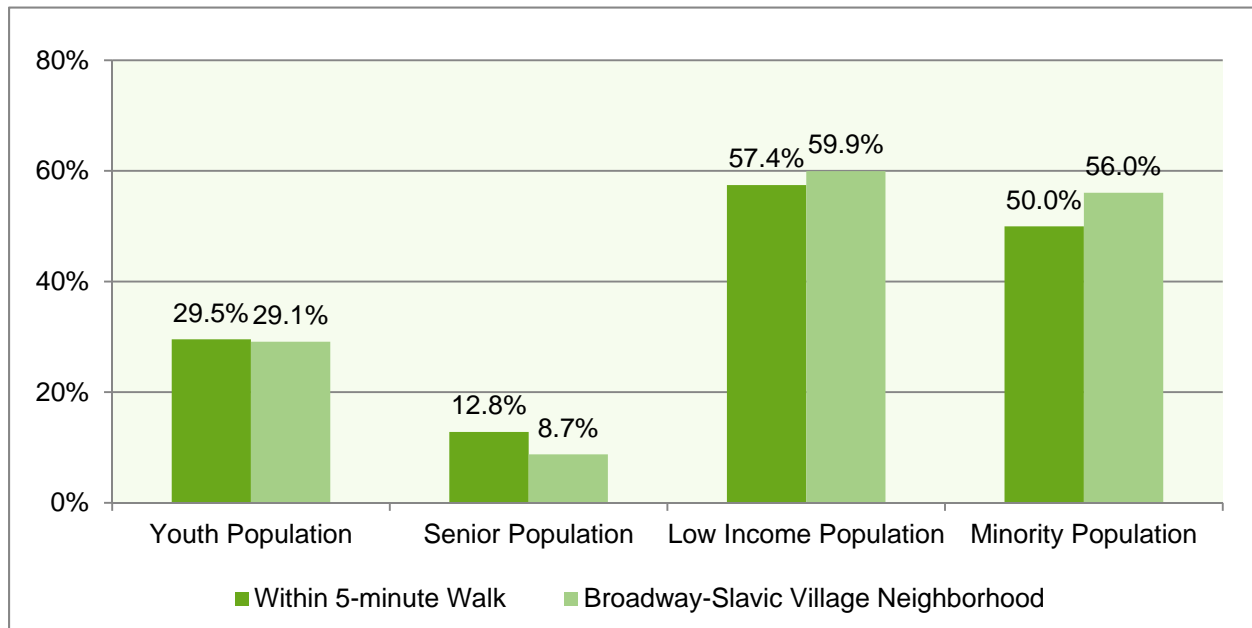


Infiltration Basin



5-minute Walk to Site

Figure 5.3: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **0.3** acres of new public space represents a **0.2%** increase in new public space in the Broadway-Slavic Village neighborhood.
- Recreational Benefits: **0.1** acre of new recreational area, **2** seating walls and **2** benches and will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **0.7** mile of new local storm sewer and **0.7** mile of improved roadway. In addition, there is **0.3** acre of distressed properties repurposed to support neighborhood revitalization. This represents a **0.2%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **8** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **1.4%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **5** community partners including City of Cleveland, Slavic Village Development, Cleveland Neighborhood Progress, LAND Studio, and Cleveland Urban Design Collaborative, to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **0.2** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **22.9** kilograms less health impacting air pollutants and **4.2** tons less GHG emissions. The avoided WWTP flow leads to **44.2** kilograms less health impacting air pollutants and **7.6** tons less GHG emissions.
- Climate Change Mitigation: **20** more trees and their respective combined shaded area represents a **50%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$6,016** in annual energy savings from avoided wastewater treatment which represents a **1.4%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.03** FTEs for green jobs and **0.14** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$14,739** in annual economic development (indirect impact) which represents **2.3%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

The decision to turn Fleet Avenue into a “complete” street with stormwater reduction during the rehabilitation project will be very beneficial to the community. The length of the street project will have rain gardens and bike racks which promotes cycling. The Fleet Avenue project is a large investment and it is attracting attention from people interested in buying buildings and renovating them for residential and commercial use. This project benefits the community by contributing to stormwater reduction and beautifying the neighborhood where people would want to invest.

Green Ambassador - Urban Agriculture



GI Project Details

- 7.0 MG of stormwater managed in typical year
- 6.6 MG of CSO volume reduced pre-gray
- 1.6 MG of CSO volume reduced post-gray
- 61.0 acres of drainage area managed
- 4.8 acres is the size of the GI Feature Site
- \$11,063,035 in total net present value life cycle costs, including maintenance, over 30 years
- 566 people live within a 5-minute walk to this site, which is 7.3% of the Kinsman neighborhood population (see also Figure 5.4)

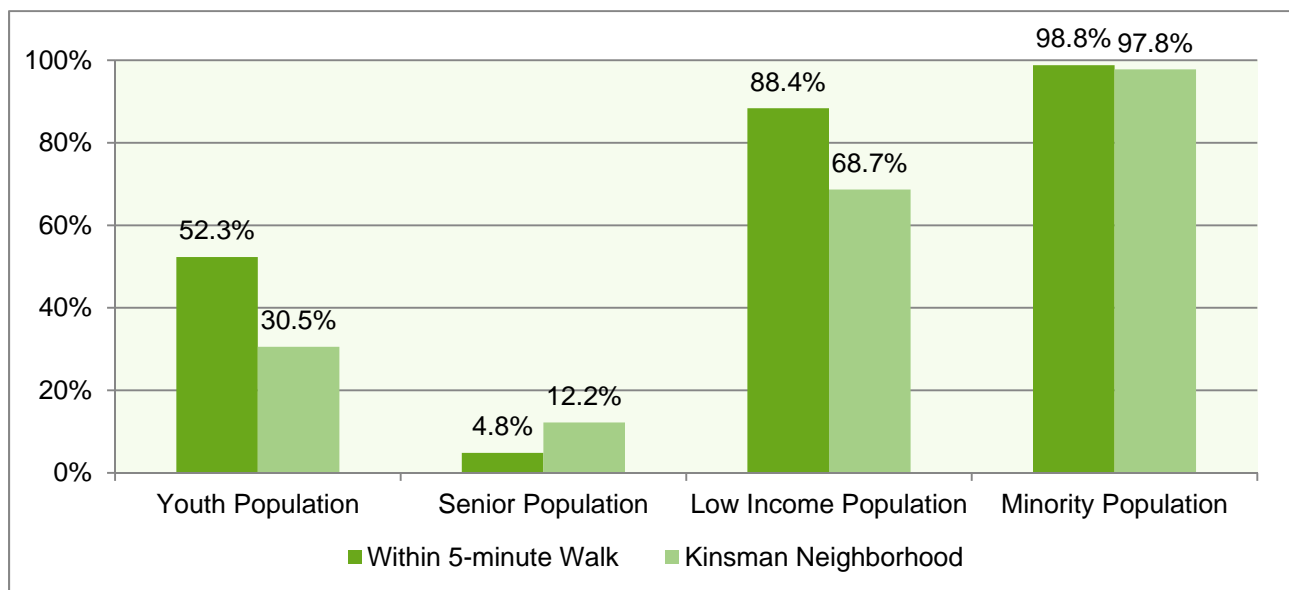


One of four Bioretention Basins and an Outdoor Classroom



5-minute Walk to Site

Figure 5.4: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **4.8** acres of new public space represents a **10.5%** increase in new public space in the Kinsman neighborhood.
- Recreational Benefits: **1.8** acres of new recreational area and **1** outdoor classroom will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **1.5** miles of new local storm sewer and **1** mile of improved roadway. In addition, there is **1.9** acres of distressed properties repurposed to support neighborhood revitalization. This represents a **1.3%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **43** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **11.4%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **3** community partners including Rid-All Green Partnership, Burton Bell Carr Development Corporation (BBCDC) and the OSU Extension, to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **1.6** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **10.3** kilograms less health impacting air pollutants and **1.9** tons less GHG emissions. The avoided WWTP flow leads to **65.8** kilograms less health impacting air pollutants and **11.4** tons less GHG emissions.
- Climate Change Mitigation: **9** more trees and their respective combined shaded area with the replaced trees represents a **42%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$8,960** in annual energy savings from avoided wastewater treatment which represents a **0.7%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.5** FTEs for green jobs and **0.24** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$21,951** in annual economic development (indirect impact) which represents **3.4%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

Urban Agriculture GI project will play a role in fostering an active and healthy neighborhood with all the activities that are done at urban agriculture. The co-benefits enhance the streetscape of the Urban Agriculture Innovation Zone and provide a public space for the Kinsman farmers. The outdoor classroom creates an environment for interactive and experiential learning. Ongoing education is done with the community through rain barrel distribution and stormwater management education. Similar stormwater reduction practices are now being incorporated in future development projects.

Green Ambassador Fairhill/MLK



GI Project Details

- **17.0 MG** of stormwater managed in typical year
- **9.6 MG** of CSO volume reduced pre-gray
- **2.4 MG** of CSO volume reduced post-gray
- **63.0 acres** of drainage area managed
- **2.0 acres** is the size of the GI Feature Site
- **\$9,338,738** in total net present value life cycle costs, including maintenance, over 30 years
- **868** people live within a 5-minute walk to this site, which is **6.2%** of the Buckeye-Shaker Square neighborhood population (see also Figure 5.5)

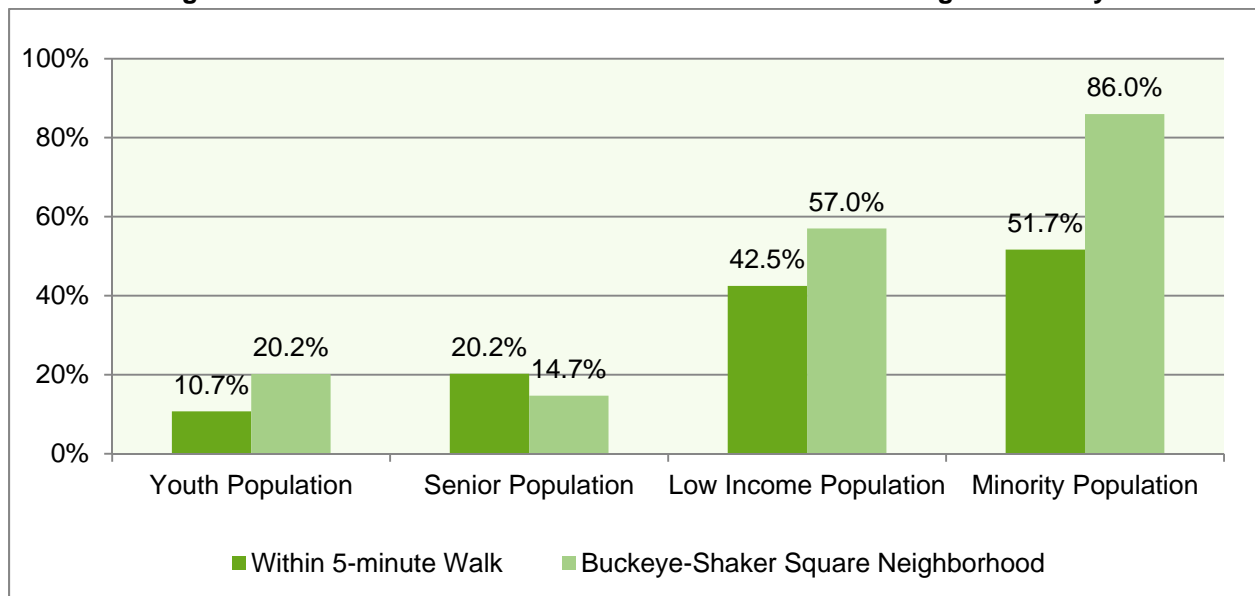


Bioretention Basin



5-minute Walk to Site

Figure 5.5: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **2** acres of improved public space incorporated into the Buckeye-Shaker Square neighborhood.
- Recreational Benefits: **0.3** acre of new recreational area, **4** benches and **3** bike racks will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **1.7** miles of new local storm sewer and **1.7** miles of improved roadway.
- Potential Property Value Increase: **7** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **1.7%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **4** community partners including Doan Brook Watershed Partnership, City of Cleveland, Greater Cleveland RTA and Buckeye Shaker Square Development Corporation (BSSDC), to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **0.6** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: The avoided WWTP flow leads to **81.9** kilograms less health impacting air pollutants and **9.9** tons less GHG emissions.
- Climate Change Mitigation: No additional benefits are created because there are no positive changes in the number of trees or impervious surfaces.



Financial Benefits

- Energy Savings: **\$8,840** in annual energy savings from avoided wastewater treatment which represents a **8%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.21** FTEs for green jobs and **0.33** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$53,311** in annual economic development (indirect impact) which represents **8.1%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

Fairhill/MLK GI project enhances the community experience because of its proximity to the Doan Brook Trail and can be a factor in improvement of quality of life. CBC is planning activities around their GI projects and the District's GI projects which are in close proximity to each other. This includes creating GI tours for people coming in from out of town who are interested in what is going on in Cleveland and educating residents on walking tours/trails about the benefits of stormwater management. Job training and work force development around GI maintenance and installation is another way that the projects value can be enhanced to the community.

E. 140th Street Consolidation and Relief Sewer



GI Project Details

- 117.8 MG of stormwater managed in typical year
- 25.3 MG of CSO volume reduced pre-grey
- 5.8 MG of CSO volume reduced post-grey
- 228.0 acres of drainage area managed
- 9.1 acres is the size of the GI Feature Site
- \$19,759,106 in total net present value life cycle costs, including maintenance, over 30 years
- 3,480 people live within a 5-minute walk to this site, which is 17.9% of the East Cleveland neighborhood population (see also Figure 5.6)

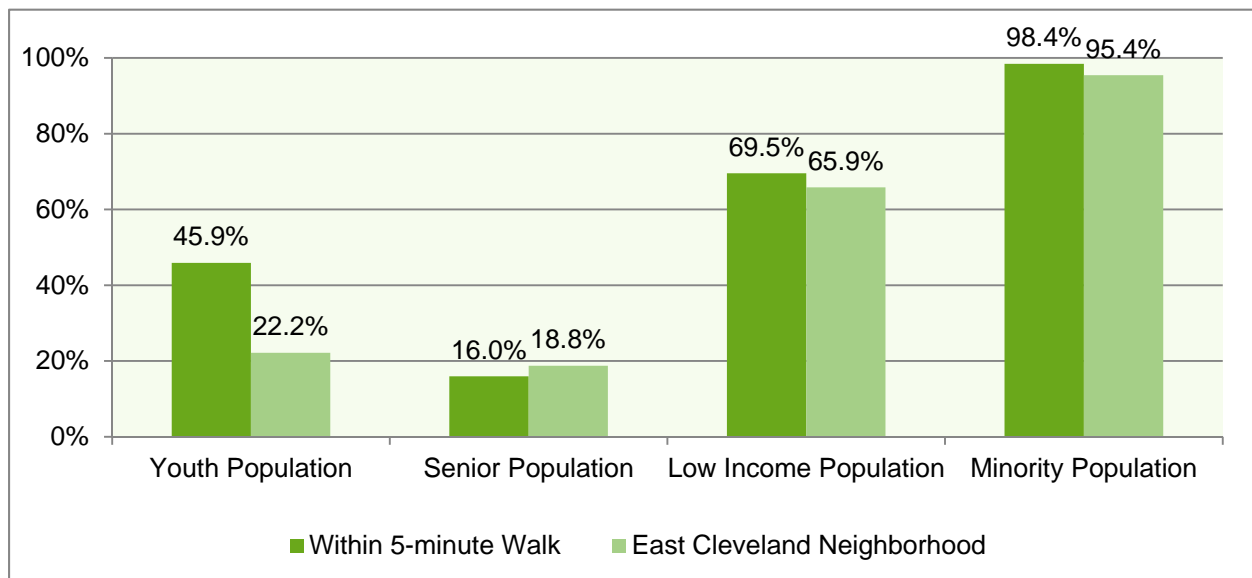


One of Three Detention Basins



5-minute Walk to Site

Figure 5.6: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **9.1** acres of new public space represents a **4.5%** increase in new public space in the East Cleveland neighborhood.
- Recreational Benefits: **2.1** acres of new recreational area and **20** benches will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **2.3** miles of new local storm sewer and **2.3** miles of improved roadway. In addition, there are **9** acres of distressed properties repurposed to support neighborhood revitalization. This represents a **24.5%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **69** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **4.9%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **1** community partner, City of East Cleveland to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **4.9** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **75.6** kilograms less health impacting air pollutants and **13.9** tons less GHG emissions. The avoided WWTP flow leads to **567.7** kilograms less health impacting air pollutants and **68.3** tons less GHG emissions.
- Climate Change Mitigation: **66** more trees and their respective combined shaded area, along with **5** acres of less impervious surfaces, represents a **21%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$61,256** in annual energy savings from avoided wastewater treatment which represents a **42.6%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.94** FTEs for green jobs and **0.45** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$369,411** in annual economic development (indirect impact) which represents **56.4%** of total annual economic impact from the Appendix 3 GI Projects.

Woodland Central



GI Project Details

- **41.0** MG of stormwater managed in typical year
- **14.3** MG of CSO volume reduced pre-gray
- **5.7** MG of CSO volume reduced post-gray
- **144.0** acres of drainage area managed
- **15.6** acres is the size of the GI Feature Site
- **\$19,088,888** in total net present value life cycle costs, including maintenance, over 30 years
- **189** people live within a 5-minute walk to this site, which is **1.7%** of the Central neighborhood population (see also Figure 5.7)

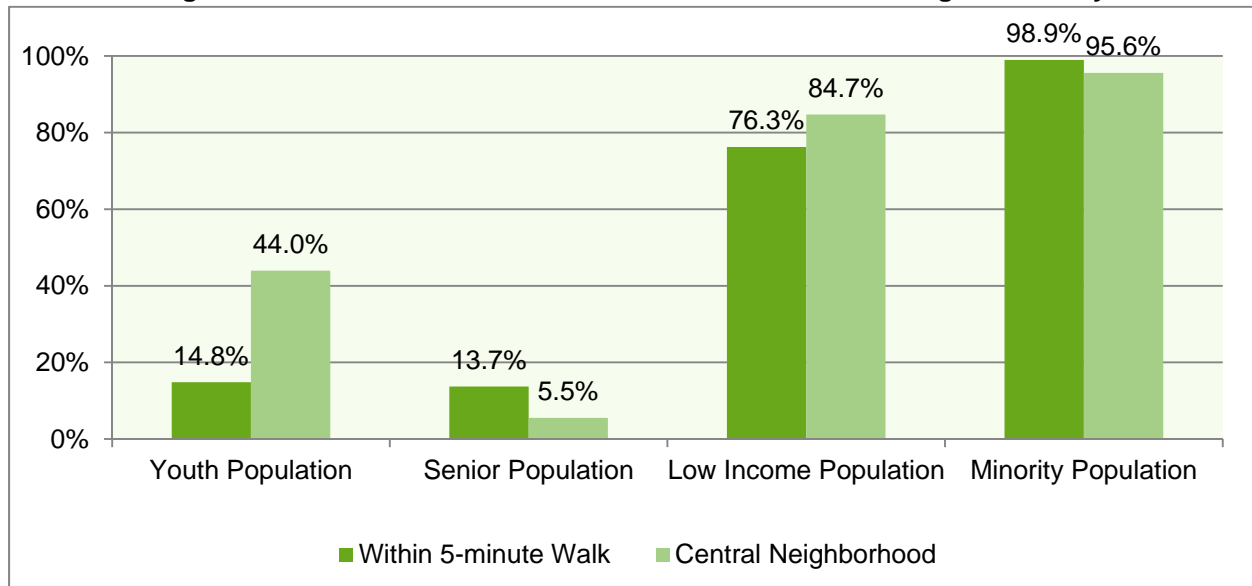


Two Bioretention Basins



5-minute Walk to Site

Figure 5.7: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **15.6** acres of new public space represents an **87.8%** increase in new public space in the Central neighborhood.
- Recreational Benefits: **2** acre of new recreational area and **4** benches will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **2.3** miles of new local storm sewer and **2.3** miles of improved roadway. In addition, there are **13** acres of distressed properties repurposed, including **6** acres of managed brownfields, to support neighborhood revitalization. This represents a **15.3%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **37** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **13.3%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **5** community partners including Burton, Bell, Carr Development Corporation (BBCDC), City of Cleveland, Cuyahoga Housing Metropolitan Authority (CHMA), Maingate Business, and local churches, to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **7.6** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **1551** kilograms less health impacting air pollutants and **285.2** tons less GHG emissions. The avoided WWTP flow leads to **385.5** kilograms less health impacting air pollutants and **66.7** tons less GHG emissions.
- Climate Change Mitigation: **1,354** more trees and their respective combined shaded area, along with **10** acres of less impervious surfaces, represents a **37.2%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$52,480** in annual energy savings from avoided wastewater treatment which represents a **23.5%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **1.62** FTEs for green jobs and **0.44** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$128,573** in annual economic development (indirect impact) which represents **19.6%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

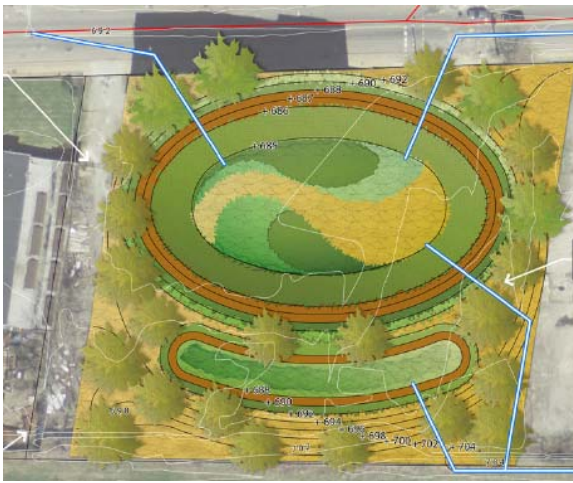
The vision for the community is to create economic generators and economic access for residents to foster and engage an educated resident base and ultimately create a new neighborhood identity that would influence people to partake in community and recreational activities as well as work and live there. The District is doing predevelopment work and improving the quality of the land in the vicinity so that there is a little bit of a spark to attract new development. Hopefully, there is a way to integrate the GI projects into additional projects in the future such as a linear greenway that takes advantage of stormwater management and promotes green space for quality of life and recreational amenities.

Union



GI Project Details

- **10.0** MG of stormwater managed in typical year
- **4.2** MG of CSO volume reduced pre-gray
- **1.2** MG of CSO volume reduced post-gray
- **42.0** acres of drainage area managed
- **2 acres** is the size of the GI Feature Site
- **\$10,044,238** in total net present value life cycle costs, including maintenance, over 30 years
- **773** people live within a 5-minute walk to this site, which is **3.5%** of the Broadway-Slavic Village neighborhood population (see also Figure 5.8)

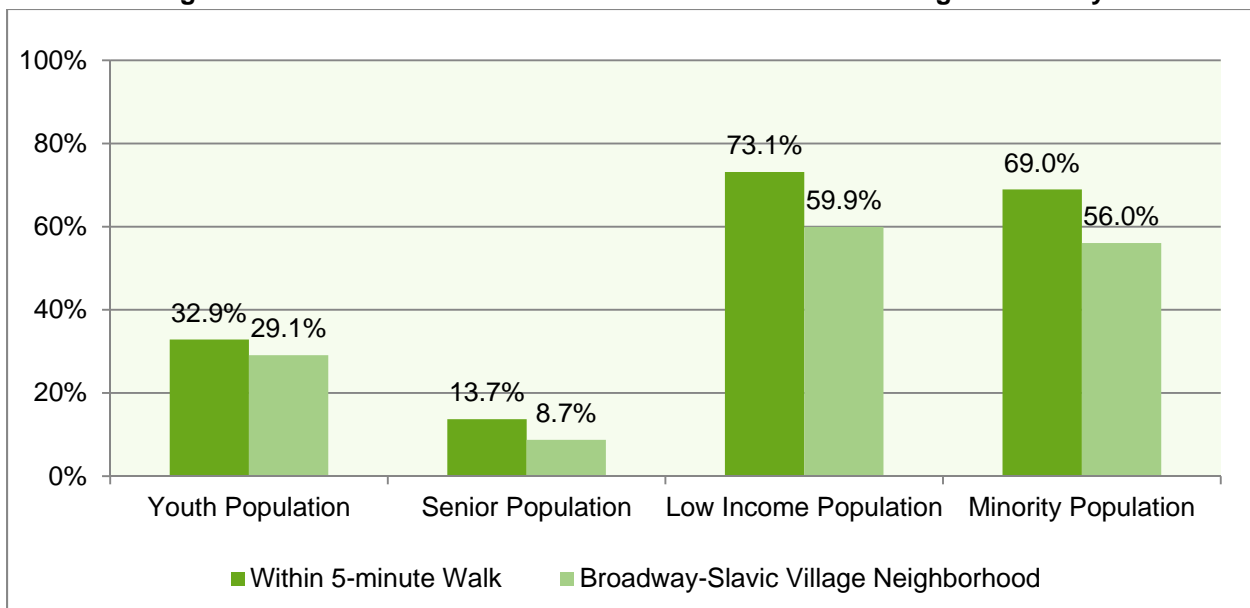


Bioretention Basin



5-minute Walk to Site

Figure 5.8: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **2** acres of new public space represents a **1.6%** increase in new public space in the Broadway-Slavic Village neighborhood.
- Recreational Benefits: **0.5** acre of new recreational area and **1** bench will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **1.2** miles of new local storm sewer and **1.2** miles of improved roadway. In addition, there are **2** acres of distressed properties repurposed, including **2** acres of managed brownfields, to support neighborhood revitalization. This represents a **1.4%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **10** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **3.4%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **2** community partners including City of Cleveland and Slavic Village Development (SVD), to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **1.3** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **22.9** kilograms less health impacting air pollutants and **4.2** tons less GHG emissions. The avoided WWTP flow leads to **94** kilograms less health impacting air pollutants and **16.3** tons less GHG emissions.
- Climate Change Mitigation: **20** more trees and their respective combined shaded area represents a **40%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$12,800** in annual energy savings from avoided wastewater treatment which represents a **0.9%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.21** FTEs for green jobs and **0.24** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$31,359** in annual economic development (indirect impact) which represents **4.8%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

Union Ave is part of the Model Block Area and "Rails to Trails" project which was created to target additional improvements in the neighborhood. The project is adjacent to Trail Side (new housing development) and runs along the Morgana Run Trail which is part of a plan to create more greenway and places along the trail that can be bumped out and widen as time went goes on. The trail connects to Metro Park facilities and their towpath and parks. The increased usage of these facilities presents educational opportunities for the community to see the benefits of stormwater reduction and the beautification provided by the GI projects. The GI projects fit perfectly into SVD's vision to create a community that is sustainable, incorporates active living, and also creates economic opportunities and investment.

Buckeye

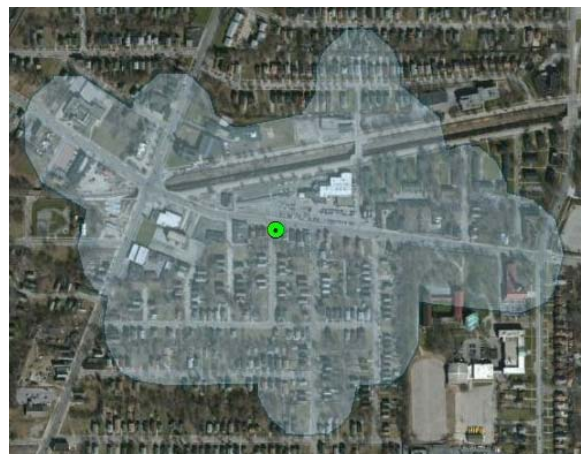


GI Project Details

- 10.0 MG of stormwater managed in typical year
- 3.7 MG of CSO volume reduced pre-gray
- 1.1 MG of CSO volume reduced post-gray
- 22.0 acres of drainage area managed
- 3.2 acres is the size of the GI Feature Site
- \$8,343,864 in total net present value life cycle costs, including maintenance, over 30 years
- 1,161 people live within a 5-minute walk to this site, which is 14.7% of the Buckeye-Woodhill neighborhood population (see also Figure 5.9)

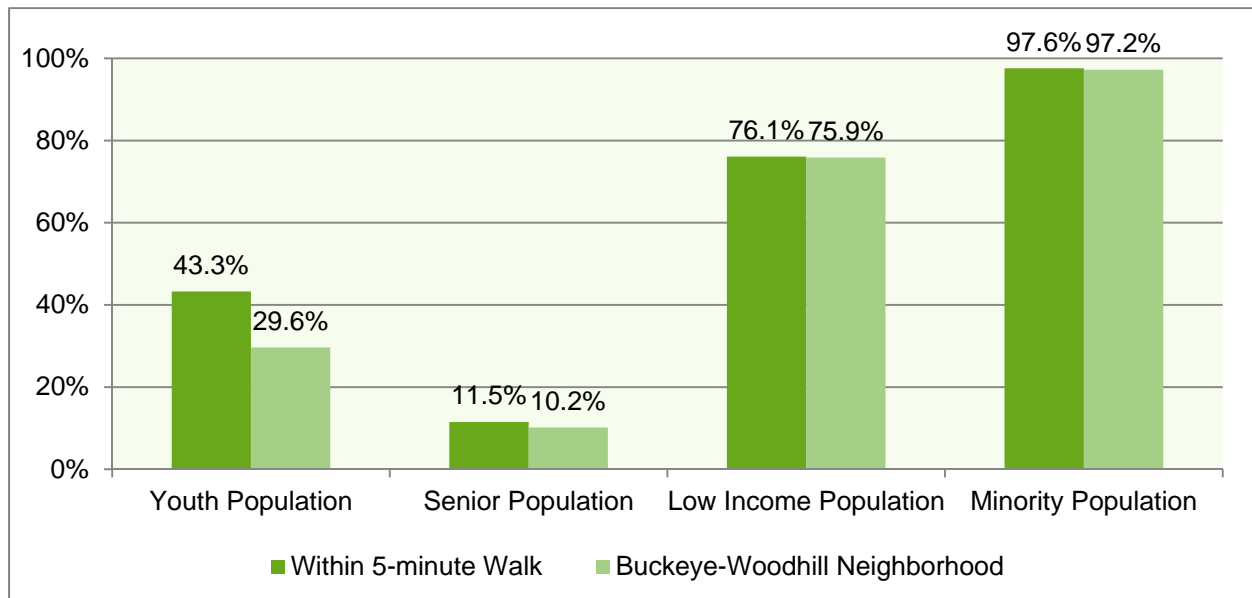


Multiple Bioretention Basins



5-minute Walk to Site

Figure 5.9: Socio-economic Characteristics of the Surrounding Community





Community Benefits

- Aesthetic Improvements: **3.2** acres of new public space represents a **26.4%** increase in new public space in the Buckeye-Woodhill neighborhood.
- Recreational Benefits: **1.6** acre of new recreational area and **9** benches will be added at the GI Feature Site.
- Quality of Life Benefits: Infrastructure improvements include **0.5** mile of new local storm sewer and **0.5** mile of improved roadway. In addition, there are **1.3** acres of distressed properties repurposed to support neighborhood revitalization. This represents a **1.8%** decrease of distressed property in the neighborhood.
- Potential Property Value Increase: **30** properties in the surrounding community could observe a positive impact in property values because of these improvements which represents **6.5%** of the parcels within the ¼ mile area.
- Community Engagement: The District is working with **3** community partners including City of Cleveland, Greater Cleveland RTA, and Morning Star Baptist Church, to integrate the GI Feature Site into the neighborhood.



Environmental Benefits

- Ecological Benefits: **1.3** acres of new natural areas planted with native species will provide micro-habitats for birds, bees, and other pollinators.
- Air Quality Benefits: Changes in biomass at the GI Feature Site leads to **66.4** kilograms less health impacting air pollutants and **12.2** tons less GHG emissions. The avoided WWTP flow leads to **48.2** kilograms less health impacting air pollutants and **5.8** tons less GHG emissions.
- Climate Change Mitigation: **58** more trees and their respective combined shaded area, along with **1.6** acres of less impervious surfaces, represents a **20.3%** change at the GI Feature Site and will create a cooling effect on site.



Financial Benefits

- Energy Savings: **\$5,200** in annual energy savings from avoided wastewater treatment which represents a **11%** reduction in the potential energy costs of treating wastewater from the drainage area.
- Jobs and Economic Development: The project may support **0.33** FTEs for green jobs and **0.1** FTEs for gray jobs (direct impact). The share of employment associated with this GI project leads to **\$31,359** in annual economic development (indirect impact) which represents **4.80%** of total annual economic impact from the Appendix 3 GI Projects.

Stakeholder Input

Buckeye-Woodhill is one of the neighborhoods where there is a good concentration of GI projects being built or planned in a high priority area for neighborhood stabilization. The area has gone through a lot of abandonment and demolition over the years; there is hope that this concentration of GI can help the community with more than stormwater issues. The Buckeye-Shaker Development Corporation (BSDC) vision is for transit orientated development around the Buckeye-Woodhill train station and that GI projects can be a visual enhancement for vacant houses and commercial properties. BSDC has embraced stormwater management through rain barrel distribution, test site rain gardens and education with the community. Cleveland Botanical Gardens is planning activities around their GI projects and the District's GI projects which are in close proximity to each other. This includes creating GI tours for people coming in from out of town who are interested in what is going on here and leading residents on walking tours or coordinating signage so that people can go from one project to the next and do self-guided tours.

6. Evaluation

Program-wide Summary

Program-wide results are presented in Figure 6.1 as the sum of key indicator values across all nine Appendix 3 GI Projects. Overall performance and benefits of these projects are linked in various ways to the 209 MG of stormwater that these projects manage and the projects' total footprint, including 10 miles of new sewers within respective drainage areas and 63 acres of land improvements at the GI Feature Sites.

The projects represent new public assets for over 10,000 people who live within a 5-minute walk of the project site. Of those, the families living in 231 properties adjacent to the sites have a reasonable chance of benefitting from property value increases over time due to these improvements.

The conversion of existing underutilized land to GI will permanently repurpose 29 acres of distressed properties, and all hardscapes, landscaping and natural areas will be maintained in perpetuity by the District. Across all drainage areas, about 2,800 families will benefit from some combination of new local infrastructure including improved sewers, streets and sidewalks in front of their homes.

Figure 6.1: Program-wide Results

Key Indicators			Program Totals
Community Benefits	Community Engagement	Number of People within Walking Distance to Site	10,261
	Recreational Benefits	Acres of New Public Space	39
	Potential Property Value Increases	Number of Existing Parcels Adjacent to the GI Site	231
	Aesthetic Improvements	Acres of Distressed Properties Repurposed	29
	Quality of Life Benefits	Number of Households with New Local Infrastructure	2,812
Environmental Benefits	Ecological Benefits	Number of New Trees	1,508
	Ecological Benefits	Acres of Natural Areas	18
	Climate Change Mitigation	Acres of Shaded and Pervious Surface Area	39
	Climate Change Mitigation	Metric Tons of Potentially Reduced Greenhouse Gas at WWTP	187
	Air Quality Benefits	Kilograms of Potentially Reduced Air Pollutants	3,022
Financial Benefits	Energy Savings	Annual Energy Cost Savings at WWTP	\$156,328
	Jobs and Economic Development	Annual Economic Impact (indirect)	\$654,466

Environmental benefits stem from the nearly 1,508 new trees across the GI Feature Sites and the overall avoided wastewater treatment processing due to diverted stormwater.

Across all sites, the projects produce 22 acres of new shade from trees and a reduction of 17 acres of impervious surfaces which help to lower ambient temperatures at the sites during the summer. In addition, the trees and lower energy demand for wastewater treatment reduce emissions by over 3,000 kilograms of air pollutants and over 180 metric tons of greenhouse gases.

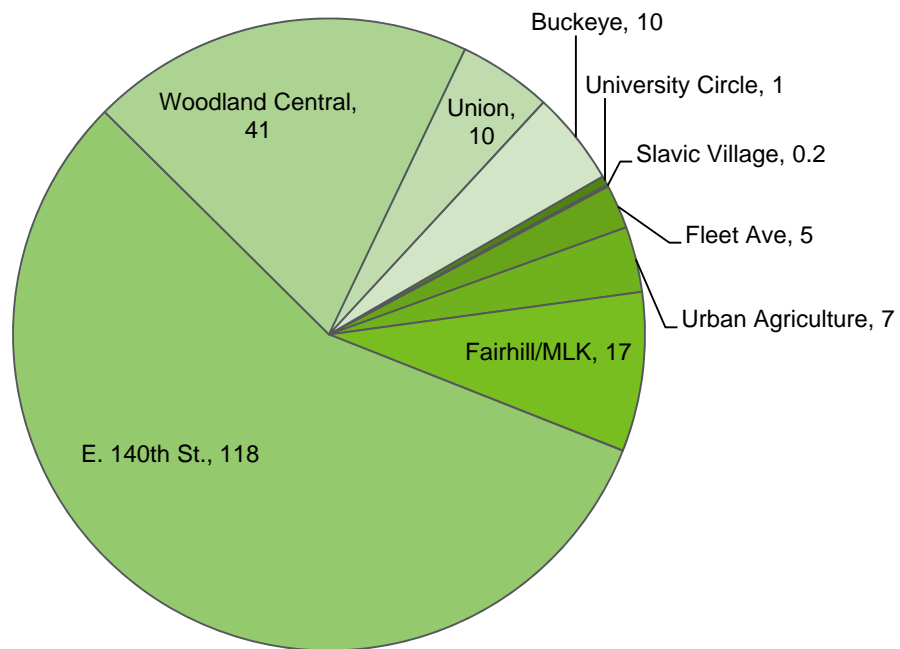
Financial and economic indicators of the program include over \$150,000 in annual energy savings at the wastewater treatment plants and over \$650,000 in annual economic impact based on changes in income, gross regional product, and sales and property tax revenue associated with each new O&M job created (indirect impact). This sum is determined from results of a local study that found that each stormwater or green infrastructure maintenance job generated about \$110,000 in annual economic impact for the region. This impact includes the direct salary of the employee as well as their subsequent purchases that impact the local economy.

It is important to specifically note the findings of this analysis related to life-cycle costs of GI versus traditional gray infrastructure. At the volumes of CSO which the District is controlling and the specific parameters of the District's combined sewer system, GI has a higher life-cycle cost than gray infrastructure.

Comparison of Appendix 3 GI Projects

As suggested under the Program-wide Summary above, many of the community, environmental and economic benefits are linked to the size or footprints of the GI projects and related volumes of stormwater managed. Altogether, the Appendix 3 GI Projects are designed to manage 209 MG of stormwater annually. The largest projects are E. 140th and Woodland Central projects, which capture 118 and 41 MGs, respectively and together amount to almost 76% of the entire program. University Circle and Slavic Village Demonstration Site are the smallest projects, amounting to only 1.0 and 0.2 MG, respectively. The comparison of co-benefits below for different Appendix 3 GI Projects will illustrate a similar trend—the largest projects provide the greatest community, environmental and economic benefits.

Figure 6.2: Millions of Gallons of Stormwater Managed by GI Project



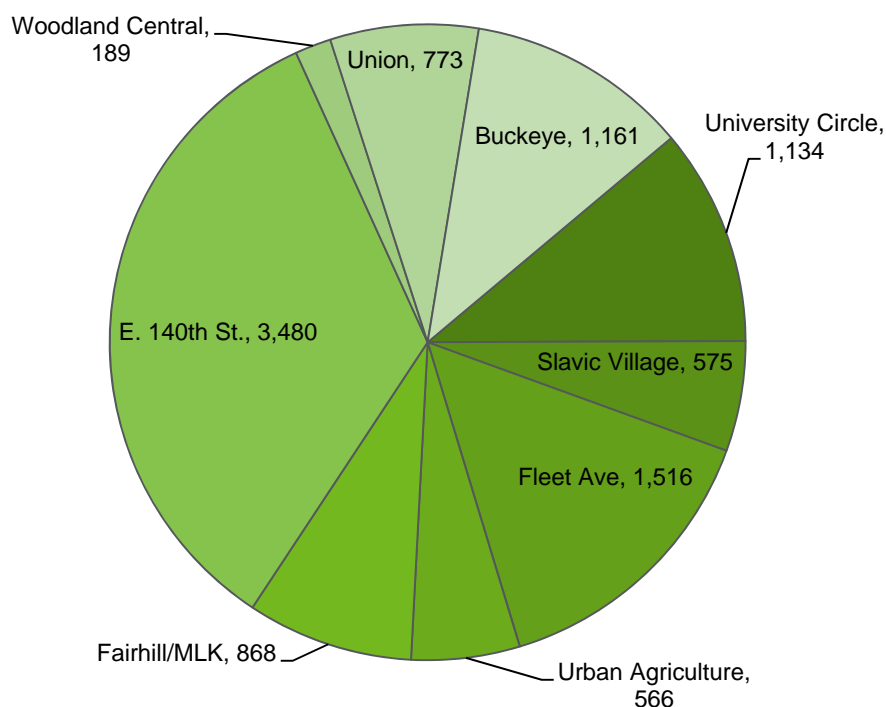


Community Benefits

Community Access to GI Feature Sites

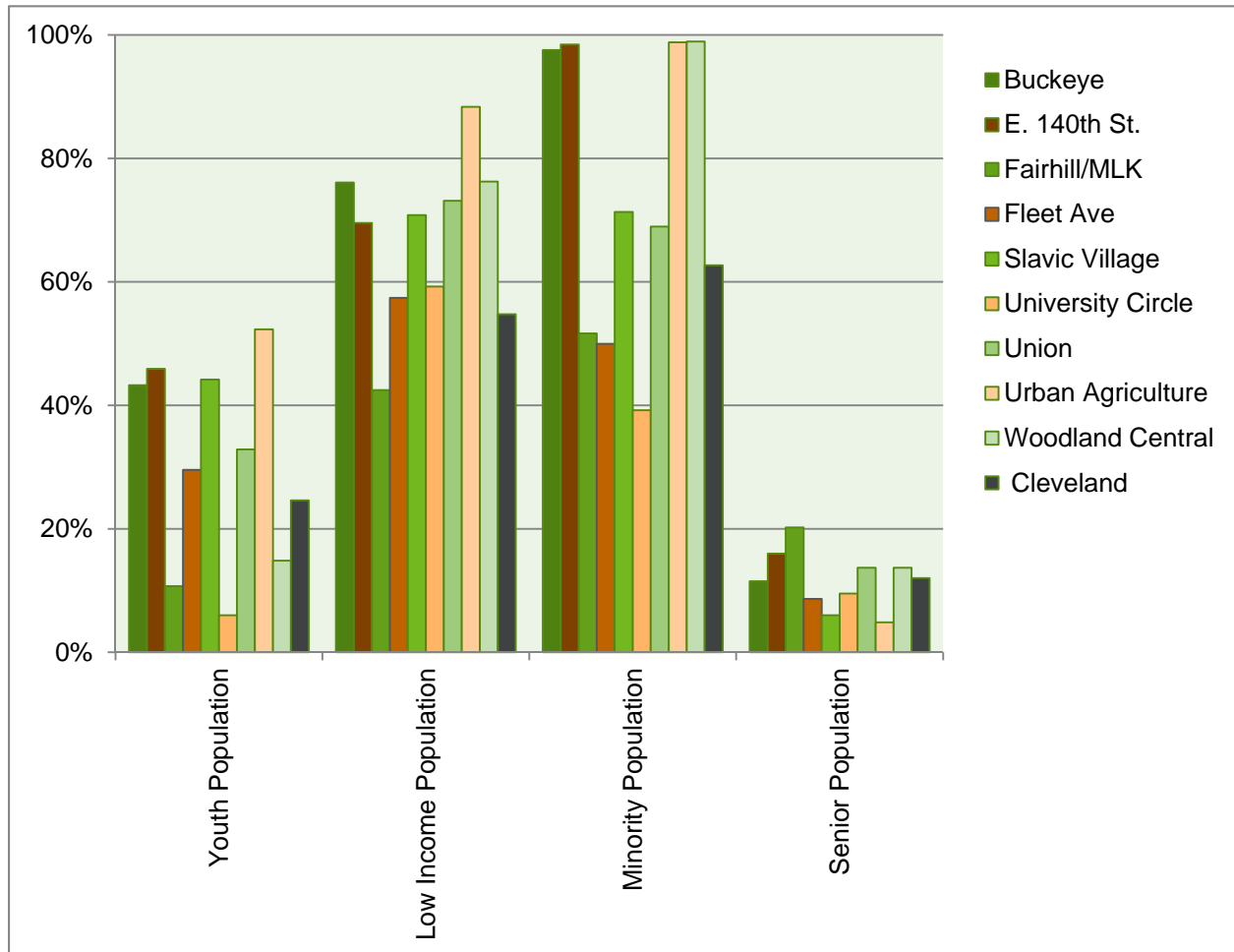
The number of people within a 5-minute walk, or approximately $\frac{1}{4}$ mile of the site, is an important indicator of who potentially benefits most based on access and connections to the GI Feature Sites. Figure 6.3 indicates that the project with the most significant community connection is the E. 140th Street site, which can be easily accessed by nearly 3,500 people. These residents represent about 20% of the total East Cleveland population. By contrast, Woodland Central is more remote and only 189 people within walking distance. Other significant sites include the over 1,000 people each in the surrounding communities of the University Circle and Buckeye sites. These residents are each about 15% of their respective neighborhood populations.

Figure 6.3: Number of People in Walking Distance to GI Projects



In addition to the sheer number of people near the GI Feature Site, the characteristics of the surrounding communities are important indicators. The surrounding communities of Urban Agriculture, Buckeye and Union projects exceed the citywide averages for environmental justice indicators: populations who are under 16, low income, minority, and over 65. Most of the GI projects represent new public investments in communities that have greater needs overall.

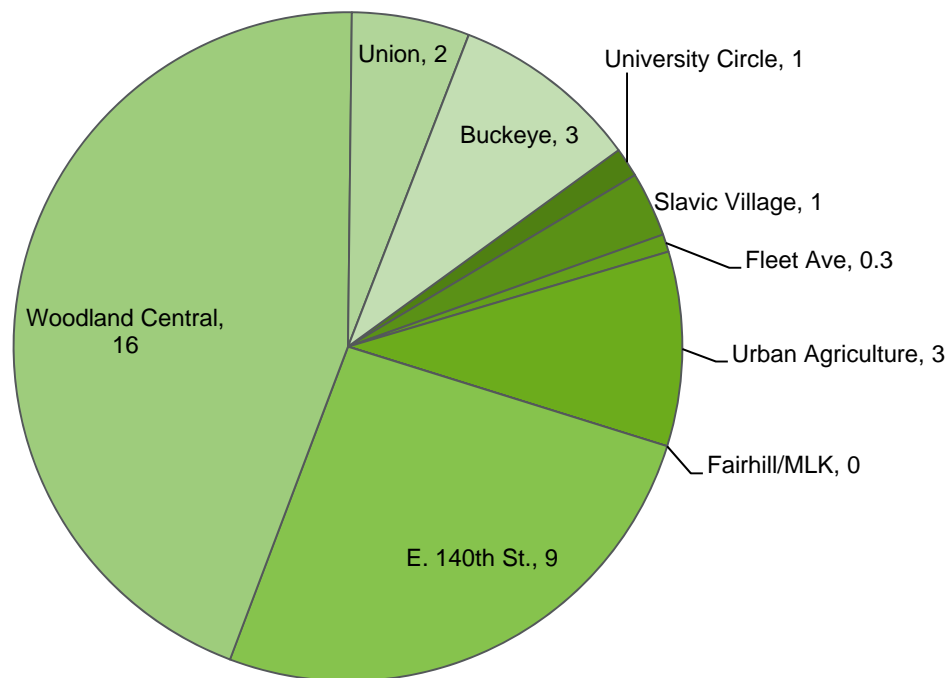
Figure 6.4: Environmental Justice Indicators, % of Population within Surrounding Community



New Public Space

The size of the GI Feature Site is a key determinant of its community value since larger sites accommodate more people and create more significant aesthetic improvements. Apart from the size, most sites provide visitors with amenities such as trails and park benches or unique features such as the outdoor classroom at Urban Agriculture. The largest sites are Woodland Central (16 acres) and E. 140th Street (9 acres). The Woodland Central GI project will result in an 88% increase of public space currently available for the entire Central Neighborhood. Similarly, Buckeye's 3.2 acres represents a 26% increase in public space for Buckeye-Woodhill neighborhood. The increase in public space in other neighborhoods is less than 11% as a result of the Appendix 3 GI Projects. The total aggregate of new or improved public spaces for the Union, Slavic Village Demonstration and Fleet Avenue in the Broadway-Slavic Village neighborhood represent a 3% increase for the neighborhood.

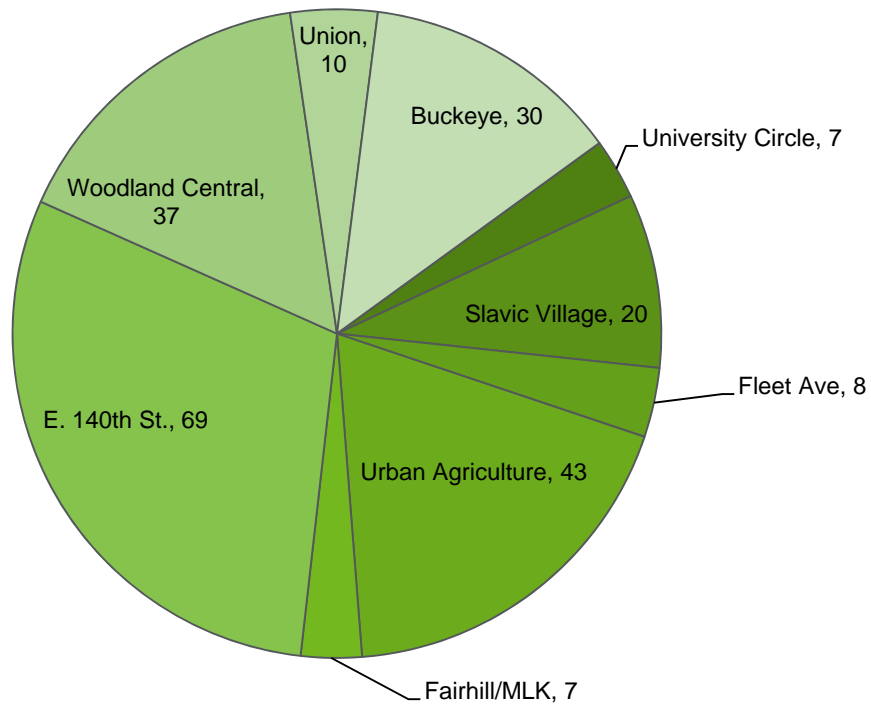
Figure 6.5: Acres of New Public Space Created by GI Project



Potential Property Value Increases

A property's proximity to new, aesthetically-improved public gathering spaces, which in most cases involve the clean-up of distressed properties, can potentially improve property values. The greatest potential for such increases would be observed in properties which are adjacent to the GI Feature Sites. Of all projects, E 140th St represents the largest numbers of households that may see potential gains. These 69 parcels that are adjacent to the site and greening of the roadway represent 5% of households within a walking distance. The next highest are the 43 parcels next to Urban Agriculture site that represent about 13% of the households in the surrounding community. Around other sites, the smaller number of adjacent properties amount to less than 11% of the properties within the surrounding communities.

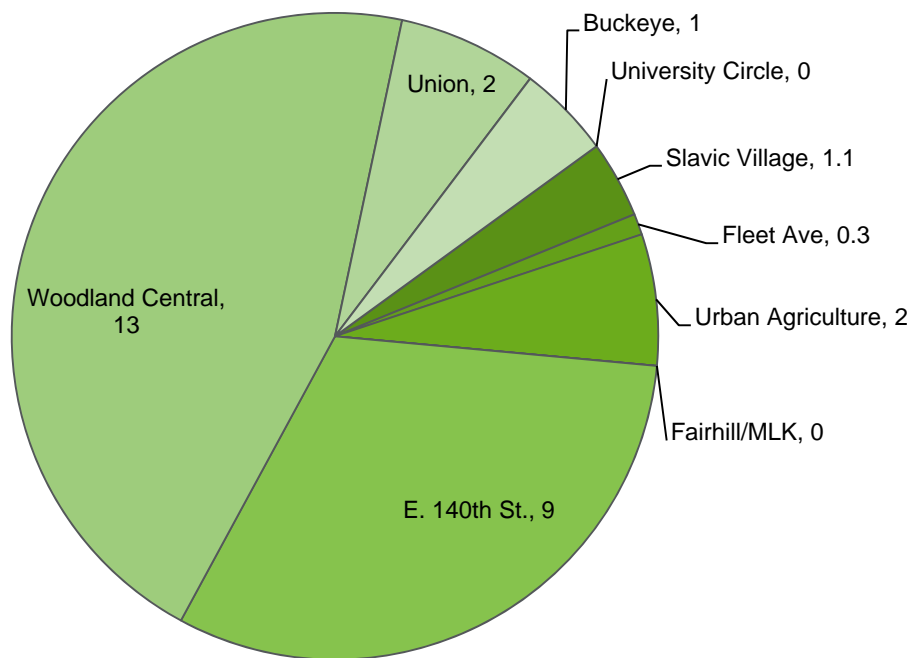
Figure 6.6: Number of Parcels Adjacent to GI Feature Site



Distressed Properties Permanently Repurposed

The GI project sites include 29 acres of properties that currently include abandoned or blighted structures, illegal dumping areas and brownfield sites that will be repurposed by the Appendix 3 GI Projects. Also at the GI Feature Site level, the establishment of vegetated ground cover may stabilize sites exposed to erosion and, in turn, reduce risk of lead or other contaminant exposure in local neighborhood. Of these 29 acres, the E. 140th Street and Woodland Central projects provide the largest impact with 9 and 13 acres of distressed area repurposed, respectively. Repurposed acreage at the E.140th Street site represents about 99% of its entire area and over 24% of such properties in the East Cleveland neighborhood. At Woodland Central, 81% of its site will be repurposed representing about 15% of the distressed properties in the neighborhood. University Circle and Fairhill/MLK GI projects did not replace any distressed properties. Three projects in the Broadway-Slavic Village neighborhood, Union, Slavic Village Demonstration and Fleet Avenue, will repurpose 2 % of the distress property acreage neighborhood-wide.

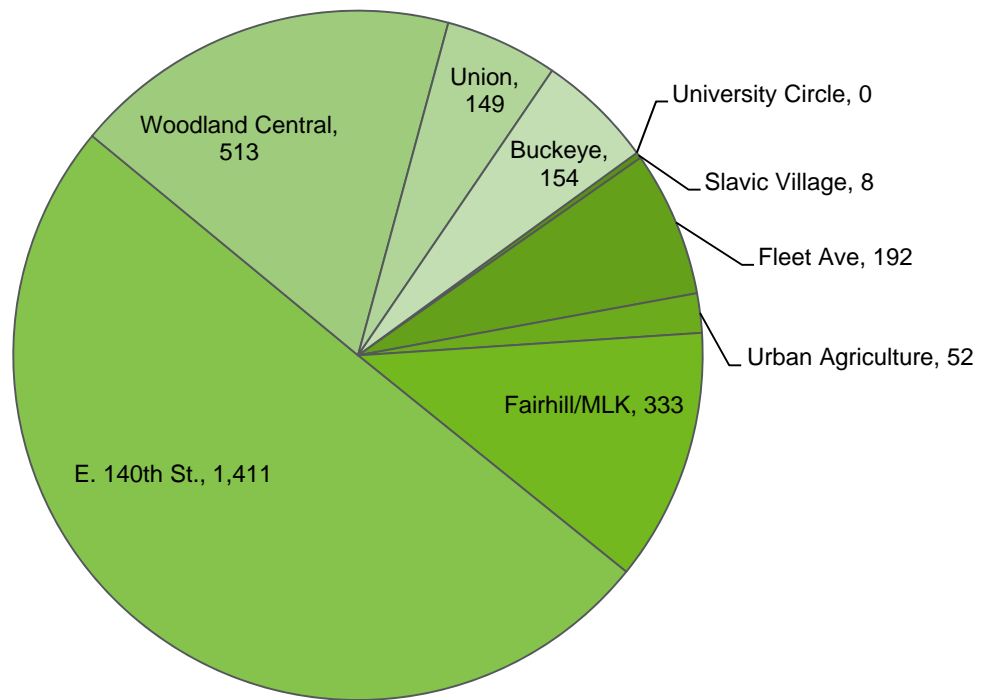
Figure 6.7: Acres of Repurposed Properties by Project



Households in Drainage Area with New Local Infrastructure

Households who live along streets where sewer separation will occur gain from new sewers, improved roads, and areas of sidewalk replacement after the project is completed. The large drainage area that feeds the E. 140th Street GI Feature Site explains why this project has the highest number of beneficiaries (1,411), which is about 18% of households in the entire neighborhood. In comparison, Woodland Central's 513 households in the drainage area represent 12% of households in its neighborhood. In other projects, those households in the drainage areas represent less than 5% of households in their respective neighborhoods.

Figure 6.8: Number of Households in Drainage Area





Environmental Benefits

Increase in Trees and Natural Areas

The number of trees and creation of natural areas including diverse blooming species varies considerably across sites. The largest project in trees added is Woodland Central which amounts to more than 1,300 additional trees and 8 acres of natural areas. The next largest in number of trees is E 140th Street with 66, while Buckeye is the next largest in total trees following the construction of the Appendix 3 GI Projects. Note that while all projects will add trees, in the case of Fairhill/MLK, there is a reduction in trees at the site because more trees are removed than added. The District intends to mitigate this reduction during construction of these projects.

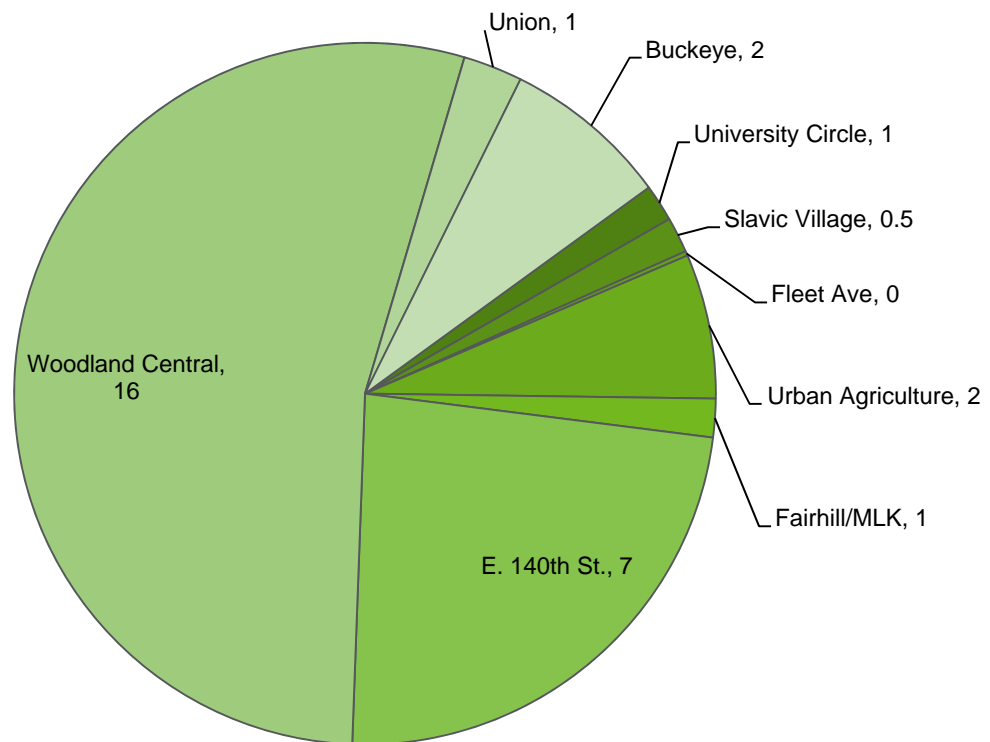
Figure 6.9: Change in Number of Trees and Natural Areas by Project

Appendix GI Project	Change in Number of Trees	Change in Acres of Natural Areas
University Circle Demonstration	3	0
Green Ambassador - Slavic Village Demonstration	14	0.9
Fleet Ave	20	0.2
Green Ambassador - Urban Agriculture	9	1.6
Green Ambassador – Fairhill/MLK	-36	0.6
E. 140th St	66	4.9
Woodland Central	1,354	7.6
Union	20	1.3
Buckeye	58	1.3
Total	1,508	18.4

Climate Change Mitigation

Design features at each site, especially pervious surfaces and trees can reduce ambient temperatures at a local level. These indicators represent an attempt to capture the mitigating effects that the Appendix 3 GI Projects can have on urban heat island and climate change. Measured in terms of the shade created by trees and the acreage of pervious surfaces to be maintained, the sites with the largest such impacts include Woodland Central and E. 140th Street, which create 16 and 7 acres of mitigated area, respectively. These impacts are driven primarily by the significant reduction in impervious surfaces at Woodland Central with 10 acres, and E. 140th Street with 5 acres. In addition, Woodland Central will plant around 1,514 trees that will eventually create 10 acres of shade.

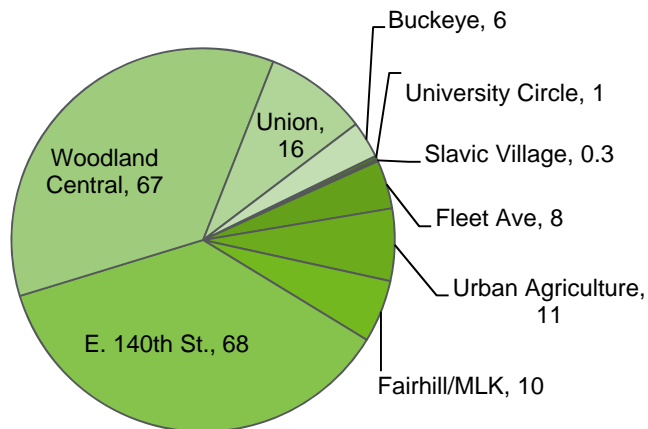
Figure 6.10: Acres of Shaded and Impervious Surface Area Reduction



GHG Reduction

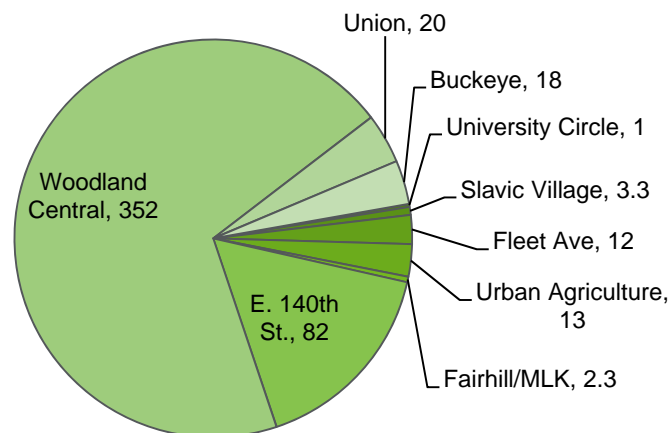
Potential reductions in atmospheric greenhouse gases occur because of avoided treatment at WWTPs and carbon sequestration by trees. The combined effect of these impacts is shown in Figure 6.12. The two largest projects in terms of avoided treatment, E. 140th Street and Woodland Central, are similarly the largest in reduced GHG emissions. The relative proportions of GHG reduction is not equivalent to wastewater treatment avoided because of differences in energy efficiency at the plants. That is, because the energy efficiency is higher at the plant serving E. 140th Street drainage area, the avoided wastewater flows amount to a lower reduction in emissions compared to the plant serving the Woodland Central drainage area as shown in Figure 6.11.

Figure 6.11: Metric Tons of Reduced GHG Emissions from Avoided Wastewater Treatment



An examination of the total impact on energy demand from avoided wastewater treatment and the increase in trees at each site is shown in Figure 6.12. The significant increase in trees at Woodland Central provides over 450 metric tons of carbon sequestration which alone is almost three times greater than all reductions in GHG emissions from potentially reduced energy use at the treatment plants due to the avoided treatment of wastewater flow. Combined, these projects reduce total annual GHG emissions by 710 tons.

Figure 6.12: Metric Tons of Total Reduction in Atmospheric GHG



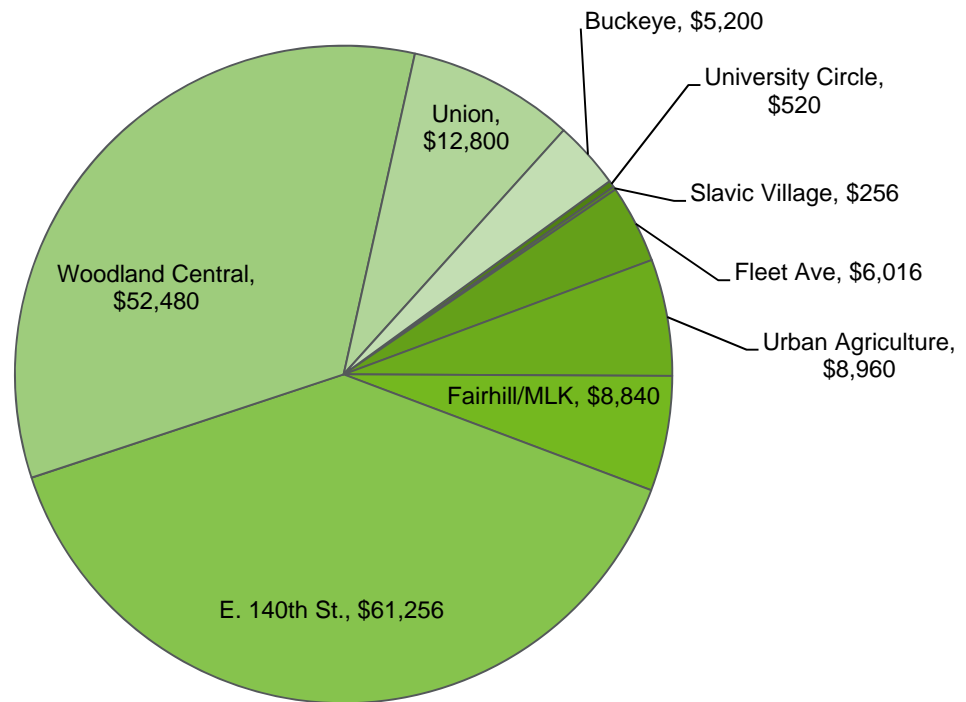


Financial Benefits

Energy Savings at Wastewater Treatment Plants

The same potential energy reductions that produced GHG reductions can also be monetized to reveal the total annual energy savings for the wastewater treatment plants. Accordingly, the size of the segments for each project in Figure 6.11 is the same as in Figure 6.13. The greatest cost savings occur from the larger volumes of stormwater removed from the combined sewer system and managed at E. 140th Street and Woodland Central.

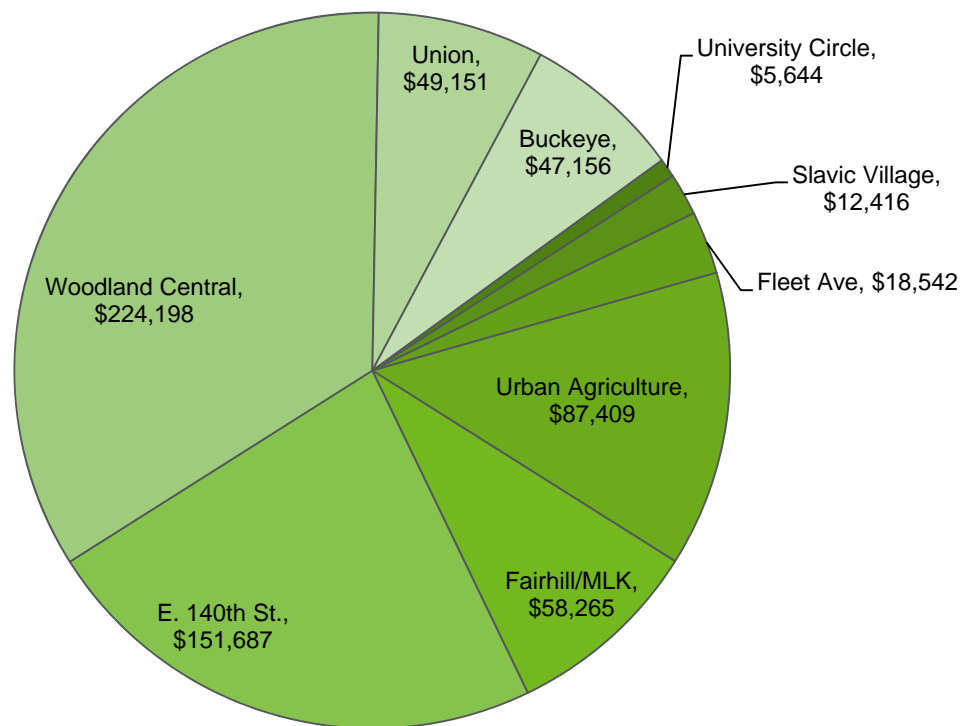
Figure 6.13: Annual Energy Cost Savings due to Avoided Treatment



Regional Economic Impact of O&M Jobs

Estimates of total economic impact from the Appendix 3 GI Projects are derived from two FTE units to inspect and maintain new storm sewers and catch basins and four FTE units to inspect and maintain GI Feature Sites. The indirect annual economic impact to the City is derived from the income and expenditures of these employees. As a proportion of each project's sewer length and GI Feature Site acreage, the share of this total economic impact is estimated by project in Figure 6.14. E.140th is the largest because of the large volume managed and its drainage area. The University Circle site is the smallest for the same reason.

Figure 6.14: Annual Economic Impact of Project Maintenance



Green vs. Gray Infrastructure Comparisons

Comparisons of green and gray infrastructure options can be performed for life cycle costs and embodied energy at the programmatic level. That is, the life cycle costs and embodied energy for GI is determined for all projects in Appendix 3. The gray infrastructure impact on costs and embodied energy is defined as the “Avoided Gray” infrastructure, which is the avoided upsized gray infrastructure identified in the Consent Decree to achieve the 44 MG of equivalent additional CSO control. This is not strictly an “apples to apples” comparison. The gray infrastructure systems were avoided for GI despite differences in drainage areas, location, and size. They are comparable with respect to meeting the Consent Decree requirements, but not from an engineering performance and cost perspective.

The analysis of life cycle costs includes design, construction, O&M, and residual value for both Appendix 3 and Avoided Gray Infrastructure options. GI options also account for land acquisition and additional R&R costs after 10 years for the first foot of bioretention media and replanted vegetation, or other R&R requirements specific to the GI technology. Other assumptions on computing life cycle costs are included in Figure 6.16. The Appendix 3 GI Projects may reduce CSO volumes by 18.5 MG and the Avoided Gray Infrastructure would reduce CSO volumes by 40.3 MG. All capital costs were converted to 2014 dollars using the Engineering News-Record (ENR) Cleveland Construction Cost Index (CCI).

Figure 6.16: Life Cycle Cost Assumptions

Assumptions Included	Appendix 3 GI Projects	Avoided Gray Infrastructure
Year 1	2014	2014
Length of Analysis	30 years	30 years
Discount Rate	5.5%	5.5%
Life of Asset	10/30 years*	50 years
Total CSO Volume Reduction	18.5 MG	40.3 MG

* 10 years assumed for first foot of bioretention media only and these costs reflected in R&R Costs and Residual Values; the rest of the GI systems are assumed to have a life of 30 years.

Results in Figure 6.17 indicate that the Avoided Gray Infrastructure costs are approximately \$35 million lower than the Appendix 3 GI Projects or about \$2.4 million less per year over 30 years. At \$4.45 per gallon of CSO reduced, the costs for the Appendix 3 GI Projects post-gray is \$3.29 per gallon more than the costs associated with the Avoided Gray Infrastructure.¹ One reason why Avoided Gray Infrastructure projects are much more cost effective per CSO reduced than the Appendix 3 GI Projects is that the Avoided Gray Infrastructure reduces CSO volume by about 22 MG more than Appendix 3 GI Projects as shown in the last line of Figure 6.16.

¹ Note that the Appendix 3 GI Projects manage (i.e., capture and treat onsite before discharging) over 10 times more gallons of stormwater than gallons of CSO reduced (i.e., 209 MG vs 19 MG, respectively). Accordingly, the net present value cost to manage stormwater across all Appendix 3 GI Projects is about \$0.39 per gallon compared to \$4.45 per gallon of CSO reduced.

Figure 6.17: Life Cycle Cost Results

Program-wide	Total Capital Cost (\$ Mil)	Total O&M Cost (\$ 000)	Property Acquisition Cost (\$ 000)	Repair & Replace, NPV (\$ 000)	Life Cycle Cost, NPV (\$ Mil)	Annualized Cost(\$ Mil)	Cost per Gallon of CSO Reduced
Appendix 3 GI Projects	\$58.7	\$1,377	\$2,863	\$929	\$82.0	\$5.6	\$4.45
Avoided Gray Infrastructure	\$50.6	\$25	\$0	\$0	\$46.9	\$3.2	\$1.16

The difference in green vs. gray infrastructure costs per gallon is largely a result of the maintenance assumptions for the Appendix 3 GI Projects. Total net present value of O&M costs are estimated to be 24% of the total life cycle costs for the Appendix 3 GI Projects, compared to less than 0.05% for the Avoided Gray Infrastructure.

These costs include O&M activities for the GI Feature Sites as well separated sewers in the drainage areas based on complete designs for Green Ambassador projects and basis of designs or design option evaluations for the other Appendix 3 GI Projects. The maintenance activities and costs associated with each were estimated by the District's operations staff and are conservative in that the District plans for more frequent and comprehensive maintenance activities in the first two years following construction. Despite this, R&R costs for GI projects are necessary.

In contrast, the Avoided Gray Infrastructure is not expected to require any R&R costs within the length of analysis and is expected to perform or include residual value following the analysis period given its longer life span. The Avoided Gray Infrastructure costs for O&M include the costs for pumping and treating flow at the wastewater treatment plants.

These costs only reflect costs to the District and do not consider the savings for current property owners including the Cuyahoga County and Cleveland Land Banks and other public agencies as the District will assume the O&M for these sites in perpetuity. These other costs specific to the GI Feature Sites include standard maintenance and mowing costs as well as clean-up for illegal dumping. Both of these costs are dependent on the frequency of these activities and also weight of materials to be hauled and disposed which can vary across sites.

The life cycle analysis of embodied energy accounts for the quantities of energy and greenhouse gases used in the construction and placement of materials. The embodied energy for the Appendix 3 GI Projects includes all of the concrete pipes, and pavement resurfacing that would occur throughout the drainage area. The embodied energy in the Avoided Gray Infrastructure projects is estimated by determining the reduction in materials by avoiding larger diameter tunnels.

The results in Figure 6.18 indicate that the Appendix 3 GI Projects generate 6,400 less tons of greenhouse gas emissions compared to Avoided Gray Infrastructure. Compared to the results across all Appendix 3 GI Projects, the embodied energy is roughly equal to eight years of carbon sequestration by trees and avoided energy use at the wastewater treatment plants. If Appendix 3 GI is built to achieve the equivalent CSO volume reduction associated with the Avoided Gray Infrastructure (i.e., 40.3 MG) the total CO₂ emissions would increase to 31,123 tons as prorated in Figure 6.18.

Figure 6.18: Life Cycle Analysis of Embodied Energy

Program-wide	Total Life Cycle CO ₂ (Tons)	Prorated Life Cycle CO ₂ (Tons)	Assumptions
Appendix 3 GI Projects	14,287.3	31,123.1	Includes concrete pipes of various diameters, Pavement
Avoided Gray Infrastructure	20,662.4	NA	Includes difference in concrete pipes based on avoided upsized tunnels

Life cycle CO₂ was prorated to determine the equivalent amount of emissions if the Appendix 3 GI Projects were sized and located to achieve the 40.3MG of CSO volume reduction associated with the Avoided Gray Infrastructure. To prorate, the total life cycle CO₂ for Appendix 3 GI Projects was divided by 18.5 MG to calculate the CO₂ emissions per gallon of CSO reduced with GI, and then multiplied by 40.3 MG to determine the total life cycle CO₂ emissions for the equivalent level of control as Avoided Gray Infrastructure.

“It’s been a fantastic partnership with the District and I would like to see it continue. It has opened our eyes to some of the other work that the District is doing. We have been talking to them about the deep tunnel project that runs through our neighborhood and we want to make sure that those investments are having the same positive impact and are not hindering development in anyway.”

— University Circle Inc. (UCI): Debbie Berry, Vice President of Community Development

7. Conclusions

The co-benefits anticipated for Appendix 3 GI Projects are largely proportional to the size of the GI Feature Sites and their respective drainage areas. Only two of the Appendix 3 GI Projects do not include sewer separation: University Circle and Slavic Village Demonstration. All GI Feature Sites include the repurposing of existing parcels and long term O&M by the District. In addition, investments by the District in additional features and amenities including landscaping, hardscapes and gathering spaces at the GI Feature Sites provide significant community and financial co-benefits. In comparison, while environmental co-benefits associated with the Appendix 3 GI Projects are modest in terms of air pollutant and GHG emissions reductions they are significant in terms of ecological benefits due to number of new trees and acreage of new natural area. Additional findings from the Anticipated Co-Benefits Analysis are summarized below.

Positive features of the Appendix 3 GI Projects include:

- The District located GI in communities with a diverse combination of socio-economic characteristics and environmental justice issues.
- GI Feature Sites provide new or improved and attractive public spaces for the community along with infrastructure improvements in the drainage areas. For example, Woodland Central as currently designed provides 160% increase in public space for the entire Central Neighborhood and Buckeye represents a 26% increase in public space for the Buckeye-Woodhill neighborhood.
- The Appendix 3 GI Projects potentially reduce GHG emissions at treatment plants, increase carbon sequestration and reduce embodied energy compared to the Avoided Gray Infrastructure elements of the Consent Decree.
- Overall economic impacts stem from up to 6 FTE units of work supported to maintain the new infrastructure.

The life cycle cost results suggest:

- While the benefits increase with the size of the project, the cost per gallon of CSO reduction post-gray decreases. In other words, the District is realizing economies of scale with its larger GI projects such as E. 140th Street and Woodland Central compared to smaller GI projects such as Slavic Village Demonstration.
- Life cycle costs are greater for the Appendix 3 GI Projects post-gray compared to the Avoided Gray Infrastructure projects of the Consent Decree; \$4.45 versus \$1.16 per gallon of CSO reduced, respectively.

Overall, the process of identifying and measuring key project indicators:

- Creates opportunities to consider design improvements or standards that increase community and environmental co-benefits.
- Recognizes the importance of siting new community assets to maximize the number of people who can easily access the site or benefit from improvements in the community; for example, large projects like Woodland Central have a limited number of people who can walk to the site however community revitalization underway may result in a greater access to this site in the future.
- Identifies additional amenities for GI Feature Sites that would increase life cycle costs for the District but presents opportunities for long term community partnerships.

As a result of the District's partnerships within key stakeholder groups, Appendix 3 GI Projects are integrated into the community in the following ways:

- The District's projects along with others help support activity in the neighborhoods in which they occur.
- The significant blight elimination and neighborhood beautification provided by these projects are a great positive to the future development of an area.
- Most stakeholders hope that GI projects will result in jobs for people within their community and result in economic growth from within.
- Community groups have embraced the concept of stormwater management and found ways to incorporate it into future development e.g., permeable pavements in parking lots, rain gardens and other diversion practices.
- Several groups are interested in adding their own touches at the GI Feature Sites such as murals or other contributions from within the community.
- There is a desire to partner on future projects based on these successful collaborations to implement Appendix 3 GI Projects.

"We are looking forward to working with the District on other projects in the community. For us, this is the beginning and what we learned is how much these projects impact stormwater reduction so it helps us look at all the projects we have in development in new ways. Because you are actually a part of something, it helps you incorporate that thinking overall into the bigger picture as little projects and big projects come before us."

— Slavic Village Development (SVD): Marlane Weslian, Neighborhood Development Officer

8. Addendum No. 1

Addendum Scope

The purpose of this addendum is to provide responses to the letter of conditional approval on the Anticipated Co-Benefits Analysis Report from EPA dated September 2, 2015. The letter of conditional approval is included in Appendix E of this report. The three conditions are listed below:

Condition 1: *NEORSD shall revise the Anticipated Co-Benefits Analysis Report to include updated stormwater volume capture values for each of the green infrastructure (GI) projects, to be implemented pursuant to Appendix 3 and identified in this Report, and shall update, any portion of the Report that stem from the stormwater volume capture values. NEORSD may provide the update to the Report itself or may include an addendum to the Report.*

Condition 2: *NEORSD shall revise the Anticipated Co-Benefits Analysis Report to include an updated draft GI project factsheet template, currently located in Appendix A of the Report, which characterizes NEORSD's GI projects using consistent and complete terminology and descriptions.*

Condition 3: *NEORSD shall revise and resubmit the Anticipated Co-Benefits Analysis Report to EPA and Ohio EPA within 45 days of receipt of this letter addressing specified conditions 1 and 2. NEORSD shall include this letter of conditional approval (including the enclosure) in the revised and resubmitted Report.*

Up-to-Date Stormwater Volume Capture Values

The Appendix 3 GI projects were in various stages of design, construction and completion at the time of the Anticipated Co-Benefits Analysis as identified in Figure 4.1. Results of the anticipated co-benefits for each Appendix 3 GI project are included in Section 5, including but not limited to these impacted by volume of stormwater managed, and are based on the characteristics of the projects at the identified stage of the project. However, as the projects advance through design and final construction, the co-benefits model developed as part of the Anticipated Co-Benefits Analysis can be utilized to evaluate the change in estimated co-benefits based on the revised characteristics.

Stormwater volumes managed by Appendix 3 GI projects, as calculated in the Appendix 3 GI Anticipated Co-benefits Model (co-benefits model) and reported in the Final Report, influence two co-benefit categories identified in Appendix 3 of the Consent Decree: air quality and energy savings benefits.

Air quality benefits are a result of four indicators. Two of the indicators are influenced by stormwater volumes managed by the GI project and the remaining two indicators are influenced by the additional coverage of biomass (e.g. trees) from the GI project. The indicators are listed below:

- Stormwater managed (MG) indicators
 - Avoided air pollutant emissions
 - Reduced greenhouse gas (GHG) emissions
- Additional coverage of biomass indicators
 - Reduced air pollutants in the project area
 - Reduced atmospheric carbon

Energy savings are projected from avoided wastewater treatment and computed by multiplying the stormwater volume managed by the amount of energy and the treatment cost per gallon.

Furthermore, the Appendix 3 GI Anticipated Co-benefits Analysis examined the program-wide impact of all the Appendix 3 GI projects in Section 6. Through this analysis, it was determined that energy savings are measureable, however, they are modest compared to the life cycle cost of the Appendix 3 GI projects. The program-wide impact on air quality benefits were determined to be significant from the planting of biomass compared to the avoided wastewater treatment. Therefore, the reduction of stormwater managed is estimated to have a minor impact on air quality and energy savings program-wide.

Updated Draft GI Project Factsheet Template

A revised draft GI project factsheet template has been included in Appendix A of this report with corrected terminology and descriptions. As discussed previously, the Appendix 3 GI projects were in various stages of design, construction and completion at the time of the Anticipated Co-Benefits Analysis. For report consistency, the revised factsheet template included within this report for the Green Ambassador Fairhill/MLK GI Project is utilizing the same details and results in Section 5 of the report.

EPA Letter of Conditional Approval

EPA's Letter of Conditional Approval dated September 2, 2015 has been added to this Report as Appendix E.


Appendix A: Draft Appendix 3 Green Infrastructure Anticipated Co-Benefits Factsheet Template

Below is a draft template that will be used to develop a factsheet for each Appendix 3 GI Project. This template will be modified to highlight the co-benefits on a project by project basis.

FAIRHILL/MLK


GREEN INFRASTRUCTURE PROJECT

Green Ambassador


FAST FACTS

63 acres




Total drainage area managed within the Larchmere neighborhood

2 acres



Amount of enhanced public space such as a bus stop, bike racks, benches, and recreational area

17 million



Gallons of stormwater that will be managed on-site, reducing pollution to Doan Brook by 2+ million gallons per year through the control of combined sewer overflow

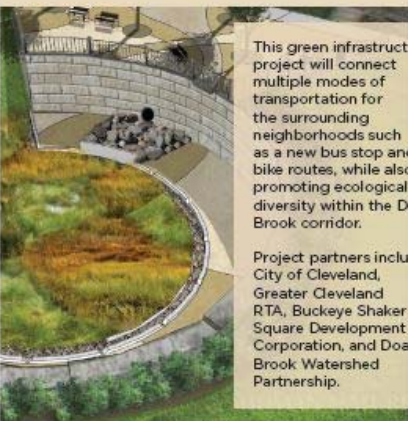
GREEN INFRASTRUCTURE includes a range of stormwater control measures—plant/soil systems, permeable pavement or other forms of stormwater harvest/reuse—to store, infiltrate, or evapotranspire stormwater and reduce flows to the combined sewer system.

ABOUT THE PROJECT

This Green Infrastructure Ambassador Project includes construction of a large bioretention basin and installation of new separate storm sewers along E. 124th Street and portions of Fairhill Road, Martin Luther King, Jr. Boulevard, Britton Drive, Mt. Overlook and E. 126th Street. Upon completion, it will help reduce combined sewer overflows by more than 2 million gallons per year.

PROJECT FEATURE

COMMUNITY CONNECTIONS



This green infrastructure project will connect multiple modes of transportation for the surrounding neighborhoods such as a new bus stop and bike routes, while also promoting ecological diversity within the Doan Brook corridor.

Project partners include City of Cleveland, Greater Cleveland RTA, Buckeye Shaker Square Development Corporation, and Doan Brook Watershed Partnership.

LEARN MORE See project details and map at neorsd.org/greenMLK • neorsd.org/CleanLake

2015 0914

FAIRHILL/MLK GREEN AMBASSADOR PROJECT



COMMUNITY BENEFITS BRIEF

What are anticipated environmental benefits of the Fairhill/MLK project?

- 1.3 acres of increased diverse natural area
- 17,000 square feet of blooming species added for pollinators like butterflies



KEEPING OUR GREAT LAKE GREAT.

The Northeast Ohio Regional Sewer District strives to be the environmental leader in enhancing quality of life in the region and protecting its water resources. We treat more than 200 million gallons of wastewater every day, employ 600+ Northeast Ohioans, and manage three wastewater treatment plants and 300 miles of sewer infrastructure.

(216) 881-8247 • neorsd.org • Tweet us @neorsd

LEARN MORE See project details and map at neorsd.org/greenMLK • neorsd.org/CleanLake

Appendix B: Glossary of Terms

Avoided Gray Infrastructure: The avoided upsized gray infrastructure identified in the Consent Decree to achieve the 44 MG of equivalent additional CSO control.

Calculation Parameter: Factors used to convert specific design features, site conditions and community characteristics into Co-Benefit Indicators. These parameters may be drawn from existing economic and engineering literature as well as data on site characteristics.

Co-Benefit Category: A distinct type of outcome that could arise from a GI project. The Co-Benefit Categories in this analysis have been identified in Appendix 3 documentation. For example, “Air Quality Benefits” is a Co-Benefit Category that accounts for the change in air pollution due to GI project implementation.

Co-Benefit Indicators: Measures of impact associated with a GI project that is directly related to a Co-Benefit Category. The indicator will be a continuous variable (e.g. number of tons) to the greatest extent possible. A Co-Benefit Indicator for Air Quality Benefits could be the “Reduction in Particulate Matter (Tons)”.

Design Feature: A specific component of a GI project that includes its functional elements for managing stormwater as well as ancillary elements which provide aesthetic, recreational or other types of value.

Distressed Property: Properties and areas which consist of land bank properties, abandoned or blighted structures or illegal dumping areas.

Existing Community Characteristics: Demographics including socioeconomic or environmental justice statistics providing information about the community directly affected by a specific GI project. Community characteristics are evaluated from within the vicinity of the GI site, which is defined as ¼ mile away.

Existing Site Conditions: Variables or data points that relate to existing surface features of a specific GI project site and representing a change following construction of a specific GI project. The site where a GI project is located can also be characterized by the local ecology and connectivity to open space and recreational opportunities in the community, which is defined as ¼ mile and ½ mile away.

GI Feature Site: The land area within the borders of the property that will be the site of bioretention, infiltration or permeable pavement installations plus the surrounding area on site to be maintained by the District including easements as part of the District’s Appendix 3 GI Projects.

GI Project: The GI Feature Site and the corresponding drainage areas with sewer separation as part of the District’s Appendix 3 GI Projects.

GI Project Area or Project Area: The GI project and immediate areas most affected referred to as the surrounding community, 5-minute walk or adjacent parcels in this report.

Mapping Diagrams: A graphical presentation of data and calculation methods used to convert GI project design features, site conditions and community characteristics into Co-Benefit Indicator values, or quantitative analysis results.

Pre-Gray: District modeling and/or engineering calculation of baseline conditions to estimate CSO capture for each GI project.

Post-Gray: District modeling and/or engineering calculation of consent decree conditions to estimate CSO capture for each GI project.

Program-wide: The impact of certain co-benefits collectively across the District’s Appendix 3 GI Projects.

Surrounding Community: Defined as a 5-minute walk to the GI Project Area.

Typical Year: A synthetic typical year rainfall time series was developed in 1995 as part of the District's CSO facilities planning effort. This synthetic typical year consists of 121 representative events compiled predominately from recorded rainfall that occurred in 1991 and 1993.

Appendix C: Anticipated Co-Benefits Model Description

Model Purpose

The Anticipated Co-Benefits Model is an Excel based tool and workbook that allows information about GI design features and existing site conditions and community characteristics to produce Anticipated Co-Benefit Indicator values. An electronic copy of the model is included with this report.

The model was constructed as a series of linked worksheets including data banks, data sources, and project specific input and output summaries to calculate anticipated co-benefit indicators and describe related co-benefits. The measurement of co-benefit indicators is based on determining the incremental difference between existing or baseline conditions and the anticipated future conditions after the GI project is built. The data used to determine the change between the existing conditions and future effects of the project includes various inputs to the data bank (site-specific design features of each project, the existing site conditions, and existing community characteristics surrounding the GI Feature Site) to determine the direct output (change in existing conditions).

The final output from the model presents meaningful information used to evaluate the GI projects in the context of their geographic location, as well as the Citywide Program.

Model Contents

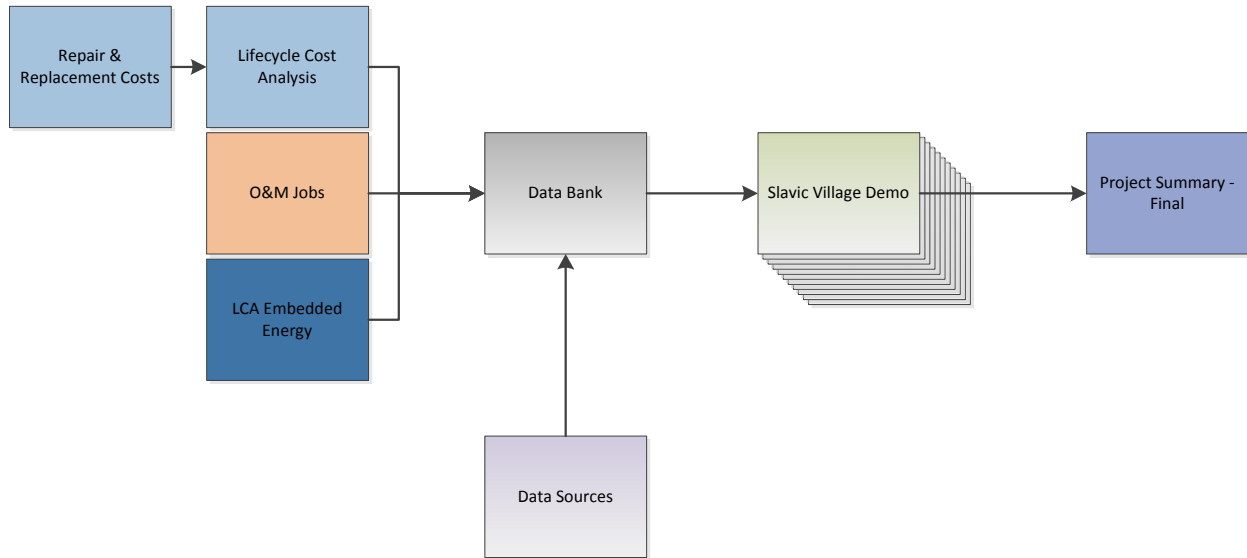
The Co-Benefits Model is an Excel based tool and workbook that allows information about the GI Design Features, Existing Site Conditions, Community Characteristics, and Calculation Parameters to produce the Co-Benefit Indicator values. Technical aspects in the Workbook include the following worksheets:

- **Data Bank:** contains all the information for the GI Design Features, Existing Site Conditions, Community Characteristics, and Calculation Parameters.
- **Data Sources:** contain the source document or file for the corresponding Data Bank value.
- **Project Specific Results:** contains the inputs and calculations final estimates of co-benefit Indicators for each project. Each Project Specific Presentation worksheet presents data input, indicator results and calculations in an identical manner. Co-Benefit Indicators themselves in summary tables near the top of the sheet. See example in **Error! Reference source not found..**
- **Lifecycle Cost Computations:** this worksheet compiles all relevant data for performing the comparison of lifecycle costs for GI and grey and computes the cost difference for three specific sites. The calculations from here feed into the Data Bank sheet.
- **Repair & Replacement Costs:** this worksheet compiles all relevant used in the Lifecycle cost computation with respect to site specific repairs and upgrades over the timeframe of analysis.
- **O&M Jobs:** this worksheet calculates each GI site's share, based on total acres, of the economic impact of the 6 (4 GI, 2 Storm water) O&M jobs needed for the program. The data from here feeds into the Data Bank sheet.

- **LCA Embodied Energy:** this worksheet calculates the energy (and emissions) that come from the physical construction of sewer systems. It provides another level of analysis to determine the total lifecycle cost of a project.
- **Summary Sheet:** this worksheet acts a 'dashboard' and provides a high-level, program wide over of all the Co-Benefit Indicators and socioeconomic conditions of all the GI project sites in one location. It pulls data directly from the Project Specific Results sheets.

Figure 11 presents an overview of how the various components of the model interact.

Figure 11: Overview of Model



Appendix D: Data Sources

File/Source Description	File Name/Web Link
2008 through 2013 Wastewater Treatment Plant Cost per unit of Flow	Flow_Cost per Unit 2008 – 2013 Wastewater Treatment Cost per Unit.xls
Annual energy use and cost for Southerly and Easterly plants	5 year comp gas.elec usage per mcf plt flow.xlsx
Appendix 3 GI Summary Table for EPA Response Comments	GIPCM Response Table 01082015-DM.xlsx
Appendix 3 GI Summary Table for EPA Response Comments	GIPCM Response Table 01082015-DM.xlsx
Area breakdown of different landscape types at GI project site	Draft GA GI Sites_O&M Breakdown.pdf
Basis of Design: E 140th St Consolidation & Relief Sewer	E140CRS_BOD_Report Body.pdf
Basis of Design: E 140th St Consolidation & Relief Sewer (Appendix F)	Appendix F - Estimate of Probable Construction Cost.pdf
Basis of Design: Fairhill/MLK	Faihill_MLK_BOD_20140502.pdf
Basis of Design: Giddings Brook	GiddingsBrook_BOD_20120928.pdf
Basis of Design: Green Ambassador-Urban Agriculture	Urban_Ag_Innovation_Zone_BOD_20140523.pdf
Basis of Design: Woodland Central	Woodland_Central_BOD_20120926.pdf
Census 2010	NA
Design Options Evaluation: Giddings Brook Zone 2- Buckeye Road	GiddingsBrookZone2_DOE_20140103.pdf
Design Options Evaluation: Slavic Village-Union Ave	SlavicVillage_DOE_20140103.pdf
Design Options Evaluation: Woodland Central	Woodland_Central_DOE_20140114.pdf
Design Plans: Fleet Avenue	2013-12-23_FleetAvenuePlansFULL.pdf
Design Plans: Green Ambassador - Fairhill/MLK	Faihill_90%_DRW_20140502.pdf
Design Plans: Green Ambassador - Slavic Village Demonstration	Slavic Village Final Design 12-15-13.pdf
Design Plans: Green Ambassador - University Circle Demonstration	Design_Ser_09302011.pdf
Design Plans: Green Ambassador - Urban Agriculture	UrbanAg_Final_DRW_20140523.pdf
GIS ESRI aerial map 2012: land use map, land bank, parcel,	GI Co-Benefit Analysis - Demographic Analysis Results.mxd
Manual of Woody Landscape Plants	Dirr, Michael A. 1983. Manual of Woody Landscape Plants; Stipes Publishing; Champaign, Ill. Third Edition
NEO CANDO 2010+ system, Northeast Ohio Data Collaborative	http://neocando.case.edu/neocando/
NEORSD Advanced Facility Planning and Program Support Services Project (WBS 1304) Green/Gray Infrastructure for CSO Control – Alternative Cost Comparison	CSO_AFP_TBL_Gray_Green_Cost_Comparison_20140423.xlsx

File/Source Description	File Name/Web Link
NEORSD Capital Plant Cost Estimate Assessment for the CSO Advanced Facilities Plan and Program Support Services Project Contract 1304 Final Memo	Capital Plan Cost Estimate Assessment – Final Memorandum
NEORSD CSO AFP – Green Infrastructure for Gray Infrastructure Alternatives Cost Comparison Approach Memo	Green_Gray_Cost_Comparison_CS0_AFP_20140326.pdf
NEORSD CSO AFP –Green/Gray Comparison Approximate Tunnel Volume Cost Increase to Achieve One Overflow in the Typical Year	Copy of Task 2E - CostTool_tunnelincrease_one-overflow_20141124.pdf
NEORSD Equivalent Gray Alternative to Woodland Central, Urban Agriculture and Buckeye Green Infrastructure (GI) Projects	CSO_AFP_AMM_Gray-Green_TM_20141203.docx
O&M cost estimate for E140th St Consolidation & Relief Sewer	CDM_Smith_G.I._Maintenance_Estimate_E140CRS_V2.xlsx
O&M costs from CSO Advanced Facilities Planning and NEORSD	Appendix_3_OM_Costs_101314.xlsx
Opinion of Probable Construction Cost: Fairhill/MLK	Fairhill-MLK 100 Percent Re-Submittal OPCC Support 11.14.14.xlsx
Opinion of Probable Construction Cost: Fleet Ave	1313_EST_A_20131223.pdf
Opinion of Probable Construction Cost: Slavic Village	Slavic Village Bid Tab Summary - OPCC Update 12-3-13.xlsx
Opinion of Probable Construction Cost: Urban Agriculture	Urban Ag Final Submittal Revised OPCC Calculations 092614.xlsx
Public Participation Plan and Implementation Report: Fairhill/MLK	Fairhill-MLK GO Project Public Participation Plan 2-7-14_Revised
Public Participation Plan and Implementation Report: Fleet Avenue GI Project	Fleet Public Participation Plan_Final_01092014.pdf
Public Participation Plan and Implementation Report: Slavic Village Demonstration Project	Slavic Village Demonstration Public Participation Plan v7 Final 6-20-14.doc
Seeing Green Report developed by the Cleveland and Rockefeller Foundations	FINAL_seeing_green.pdf
Technical Memo: Green Ambassador-Slavic Village Demonstration Project	EPA_SlavicVillage_Demonstration_TM_20131031.pdf
Urban Agricultural Innovation Zone Outdoor Classroom - Design Concepts	2014-05-19-UAIZ-Outdoor Classroom Concept Pres-Updates.pdf
US EPA - 2011 National Emissions Inventory	http://www.epa.gov/ttn/chief/net/2011inventory.html
US EPA - Carbon Dioxide Emissions Coefficients	http://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11
US EPA - Emissions & Generation Resource Integrated Database	http://www.epa.gov/cleanenergy/energy-resources/egrid/
USDA Forest Service - iTrees Street	https://www.itreetools.org/streets/index.php