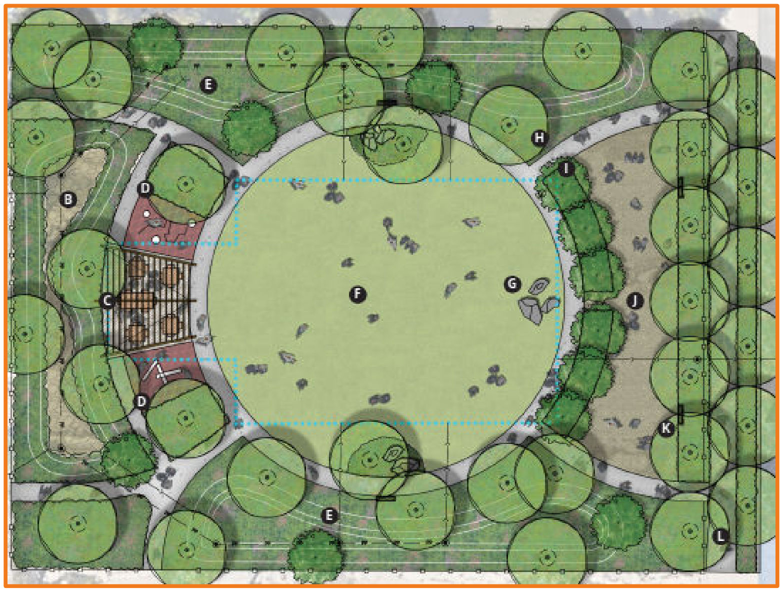

StormStore Terra Firma Pilot Project

October 14, 2023
ECT No. 230201

Metropolitan Planning Council
Chicago,IL

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Lombard, Illinois 60148
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Document Review

The dual signatory process is an integral part of Environmental Consulting & Technology, Inc.'s (ECT's) Document Review Policy. All ECT documents undergo technical/peer review prior to dispatching these documents to any outside entity.

This document has been authored and reviewed by the following employees:

Thomas Price	Jonathan Lawrence
Author	Peer Review
Signature	Signature
Date	Date

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1.0 Introduction and Purpose

The Metropolitan Planning Council (MPC) and The Nature Conservancy (TNC) have led development of a stormwater credit trading program (known as StormStore) in Cook County, IL. MPC recently retained Environmental Consulting and Technology (ECT) and One Water Econ to prepare a schematic level design for a project located within the City of Chicago to study the credit-generating potential of nature-based solutions and to assess the costs and benefits of the project. The project began with 16 potential sites where a StormStore project could be located to address neighborhood flooding while simultaneously providing amenities that would be attractive to the neighborhood beyond flood reduction benefits.

The project included the following elements

- **Site Selection:** 16 potential sites were evaluated in terms of their need for flood reduction, their ability to receive runoff from offsite areas, and other factors.
- **Project Design:** A site and stormwater plan was developed for the selected site to provide necessary stormwater storage to manage the captured drainage area while also providing neighborhood amenities. As part of this effort, a co-benefit valuation was conducted to determine stormwater amenities that would add the most value to the project.
- **Project Valuation:** A valuation of the proposed project was conducted to understand the total value of the project including both stormwater and co-benefit values. The valuation compared the present value of the project benefits to the costs of construction and annual maintenance.

2.0 Site Selection

ECT was provided a list 16 potential sites as shown in Exhibit 1. Each of the sites were evaluated in terms of their potential to capture and manage runoff, the location's need for flood reduction, and potential co-benefits. Appendix A describes the selection process in greater detail but sites with little impervious drainage area or where it would be difficult to direct the runoff to the site were not considered. Sites with relatively large impervious drainage areas that were easy to capture and where there was evidence of downstream flooding were favored.

The selected site is located at approximately 6826 S. Stoney Island Avenue and the entire block can be drained to the site with nominal interventions. The project site and its drainage area, are shown in Figure 1. The drainage area, including the project site is 4.85 acres. The site was chosen because it had a relatively large drainage area, had sufficient site area to manage the tributary runoff, had a layout that was conducive to directing runoff to the site, and was in a location where water levels in the downstream sewer system threaten basement flooding. In addition, there have been resident reports of basement flooding downstream of the system. In addition to being a good candidate from a flood prevention perspective, the project is located in an area where parks, schools and other public open space are relatively distant compared to the other viable candidate sites.

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MPC STORMSTORE
PILOT PROJECT

PROJECT NO. 230201

REVISIONS		
NO.	DATE	DESCRIPTION

DRAWN BY: GM
SCALE: 1" = 20'
JOB: 230201
FILE: x–mpc–base.dwg

NORTH
KEY PLAN

WARNING: ASBESTOS-CONTAINING BUILDING MATERIALS ARE OR MAY BE PRESENT IN THIS BUILDING. AN ASBESTOS MANAGEMENT PLAN IS AVAILABLE IN THE SCHOOL FOR REVIEW UPON REQUEST. NO PERSON MAY DISTURB ASBESTOS-CONTAINING MATERIALS UNLESS THAT PERSON IS A LICENSED ASBESTOS WORKER OR CONDUCTS SUCH WORK IN ACCORDANCE WITH SPECIFICATION(S) CONTAINED IN THE PROJECT DOCUMENTS AND IN COMPLIANCE WITH ILLINOIS DEPARTMENT OF HEALTH RULES AND REGULATIONS.

SHEET TITLE

DRAINAGE AREA

DRAWING NO.

Figure 1

3.0 Proposed Project

A site and stormwater plan was developed for the selected site. The plan addresses conveyance of runoff to the project site and management of stormwater runoff within the site. The project site was also designed to provide significant non-stormwater value to the neighborhood (co-benefits).

The site and its drainage area are shown in Figure 1. As discussed further below, it was determined that only the portion of the site north of the alley was needed to provide the necessary stormwater volume to meet the performance goals.

As discussed further in subsequent sections, a “Baseline plan” was needed to provide a basis of comparison for the Pilot study plan. Thus, two versions of the plan were developed. The Pilot study version of the plan was designed to manage runoff from the entire drainage area shown in Figure 1. The Baseline plan was designed to manage only the runoff from the project site. Only the difference in stormwater volume between the pilot and baseline condition can be used as credit under the proposed StormStore program. In addition to the Pilot project and Baseline project, a no-action plan (existing conditions) was evaluated. The no-action plan was needed as a basis of comparison for the co-benefits analysis.

3.1 Performance Goals

The project was designed to meet the Chicago Department of Water Management (CDWM) stormwater standards for the drainage area, bringing the entire block into compliance with the stormwater ordinance. Because the drainage area exceeds 1.75 acres, the CDWM ordinance specifies that the discharge be limited to the capacity of the sewer system. For the purposes of the Pilot project scenario, it was assumed that the capacity shown in the Outlet Sewer Capacity map within the Chicago Stormwater Management Ordinance Manual controls. (0.27 cfs/acre or 1.31 cfs for the 4.85 acre drainage area).

For the Baseline scenario, the drainage area is limited to the site area that is equal to 0.86 acres. Because the drainage area is less than one acre, the CDWM standard maximum release rate was used. For the 0.86 acre drainage area, the standard maximum release rate is 0.22 cfs.

Although no geotechnical investigation or infiltration test were conducted for this study, the Stormwater Manual includes a Chicago Soils Map depicting the general location where sand and gravel is found within the City. The Pilot project is located within this area and therefore it was assumed that infiltration would be feasible at the project site. However, to be conservative, the minimum value for which infiltration may be counted in the stormwater calculations was used (0.5 inches per hour). This value was used for both the Pilot project scenario and the Baseline scenario.

3.2 Site Design

In addition to providing stormwater control, the project site was designed to provide program elements that would provide additional benefits to the community.

The Trust for Public Lands' (TPL) Natural Solutions Tool for Greater Chicago was used to inform selection of site program features that would add the most value. For this site, the tool showed significant indicators in both the Equity and Health categories including population under age 5, daytime heat island, lack of tree canopy, and health indicators such as diabetes, asthma, depression, obesity, and poor air quality. Based on this information, the site was designed with natural play areas for younger children, a large lawn to provide flexible ball play to encourage physical activity, and natural landscapes and trees to improve air quality as well as mental health. The proposed features for the site are depicted in Exhibit 2.

The various program elements that were considered and their estimated value are documented in the Co-Benefits Memo included in Appendix B that discusses green stormwater infrastructure co-benefits and their relevance to the project location. In addition to helping inform selection of site amenities that would be most beneficial to the neighborhood, the memo was used to support valuation of the project as discussed in a Section 4 of this report.

3.3 Stormwater Improvements

The proposed stormwater improvements are included in Exhibit 2 and the drainage area to the site as well as the improvements necessary to convey runoff to the site are depicted in Exhibit 3. The stormwater improvements include bioretention and open-bottom underground chambers. Bioretention was chosen because its surface can be (and often is) planted with native vegetation, which was found to provide significant co-benefits including carbon sequestration and filtering and reduction of urban heat island effects. Bioretention systems also provide significant runoff reduction benefits due to the water holding capacity of the organic-rich bioretention soil and due to the storage that allows time for infiltration into subgrade soils.

Underground chambers were chosen because they allow for other site improvements above them including lawn areas for active play, paths, and paved gathering spaces. In addition, the chambers are set on an open gravel bed that allows for infiltration into subgrade soils.

To facilitate drainage to the bioretention and chamber systems, the plan includes trench drains for the full length of the alley. The trench drains ensure that all runoff that drains to the alley is routed to the stormwater system rather than potentially surface draining to the adjacent streets or existing storm inlets in the alley. Trench drains were selected rather than storm sewers because trench drains are shallow systems that facilitate drainage to the relatively shallow bioretention.

Runoff that enters the west side of the site from the alley is distributed throughout the bioretention system using the culverts and perforated pipe that are depicted in Exhibit 2. The runoff from the project drainage area entering the site via the trench drains is filtered by the bioretention soils prior to discharge to the chamber system, reducing cleaning and maintenance needs of the chamber system.

To improve infiltration and reduce the runoff discharged to the sewer system, the drain for the stormwater system is located one foot above the bottom of the storage. As discussed further in the Valuation Section of this report and Appendix B, this reduces the volume of runoff that has to be treated at the wastewater plant, reducing energy consumption and associated carbon and other greenhouse gas emissions as well as other pollutants that contribute to poor air quality.

The improvements associated with the Pilot Project are depicted in Exhibit 2. The improvements associated with the Baseline project would look largely the same from the surface. However, the Baseline project needs less storage and therefore the underground chambers were not included and the area of the bioretention was reduced. The areas no longer needed for bioretention were still assumed to be planted as native landscapes but would not include a surface depression, bioretention soil, or gravel storage.

3.4 Stormwater Performance

The bioretention and chamber systems were sized using CDWM's Stormwater Spreadsheet Tool as would be required by Chicago's Regulations for Sewer Construction and Stormwater Management (CDWM stormwater ordinance). As indicated previously, the project was designed to meet the release rate required by the regulations and utilized a conservatively low infiltration capacity of 0.5 inches per hour (low for this area of the City) over the area of the bioretention and chambers.

To determine the annual runoff volume reduction, a WinSLAMM model[1] was developed to estimate average annual runoff volumes and volume reductions for the Baseline and Pilot project scenarios. WinSLAMM is a continuous simulation model and the model was run for a three year period using Midway precipitation. To determine peak flow rates, a HydroCAD model[2] was developed. This allowed estimation of peak flow rates for both managed and unmanaged areas.

The modeling results are presented in Table 1 below. As can be seen from the table, the Pilot project produces very little runoff (annual runoff volume and runoff from 1 inch event) due to the sandy soils that infiltrate most of the runoff. The Pilot project also reduces peak flow rates by 90% to 95% relative to the existing condition (No-Action). The Baseline condition also reduces runoff volumes and peak flows but not nearly as well as the Pilot project. This is because the majority of the drainage area (3.99 of the total 4.85 acres) is unmanaged and therefore no runoff reduction or peak flow attenuation for the that area.

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[1] WinSLAMM model V10.5 by PV & Associates. The Source Loading and Management Model was developed by Robert Pitt and John Voorhees and is used extensively in the State of Wisconsin for stormwater design and evaluation.
[2] HydroCAD V10.00. HydroCAD is commonly used stormwater hydrology and hydraulics model.

Table 1 Modeling Results

Metric	No-Action	Baseline	Pilot Project
Analysis Area (acres)	4.85	4.85	4.85
Managed Area (acres)	0	0.86	4.85
Stormwater Area (acres)	0	0.07	0.51
Total Storage (million gallons)	0	0.027	0.392
Annual Runoff Volume (million gallons/year)	1.86	1.53	0.03
Runoff Volume Reduction (million gals/yr)	-	0.33	1.83
1-inch event runoff volume (gallons)	59,300	43,000	0
1-inch event runoff volume reduction (gallons)	0	16,300	59,300
2-yr peak flow (cfs)	9.1	6.9	0.73
5-yr peak flow (cfs)	12.4	9.5	0.89
100-yr Peak Flow (cfs)	28.9	23	1.3
2-yr peak flow reduction (cfs)	-	2.2	8.37
5-yr peak flow reduction (cfs)	-	2.9	11.5
100-yr Peak Flow Reduction (cfs))	-	5.9	27.6
2-yr peak flow reduction (%)	-	24%	92%
5-yr peak flow reduction (%)	-	23%	93%
100-yr Peak Flow Reduction (%)	-	20%	96%

3.5 Project Costs

Cost estimates were prepared for the both the Pilot project and the Baseline condition scenarios. For each of those two scenarios, cost estimates were prepared for the capital improvements and life cycle maintenance activities. The estimates are discussed further below.

3.5.1 Capital Costs

Capital (construction) cost estimates were prepared for both the Pilot project and the Baseline condition. The detailed cost estimates are provided in Appendix C and a summary is provided in Table 2.

Table 2 Project Construction Costs

Line Item	Baseline	Pilot Project
Demolition and Site Preparation/Earthwork	$311,661	$213,411
Site preparation, demolition, and erosion control earthmoving and grading outside stormwater areas topsoil		
Site Utilities	$237,525	$1,041,375
Stormwater improvements Site lighting		
General Site Construction/Amenities/Planting	$615,012	$569,263
paving fencing and gates furniture and play spaces herbaceous planting/trees/mulch		
25% Contigency	$291,050	$456,012
Bonding/Insurance/Contractor fees	$261,945	$410,411
Total	**$1,717,193**	**$2,690,472**

As previously discussed, the Baseline condition only includes stormwater management for the project site depicted in Exhibit 2 and the Pilot Project provides stormwater management for the entire block depicted in Exhibit 3. The volume of storage provided for the Pilot Project scenario is much greater than the volume provided for the Baseline scenario and that difference is reflected in the higher cost in the Site utilities line item in Table 2. Conversely, the Earthwork and Planting line items are higher for the Baseline condition than for the Pilot Project condition. This is because the excavation and planting associated with the bioretention and chambers are included in the site utilities line item but the excavation to provide topsoil and the material to plant the larger non-bioretention areas in the Baseline are included in the other two line items.

3.5.2 Life Cycle Costs

Lists of life cycle maintenance activities and costs, including replacement, were prepared for both the Pilot project and the Baseline condition. The detailed lists are provided in Appendix D and a summary is provided in Table 3. The lists are intended to be comprehensive and include frequencies, labor hours, and equipment needs. Average annual values are calculated based on the expected frequency of each activity including maintenance and replacement. The lists include general maintenance activities such as inspections, debris removal, weeding, and mowing that are conducted multiple times per year. The lists also include less frequent remedial maintenance such as sediment removal and tree trimming and end-of-life replacement activities such as replacement of the trench drains and chambers.

Table 3 Average Annual Life Cycle Costs

Line Item	Baseline	Pilot Project
Bioretention & Landscape	$6,300	$6,600
inspection		
weeding and trash removal		
topsoil		
sediment removal		
cleaning of underdrains		
end-of-life landscape replacement		
Chamber System	-	$6,411
inspection		
sedimnet removal		
end-of-life replacement		
Permeable Paving	$343	$343
inspection		
general and remedial cleaning		
end-of-life replacement		
Trench Drain	-	$2,800
Inspection		
periodic sediment removal		
end-of-life replacement		
Total	**$6,643**	**$16,154**

The primary difference in life cycle costs between the two options is the lack of chambers and trench drain for the Baseline scenario. The bioretention line item costs are similar for the Baseline and Pilot Project scenarios since the line item includes landscape maintenance throughout the site, including the bioretention and non-bioretention areas and the amount of landscape is the same with the two scenarios.

4.0 Project Valuation

The proposed project as outlined in this document derives benefits from three sources – reduction of local flood risk, credit trading value in an open market under StormStore, and co-benefits associated with installation of green stormwater infrastructure. There are also project costs associated with construction and on-going maintenance activities as outlined in Section 3.5.

A detailed discussion of potential co-benefits associated with GSI and the actual co-benefits of the proposed project is included in Appendix B. The discussion in this section of the report will be limited to the co-benefits that are applicable to this project. Sources used for the analysis included U.S. Census Bureau data, the Water Research Foundation (WRF) Triple Bottom Line Green Stormwater Infrastructure (TBL) tool, a report prepared by Elevate Energy on the energy use associated with provision of water and wastewater treatment, and other data sources as documented in Appendix B.

4.1 Co-Benefit Values

Co-benefits of GSI were valued in terms of the following categories and brief discussion of each category is provided below.

- Avoided gray infrastructure
- Energy savings
- Air Quality improvement & related health benefits
- Increased property values
- Recreation
- Urban heat island reduction
- Habitat
- Job Creation

Avoided Gray Infrastructure: Chicago, including the project neighborhood, is served by combined sanitary and storm sewers and therefore runoff from the study area is conveyed to the wastewater reclamation facility (WRF) for treatment rather than being discharged directly to local waterways. The stormwater and wastewater systems in Chicago are currently at or above capacity and capacity needs will only increase in the future due to climate change impacts and growth in the City. Due to the storm runoff reduction benefits of green infrastructure, the need to increase peak WRF capacity can be reduced, thereby reducing the need for capital improvements at the facility. As documented in Appendix B, the cost of peak flow capacity upgrades is $5 million per MGD and that was used here to determine the cost avoidance associated with storm runoff reduction. This value was combined with daily runoff reduction associated with a typical one inch storm event as documented in Section 3.4 of this report.

In addition to WRF capacity, increased sewer capacity is needed to convey runoff to the facilities without flooding and basement backups. By reducing peak flows, GSI can reduce the need for relief sewers to provide required capacity. The estimated avoided cost was determined by estimating the cost of a relief sewer serving the area and the proportion of the relief sewer capacity that the study area would need to accommodate a 5-year design event. Based on this analysis, the unit cost of relief sewer capacity was calculated to be $21,100 per cfs of peak flow capacity. This value was combined with peak flow reduction associated with the 5-year storm event as documented in Section 3.4 of this report to determine the benefit of the baseline and pilot scenarios.

Energy Savings: In the context of this project, energy savings results from the reduction in energy use associated with wastewater collection, pumping, and treatment due to the reduction in runoff discharged to the WRF. The average MWRD energy use is 1,978 kilowatt hour (kWh) per MG of water treated. Combining this with the average industrial energy cost of 8.4 cents per kWh results in a treatment cost of $159/MG of runoff. This was combined with the annual runoff reduction from Section 3.4 to obtain the annual energy savings

Air Quality Improvement and Related Health Benefits: Air quality improvements result from the pollutant filtering benefits of trees and native vegetation and the reduced emissions due to avoided energy use associated with wastewater treatment. As presented in Appendix B, each tree provides $202 in annual benefit and each 1,000 square feet of native landscape provides $31 in annual benefit. The benefit derived from avoided energy use is $173 per MG of reduced runoff per year. These benefits all derive from avoided health care costs.

Carbon Reduction: Carbon reduction derives from both sequestration by trees and vegetation and from avoided emissions due to reduced energy use associated with wastewater treatment. As presented in Appendix B, each tree provides $17 in annual benefit and each 1,000 square feet of native landscape provides $6 in annual benefit. The benefit derived from avoided energy use is $103 per MG of reduced runoff per year.

Increased Property Values: As documented in Appendix B, various studies have shown that property values are increased by the presence of nearby pocket parks and increased tree canopy. Overall, the data shows 3% to 11% increases in property values. Using the middle of this range along with a total value of $27 million for the 142 housing units on the block equates to a total value of $96,900 property value increase per year.

Recreation: Using the TBL tool, the recreational value of the park was estimated to be $65,700 per year. This was based on playground and passive recreational uses of the park and the tool-estimated number of annual visits (9,073).

Urban Heat Island Reduction: The urban heat island reduction was estimated based on the health benefits associated with the increased area of vegetative cover. Specifically, the TBL tool indicates that every 1,000 square feet of native vegetation results in $1,283/year in benefits. The tool also indicates that the benefit of tree canopy would be $1,479 per tree at maturity.

Habitat: Systems of GSI practices can contribute to the network of green spaces that support ecosystems and biodiversity in urban settings. The TBL tool indicates that trees provide close to $91 in habitat benefit per year. Based on estimates of habitat benefit of native vegetation by the TBL tool and the Federal Emergency Management Agency, a value of $103 per 1,000 square feet was determined to be an appropriate value for this analysis.

Job Creation: Based on the estimates of construction and maintenance costs of the project and using the TBL tool and information from the Jobs for the Future organization, it is estimated that construction of the Baseline and Pilot projects would result in $34,020 and $52,920 in job creation benefits, respectively. The ongoing maintenance activities would result in annual benefits of $505 and $1,011 per year for the respective scenarios.

4.2 Valuation Results

Table 4 provides unit values for the pilot project benefits (relative to no-action) for each of the co-benefits described above. As applicable, unit value benefits are shown per volume of runoff retained or peak flow reduced and per project feature. As indicated, most of the benefits are annual benefits but some are one time benefits at the time of construction.

It is important to note, that the benefits of each of the features cannot simply be added. For example, the tree canopy, native vegetation, and open space areas must be considered together when assessing heat reduction benefits – they are not necessarily additive when planted together. In addition, the values in Table 4 show the benefits associated with trees at full growth, and do not account for tree growth over time (i.e., a newly planted tree will provide a small fraction of benefits that large mature trees provide). Finally, since some of the benefits are annual benefits and some are one time, they cannot be added together and must be viewed separately.

Table 4 Unit Value Benefits – Pilot Project

Benefit Category	GSI annual runoff retention ($/MG)[a]	GSI 1" event runoff retention ($/gallons)[a]	GSI 5-yr event peak flow reduction ($/cfs)	Trees ($/each)	Native vegetation ($/1,000sf)	Open space ($/1,000sf)	Project site amenities (project total)
Avoided Gray Infrastructure[b,e]		$5	$20,890				
Energy Savings[c]	$166						
Air Quality (avoided production + filtering)	$176			$202	$31		
Carbon Reduction (avoided emissions + sequestration)	$103			$17	$6		
Property Value Increase							$96,900
Recreation							$65,700
Urban Heat island				$1,479	$1,283		
Habitat				$91	$54	$103	
Construction Job Creation[e]							$52,900.00
Maintenance Job Creation							$1,011.00
Total Unit Value (annual)	$445	-	-	$1,789	$1,374	$103	$163,611
Total Unit Value (One Time)	-	$5	$20,890	-	-	-	$52,900
Units provided	1.83	59,300	11.50	47	15	37.5	1
Total Value (annual)	$814	-	-	$84,083	$20,610	$3,859	$163,611
Total Value (one time)	-	$296,500	$240,235	-	-	-	$52,900

[a] Volume retained and not discharged to the sewer system.
[b] Avoided need for additional treatment plant and relief sewer capacity
[c] Avoided energy use to due to reduced storm/wastewater treatment and pumping
[d] Benefit at mature tree canopy
[e] One time benefit. All other benefit values are annual

Assuming a 50-year design life for the proposed improvements, Table 5 provides a present value analysis to allow summing of the annual and one-time benefits and to allow comparison of the benefits to the costs of construction and on going maintenance. The benefits are relative to the no-action scenario. The analysis presented in the table accounts for the different factors noted above (i.e., in relation to additivity and increase in tree canopy over time). The present value cost is also relative to the no-action condition and incorporates both initial construction cost and life-cycle maintenance costs. This analysis assumes a 3% discount rate. As shown, the expected project benefits significantly outweigh the projected life cycle costs for both the Baseline and Pilot scenarios. The differential and ratio between benefits and cost are greater for the Baseline scenario than for the Pilot. However, the analysis does not include the potential revenue associated with selling stormwater credits. Stormwater credits could only be sold for the excess stormwater volume beyond the baseline condition. Thus, the value of the credits only accrues to the Pilot project scenario.

Table 5 Present Value Benefits and Costs

Benefit Category	Present value benefits (baseline)	Present value benefits (pilot)
Avoided gray infrastructure costs		
Avoided treatment plant capacity upgrades	$79,100	$287,900
Avoided conveyance upgrades	$58,300	$233,000
Energy savings	$1,400	$7,800
Air quality improvements	$156,000	$163,800
Carbon Reduction	$15,200	$19,200
Property Value Increase	$2,493,200	$2,493,200
Increased recreational opportunities	$1,690,400	$1,690,400
Urban heat island reduction	$2,163,500	$2,163,500
Improved habitat	$99,300	$99,300
Job creation	$45,500	$76,400
Total present value benefits	**$6,801,900**	**$7,234,500**
Total present value costs	**$1,831,651**	**$3,012,100**

Appendix A Site Selection

> memo

ECT

To:	Metropolitan Planning Council Terra Firma Pilot Project
From:	Garrett Moran and Tom Price, Environmental Consulting & Technology, Inc. (ECT)
CC:	Jonathan Lawrence, Environmental Consulting & Technology, Inc. (ECT)
Date:	May 30, 2023
Re:	Pilot Project Site Selection ECT Project No. 230201

This memorandum outlines the steps used to evaluate and select a site for the MPC StormStore Project. 16 potential green stormwater infrastructure (GSI) sites were evaluated with a multi-phase process that used a combination of site suitability, flood risk, and social factors to select the recommended site. The sites are depicted in the attached figure. The evaluation steps included:

1. Site Suitability Evaluation: This evaluation considered the potential drainage area to the site as well as location specific conditions that would help or hinder drainage.
2. Flood Reduction Need: This selection step considered the need for flood reduction based on the peak water level in the sewer system during the 5-year event relative to basement elevations.
3. Potential Social Co-Benefits: The distance to the nearest park and the number of faith-based organizations within ¼ mile of the site was determined for the top scoring sites from the two previous evaluations.

An evaluation matrix was prepared and is attached.

Site Suitability Evaluation

This first phase of the selection process included evaluating several features of the site that would help determine the effectiveness of GSI at each site. Sites were evaluated for total potential drainage area, drainage area to site area, and impervious drainage area. The sites were also evaluated based on more qualitative factors such as the ease of routing runoff to the project site and other site specific conditions. Based on these qualitative factors, a number of sites had site characteristics that were not conducive to implementing a project.

After this review, seven sites were selected for further review.

Flood Reduction Need

The second phase of analysis included examining flood risk data. Metrics for evaluating flood risk included assessing basement flood risk based on local 5-year high water line data as well as water in basement reports. These metrics were evaluated based on point locations that were downstream of the seven potential sites, to determine whether GSI could decrease the runoff to these sites and therefore decrease flooding risk.

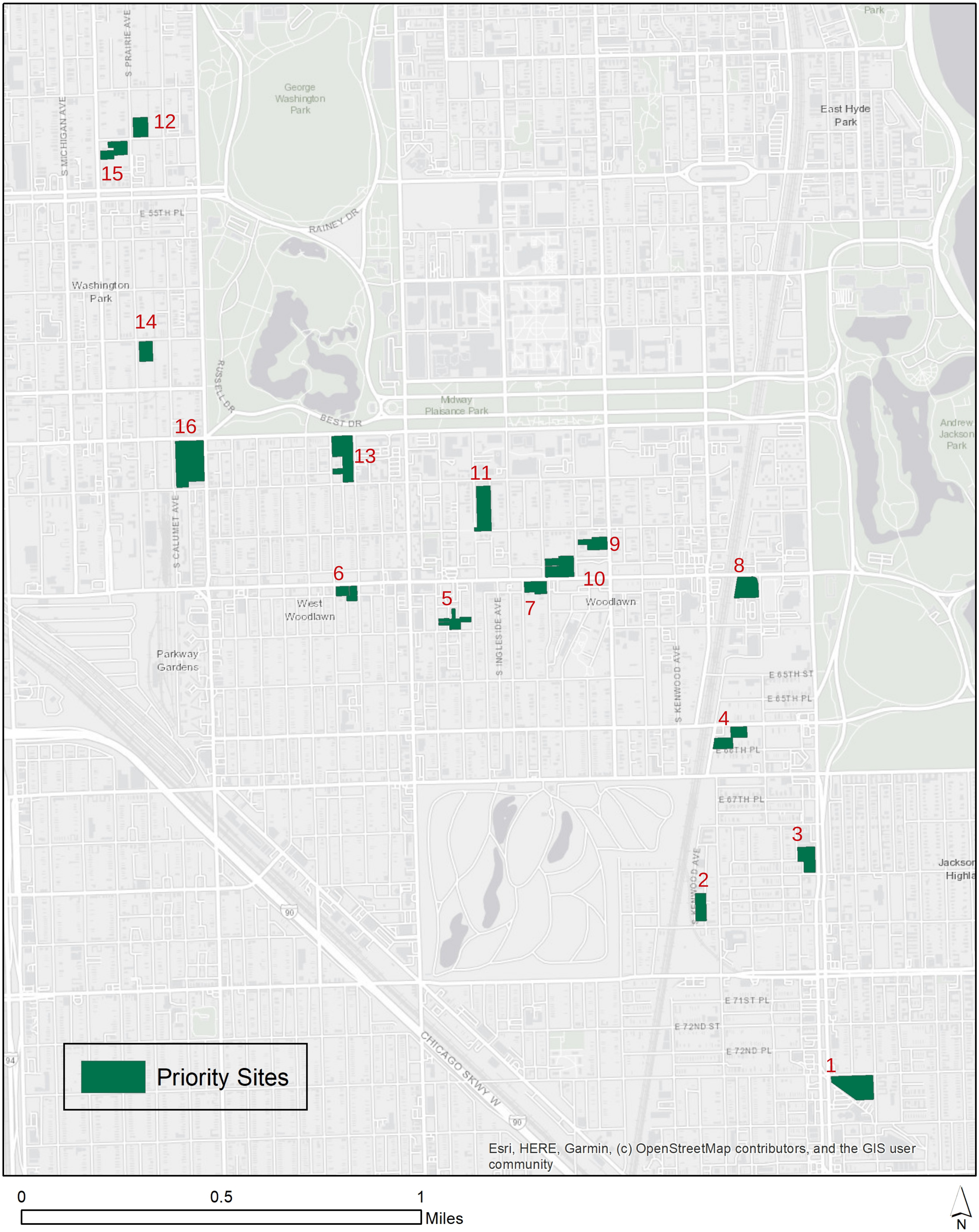
Social Co-Benefits

Metrics for evaluating the social benefits of the GSI sites include the distance to the nearest park for each site, as well as the number of faith-based institutions within 0.25 miles of the site. Decreasing the distance to a park or green area can have mental and physical health benefits for a community

and creates a more equitable city. Thus, sites with longer distance to parks were favored to allow better access to green areas.
Faith-based institutions can have a very positive effect on the amount of use and potentially the amount of maintenance that a green area can receive.

Recommended Site
Based on the evaluation described above, Site 3 located at 6840 S. Stony Is Avenue, was selected. The site has a relatively large drainage, sufficient site area to manage the runoff from the drainage area, has a layout conducive routing runoff to it, and the site is relatively clean with no obvious impediment to GSI implementation. Further, the site had the second highest percentage of HWL locations that threaten basement flooding and the most reports of basement flooding.

Priority City-Owned Vacant Sites for Green Infrastructure



Terra Firma StormStore Pilot Project Site Selection Matrix

Site Number	SITE AREA (sq ft)	ESTIMATED DRAINAGE AREA (sq ft)	Drainage Area: Site Area Ratio	rating	Notes	Total 5-year HWL locations	Percent of 5-yr HWL locations above basement floor	Percent of 5-year HWL within 6" of basement floor	Percent of 5-year HWL within 12 in. of basement floor	Number of Downstream Water in Basement reports	Commercial Corridor?	Distance from nearest park	Distance from nearest school	# of Faith-based Organizations within 1/4 miles	location link	location coordinates
7	47,496	355,172	7.48			4	0.00%	0.00%	**100.00%**	0	**Y**	750 ft	3 schools within 800 feet	5	https://www.google.	41.78023848815614, -87.5995956875074
1	140,179	321,094	2.29		No obvious vacant land. Not sure where the GSI would go					**2**					https://www.google.	41.76237301231286, -87.58516928789555
2	53,576	321,087	5.99		Significant junk storage area in northern drainage area. Block nearly 1,000 ft long. Parcel already redeveloped as community garden	6	**100.00%**	**100.00%**	**100.00%**	**2**	**N**	800 ft	550 ft	3	https://www.google.	41.76816370593209, -87.59253788713542
5	51,235	276,168	5.39			5	0.00%	0.00%	0.00%	1	**N**	435 ft	680 ft	3	https://www.google.	41.77891428863908, -87.6036647396068
3	68,572	257,196	3.75		Block has alley that can be used to direct runoff to site	5	40.00%	**100.00%**	**100.00%**	**3**	**Y**	1070 ft	1000 ft	1	https://www.google.	41.77062120950556, -87.58683810122652
12	51,851	256,496	4.95		Low impervious drainage area (mostly vacant)					**2**					https://www.google.	41.797078674335395, -87.61863803510549
8	82,833	255,244	3.08		south parking lot has catch basins (would not drain to GI)					0					https://www.google.	41.779372378440975, -87.5894405730123
16	215,639	252,229	1.17		Since the site area is part of a cleared block, there is no impervious drainage area to the practice.					1					https://www.google.	41.78524177465736, -87.61620100904571
10	52,623	239,828	4.56		Has alleys to facilitate drainage.	4	0%	25%	25%	**2**	**Y**	400 ft	100 ft	2	https://www.google.	41.780963, -87.598616
14	48,582	251,155	5.17		Low impervious drainage area (mostly vacant)					1					https://www.google.	41.78911265602006, -87.619735702888
15	61,602	248,303	4.03		Potentially good block with more site than needed. Could sell and redevelop portion of site					1					https://www.google.	41.79632693032479, -87.62041248274599
9	100,977	251,359	2.49		No alley so may be difficult to get runoff to site. Could be good spot if combined with development project at south end of block	5	0%	40%	40%	1	**Y**	1030 ft	3 schools within 1,000 ft	7	https://www.google.	41.78199428689722, -87.59694748523842
11	116,667	232,336	1.99		South portion of parcel looks like a school. Northern paved area would make good site. Block used for interview example	5	20%	20%	40%	**2**	**N**	600 ft	700 ft	1	https://www.google.	41.78293933417377, -87.60238897388577
4	70,388	185,109	2.63		More space than needed but otherwise good location. Could sell and redevelop other lot					**2**					https://www.google.	41.77453885774199, -87.5909859397084
6	45,736	180,585	3.95		Low impervious drainage area (mostly vacant)					0					https://www.google.	41.780198109747296, -87.60881318826412
13	133,830	179,217	1.34		Good potential STG site with Fiske School but building has internal roof drains					**2**					https://www.google.	41.78552679160532, -87.6090222760932

Appendix B Co-Benefits and Project Valuation

Memorandum

To:	Thomas Price and Jonathan Lawrence, ECT
From:	Janet Clements, One Water Econ
Date:	October 13, 2023
Re:	Initial assessment of potential co-benefits at MPC project site

Background

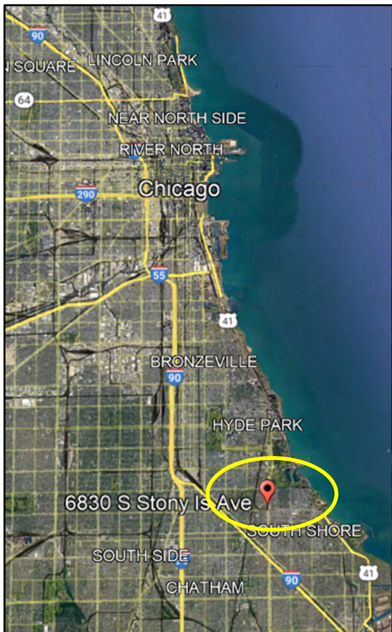
Over the past several years, the Metropolitan Planning Council (MPC) of Greater Chicago and The Nature Conservancy (TNC) have led the development of a stormwater credit trading program (known as StormStore) in Cook County, IL. MPC recently retained Environmental Consulting and Technology (ECT) and One Water Econ to conduct analyses in support of a credit-generating project located within the City of Chicago that incorporates nature-based solutions, and to assess the costs and benefits of the project. This memorandum provides a high level (i.e., screening) assessment of the potential financial, environmental, and social benefits associated with nature-based stormwater management practices (SMPs) at the selected site.

Site Overview

At the outset of this project, representatives from MPC, TNC, and ECT worked together to select a project site based on various criteria. The selected site encompasses three parcels that collectively span approximately 0.86 acres on the Southeast side of Chicago. The parcels are located approximately one mile directly west of the lakeshore (see locational map, Figure 1). The site is bordered by South Stony Island Avenue to the east – a divided parkway with multiple lanes in each direction. On the south side is East 69th Street, a more typical residential street. The parcels are publicly owned, and the site design includes public access with recreational amenities. The parcel on the southeast side is not being used for the project and is being reserved for future development on the southeast side (Figure 2).

As a first step to assessing the potential benefits of nature based SMPs at the site, it is helpful to understand the characteristics of the surrounding neighborhood. Based on data from the U.S. Census American Community Survey (ACS), the Census tract in which the parcel is located spans 90 acres (see Figure 2) and has a population of 2,582. In 2021, the median household income (MHI) in the neighborhood was $32,000 and the poverty rate was 32.2%. This compares to an MHI and poverty rate of $72,092 and 13.8%, respectively, for Cook County overall. The population of the area is relatively young - 10.4% of the population is under 5 years old and there are relatively few elderly residents, with only 2.9% of residents over the age of 65. Close to 97% of residents are African American.

The land use is mostly residential, and most housing units in the area are in multi-family buildings that mostly range in size from 2 to 20 units. In 2021, there was a 21% vacancy rate in the area, much higher than the 7.9% rate for Cook County. There are several vacant lots in the area with no structures on them. Most of these lots are covered in grass and it is not clear how/whether they are used.



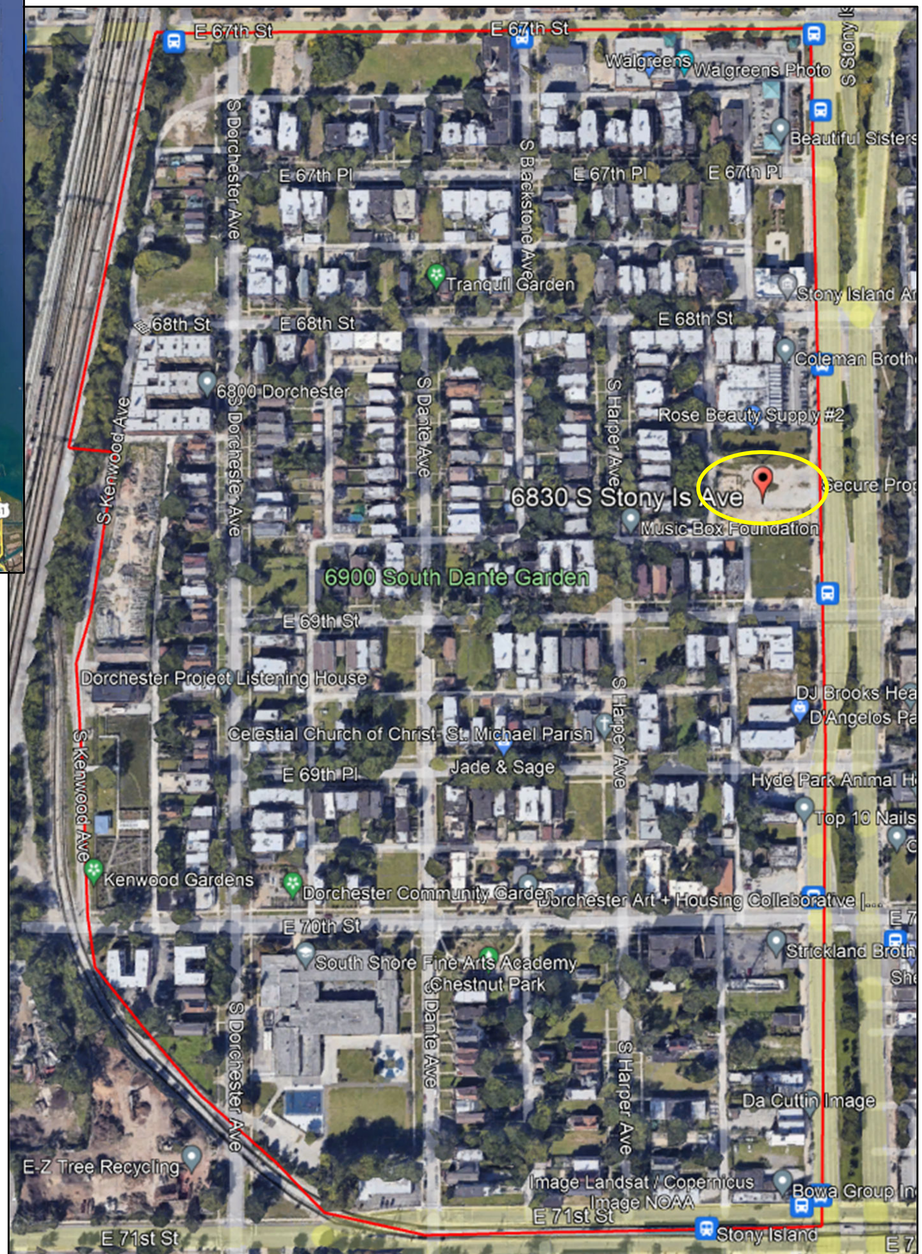
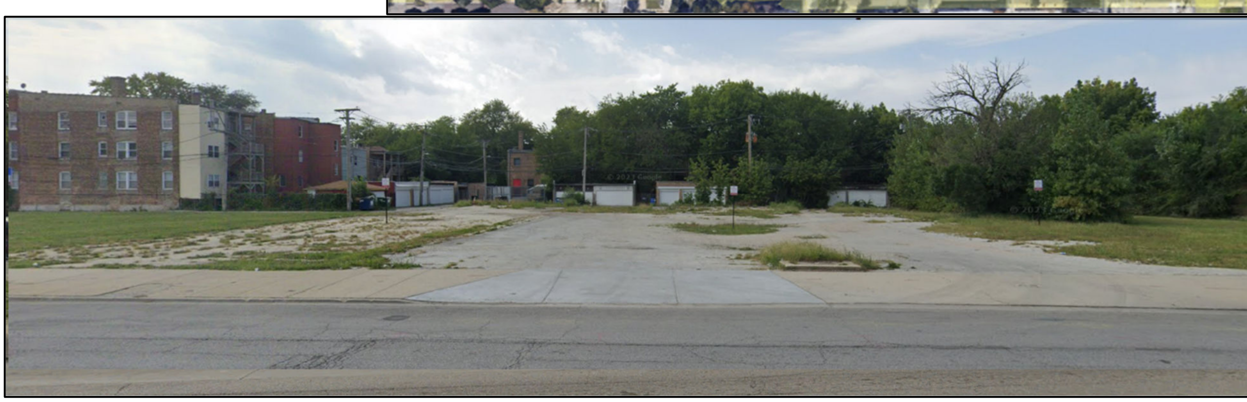


Figure 1a (top left). Location of site within greater Chicago area. Figure 1b (top right). Approximate boundary for Census tract in which site is located. Figure 1c (bottom). Street level view of site, looking west from S. Stony Island Avenue.



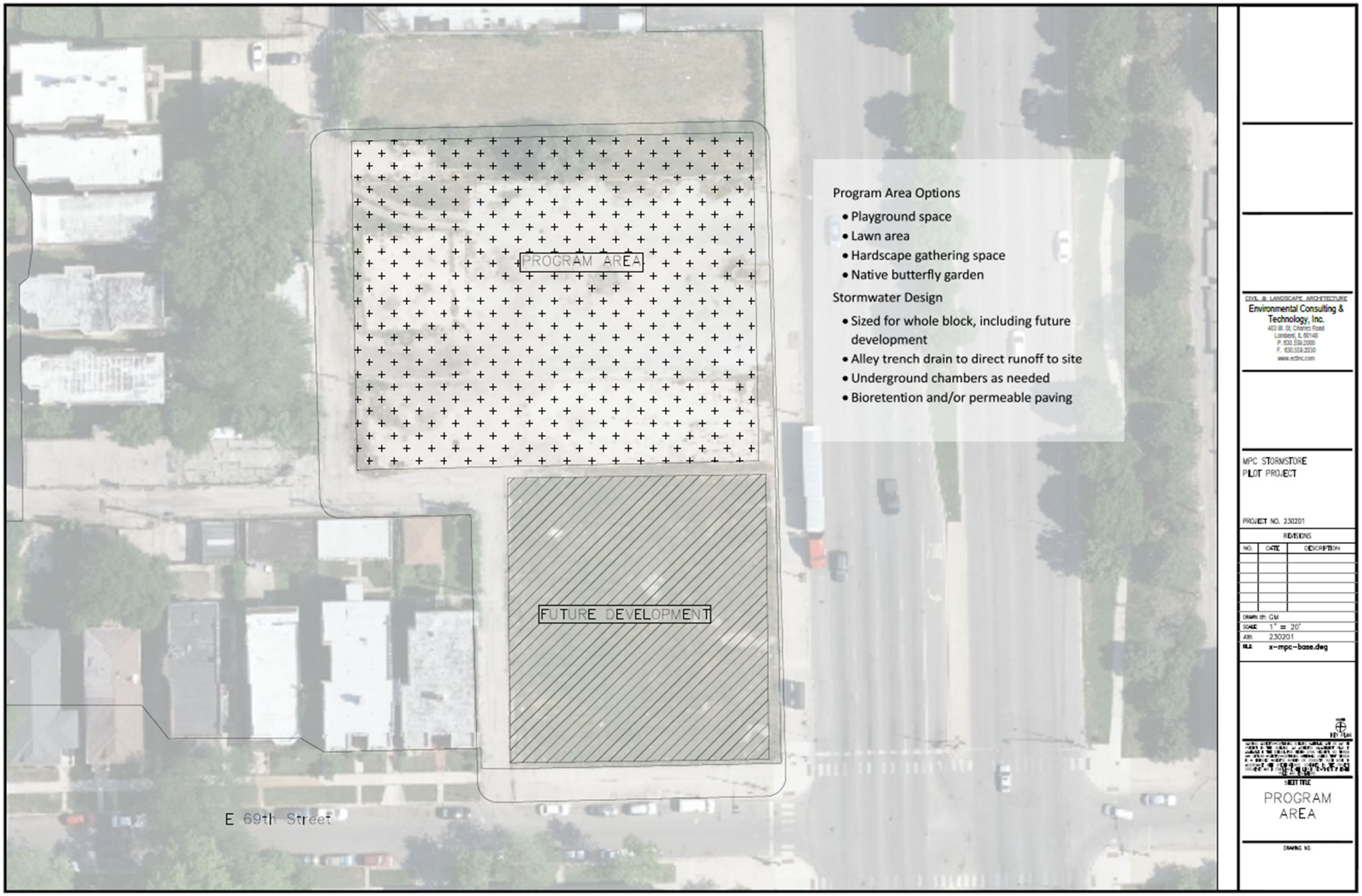


Figure 2. Future development at project site, amenities with public access on north side.

In addition to gathering socioeconomic data, MPC staff utilized the Trust for Public Lands' Natural Solutions Tool for Greater Chicago to gain an initial understanding of how nature based SMPs (or green stormwater infrastructure, GSI) might benefit residents in the surrounding neighborhood. The Natural Solutions Tool is a GIS-based planning tool intended to help users identify high priority areas for GSI implementation based on five categories of objectives or priorities, each with several subcategories.

Table 1 describes the five objectives/priority categories and how the project site scored in terms of these various objectives. As shown, the site has the potential to provide equity and health benefits for residents in the area, as well as to contribute to a network of green spaces and connective trails. While the TPL tool shows that GSI at the site would not contribute to meaningful biodiversity benefits, there are several efforts across the City to increase pollinator habitat (e.g., Project Wingspan Chicagoland, Chicago Botanic Garden), indicating that even small gardens, when implemented across the city can contribute to important habitat.

The project team used the socioeconomic data and TPL tool indicators as helpful context in considering how different SMPs at the site might provide benefits to the surrounding community. For example, given the demographic of the area, the project team designed the site to include recreational amenities for young children. In addition, the site includes the addition of many trees that will improve air quality and help to reduce the urban heat island effect, resulting in public health benefits for neighborhood residents. This information also helped the project team value the benefits of the proposed project, helping to cast potential benefits in context and understand the extent to which various interventions will provide benefits.

Potential Triple Bottom Line Benefits of GSI at Project Site

One Water Econ applied the Water Research Foundation (WRF) Triple Bottom Line Green Stormwater Infrastructure (TBL GSI) Tool, relevant literature, and other local sources to estimate the monetary value of project benefits. Like the stormwater benefits presented in the main report, the TBL benefits are cast within the context of three scenarios:

- "No action" or existing conditions scenario
- A baseline scenario in which GSI-based SMPs are implemented to manage the volume of stormwater generated onsite (i.e., across the 0.86-acre project site) as necessary to meet the City stormwater regulations
- The pilot project scenario, which includes enhanced GSI-based SMPs for managing additional runoff from offsite. Under this scenario, the project would meet or exceed the stormwater regulation standards for the entire 4.85 acre drainage area, including the project site and surrounding area.

The baseline and pilot project scenarios both incorporate nature-based solutions and recreational amenities, with the only difference being the addition of enhanced SMP capacity to manage offsite runoff under the pilot project scenario. See the main report for additional detail on the scenarios established for this analysis.

Table 1. TPL Tool categories, subcategories, and site rankings

Priority categories	Definition	Subcategories	Site score
	Retain or enhance ecological health by supporting and creating living landscapes of native species.	• Corridors • Imperiled species richness • Core areas	**0%** - GSI at site would not contribute in a meaningful way to biodiversity by supporting or enhancing wildlife corridors or species richness and it is not located in a high priority area for biodiversity.
	Support the creation of a complete network of regional trails and linear multi-benefit greenways.	Fill trail gaps	**50%** - Site could help to fill trail gaps/provide partial routes to other parks/open spaces.[a]
	Investment in areas of need where people suffer from environmental stressors and lack the benefits of nature.	• Communities of color • Linguistic isolation • Less than HS education • Population >64 or <5 years • Unemployment • Disability • Disinvested community • Life expectancy • Rent burden	**100%** - GSI at site will serve population with presence of key equity indicators. Tool scored 6 of 10 subcategories with 100%: communities of color, population under 5, unemployment, disability, life expectancy, rent burden.
	Address existing environmental conditions, such as urban heat islands and air pollution that harm human health.	• Daytime heat island • Tree canopy • Health indicators: Diabetes, asthma, obesity, chronic pulmonary disease, stroke, depression, heart disease, mental health, physical health • Air quality indicators: PM 2.5, ozone, diesel concentrations	**100%** - GSI could help to improve most of the health indicators identified.
	Promote the natural absorption of rainfall to increase resiliency, improve water quality, and reduce community flooding.	• Flow accumulation • Combined sewer area • Runoff • Impervious surface • Current flood zone • Wetlands, riparian buffers, shorelines • Open space	**33% -** GSI at site would provide moderate benefits in this category. Note: site is being designed to capture runoff from multiple surrounding parcels and benefits will likely be greater than indicated by TPL tool.

a. The results from the TPL tool showed a 50% score for this category; it is unclear why this is not a binary variable.

The following sections discuss each benefit and provide estimates of value based on standard economic approaches. To inform site design, we have summarized (as applicable/feasible) benefits by SMP type, as well as the different factors that can affect the provision of key benefits. In some cases, benefits are annual values, meaning they will continue to accrue each year, as long as the project is in place. In other cases, the benefits are one time values. To comprehensively assess benefits, the last section of this memo compares present value benefits over the life of the project.

Avoided gray infrastructure costs

Benefit background

If nature based solutions are implemented to manage onsite stormwater runoff (baseline scenario) or from the larger 4.85-acre project area (pilot project scenario), this will reduce costs associated with gray infrastructure that the city would eventually need to upgrade to accommodate runoff volumes and peak flows that are currently taxing the existing conveyance and treatment systems. An analysis conducted for the Resilient Infrastructure Sustainable Communities (RISC) by ECT and the Center for neighborhood Technology indicates that much of our current infrastructure was designed using outdated precipitation frequency estimates and is therefore undersized and that the problem will become worse with climate change.[1] The value of the project's stormwater management benefits can therefore be estimated based on the following avoided costs:

- Marginal reductions in treatment plant capacity upgrades.
- Marginal reductions in conveyance capacity upgrades.

Ongoing stormwater management through onsite SMPs will also avoid costs associated with pumping and treating the 0.33 million gallons (MG, baseline) to 1.8 MG (pilot project) of stormwater that the project would capture each year. This benefit is captured in the energy savings benefit category, as described below.

Benefit valuation for project site

To estimate the value of avoided treatment plant capacity upgrades, we applied an engineering cost estimate for peak flow capacity upgrades ($5 million per MGD, Feher Graham 2022) to the reduction in runoff expected under the baseline and pilot scenarios. Because the site will be designed to retain at least the 1" storm event, we used the volume of runoff associated with this event to estimate the marginal reduction in treatment plant capacity that would result from the project.

Under the no-action, baseline, and pilot scenarios, the runoff from the 1" event amounts to 59,300, 43,000, and 0 gallons, respectively. This translates into runoff volume reductions of 16,300 (baseline) and 59,300 gallons (pilot), relative to the no-action scenario. Applying the $5 million per MGD estimate, the avoided costs associated with reduced treatment plant capacity upgrades amounts to $81,500 under the baseline scenario and $296,500 under the pilot project scenario. This is a one-time avoided cost. While the city would likely not need to immediately install these upgrades, there would be an immediate benefit to the system. For the present value calculations, we therefore assume this benefit would begin in the first year (see Section X below).

[1] "Climate Change Preparedness of Great Lakes Communities", Sanjiv K. Sinha, Sajani Neeraja, Thomas H. Price, and Anna Wolf, Environmental Consulting & Technology, Inc., Report, 22 pp, April 2023.

To estimate the reduction in conveyance capacity needs afforded by the project, we assumed that a 60-inch sewer pipe would be needed to reduce localized flooding and that this would accommodate the 5-year storm event. At a typical cost of $400 per linear feet of sewer pipe, and assuming that one mile of sewer pipe would be needed, the cost of the sewer would amount to $2.11 million. The capacity of a 60-inch sewer is 101 cfs; thus, the unit cost of the sewer pipe (per cfs) is $20,890. Relative to no-action, the baseline and pilot scenarios reduce five-year peak flow rates by 2.86 cfs and 11.5 cfs, respectively. The associated avoided costs amount to $60,000 and $240,000 for the baseline and pilot scenarios, respectively. Like the treatment plant capacity upgrades, this is a one time benefit. Given that the neighborhood is currently experiencing localized flooding, for calculating the present value of this benefit, we assume it is an immediate cost to the city. This is a one-time avoided cost.

Water supply.

Benefit background

Rainwater harvesting (rain barrels and cisterns) is a common practice for stormwater management at the building scale. In addition to stormwater capture benefits, water collected in rainwater harvesting systems can be used for outdoor irrigation, as well as for several (non-potable) indoor uses. This reduces potable water demand for households, businesses, and other water users. The WRF TBL tool estimates that in Chicago, a 2 55-gallon rain barrel system can offset potable demands for irrigation by up to 2,955 gallons per year. A 1,000-gallon cistern has the potential to reduce potable water use by up to 23,637 gallons per year. The value of these offsets amounts to $13 and $108 per year, respectively. This is based on a billing rate of $4.55 per 1,000 gallons in the city of Chicago.

Benefit valuation for project site

Rainwater harvesting systems are not currently incorporated into site design. Therefore, we did not include this benefit in our evaluation of the site.

Energy savings.

Benefit background

Green roofs and trees can help shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling. In the Midwest climate zone (where Chicago is located, per the WRF GSI TBL tool), the average street tree saves 267 kWh in electricity and 36 therms of natural gas per year, at full growth. Applying the average of commercial and residential energy rates in Illinois, this equates to $38 in avoided electricity and $43 in natural gas costs per year per tree, at full growth ($81/tree). However, based on the location of the site, it does not appear that the trees incorporated into site design would achieve this benefit. Trees could be planted strategically around the future development and/or by surrounding buildings to result in energy savings.

If the site were to incorporate a green roof, energy savings would amount to between $39.30 and $89.25 per 1,000 square feet per year in reduced heating and cooling costs. The range reflects Chicago's climate and different green roof parameters (i.e., extensive green roofs with lower energy savings compared to intensive green roofs with depths of up to 12 inches). The site design does not incorporate a green roof; therefore, this benefit does not apply in this context

Rainwater harvesting systems that offset potable water use reduce energy demand for drinking water treatment and distribution. Rain barrels and cisterns that result in potable water supply savings reduce energy use (on average in Chicago) by 5 kWh (2 55-gallon barrels) and 38 kWh (1,000-gallon cistern), respectively. The avoided cost of this energy use would be captured in the water supply benefits reported above (potable water supply offsets), because they are monetized based on City of Chicago water billing rates, which include energy costs. However, these interventions will not be implemented at the project site.

In cities with combined sewers, like Chicago, diverting stormwater from wastewater collection, conveyance, and treatment systems reduces the amount of energy needed to pump and treat the water. Both the baseline and pilot project scenarios will reduce energy used for this purpose.

Benefit valuation for project site

The average pumping and treatment energy intensity for Chicago's wastewater treatment plant is approximately 1,978 kWh/MG (Elevate Energy 2018). Applying this estimate to the volume of runoff retained annually under each scenario (0.33 MG baseline and 1.83 MG for pilot project), results in a savings of approximately 652 kWh per year for the baseline and 3,619 kWh hours per year for the pilot project, amounting to $55 and $304 per year in avoided wastewater treatment and pumping costs (based on average industrial energy costs in Illinois of $0.084 per kWh). Combining the MWRD energy use intensity with the 8.4 cents per kWh energy cost, the cost per MG treated is $166.

Air quality improvements and related health benefits.

Benefit background

GSI-based improvements can improve air quality in several ways, including:

- Reducing emissions (e.g., SO2 and NOx) from power plants by reducing energy consumption for heating and cooling and stormwater collection and treatment.
- Absorbing gaseous pollutants [e.g., ozone (O3), carbon monoxide (CO), NO2, SO2] through leaf/vegetated surfaces
- Intercepting particulate matter (PM; e.g., dust, ash, dirt, pollen, smoke)

The public health and environmental impacts of specific air pollutants are well-documented. NOx and SOx contribute to adverse respiratory and cardiovascular effects; ground-level O3 and PM are linked to premature deaths, chronic bronchitis, asthma, respiratory infections, and other illnesses. O3 can also damage crops and increase the vulnerability of some tree species to various diseases; PM can reduce visibility in urban areas.

Benefit valuation for project site

The GSI TBL Tool estimates that in Chicago, the value of trees in improving air quality amounts to $226 per year (at full growth/maturity). Most of this value ($202 per year) is due to the health benefits of pollutant removal from trees, including interception/absorption of O_3, CO, NO_2, SO_2, and $PM_{2.5.}$ - the remainder comes from reduced energy emissions associated with building energy savings. The WRF GSI TBL tool applies a tree growth model to estimate present value benefits associated with trees over time, recognizing that benefits provided by trees will increase as they reach full growth. Tree-related present value benefits over the life of the project are reported below.

For bioretention, the GSI TBL tool estimates that every 1,000 sq. ft. results in $31 per year in avoided health costs. These estimates are based on research conducted by the U.S. Forest Service on the pollutant uptake and removal benefits of shrubs and herbaceous cover, as well as eGRID pollutant emission rates published by the U.S. EPA. Avoided healthcare costs are based on EPA estimates for specific pollutants.

Finally, the energy reductions associated with avoided pumping and treatment of stormwater also reduce energy-related emissions. As noted above, the reduction in energy use associated with the baseline and pilot scenarios amount to 652 kWh and 3,619 kWh, respectively. The air quality benefits associated with avoided energy from stormwater pumping and treatment amount to $58 (baseline) to $322 (pilot) per year – this represents the avoided health care costs from reduced pollutant emissions.This reduction equates to $176/MG of runoff reduction.

Carbon reduction

Benefit background

Carbon dioxide (CO_2) is widely recognized as a significant greenhouse gas (GHG) that contributes to rising atmospheric temperatures and associated climate change. Trees and vegetation associated with GSI remove CO_2 from the atmosphere (sequestration) and act as a sink by storing carbon in the form of biomass. In addition, GSI-related energy savings reduce CO_2 emissions and other GHGs (which can be translated to CO_2 equivalents or CO_{2e}) from power plants. The value of GHG reductions is estimated based on the social cost of carbon, a dollar per ton value that represents the damages that carbon causes across the globe. The WRF GSI TBL Tool uses a 2020 value for the social cost of carbon of $52 per ton.

Benefit valuation for project site

Based on the TBL GSI tool, in Chicago, the value of carbon reduction per tree (at full growth) is $31 per year. This includes $14 in CO_2 emissions reductions from building energy savings and $17 in value through carbon sequestration. As noted above, this assessment does not include benefits associated with building energy savings from trees due to the nature of the project site.

Every 1,000 square feet of bioretention sequesters $6 worth of carbon each year.

The avoided carbon emissions associated with avoided energy from stormwater pumping and treatment amount to $34 (baseline) to $189 (pilot) per year. The unit value of reduced carbon emissions is approximately $103/MG.

Increased property values

Benefit background

Well-designed nature-based solutions and related improvements (e.g., recreational park amenities) can increase property values in the surrounding area. The aesthetic nature of GSI SMPs, including trees and native vegetation, can enhance overall aesthetics, improve quality of life, and provide other environmental amenities. Individuals value these ecosystem services and are often willing to pay more to live or work nearby. The use of GSI at commercial or multifamily properties can also carry with it a "sustainability premium" and the ability to fetch higher rents (NRDC 2016).

As an important note, increases in property values serve as a proxy for the value that individuals hold for the different ecosystem services provided by nature-based solutions and related amenities. They are a reflection of value rather than a benefit in and of itself.

For individual sites or neighborhoods, property value increases associated with well-designed GSI improvements generally range from 2% to 5% (WRF 2020), with several studies reporting higher increases for trees and green roofs. Wolf (2007) reported “good tree cover” in a neighborhood can increase property values by up to 9%, while studies of green roofs (Abbot and Lewis 2013; Ichihara and Cohen 2011) report associated rental increases of up to 16% for commercial and multifamily buildings.

Several studies have found significantly higher increases associated with larger scale, programmatic or neighborhood improvements. In 2016, the Sustainable Business Network (SBN) of Greater Philadelphia GSI Partners published a report documenting the economic impacts and benefits associated with the first five years of Philadelphia Water’s Green City Clean Waters (GCCW) Program (SBN 2016). The study included an original hedonic analysis that estimated the effect of the City’s GSI projects on nearby residential property values. Results of the analysis indicated that public projects not located at a park, school or recreation center increase nearby (i.e., within a quarter mile) residential property values by 12.7%, while being located near a public project that occurred at a park, school or recreation center resulted in an 11.5% increase. The authors hypothesized that the larger impact from being located by a project that did not occur at park, school or recreation center is likely because these projects added green features to a neighborhood that otherwise did not have much.

The creation of a pocket park or green space available for public use can result in additional (not additive) property value benefits. In general, the literature suggests that parks contribute positively to nearby property values. However, the magnitude of increase depends on the park’s characteristics. Small “attractive” neighborhood parks have been found to have significant positive effects – upwards of 11% - on adjacent properties (Espey and Owusu-Edusei 2001; Hobden, Laughton, and Morgan 2004). Studies have also found that parks constructed primarily for passive recreational uses are more likely to have strong and positive impacts, while parks intensively used for active recreational purposes can have relatively weak and, in some cases, negative, impacts on nearby property values. This is likely due to increased noise and disturbance (Lin 2016, although this author found ball parks/courts as an exception). The magnitude of any negative impacts typically decreases as distance from the park increases; after a certain distance, a positive effect is generally expected (Crompton, 2004).

In our somewhat limited review, we did not find studies that directly compared property value increases from neighborhood parks that offer different amenities or uses. Voicu and Been (2008) studied the impact of community gardens on property values in low-income areas of New York City (specifically, the effect of converting vacant properties to community gardens). The authors found relatively significant property value increases - from 3.4% directly following completion to 7.4% 5-years after completion for properties located directly adjacent to the site. For properties located 1,000 feet away, the increase in property values ranged from 1.5% directly following completion to 1.9% five years on. A study of green roofs (Tomalty and Komorowski 2010) did compare the benefits of green roofs that offered different recreational amenities, with some including gardens. Using a hedonic pricing model, their results indicated that a recreational rooftop garden increased property values by approximately 11%, while rooftop vegetable gardens increased values by 7%, indicating a higher preference for passive recreation amenities compared to gardens.

Across all GSI practices, Wolf (2007) reports that socioeconomic condition of a residential area makes a difference. For instance, increments of value for tree planting and landscape improvements are often greater in lower-income neighborhoods. This study is confirmed by Wachter (2004), who used hedonic analysis to assess community revitalization potential from the construction of gardens in vacant lots and planting of street trees in a semi-blighted neighborhood in Philadelphia. The study found that planting street trees where none previously existed increased house prices by approximately 9%.

Benefit valuation for project site

There are 23 residential buildings located more or less adjacent to the planned project site (on the west side of S. Stony Island Avenue). Based on 2021 ACS data, we know that there are 1,284 housing units in the Census tract, with a median value of $189,900. We estimate that each residential building has an average of 6 units. Thus, the 23 multifamily buildings located by the project site contain approximately 142 housing units. The total aggregate value of these housing units amounts to $27.0 million (approximately $190,140 per unit, per ACS 2021). Applying a conservative value (3%) to only these properties amounts to a total value of $809,000. An increase of 11% (closer to those found in studies of similar improvements), would amount to close to $3.0 million in property value benefits. These represent somewhat conservative estimates as the benefits would likely extend beyond the 23 buildings located directly adjacent to the site, to at least those within 1,500 feet, as evidenced in reviewed studies. When annualized over a 30-year period (the length of a typical mortgage), the midpoint of these estimates ($1.9 million) amounts to $96,900 per year.

Recreation

Benefit background

As designed, the site would provide increased recreational opportunities and enjoyment of green space for the neighborhood by providing access to neighborhood green space and recreational amenities. Individuals value outdoor recreation for several reasons, including for physical activity and associated health benefits, improved mental health, and for building social capital. Because recreational activities associated with GSI projects are not traded in the market (i.e., there is no fee for participation), it can be difficult to establish the values associated with them. However, many researchers have conducted willingness-to-pay (WTP) surveys to estimate the value of a recreational experience across a range of activities. These studies yield what economists refer to as *direct use values*. Direct use values reflect the amount that individuals would be willing to spend to participate in a recreational activity if they had to pay for it.

Total recreational benefits associated with GSI are a function of direct use values and the additional recreational trips (often referred to as “user days”) taken as a result of the GSI improvements. However, these variables can range significantly depending on the availability of existing (i.e., baseline) outdoor recreation opportunities, the type of recreational activities facilitated by GSI improvements, the amount and quality of the recreational space, and other local conditions. Based on these factors, the GSI TBL Tool includes a series of questions to help guide users toward some basic assumptions for estimating recreational benefits.

Specifically, the Tool relies on the U.S. Army Corps of Engineers’ (ACOE’s) “Unit Day Value” method for estimating recreational benefits associated with federal water resource projects. The Unit Day Value method relies on expert or informed opinion and judgment to estimate the average WTP to participate in different types of recreational activities. Specifically, the model assigns points to recreational experiences based on various factors and assigns direct use values based on total points received and the type of recreation activity. The U.S. Army Corps of Engineers updates its Unit Day Values for different types of recreational activities each year.

Benefit valuation for project site

To estimate the number of recreational visits to the site, we relied on the Tool's estimate for small recreation areas or pocket parks. We assumed that the park would be approximately 0.86 acres and would serve approximately 1,000 residents (the maximum recommended by the National Recreation and Park Association for pocket parks). We also assumed that recreation would occur seven months of the year due to weather conditions in colder months. Based on this data, the Tool estimates there would be just over 9,073 visits to the park each year.

To estimate direct use values, the Tool walks the user through a similar series of questions for each relevant type of recreation provided and assigns points to the recreational experience based on the answers to the questions. Based on the assumption that the park would primarily provide passive recreation activities, the fact that there are at least a few recreational sites located nearby, and other key inputs, the Tool estimates the value of recreational activities to amount to $65,700 per year. This is based on an average trip value of $7.24 based on the following ratings/determinants:

- The project does not provide hunting and fishing opportunities or other specialized recreation.
- The site will provide a moderate number of general/passive recreation activities, such as a playground, benches/sitting areas, or other gathering spots.
- The site provides adequate services to support recreation and the number of expected visitors (as compared to basic or very good).
- The site is highly accessible to local residents on the west side of S. Stony Island Avenue.
- The site has average aesthetic value (as compared to high or low)
- There are at least a few recreational sites located nearby including a playground, an open space area with a gazebo, and a large public park within a mile (this lowers the average trip value a bit).

Urban heat island reduction

Benefit background

Many GSI practices create shade, reduce the amount of heat absorbing materials, and emit water vapor, all of which cool hot air and reduce the urban heat island (UHI) effect. In many areas, this cooling effect is enough to reduce heat stress-related fatalities and illnesses during extreme heat events (EHEs).

While on its own, the site will not have significant heat island reduction benefits, it could contribute to a larger scale program that increases vegetated or reflective area throughout the city. The modeling in the GSI TBL tool is based on converting 10% of impervious surfaces in urban areas to vegetated or reflective surfaces. Considering the proposed project would add significant tree canopy, it would result in some UHI reduction benefits.

Benefit valuation for project site

Using the Tool (which relies on EPA modeling and climate projections for Chicago), we estimate that in the Census block study area, a 10% increase in vegetated surface would result in a 0.5 degree Fahrenheit reduction in average temperatures. This in turn reduces the number of days where heat-related health impacts would occur by 8.1 in 2050. This, again in turn, would reduce heat-related deaths by 0.04 (a statistical annual average), emergency room visits by 6.0, and hospitalizations by 1.1. The value of these public health benefits would amount to $503,000 in 2050 (2023 USD, this value increases over time from 2023 to 2100).

Achieving this outcome would require the conversion of 10% of the Census block study area (i.e., across the neighborhood) from impervious area to vegetation, tree canopy, or reflective surface (permeable pavement). However, the planned open space area would provide incremental benefits towards that goal. Specifically, the GSI TBL Tool indicates that every 1,000 sq. ft. of bioretention, green roof, or native vegetation would result in $1,283 in benefits, while benefits in 2050 on a per tree basis would amount to $1,479 (this is for a tree at full growth). Compared to non-reflective surfaces, reflective permeable pavement results in slightly greater heat stress reduction benefits compared to vegetation – based on the Tool modeling, approximately $2,274 per 1,000 sq. ft.

Habitat

Benefit background

GSI practices can contribute to the network of green spaces that support terrestrial ecosystems and biodiversity in urban settings. This is particularly true in areas where development and impervious cover have degraded habitat for native species and/or where green spaces are isolated within the built environment.

Benefit valuation for project site

Based on the GSI TBL Tool, trees onsite will provide close to $91 in habitat benefits per year, while bioretention with native vegetation provides $54 per 1,000 square feet per year. These values are based on a meta-analysis of willingness to pay for urban wetland habitat, and research on the comparative value of habitat benefits for different land uses (i.e., green roofs, trees, native vegetation). It is worth noting that the Federal Emergency Management estimates a value of $151 per 1,000 square feet (2023 USD) for all urban green space, although this represents a national average across all urban green space types. For this assessment we take the midpoint of this range to value overall habitat benefits at the site ($103 per 1,000 square feet).

Job creation benefits

Benefit background

The construction, operations, and maintenance of GSI projects have the potential to create entry-level job opportunities for low income, low-skilled workers (JFF 2017). When paired with workforce development initiatives, GSI programs can provide participants with the technical skills necessary to enter the green workforce, earn a livable wage, and further professional development. In addition, when GSI jobs are targeted to individuals who are currently unemployed or underemployed, this creates a net social welfare gain that should be reflected in benefit-cost analysis.

Economists have developed various approaches for valuing job creation benefits associated with hiring individuals who would otherwise be unemployed. These approaches include the calculation and application of reservation and/or shadow wages (also known as the social opportunity cost of labor), as well as the estimation of avoided social costs that local, state, and federal governments would otherwise incur to support an individual who is not gainfully employed. The WRF GSI TBL Tool incorporates simplified versions of these approaches to assess job creation benefits associated with GSI.[2]

[2] Employment effects are often evaluated using economic impact analysis (EIA). EIA focuses on the effects of a project or policy on the amount and type of economic activity in a region, as well as the distribution of that activity. In

Benefit valuation for project site

To estimate construction jobs, the WRF Tool assumes that 5.3 jobs (or job years) are supported for every $1 million in spending on GSI projects. Thus, the baseline scenario would support 9 jobs and the pilot project would support 14 jobs. These jobs are short-term construction jobs. For this analysis, we assume that 20% of these jobs are filled by individuals who would otherwise be unemployed. Applying the reservation wage approach and based on these assumptions, the baseline and pilot project would result in $34,020 and $52,920 job creation benefits, respectively. This is a one-time benefit.

Ongoing maintenance also creates job opportunities. Maintenance and upkeep of the SMPs and park area is expected to require 0.03 (baseline) to 0.06 (pilot project) FTEs per year. Assuming the FTE employee would otherwise be unemployed or underemployed, this results in an annual benefit of $505 to $1,011 per year under the respective scenarios.

Summary and comparison of benefits.

Table 2 provides a summary of unit values for the pilot project scenario (relative to no action) for each of the benefits described above. As applicable, unit value benefits are shown by SMP type, per volume of runoff retained or peak flow reduction, or as one time benefits. As an important note, these benefits cannot simply be multiplied by the number of applicable units to estimate total project benefits. For example, the values below show the benefits associated with trees at full growth, and do not account for tree growth over time (i.e., a newly planted tree will provide a small fraction of benefits that large mature trees provide). In addition, the tree canopy, native vegetation, and open space area should be considered together when assessing heat reduction benefits – they are not necessarily additive when planted together. Finally, most of the values shown are annual values; however, the benefits for construction job creation and avoided gray infrastructure costs are one time benefits.

Table 3 provides a more direct comparison of benefits across the different categories. This table shows total present value benefits (by benefit category) and costs associated with the pilot project scenario (benefits relative to no action), accounting for the different factors noted above (i.e., in relation to additivity). This analysis assumes a 3% discount rate and a 50-year project life cycle. As shown, the expected project benefits significantly outweigh the projected life cycle costs.

contrast, benefit cost analysis (BCA) is used to determine an action's social welfare effects. EIAs trace the flow of spending in an economy to calculate direct, indirect, and induced effects of policies and programs. Consistent with sound methodology for BCA, the WRF GSI TBL Tool focuses only on direct effects associated with job creation.

Table 2. Unit value benefits

Benefit Category	GSI annual runoff retention ($/1,000cf/yr)[a]	GSI 1" event runoff retention ($/1,000 cf)[a]	GSI peak flow reduction ($/cfs)	Trees ($/tree)[d]	Native vegetation ($/1,000 sf)	Open space ($/1,000 sf)	Project site amenities (annual benefit values)
Avoided gray infrastructure costs[b]		$37,400	$21,100				
Energy savings[c]	$1.22						
Air quality improvements	$1.29			$202	$31.00		
Carbon Reduction	$0.76			$17	$6.00		
Property Value Increase							$96,900
Increased recreational opportunities							$65,700
Urban heat island reduction				$1,479	$1,283		
Improved habitat				$91	$54	$103	
Job Creation	$XX						

a. Volume retained and not discharged to the sewer system
b. Avoided need for treatment plant capacity and conveyance – one time benefit (all other benefit values are annual)
c. Avoided energy use due to reduced storm/wastewater treatment and pumping
d. Reflects benefits at full tree growth

Table 3. Present value benefits and costs, pilot project

Benefit Category	Present value benefits (pilot)
Avoided gray infrastructure costs[b]	
Avoided treatment plant capacity upgrades	$287,900
Avoided conveyance upgrades	$233,000
Energy savings[c]	$7,822
Air quality improvements	$163,800
Carbon Reduction	$29,100
Property Value Increase	$2,493,200
Increased recreational opportunities	$1,690,400
Urban heat island reduction	$2,163,500
Improved habitat	$99,300
Job creation	$76,400
Total present value benefits	**$7,243,300**
Total present value costs	**$3,012,100**

Appendix C Construction Cost Estimate

Terra Firma Stormstore Pilot Project - Neighborhood Stormwater Option
Cost Estimate
10/6/2023

Item	Description	Unit	Unit Price	Quantity	Extension	Comments
	A. DEMOLITION AND SITE PREPARATION/ EARTHWORK					
1						
2	Stabilized Construction Entrance	l.s.	$1,000.00	1	$1,000.00	
3	Temporary Construction Fence	l.f.	$18.00	745	$13,410.00	with windscreen. Perimeter of project site.
4	Clearing & Grubbing	s.f.	$0.35	10,000	$3,500.00	project site
5	Asphalt Paving Removal	s.f.	$1.25	33,775	$42,218.75	project site = 30,000sf and removal for trench drain = 3,775sf in alley
6	Silt Fence	l.f.	$4.00	745	$2,980.00	perimeter of project site.
7	Inlet Protection	ea.	$300.00	2	$600.00	
8	Sawcut Paving	l.f.	$8.00	1,500	$12,000.00	sawcut in alley for new trench drain and structures.
9	Earth Moving/ Excavation	c.y.	$15.00	780	$11,700.00	12" depth for gravel paving and concrete = 325cy. 30" depth for traditional landscape areas = 415cy. 6" for lawn not over chambers = 40cy.
10	Haul Off and Dispose of Soil	c.y.	$45.00	780	$35,100.00	assumes CCDD facility
11	Fine Grading	s.f.	$1.25	37,402	$46,752.50	project site
12	Planting Soil	c.y.	$90.00	415	$37,350.00	30" depth for all planting areas not bioretention or lawn. 4,505sf
12	Topsoil	c.y.	$40.00	170	$6,800.00	6" depth for lawn area. 9,210sf
13						
14	**Demolition and Site Preparation Total**				**$213,411.25**	
15						
16	**B. SITE UTILITIES**					
17	Storm: 6" Solid HDPE Pipe and Trench	l.f.	$50.00	184	$9,200.00	includes trench excavation, pipe bedding, backfill.
18	Storm: Trench Drain	l.f.	$175.00	755	$132,125.00	
19	Storm: 8" Ductile Iron Pipe and Trench	l.f.	$75.00	150	$11,250.00	
20	Storm: 8" Perforated PVC Underdrain	l.f.	$55.00	350	$19,250.00	
21	Storm: 12" Culvert	l.f.	$65.00	70	$4,550.00	
22	Storm: 10" ESVCP Pipe	l.f.	$60.00	70	$4,200.00	
23	Storm: Catch Basin - 48" diameter	ea.	$3,000.00	4	$12,000.00	
24	Storm: Catch Basin - 24" diameter	ea.	$2,750.00	8	$22,000.00	
25	Storm: Catch Basin - 48" diameter Outlet Control Structure	ea.	$3,500.00	1	$3,500.00	
26	Bioretention	s.f.	$25.00	14,972	$374,300.00	complete; including excavation, haul, #57 stone base, engineered soil, filter fabric, leaf mulch, vegetative plugs @12" centers. Assumes 18" surface depression, 18" soil depth, 12" stone depth.
27	Observation Well	ea.	$1,500.00	2	$3,000.00	
28	Underground Chamber System	cf	$9.70	30,000	$291,000.00	complete; including excavation, haul, #57 stone base, chambers.
29	Line flushing, cleaning and testing	l.s.	$5,000.00	1	$5,000.00	
30	Site Lighting	l.s.	$150,000.00	1	$150,000.00	allowance
31						
32	**Site Utilities Total**				**$1,041,375.00**	
33						
34	**C. GENERAL SITE CONSTRUCTION**					
35	CIP Concrete Paving (Pedestrian)	s.f.	$16.00	5,900	$94,400.00	5" concrete over 6" CA6 gravel base.
36	Gravel Path (Dog run)	s.f.	$10.00	2,825	$28,250.00	3" kafka granite over 6" CA6 gravel base.
37	Ornamental Iron Fence - 48" height	l.f.	$130.00	745	$96,850.00	
38	Ornamental Iron Gate - 48" height	ea.	$3,500.00	5	$17,500.00	
39	Permeable Pavers	s.f.	$35.00	850	$29,750.00	6" CA7 gravel base with edge restraint.
40	Filter Fabric	s.f.	$2.00	8,965	$17,930.00	sf of chambers includes pavers.
41	Steel Edging	l.f.	$10.00	305	$3,050.00	edge restraint around all gravel paving.
42	Asphalt Paving (vehicular restoration)	s.f.	$3.50	3,020	$10,570.00	assume 2' patch on either side of alley trench drain and structures.
43	Stone Headwalls	l.f.	$250.00	30	$7,500.00	
44						
45	**General Site Construction Total**				**$305,800.00**	
46						
47	**D. SITE AMENITIES**					
48						
49	Picnic Table	ea.	$3,000.00	4	$12,000.00	
50	Large Picnic Table	ea.	$3,500.00	1	$3,500.00	
51	Benches	ea.	$1,750.00	4	$7,000.00	
52	Play Area	l.s.	$30,000.00	1	$30,000.00	allowance
53	Shade Structure	l.s.	$90,000.00	1	$90,000.00	allowance
54	Landscape Boulders	ea.	$1,000.00	7	$7,000.00	
55	Trash Receptacles	ea.	$750.00	4	$3,000.00	
56	Bike Rack	ea.	$1,000.00	2	$2,000.00	
57	Interpretive Signage	ea.	$500.00	4	$2,000.00	
58						
59	**Site Amenities Total**				**$156,500.00**	
60						
61	**F. PLANTING**					
62	Deciduous Tree	ea.	$1,250.00	35	$43,750.00	3" caliper.
63	Ornamental Tree	ea.	$1,250.00	12	$15,000.00	8-10' tall.
64	Perennials	ea.	$12.00	2,300	$27,600.00	4,505 sf. @ 18" O.C. for traditional planting areas, not bioretention.
65	Turfgrass Sod	s.f.	$1.25	9,210	$11,512.50	
66	Deciduous Shrub	ea.	$50.00	100	$5,000.00	5 gal.
67	Leaf Mulch	c.y.	$90.00	30	$2,700.00	2" depth for all perennial planting areas.
68	Mulch	c.y.	$40.00	35	$1,400.00	Assume 0.66 CY per tree. Minimal shrub mulching.
69						
70	**Planting Total**				**$106,962.50**	
71						
72	**G. SUMMARY**					
73						
74	**A. Demolition and Site Prep Total**				$213,411.25	
75	**B. Site Utilities**				$1,041,375.00	
76	**C. General Site Construction**				$305,800.00	
77	**D. Site Amenities**				$156,500.00	
78	**E. Planting**				$106,962.50	$569,262.50
79	Basic Services Subtotal				$1,824,048.75	
80	25% Contingency				$456,012.19	
81	Bond, GC, insurance, contractor fees				$410,410.97	
82						
83						
84	**Total Estimated Construction Cost - Basic Services**				**$2,690,471.91**	

Note: line items include materials, delivery, and installation including labor.

Terra Firma Stormstore Pilot Project - Baseline Option
Cost Estimate
10/6/2023

Item	Description	Unit	Unit Price	Quantity	Extension	Comments
	A. DEMOLITION AND SITE PREPARATION/ EARTHWORK					
1						
2	Stabilized Construction Entrance	l.s.	$1,000.00	1	$1,000.00	
3	Temporary Construction Fence	l.f.	$18.00	745	$13,410.00	with windscreen. Perimeter of project site.
4	Clearing & Grubbing	s.f.	$0.35	10,000	$3,500.00	project site
5	Asphalt Paving Removal	s.f.	$1.25	33,775	$42,218.75	project site = 30,000sf and removal for trench drain = 3,775sf in alley
6	Silt Fence	l.f.	$4.00	745	$2,980.00	perimeter of project site.
7	Inlet Protection	ea.	$300.00	2	$600.00	
8	Sawcut Paving	l.f.	$8.00	1,500	$12,000.00	sawcut in alley for new trench drain and structures.
9	Earth Moving/ Excavation	c.y.	$15.00	1,435	$21,525.00	12" depth for gravel paving and concrete = 325cy. 30" depth for traditional landscape areas = 415cy. 6" for lawn not over chambers = 40cy. Native landscape areas = 655cy.
10	Haul Off and Dispose of Soil	c.y.	$45.00	1,435	$64,575.00	assumes CCDD facility
11	Fine Grading	s.f.	$1.25	37,402	$46,752.50	project site
12	Planting Soil	c.y.	$90.00	1,070	$96,300.00	30" depth for all planting areas not bioretention or lawn, 4,505sf. 18" depth for native landscape areas, 11,752 sf.
12	Topsoil	c.y.	$40.00	170	$6,800.00	6" depth for lawn area. 9,210sf
13						
14	**Demolition and Site Preparation Total**				**$311,661.25**	
15						
16	**B. SITE UTILITIES**					
17	Storm: 4" Perforated PVC Underdrain	l.f.	$55.00	85	$4,675.00	includes trench excavation, pipe bedding, backfill.
18	Storm: 10" ESVCP Pipe	l.f.	$60.00	70	$4,200.00	
19	Storm: Catch Basin - 48" diameter	ea.	$3,000.00	1	$3,000.00	
20	Storm: Catch Basin - 24" diameter	ea.	$2,750.00	1	$2,750.00	
21	Storm: Catch Basin - 48" diameter Outlet Control Structure	ea.	$3,500.00	1	$3,500.00	
22	Bioretention	s.f.	$20.00	3,220	$64,400.00	complete; including excavation, haul, no stone base, engineered soil, filter fabric, leaf mulch, vegetative plugs @12" centers. Assumes 8" surface depression and 18" soil depth.
23	Line flushing, cleaning and testing	l.s.	$5,000.00	1	$5,000.00	
24	Site Lighting	l.s.	$150,000.00	1	$150,000.00	allowance
25						
26	**Site Utilities Total**				**$237,525.00**	
27						
28	**C. GENERAL SITE CONSTRUCTION**					
29	CIP Concrete Paving (Pedestrian)	s.f.	$16.00	5,900	$94,400.00	5" concrete over 6" CA6 gravel base.
30	Gravel Path (Dog run)	s.f.	$10.00	2,825	$28,250.00	3" kafka granite over 6" CA6 gravel base.
31	Ornamental Iron Fence - 48" height	l.f.	$130.00	745	$96,850.00	
32	Ornamental Iron Gate - 48" height	ea.	$3,500.00	5	$17,500.00	
33	Permeable Pavers	s.f.	$35.00	850	$29,750.00	6" CA7 gravel base with edge restraint.
34	Filter Fabric	s.f.	$2.00	850	$1,700.00	for pavers.
35	Steel Edging	l.f.	$10.00	305	$3,050.00	edge restraint around all gravel paving.
36	Asphalt Paving (vehicular restoration)	s.f.	$3.50	500	$1,750.00	street sewer connection repair
37						
38	**General Site Construction Total**				**$273,250.00**	
39						
40	**D. SITE AMENITIES**					
41						
42	Picnic Table	ea.	$3,000.00	4	$12,000.00	
43	Large Picnic Table	ea.	$3,500.00	1	$3,500.00	
44	Benches	ea.	$1,750.00	4	$7,000.00	
45	Play Area	l.s.	$30,000.00	1	$30,000.00	allowance
46	Shade Structure	l.s.	$90,000.00	1	$90,000.00	allowance
47	Landscape Boulders	ea.	$1,000.00	7	$7,000.00	
48	Trash Receptacles	ea.	$750.00	4	$3,000.00	
49	Bike Rack	ea.	$1,000.00	2	$2,000.00	
50	Interpretive Signage	ea.	$500.00	4	$2,000.00	
51						
52	**Site Amenities Total**				**$156,500.00**	
53						
54	**F. PLANTING**					
55	Deciduous Tree	ea.	$1,250.00	35	$43,750.00	3" caliper.
56	Ornamental Tree	ea.	$1,250.00	12	$15,000.00	8-10' tall.
57	Perennials	ea.	$12.00	8,300	$99,600.00	16,260 sf. @ 18" O.C. for traditional planting areas, not bioretention.
58	Turfgrass Sod	s.f.	$1.25	9,210	$11,512.50	
59	Deciduous Shrub	ea.	$50.00	100	$5,000.00	5 gal.
60	Leaf Mulch	c.y.	$90.00	100	$9,000.00	2" depth for all perennial planting areas.
61	Mulch	c.y.	$40.00	35	$1,400.00	Assume 0.66 CY per tree. Minimal shrub mulching.
62						
63	**Planting Total**				**$185,262.50**	
64						
65	**G. SUMMARY**					
66						
67	**A. Demolition and Site Prep Total**				$311,661.25	
68	**B. Site Utilities**				$237,525.00	
69	**C. General Site Construction**				$273,250.00	
70	**D. Site Amenities**				$156,500.00	
71	**E. Planting**				$185,262.50	$615,012.50
72	Basic Services Subtotal				$1,164,198.75	
73	25% Contingency				$291,049.69	
74	Bond, GC, insurance, contractor fees				$261,944.72	
75						
76						
77	**Total Estimated Construction Cost - Basic Services**				**$1,717,193.16**	
78						
79	Note: line items include materials, delivery, and installation including labor.					

Appendix D Life Cycle Cost Analysis

Stoney Island Stormwater Park Operation and Maintenance Activities and Costs - Pilot Project*

STORMWATER SYSTEM OPERATION AND MAINTENANCE PROGRAM RECOMMENDATION										
Asset	**Procedure**	**Recommended Frequency[1]**	**Times per year[2]**	**Hours per time[3]**	**Average annual O&M Hours[4]**	**Rate ($/hour)[5]**	**Equipment needed[6]**	**Material/ equipment cost[7]**	**Average annual cost[8]**	**Notes**
Bioretention, Native Landscape, and Landscape	Inspect for ponded water & asses cause Inspect for and remove obstructions at inlet and outlet structures Inspect for and remove accumulated trash	Approximately bi-weekly after significant rain event	12.00	1.00	12.0	$20	Trash bag	$1	$252	Time assumes generally no significant ponding but some trash removal each time.
	Remedial maintenance for clogging	As Needed	0.20	16.00	3.2	$20	Trash bags	$200	$104	Limit maintenance to areas of clogging. Rake surface to remove sediment that is clogging the soil. Replace plants as needed. Assumed frequency every five years.
	mowing	weekly	17.00	1.00	1	$20	mower	$2	$58	Central turf circle area outside bioretention. Material cost is for lawn mower gas or charging
	Spot herbicide	Annually- Spring-Summer-Fall before they go to seed	3.00	8.00	24.0	$20	trash bag, herbicide applicator	$10	$510	
	Tree Trimming entire property	As Needed	0.10	16.00	1.6	$150	cherry picker truck		$240	Assumes two person crew and equipment cost including in hourly rate
	Mulching	Annually - early spring	1.00	8.00	8.0	$20		$200	$360	Use leaf mulch
	Inspect underdrains for root obstruction	Every two years or as needed	0.50	4.00	2.0	$20	Cable camera		$40	Remove clean out cap and observe using cable style camera.
	Replanting all lansdcape areas	As Needed	0.10					$50,000	$5,000	Assumes entire area re-landscaped by landscape contractor but retaining trees
	Clean underdrains when obstructed by roots	As Needed	0.10	4.00	0.4	$40	Root cutter	$200	$36	Assumes specialized contractor cleaning every ten years
Chamber System	Inspect port for sediment accumulation	Annually	0.50	2.00	1	$20	Stadia rod & flashlight	$5	$23	open inspection port and measure with stadia rod
	Remove sediment when accumulation exceeds 3 inches	As Needed	0.10	12.00	1	$40	JetVac	$1,000	$148	Assumes specialized contractor cleaning every ten years
	Inspect outlet control structure	Approximately bi-weekly after significant rain event	12.00	1.00	12	$20	manhole pic		$240	After first year, inspection cycle could potentially be reduced based on experience
	Replace system at end of design life	every 50 years	0.02		0			$300,000	$6,000	Excavate and replace chambers, reuse gravel, replace surface materials

Stoney Island Stormwater Park Operation and Maintenance Activities and Costs - Pilot Project*

STORMWATER SYSTEM OPERATION AND MAINTENANCE PROGRAM RECOMMENDATION											
Asset	**Procedure**	**Recommended Frequency[1]**	**Times per year[2]**	**Hours per time[3]**	**Average annual O&M Hours[4]**	**Rate ($/hour)[5]**	**Equipment needed[6]**	**Material/ equipment cost[7]**	**Average annual cost[8]**	**Notes**
Permeable Paving	Routine sweeping	As Needed	2.00	1.00	2	$20	Stiff push broom		$40	sweep with push broom to remove leaf & other debris
	Weed removal - hand pulling and torch	Annually	1.00	4.00	4	$20	torch, gloves		$80	hand pull larger, easy to remove weeds. Torch harder to remove weeds and sweep soot
	Remedial maintenance for clogging	Every five years	0.20	8.00	2	$30	power washer, replacement gravel	$25	$53	evacuate top two centimeters of joint gravel using power washer or hand pick and replace joint gravel
	Replace system at end of design life	every 50 years	0.02					$8,500	$170	Remove and replace pavers and setting bed. Retain gravel storage in place.
Trench Drain	Inspect for sediment accumulation	Annually - Spring	1.00	1.00	1	$20	Yard stick		$20	Can be done at same time as stormwater basin inspections
	Remove sediment when accumulation exceeds 1 inch	As Needed	0.50	4.00	2	$40	vac truck		$180	Assumes specialized contractor other year
	Replace trench drain at end of design life	As Needed	0.02					$130,000	$2,600	Assumes specialized contractor other year
				Total Annual O&M	***77***			**Total Annual O&M Cost**	$16,154	

* Project designed to manage runoff from surrounding block
1 Recommended frequency per typical requirements. Actual frequency will vary based on site conditions
2 Times per year is the inverse of the frequency. Used to calculate annual O&M hours
3 Labor hours required to complete the task
4 Average annual O&M hours accounting for frequency of activity (product of times per year and hours per time)
5 Many activities could be completed using volunteer labor but labor rate assumes use of paid workers
6 Some activities require readily available equipment while others require special equipment
7 Cost to complete the work one time using outside service and/or cost of special equipment
8 Average annual cost (for labor and material/equipment cost accounting for frequency of activity

ECT

Stoney Island Stormwater Park Operation and Maintenance Activities and Costs - Baseline Project*

STORMWATER SYSTEM OPERATION AND MAINTENANCE PROGRAM RECOMMENDATION

Asset	Procedure	Recommended Frequency[1]	Times per year[2]	Hours per time[3]	Average annual O&M Hours[4]	Rate ($/hour)[5]	Equipment needed[6]	Material/ equipment cost[7]	Average annual cost[8]	Notes
Bioretention, Native Landscape, and Landscape	Inspect for ponded water & asses cause Inspect for and remove obstructions at inlet and outlet structures Inspect for and remove accumulated trash	Approximately bi-weekly after significant rain event	12.00	1.00	12.0	$20	Trash bag	$1	$252	Time assumes generally no significant ponding but some trash removal each time.
	Remedial maintenance for clogging	As Needed	0.20	8.00	1.6	$20	Trash bags	$200	$72	Limit maintenance to areas of clogging. Rake surface to remove sediment that is clogging the soil. Replace plants as needed. Assumed frequency every five years.
	mowing	weekly	17.00	1.00	1	$20	mower	$2	$58	Central turf area. Material cost is for lawn mower gas or charging
	Spot herbicide	Annually- Spring-Summer-Fall before they go to seed	3.00	4.00	12.0	$20	trash bag, herbicide applicator	$10	$270	
	Tree Trimming entire property	As Needed	0.10	16.00	1.6	$150	cherry picker truck		$240	Assumes two person crew and equipment cost including in hourly rate
	Mulching	Annually - early spring	1.00	8.00	8.0	$20		$200	$360	Use leaf mulch
	Inspect underdrains for root obstruction	Every two years or as needed	0.50	2.00	1.0	$20	Cable camera		$20	Remove clean out cap and observe using cable style camera.
	Replanting all lansdcape areas	As Needed	0.10					$50,000	$5,000	Assumes entire area re-landscaped by landscape contractor but retaining trees
	Clean underdrains when obstructed by roots	As Needed	0.10	2.00	0.2	$40	Root cutter	$200	$28	Assumes specialized contractor cleaning every ten years
Permeable Paving	Routine sweeping	As Needed	2.00	1.00	2	$20	Stiff push broom		$40	sweep with push broom to remove leaf & other debris
	Weed removal - hand pulling and torch	Annually	1.00	4.00	4	$20	torch, gloves		$80	hand pull larger, easy to remove weeds. Torch harder to remove weeds and sweep soot
	Remedial maintenance for clogging	Every five years	0.20	8.00	2	$30	power washer, replacement gravel	$25	$53	evacuate top two centimeters of joint gravel using power washer or hand pick and replace joint gravel
	Replace system at end of design life	every 50 years	0.02					$8,500	$170	Remove and replace pavers and setting bed. Retain gravel storage in place.
				Total Annual O&M	***45***			**Total Annual O&M Cost**	$6,643	

* Project designed to manage project site runoff only

[1] Recommended frequency per typical requirements. Actual frequency will vary based on site conditions

[2] Times per year is the inverse of the frequency. Used to calculate annual O&M hours

[3] Labor hours required to complete the task

[4] Average annual O&M hours accounting for frequency of activity (product of times per year and hours per time)

[5] Many activities could be completed using volunteer labor but labor rate assumes use of paid workers

[6] Some activities require readily available equipment while others require special equipment

[7] Cost to complete the work one time using outside service and/or cost of special equipment

[8] Average annual cost (for labor and material/equipment cost accounting for frequency of activity