

JUNE 2019

THE ECONOMIC. SOCIAL, AND **ENVIRONMENTAL CASE FOR GREEN CITY**, **CLEAN WATERS: AN UPDATE**





GREEN STORMWATER INFRASTRUCTURE PARTNERS™

REIMAGINING STORMWATER

BACKGROUND

The mission of the Sustainable Business Network of Greater Philadelphia (SBN) is to build a just, green, and thriving local economy in the Greater Philadelphia region. SBN accomplishes this by educating and growing a broad base of local, independent businesses and educating policymakers and the public. In 2012, in response to the City of Philadelphia's ambitious Green City, Clean Waters (GCCW) plan, SBN launched the industry-specific initiative Green Stormwater Infrastructure (GSI) Partners. SBN's GSI Partners is a network of local businesses in the region in the GSI industry, including firms in design, engineering, construction, and maintenance, as well as material supply. SBN, via the GSI Partners, is working to advance the local industry and innovation, amplifying the triple bottom line (social, economic, environmental) impact in the region.

For this report, SBN hired Econsult Solutions Inc. (ESI) to quantify the economic, social, and environmental benefits of both public and private GSI projects to help measure the benefits that GSI Partners and the GSI industry have across Philadelphia. GCCW is an inspiring example of the triple bottom line in action: we find significant economic, social, and environmental impacts from GCCW, and equitable distributions of those impacts. For example, public GSI projects, located primarily in low and moderate-income neighborhoods, further promote equity in Philadelphia. Philadelphia has everything to gain from strong investments in the nature-based practices foundational to GCCW: billions of dollars for our local economy, thousands of jobs, reductions in crime, equitable access to public open space, healthy rivers and streams, better climate resilience – and so much more.

SUMMARY STATISTICS ON GSI PROJECTS

The City of Philadelphia is investing public funds – augmented by large expenditures from the private sector – to create a citywide mosaic of green stormwater infrastructure (GSI).

GSI integrates into the City's green spaces, streetscapes, and public and private buildings. The scope of GSI ranges from simple home rain barrels and downspout planters to complex bioretention swales. Along with rain gardens, tree trenches, green roofs, and urban wetlands, this infrastructure attempts to mimic a natural hydrologic state. Philadelphia hopes to create the most extensive green stormwater infrastructure network in the United States by the mid-2030s.

FIGURE 1

GREEN STORMWATER INFRASTRUCTURE PROJECTS IN PHILADELPHIA

vast network of rain gardens, green roofs, wetlands, and other infrastructure to capture stormwater and has hundreds of more projects planned and under construction (see Figure 1).



10 Miles

¹Philadelphia Water Department, "Green City, Clean Waters," (2018).

Source: City of Philadelphia (2019)

The Philadelphia Water Department (PWD) has taken the lead in building the City's green infrastructure through GCCW.¹ Since 2006, in collaboration with environmental groups and civic associations, PWD has completed more than 100 publicly funded green stormwater infrastructure projects (see Figure 2). Nearly 300 additional projects are planned for and under development at schools, parking lots, parks, and rooftops. Private owners have also "greened" through the redevelopment of properties or stormwater retrofits. Between 2006 and 2017, nearly 900 private projects were completed, with more than 250 additional planned for development (see Figure 3). Approximately 18 percent of private projects and 77 percent of public projects have a vegetated component. This shows that PWD is leading the way on vegetated practices, and there is room for significant growth in the use of vegetated practices in private development.

We sourced public projects representing planned and complete GSI from a relational database hosted by the Water Department. The raw data were downloaded as line geometric line features (street segments) and points and then combined in a tabular dataset. We filtered the data for unique entries using the 'PROJECTID' column so projects would not be double-counted. For public projects, we used the 'STATUS' field to determine a project's status. If any record in the database contained the following values, a project was considered complete: Closed; Construction – Contract Closed; Construction – Substantially Complete.

We also sourced private projects representing planned and complete GSI from a second relational database hosted by the Water Department. The raw data were downloaded as point features and did not need to be de-duplicated. For private projects, we used the 'STATUS' field to determine a project's status. If any record in the database contained the following values, a project was considered complete: Complete; Verified.









Source: City of Philadelphia (2019)







GSI Feature Constructed Planned **Total** Tree Trench 255 809 1,064 Planter 55 169 224 Bumpout 25 302 327 99 150 249 Rain Garden 5 9 Basin 4 582 Infiltration Storage Trench 164 746 17 27 Pervious Paving 44 41 59 Swale 18 0 4 Wetland 4 Green Roof 2 0 2 0 0 Other 0 Stormwater Tree 100 62 162 0 4 Drainage Well 4

TABLE 1FEATURES OF PUBLICGSI PROJECTS (AS OFMARCH 2019)

Total Projects	194	291	499	
Total Features	745	2,159	2,904	
Infiltration Columns	0	0	0	
Depaving	6	1	7	
Blue Roof	0	0	0	
Green Gutter	0	3	3	

TABLE 2 FEATURES OF PRIVATE GSI PROJECTS (AS OF MARCH 2019)

GSI Feature	Constructed	Planned	Total
Surface Infiltration Basin	103	68	171
Subsurface Infiltration Basin	219	756	975
Surface Detention Basin	17	118	135
Subsurface Detention Basin	92	432	524
Bioinfiltration	105	188	293
Bioretention	105	353	458
Cistern	9	15	24
Green Roof	119	195	314
Porous Pavement	145	383	528
Water Quality Treatment Device	53	61	114
Total Features	2,569	967	3,536
Total Projects	889	256	1,145

Source: City of Philadelphia (2019)

THE ECONOMIC IMPACT OF SBN'S GSI PARTNERS

In 2014, we surveyed the GSI Partners and collected data on their annual revenue, the percentage of their revenue that is from Philadelphia, and the number of their employees (FTE) working in the City.



This estimate was then scaled-up to account for both business growth and inflation. Based on survey data, we estimated that 19 percent of operations took place in Philadelphia. With an average annual revenue of \$ 1.2 million, the 61 GSI Partners together have an estimated direct impact in Philadelphia of \$73 million (see Table 3) within various industries (construction, building material retail, architectural and engineering services, environmental consulting services, and landscaping).

After accounting for the margin on retail, the direct annual impact is approximately \$55 million which generates \$34 million in indirect and induced impacts within the City. The total impact of the GSI Partner operations is \$89 million, supporting 927 jobs with \$30 million in employee compensation (see Table 4). The economic impact of GSI Partners captures just the segment of GSI work undertaken by these businesses. The full GCCW impact was evaluated in a <u>2016 report</u>.

TABLE 3 GSI PARTNER ANNUAL REVENUE

	Number of Members	Philadelphia-Based Revenue (\$M)	Employees	
Aggregate Impact	61	\$73.0	724.2	
Average Per Member		\$1.2	11.9	

Source: GSI Partners (2014)

TABLE 4 GSI PARTNER ANNUAL ECONOMIC IMPACT

	City of Philadelphia
Direct Impact	\$55M
Indirect and Induced Impact	\$34M
Total Impact	\$89M
Total Employment	927
Employee Compensation	\$30M

THE SOCIAL IMPACT OF GCCW: CRIME REDUCTION

Prior research on GSI projects and vegetated green spaces has demonstrated that both improve public safety through crime reduction.

We aggregated both the GSI projects and vegetated green space research to estimate the impact of vegetated GSI projects on crime in Philadelphia. Using the aggregated effects, we calculated the expected impact that all completed vegetated GSI projects have on Philadelphia.²

In their analysis of greened vacant lots, Kondo et al. "performed a difference-in-differences analysis of the effects of [vegetated projects] on crime in and around newly treated lots, in comparison to crimes in and around randomly selected and matched, untreated vacant lot controls."³ Kondo controlled for sociodemographic factors and conducted a linear and Poisson regression of the matched pairs. They demonstrated a statistically significant spillover crime reduction effects within a ¼ mile of the vegetated lots. They found that all crime types, except motor vehicle thefts, were reduced by at least 7 percent within a ¼ mile of the greened lots, with an 85 percent reduction in felony assaults and a 24 percent reduction in burglaries.⁴ To estimate the total impact of vegetated GSI projects in Philadelphia, we used a conservative, blended rate of 10 percent reduction across all crime types. To calculate the number of crimes this impact amounts to, we first identified all vegetated GSI projects identified as "complete" by PWD. We then used 2018 crime data from the Philadelphia Police Department to map and calculate all crimes that occurred within a ¼ mile of the "complete" vegetated GSI projects.

From this, we calculated the crime reduction





Type of Crime	2018
Homicide	204
Rape	580
Aggravated Assault	4,508
Robbery	3,271
Arson	245
Motor Vehicle Theft	1,429
Stolen Property	24,951
Household Burglary	4,000
Total Crime	39,188



Kondo et al. also conducted a mixed-effects regression model and matched control sites to compare safety (crime rates) of pre- and posttreatment vegetated GSI projects in Philadelphia.⁴ The research found statistically significant reductions in burglaries and narcotics possessions within a ¼ mile of the vegetated GSI sites, with non-significant decreases in other types of crime. accounted for by GSI projects. In 2018, 39,200 crimes occurred within a ¼ mile of vegetated GSI projects. The majority of crimes were stolen property crimes (see Table 5). Employing the 10 percent assumption, the total number of crimes in these areas would have been nearly 44,000 in the absence of GSI projects. The 39,000 crimes that occurred within a ¼ mile of GSI projects in 2018 is estimated to be 10 percent lower than the crime would have been if the GSI projects were not built.⁵

- ² Using PWD data, we included all "verified" and "completed" private projects, and all "closed," "construction contract closed," and "construction substantially complete" public projects. In our analysis, we calculated the estimated impact of these projects on Philadelphia once they are finalized.
- ³ Kondo et al. "Effects of greening and community reuse of vacant lots on crime." *Urban Studies* (2016)
- ⁴ Kondo et al. "The Impact of Green Stormwater Infrastructure Installation on Surrounding Health and Safety." *American Journal of Public Health* (2015).
- ⁵ Perelman School of Medicine at the University of Pennsylvania,"More Green, Less Crime," (2011).

By reducing the total number of crimes by an estimated 4,400 annually, the GSI projects are also lowering the cost of crime. Crime generates costs for both the victims and society and reducing the number of crimes makes benefits for both the victims and society as a result of eliminating these costs. The crime costs include real costs, which include victim costs such as medical expenses, property loss/damage, and missed worked, and criminal justice costs. The intangible costs include pain and suffering. The total costs of crime to society vary by the type of offense and range from over \$9.7 million for murder to approximately \$6,500 for household burglary.⁶ In total, the estimated 4,400 crimes that would have occurred in the absence of the GSI projects would have cost approximately \$337 million (see Table 6). Kondo's mixed-effects regression model and matched control sites analysis also found that vegetated GSI projects reduced drugrelated crimes by 18 percent within 1/4 mile of project sites.⁴ Applying this number to vegetated GSI sites in Philadelphia, we estimate that there were 1,524 fewer drug-related crimes in 2018 than there would have been in the absence of those projects.

TABLE 6 CRIME REDUCTION BENEFIT

Type of Crime	2018 (actual)	2018 (without GSI)	Crime reduction due to GSI	Costs per Crime	Crime reduction due to GSI (\$M)
Homicide	204	227	23	\$9.73 M	\$220
Rape	580	644	64	\$240,900	\$16
Aggravated Assault	4,508	5,009	501	\$114,500	\$57
Robbery	3,271	3,634	363	\$43,900	\$16
Arson	245	272	27	\$21,400	\$1
Motor Vehicle Theft	1,429	1,588	159	\$10,800	\$2
Stolen Property	24,951	27,723	2,772	\$8,000	\$22
Household Burglary	4,000	4,444	444	\$6,500	\$3
Total Crime	39,188	43,542	4,354		\$337

⁶ McCollister, K. E., French, M. T., & Fang, H., "The Cost of Crime to Society," (2010).

THE SOCIAL IMPACT OF GCCW: HEALTH-RELATED COST SAVINGS OF OPEN SPACE

PWD has 85 public open space projects that have been or will be completed. Sixty-five percent of them are in low- and moderate-income census block groups (see Figure 4).



The location of these projects increases equity in access to recreation and health benefits. Low- and moderate-income communities are underserved by public and open space recreation. Open space amenities offer a tremendous public health resource by giving residents a safe and relaxing place to walk or exercise. Physical activity also increases workplace productivity, and people using recreational amenities enjoy an intangible boost to their overall well-being. To measure the positive impacts of these open space projects, we estimated the health and recreation benefits of the 85 public open space projects once they are completed.

To calculate these impacts, we used 2018 as a baseline to calculate the effect of these 85 projects once they are completed. We calculated healthcare cost savings using 2018 population estimates from ESRI Business Analyst, a powerful geospatial tool that provides nationwide demographic information. Using ESRI data, we calculated the working-age population that lives within a quarter mile of an open space project. This analysis uses the idea of a pedestrian shed, defined as a quarter mile radius within which the average pedestrian can comfortably walk. We then used the Pennsylvania Department of Conservation and Natural Resources Residents' Survey on Outdoor Recreation to determine the number of people who use the trails and are considered active. Based on the literature, we define active as engaging in 3 sessions per week of at least 30 minutes of physical activity per session.⁷ Finally, using average reported expenditure differences in healthcare spending between physically active people and inactive people, we calculated the healthcare savings accrued from people spending less on healthcare expenses due to their physical activity.

For the 170,000 working-age Philadelphia residents living with a quarter mile of the 85 open space locations, there is an estimated \$50.1 million in annual total savings (Table 7).

FIGURE 4 OPEN SPACE PROJECTS IN PHILADELPHIA



TABLE 7 HEALTH COST BENEFITS OF GSI OPEN SPACE PROJECTS

Savings Type	Open Space (1/4 Mile) Savings	
Direct Medical Cost Savings	\$8.9 million	
Indirect Medical Cost Savings	\$26.6 million	
Direct Workers' Comp Savings	\$0.1 million	
Indirect Workers' Comp Savings	\$0.5 million	
Lost Productivity	\$14.1 million	
Total	\$50.1 million	

Source: ESRI (2019), Pennsylvania Department of Conservation and Natural Resources (2019)

⁷ Pennsylvania Department of Conservation and Natural Resources, "Pennsylvania's Statewide Comprehensive Outdoor Recreation Plan," (2014-2019).

A 2011 Delaware Valley Regional Planning Commission (DVRPC) study quantified the perhousehold recreation benefit of open space in Southeastern Pennsylvania at \$392 per household. This amount represents the amount the average household would be willing to pay for access to private recreation spaces but instead enjoys due to open space. DVRPC calculated the value by dividing the 1.4 million households in the study area (the Philadelphia 5-County region) by the \$577 million in benefits that accrue annually to residents who participate in recreational activities on protected open space. Inflated to 2019\$, this is \$450 per year. We assume that 50 percent of recreation on public open space for households within a ¼ mile of these sites occurs at GSI open space locations. We, therefore, credit an average of \$225 per year to the more than 100,000 Philadelphia households that are within a ¼ mile of these sites. In aggregate, the recreation benefit of these open space locations is \$22.7 million (see Table 8).

TABLE 8

RECREATIONAL BENEFITS OF GSI OPEN SPACE PROJECTS (2019\$)

Recreational Benefit per Household	\$450
Recreational Benefit per Household Credited to GSI Open Space Sites	\$225
Households	101,009
Aggregate Benefit (\$M)	\$22.7

Source: ESRI (2019), DVRPC (2011)

THE ENVIRONMENTAL IMPACT OF GCCW: URBAN HEAT ISLAND MITIGATION

In urban areas where there is a lack of vegetated land surfaces, heat islands pose significant health and equity concerns for vulnerable populations.



Heat islands are increased temperatures in urban areas caused by buildings, roads, and other infrastructure that have eliminated or significantly reduced open land and vegetation. Open land and vegetation provide shaded and moist, permeable sources that cool air and surface temperatures. Urban heat islands require homeowners and businesses to run additional cooling mechanisms, including air conditioners and fans, leading to increased energy consumption and subsequent air pollution and greenhouse gas emissions.⁸ High heat can also worsen chronic conditions and lead to additional adverse health outcomes as severe as heat-related fatalities.

Most heat islands in Philadelphia are in low- and moderate-income census blocks, posing health risks for those who cannot afford or do not have access to air conditioning.⁹ Research has shown that GSI projects reduce surface temperatures in urban areas and mitigate heat island effects.¹⁰ A study estimating the possible reductions in heat-related mortality in Washington D.C. using GSI found that a 10 percent increase in vegetative cover yielded a 7 percent reduction in mortality during heat events.¹¹

To calculate the location of GSI projects relative to heat islands, Land Surface Temperature was estimated using Landsat 8 thermal bands captured on June 15, 2018, at 3:38 PM (see Figure 5). These thermal band images were converted into degrees Fahrenheit to locate high-risk heat islands. For this analysis, we define high-risk heat islands as those where the surface temperature is more than 20 degrees F above the air temperature and extreme-risk as those where the surface temperature is more than 25 degrees F above the air temperature on June 15. At that time, the average air temperature in Philadelphia was 79 degrees. The

FIGURE 5



hottest surface temperature recorded in Philadelphia at that time was above 100 degrees F.

In total, 31 percent of Philadelphia land was at "high-risk" on that date, and 4 percent of the City was at extreme risk. With 51 percent of public projects and 40 percent of private projects located in high-risk areas, this demonstrates that GSI projects are helping to bring equity through heat island reduction.

⁸ United States Environmental Protection Agency, "Heat Island Effect," (2019).

- ⁹ United States Environmental Protection Agency, "Reducing Urban Heat Islands," (2014).
- ¹⁰ Cornelius, K., "How Phoenix is Working to Beat Urban Heat," (2019).
- ¹¹ Kalkstein et. al. "Assessing the Health Impacts of Urban Heat Island Reduction Strategies in the District of Columbia," (2019).

Source: Econsult Solutions (2019), City of Philadelphia (2019)

Green City, Clean Waters is Philadelphia's 25-year stormwater management program that primarily uses green stormwater infrastructure to manage combined sewer overflows. The vision of Green City, Clean Waters is "to unite the City of Philadelphia with its water environment, creating a green legacy for future generations while incorporating a balance between ecology, economics, and equity."*

WHAT IS GSI?

Forms include:

TREE TRENCHES

RAIN GARDENS

EMPLOYEE

COMPENSATION

25-YEAR

IMPACT

ECONOMIC

GSI (Green Stormwater Infrastructure) are soil-water-plant systems that manage wet weather through infiltration or retention.

STAYING HEALTHY

BILLION

Existing research shows that access to parks and green spaces for recreation reduces chronic disease and stress rates, and improves mental health and function.



KEEPING COOL

Green City Clean Waters

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GSI projects reduce surface temperatures and mitigate urban heat islands that elevate air pollution and greenhouse gases, and increase energy consumption.

PUBLIC PRIVATE percentage of both public projects are

GREEN ROOFS PLANTERS

WHERE IS GSI?



income census

reduce crime within 1/4 mile of site by 10%

COSTS AVOIDED: \$337M







GREEN STORMWATER INFRASTRUCTURE PARTNERS[™]

REIMAGINING STORMWATER

*Philadelphia Water Department, Green City Clean Waters The City of Philadelphia's Program for Combined Sewer Overflow Control Program Summary, June 2011

CONCLUSION

GSI projects have significant economic, social, and environmental benefits.

They are also an equalizing force in Philadelphia, bringing investments — and positive externalities — to lowand moderate-income communities across the City.



In our analysis, we found:

The total annual economic impac of SBN's GSI partners is \$899

An estimated 4,354 fewer crimes occurred in Philadelphia in 2018 due to GSI projects, which is a \$337 million annual benefit to

65 percent of open space projects are in low- or moderate-income communities The health-related cost savings of GSI projects due to recreation access is \$50.1 million annually

The recreational benefit of GSI open space sites is \$22_7 million annually **51** percent of public GSI projects and 40 percent of private GSI projects are in high-risk heat

Philadelphia

Increased investments in nature-based practices foundational to Green City, Clean Waters will continue to result in an economically vibrant, climate resilient, and socially just region. Thank you to the Philadelphia Water Department for their support on this project. Thank you to Spring Point Partners, LLC for their support of this project. Thank you to Econsult Solutions Inc. for conducting this research on our behalf.



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