Greening Camden:
Assessing Opportunities to Improve Communities Through Green Infrastructure

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THE TRUST FOR PUBLIC LAND

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i. Executive Summary

The management of urban stormwater is a major challenge for 21st century cities. Conventional in-line or end-of-pipe management approaches can be extremely costly and also difficult to plan, design, and manage given regulatory, environmental, and economic conditions, as well as space limitations in cities. Green Infrastructure (GI) is a decentralized and potentially cost-effective alternative management strategy that can reduce stormwater at its source, while simultaneously providing communities with a number of other valuable urban ecosystem services – direct and indirect benefits that people can derive from urban ecosystems. With a focus on Camden, NJ, this study demonstrates how strategically planned GI projects can transform the burden of stormwater management into an opportunity for urban revitalization.

The goal of this project was to develop a decision-support framework for planning GI systems that maximize urban ecosystem services. Though the focus here is Camden, NJ, the framework is designed to be portable and replicable for use in other communities with similar challenges. Development of the framework began with a literature review regarding key urban ecosystem services, and their determinants, followed by a sequence of stakeholder consultations. Next, a variety of local geospatial datasets were used to map spatially-explicit urban ecosystem service levels with a focus on urban agriculture expansion, CSO reduction, heat island reduction, flooding reduction, capacity building / green jobs expansion, fitness expansion, and stress reduction. This process consisted of identifying factors used to quantify each of these services and weighting them to produce a normalized value for each service for each drainage sub-basin within the city. Maps were developed identifying gap areas – places where certain services were lacking. Next, four case study sites were identified for conceptual design development. The selection of case study sites was informed by the ecosystem service gap scores, current land tenure, and a field investigation. Emphasis was placed on public properties (e.g., schools and parks), abandoned sites, and brownfield sites because of synergies with the interests of a key stakeholder, the Camden County Municipal Utilities Authority (CCMUA). Table ES-1 (Table 4-1 in the report) summarizes the names, locations, ecosystem service gap scores and selected GI strategy invoked at each of the four case study sites.

	Site Area (acre)	Site Address	Drainage Sub-Basin	ROW Contributing Area		Onsite Contributing Area		Ecosystem Service Gap Score							Opinion of Probable Cost
				Direct (SF)	Adjacent (SF)	Roof (SF)	Impervious Ground Surface (SF)	Combined	1st Ranked		2nd Ranked		3rd Ranked		
Alberta Woods Park	1	S. 30th St and Fremont Ave	C22-4	21,471	115,444	-	-	0.61	Urban Agriculture Expansion	0.77	Stress Reduction	0.72	Heat Island Reduction	0.69	$ 887,523
Charles Sumner Elementary School	3.2	1600 S. 8th St	C3-12	32,913	40,287	37,272	87,643	0.65	Stress Reduction	0.73	CSO Reduction	0.68	Fitness Expansion	0.67	$ 1,718,377
Vine and Willard Vacant Lots	0.6	Vine St & Willard St	C15	12,648	20,696	-	1,197	1	Capacity Building Expansion	1.00	Heat Island Reduction	0.93	CSO Reduction	0.85	$ 1,320,782
Former Camden Labs	3.8	1667 Davis St	Referencing C3-8	20,248	89,339	23,411	36,843	0.91	Stress Reduction	0.99	Urban Agriculture Expansion	0.88	Fitness Expansion	0.88	$ 3,845,257

TABLE ES-1: FOUR CONCEPTUAL SITES SUMMARY

Conceptual design development also considered how engaging the community in facility operation and maintenance (O&M) could help to minimize project life cycle costs. Specifically, the goal was to illustrate how strategic structuring of GI O&M activities could facilitate job creation and community engagement in local infrastructure and green space management activities.

The conceptual designs represent a starting-off point for a full-blown design process that would include additional feedback from community partners and key stakeholders, site surveying, and additional prioritization of ecosystem service gaps to fill at each site through the design. Because multifunctional GI designs are potentially eligible for various sources of funding, development of final designs would also consider site eligibility criteria for opportunities such as brownfield revitalization funds, Department of Transportation improvement funds and, of course, stormwater and CSO management obligations to improve water quality and reduce flooding.

It is believed that utilization of this framework will help cities like Camden to sustainably manage urban stormwater while also address a diverse, and locally relevant suite of other urban needs. Planning of multifunctional GI investment can help city planners to leverage their federally mandated urban stormwater management activities to promote sustainable urban redevelopment.

ii. Table of Contents

iii. List of Figures

iv. List of Tables

v. List of Acronyms

Camden SMART Initiative	Camden Stormwater Management and Resource Training Initiative
CCMUA	Camden County Municipal Utilities Authority
CRA	Camden Redevelopment Agency
CSO	Combined Sewer Overflows
DEM	Digital Elevation Model
GI	Green Infrastructure
GIS	Geographic Information System
LTCP	Long-Term Control Plans
NJDEP	New Jersey Department of Environmental Protection
ROW	Right-of-Way
SF	Square feet
TPL	The Trust for Public Land
USEPA	United States Environmental Protection Agency

1 Introduction

Twenty-first century cities face a wide range of challenges, including: climate change, aging infrastructure, reduced federal infrastructure financing, and ever more stringent environmental regulations. While these issues are challenging for planners everywhere, they are especially difficult in post-industrial cities struggling to meet the diverse needs of vulnerable populations while handicapped by eroded tax and infrastructure user bases. In such contexts, there is a need to maximize the suite of community benefits that can be engendered from every major infrastructure investment. That is, a new vision for urban services is required whereby infrastructure designed to comply with specific regulations is planned holistically considering the full range of needs facing the city. Of key interest are multifunctional infrastructure strategies that contribute to economic, environmental, and social bottom lines (Ahern 2011; Montalto et al 2012, USEPA 2016).

This report focuses on the opportunity presented by federally-mandated stormwater management requirements. The Clean Water Act of 1972 requires communities equipped with combined sewers to develop Long-Term Control Plans (LTCPs) to reduce the frequency and volume of combined sewer overflows (CSOs). CSOs occur when urban stormwater entering combined sewers exceeds the pipe conveyance capacity, triggering discharge of untreated combined wastewater and stormwater to local water bodies. There are roughly 750 municipalities nationwide (USEPA 2004) with combined sewers, including some of the largest cities in the Mid-Atlantic, Midwest and Northeast regions of the United States. In response to federal policy, urban stormwater managers have, over the past two decades, been investigating a wide range of strategies for controlling CSOs, including the use of in-line or end-of-pipe control strategies such as tanks and tunnels. Such centralized strategies may be effective at reducing CSO frequencies and volumes but can also be both expensive and difficult to site in urban areas where space is limited and land acquisition costs can be relatively high (Montalto et al 2007).

Many large cities like Philadelphia and New York are instead increasingly opting to comply with federal CSO control policy using a hybrid, decentralized approach (Mittman 2015). Known generally as Green Infrastructure (GI), this approach seeks to retain, detain, or reuse stormwater at its source. The USEPA (2016), which has been releasing policy documents on GI since 2007, defines GI as "a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits." GI systems may include green roofs, permeable pavements, right-of-way bioswales, constructed wetlands, backyard rain gardens, and a suite of other approaches integrated into the design of streets and parcels.

To significantly reduce CSOs, GI needs to be applied widely within urban watersheds. Not surprisingly, municipal GI programs routinely exceed one billion dollars and involve implementation periods spanning multiple decades. While centralized grey infrastructure solutions take many years to design and construct prior to any realized benefit, the decentralized nature of GI allows it to be implemented at a flexible pace according to municipal capacity, and start producing immediate tangible benefits. The distributed and phased nature of the GI programs creates new opportunities for adaptively re-imagining the design of streets, parks, buildings, and other urban land uses to address multiple sets of goals. In this way, the need to capture stormwater becomes an opportunity for also replenishing water tables, restoring habitats, beautifying streetscapes, creating opportunities for employment and recreation, raising property values, reducing urban temperature, cleaning the air, sequestering greenhouse gases, and enhancing biodiversity (USEPA 2013, Grant 2010, Dunn 2010, Schilling 2008).

One way of considering these varied benefits is as ecosystems services – direct and indirect benefits that humans derive from ecosystems. This term gained widespread use after publication of the Millennium Ecosystem Assessment (MEA 2005), but only recently has been applied in urban contexts (Miller 2015). Ecosystem services can be grouped into four general categories: provisioning services (such as food, water, and timber), regulating services (such as regulation of climate, floods, disease), cultural services (such as recreation, aesthetic enjoyment, spiritual fulfillment), and supporting services (such as soil formation, pollination, nutrient cycling). Strategically planned, sited, operated, and maintained, GI systems can provide many different services in each of these categories. By using the ecosystem services framework to guide GI planning, a comprehensive set of potential project benefits and tradeoffs can be considered by urban planners and stormwater managers.

Working with the New Jersey Department of Environmental Protection (NJDEP), the USEPA and the Environmental Infrastructure Trust funds, the Camden County Municipal Utilities Authority (CCMUA) is currently ahead of schedule in developing its CSO LTCP. As it develops the specifics of its plan, CCMUA has been partnering with academic institutions (Rutgers and Rowan Universities) and environmental nonprofits (e.g., The Nature Conservancy) to pilot GI projects throughout the cities of Camden and Gloucester. GI is an important component of NJDEP's LTCP requirements, and CCMUA is interested in GI retrofit strategies that can reduce CSOs while also addressing some of the other key needs of the City, especially as they pertain to economic development, enhanced quality of life, and social equity.

This study was commissioned with joint funding from CCMUA, Robert Wood Johnson Foundation, and The Trust for Public Land (TPL). The overarching project goal is to explore how GI projects can be strategically planned in Camden so as to both manage stormwater and enhance urban ecosystem services. The City of Camden, New Jersey, was chosen as a case study because it is served by combined sewers, is currently developing its CSO LTCP, and faces a sequence of other interrelated issues that can potentially be addressed through multifunctional GI projects. In 2016, it faces high rates of poverty, high unemployment, significant recent population loss, a large number of abandoned properties and brownfields, and a suite of other economic and environmental challenges. Through the Camden SMART (Stormwater Management and Resource Training) Initiative (a collaboration among the City of Camden, Cooper's Ferry Partnership, New Jersey Department of Environmental Protection, Rutgers Cooperative Extension Water Resources Program, CCMUA, and the New Jersey Tree Foundation), a sampling of GI projects have already been implemented throughout the city.

This project seeks to develop a framework to help the city move beyond the pilot phase of GI planning, devising key strategies for how a municipal GI program could be integrated into other strategies for sustainable urban redevelopment.

This framework focuses on seven key ecosystem services (urban agriculture expansion, CSO reduction, heat island reduction, flooding reduction, capacity building / green jobs expansion, fitness expansion, and stress reduction), all of which can potentially be addressed with GI in Camden. These particular services were selected after an extensive literature review and a sequence of key stakeholder consultations. To quantify baseline conditions, a variety of local geospatial datasets were used to develop spatially-explicit normalized rankings for each ecosystem service in each of the city's drainage sub-basins. Maps were developed identifying gap scores – a relative measure of certain services that were lacking. Four case study sites were then identified for conceptual design development. The selection of case study sites was informed by the ecosystem service gap scores, current land tenure, and a field investigation. Emphasis was placed on public properties (e.g., schools and parks), abandoned sites, and brownfield sites, because of synergies with the interests of CCMUA. The conceptual designs included basic plans and renderings, estimates of project benefits and costs, and ecosystem service flow diagrams. The intention is that these conceptual designs and the framework used to develop them will be of value in planning future GI retrofits not only in Camden, but also in other cities that seek to leverage this investment to promote sustainable and resilient forms of redevelopment.

2 Methodology

2.1 Overview of Methods

The goal of this project was to develop a decision-support framework to maximize ecosystem services through an innovative and comprehensive GI planning process. This framework, while specifically designed for Camden, can be adapted and utilized by urban communities in general to maximize community benefits obtained from GI systems.

The methodology followed in this analysis can be separated into four phases as shown in Figure 2-1. The first step is to determine a shortlist of target ecosystem services based on community needs, the potential applicability of GI, and the availability of necessary datasets. The second step is to utilize a Geographic Information System (GIS) to map service levels and gaps and to determine GI priority areas based on desired benefits. The third step is to prioritize individual sites based on stormwater management potential and site characteristics. Finally, the fourth step is to develop conceptual designs for further discussions with the local community. These four phases are further described in the subsections below.

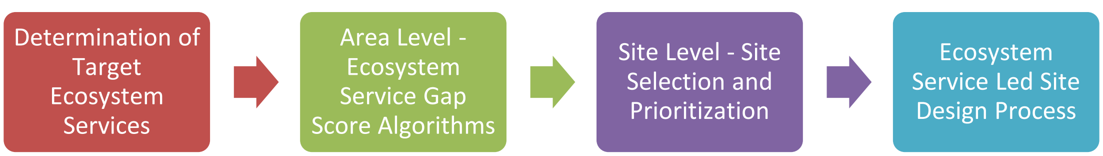


FIGURE 2-1: METHODOLOGY PHASES

2.2 Determination of Target Ecosystem Services

A literature review was conducted to identify the urban ecosystem services that could best be enhanced by the promotion of GI in Camden. Table 2-1 includes key studies referenced by the project team during the first phase of the work. For example, reduction of urban heat island effect, derived from the “moderation of extremes” ecosystem service identified by the Millennium Ecosystem Assessment, was considered in this analysis given the potential for tree cover and green spaces to reduce surface temperatures (McPherson et al. 1997). To the extent that they can be designed to provide shade, GI systems can potentially lower air conditioning needs (reducing greenhouse gas emissions) while also encouraging more residents to enjoy outdoor activities (a cultural service).

Simultaneously, meetings were conducted by TPL in consultation with CCMUA with governmental, non-governmental, and private stakeholders at the local, state, and federal levels to select specific datasets needed to quantify and spatially rank urban ecosystem service levels in Camden (Appendix A). The literature review, stakeholder engagement, and subsequent database development culminated in the following list of target urban ecosystem services for the study: urban agriculture expansion, CSO reduction, heat island reduction, flooding reduction, capacity building / green jobs expansion, fitness expansion, and stress reduction.

Category	Ecosystem Service (Description)	Ecosystem Service Factor	Factor Weighting	Key Data Sets	Notes
Provisioning	Urban Agriculture Expansion (Expansion of gardening and farming opportunities for food production)	Food Desert	0.5	Grocery Store Locations Community Garden Locations	In some geographical areas and in particular periods, however, food production from urban agriculture can play an important role for food security, especially during economic and political crises (Barthel 2013).
		Population Density	0.5	Population Density	
Regulating	CSO Reduction (Reduction of volume and frequency of CSO)	CSO Density	0.5	Average Annual CSO Volume	
		Impervious Cover Density	0.25	Impervious Area Coverage	
		Population Density	0.25	Population Density	
	Flooding Reduction (Reduction of localized flooding due to improper surface drainage)	Flood Location Density	0.4	Flooding Locations	
		Mean Elevation	0.2	NJDEP - DEM	
		Impervious Cover Density	0.2	Impervious Area Coverage	
		Population Density	0.2	Population Density	
	Heat Island Reduction (Reduction of local ground surface temperatures)	Tree Cover Density	0.25	Tree Canopy Cover	Urban forests can mitigate urban heat island effects and conserve cooling energy by shading buildings and other heat-absorbing surfaces, as well as lowering summer air temperatures through evapotranspirational (ET) cooling (Meier 1991).
		Heat-Vulnerable Population Density	0.25	Heat-Vulnerable Population Density (<5, >65)	
		Impervious Cover Density	0.25	Impervious Area Coverage	
		Population Density	0.25	Population Density	

TABLE 2-1A: ECOSYSTEM SERVICES TABLE (1 OF 2)

Category	Ecosystem Service (Description)	Ecosystem Service Factor	Factor Weighting	Key Data Sets	Notes
Cultural	Capacity Building and Green Job Expansion (Expansion of education, professional development, and employment opportunities)	Capacity Building Opportunities	0.5	Environmental Community Organization Locations	Exposure to nature and green space provide multiple opportunities for cognitive development which increases the potential for stewardship of the environment and for a stronger recognition of ecosystem services (Krasny 2009; Tidball 2010).
				Public Elementary and Secondary School Locations	
		Median Household Income	0.25	Median Household Income	
		Unemployment Rate	0.25	Unemployment Rate	
	Fitness Opportunity Expansion (Expansion of access to outdoor destinations for fitness)	Outdoor Destination Density	0.5	Public Park Locations	Moreover, (Mitchell, 2007) found that populations of individuals below retirement age with greater exposure to green space had lower rates of mortality in general and a lower rate of mortality specifically from circulatory diseases. The body mass index of children showed an inverse relationship to exposure to green space (Bell et al 2008).
				Community Garden Locations	
		Median Household Income	0.25	Population Density	
		Population Density	0.25	Median Household Income	
	Stress Reduction (Expansion of access to stress reduction features)	Stress Reduction Services Density	0.5	Mental Health Service Centers	This study showed that when subjects of the experiment were exposed to natural environments the level of stress decreased rapidly, whereas during exposure to the urban environment the stress levels remained high or even increased. (Ulrich et al 1991). Another study on recovery of patients in a hospital showed that patients with rooms facing a park had 10% faster recovery and needed 50% less strong pain-relieving medication compared to patients in rooms facing a building wall (Ulrich 1984). The presence of trees can reduce crime rates in public-housing complexes (Kuo 2001, Troy et al 2012).
				Public Park Locations	
				Community Garden Locations	
		Median Household Income	0.167	Median Household Income	
		Unemployment Rate	0.167	Unemployment Rate	
		Population Density	0.167	Population Density	

TABLE 2-1B: ECOSYSTEM SERVICES TABLE (2 OF 2)

2.3 Area Level - Ecosystem Service Gap Score Algorithms

Next, algorithms were developed to quantify ecosystem service levels for drainage area sub-basins within the city. Drainage area sub-basins, and not neighborhood boundaries, zip codes, land uses, or other geographic units, were selected as the base modeling unit to synchronize this project with CCMUA's LTCP development process. Drainage sub-basins are geographic areas that are tributary to specific CSO outfall locations, and thus make for convenient stormwater capture target setting. As part of its LTCP planning process, CCMUA must quantify stormwater volumes and water quality impacts (i.e., CSO volume and/or frequency reductions), and modeling activities are typically implemented at the sub-basin level. Also, the median sub-basin size in Camden, approximately 50 acres, is an appropriate scale within which to approach GI planning.

The algorithms used to derive the scores for each of the seven target ecosystem services were developed by mathematically combining different spatially-differentiated variables. A value for each of these variables was developed for each sub-basin area as a normalized value from 0-1, where 1 represents the highest priority, and 0 represents the lowest. Informed by the stakeholder engagement process, weights were also assigned based on the anticipated impact of each variable to each service. The summation of the weighted factors equals the service gap score (equations shown below).

$$\mathrm{SG_i} = (\mathrm{W_1} * \mathrm{V_1}) + (\mathrm{W_2} * \mathrm{V_2}) + \cdots (\mathrm{W}_n * \mathrm{V}_n)$$

SG = raw service gap score

W = weight value

V = variable value

$$\mathrm{SGN_i} = \frac{\mathrm{SG_i} - \mathrm{SG_{min}}}{\mathrm{SG_{max}} - \mathrm{SG_{min}}}$$

SGN = service gap score normalized

Urban agriculture expansion is used as an example to illustrate how the algorithms work. The service gap score for this service considers population density within the sub-basin and its "food desert" density, defined as the relative prevalence of grocery stores and community gardens. Sub-basins with high population density and high food desert density (e.g. fewer grocery stores and community gardens) relative to their respective means for the city, were awarded the lowest ecosystem service levels. Regions with the lowest ecosystem service levels had the highest ecosystem service gap score for this service. GI systems conceived for areas with a high urban agriculture gap score would ideally be designed to include some kind of local food production capacity, for example, by including above ground planters, orchards or other such features.

Table 2-1 and Table 2-2 summarize all of the variables considered in the algorithms used to develop the gap scores for each of the seven ecosystem services. The complete algorithms are included in Appendix B.

After gap scores were developed for each of the seven target ecosystem services within each sub-basin, a composite score was developed. Though various weighting schemes could be used for combining the individual ecosystem service gap scores, for demonstration purposes an arithmetic average was utilized in this analysis. This composite gap score was then used to rank the sub-basins in order of highest composite service gap score to the lowest, allowing different drainage sub-basins to be compared to one another using a common metric. The composite ranks were considered, along with other site assessment factors, in the subsequent Site Level - Site Selection and Prioritization section.

2.4 Site Level - Site Selection and Prioritization

The composite service gap scores were used to prioritize specific drainage sub-basins for GI implementation. Sub-basins with the highest composite gap-scores were assigned the highest priority. Next, a total of 18 schoolyards, parks, vacant lands, and brownfields were identified within the highest priority sub basins, as enumerated in Figure 2-2.

GREENING CAMDEN - Demonstration site selection

Healthy Communities Feasibility Study

= (today)

						STORM WATER MANAGEMENT							SITE ASSESSMENT RATING 4-excellent, 3-good, 2-moderate, 1- poor/none													Qualitative Community Assessment					
								SWM Rating					Condition Rating				Circ. Rating			Loc. Rating											
Candidate Site #	Candidate Site Type	Candidate Site Name Location	Combined Ecosystem Service SCORE (average score of range for parcel)	Site Size (acres)	Choice Neighborhoods	Onsite Potential Imp. DA (Acres)	ROW Potential Imp. DA (Acres)	Surface condition	Shallow Grade change	Shape of site	Number of low points	Condition of existing SMS	Fencing condition	Condition of amenities	Existing tree root conflicts	Existing lighting	Parking conflicts	Pedestrian Circulation to site / ADA	Vehicle Circulation to site	Eyes on Site	Proximity of positive use	Surrounded by Dense Residential	SITE ASSESSMENT SCORE	Known Regulated Site**	Quantative SCOPE (CESS X SAS)	School Popluation Information. Community based improvements? (garden, murals, courts, etc) Group leading these efforts.	Potential for longterm stewardship	Support for Community Engagement	Prevelance of chronic negative use	Comments, observations and notes	TPL Recommendation Green-Go, Yellow-Slow, Red-Stop
1	School	**Henry L. Bonsall Family School** 1575 Mt Ephraim Ave	0.9	0.8	Yes - Liberty Park			2	3	3			3	1	4	1				4	4	4				703 students, PK-8, 72% AA				Park behind homes, Entrance on Benson Ave	
2		**Yorkship Family School** 1251 Collings Avenue	0.7	1.0	No			2	4	3			3	1	4	4				3	4	3				567 students, PK-7, 98% Hispanic and AA				Camden SMART some GI work. School was good to work with. Teachers interested in rain garden with an outdoor reading area.	
3	Park	**Whitman Square** Sayrs Ave & Davis St.	0.9	1.7	Yes - Whitman Park			2	4	4			NA	4	3	1				4	4	4								Mayor recently worked with Kaboom to install play structure in the park.	
4		**Mickle & Eutaw Park** 205 N Grand Street	0.7	1.0	No			1	4	1			2	2	3	1				1		4								The park is behind a series of row houses, not on a direct circulation route.	
5	Park	**Alberta Woods Park**	0.7	1.0	No			2	4	4			4	2	3	1				4	4	3								Has potential	
6	Sch	**Francis X McGraw Elem. School** 3051 Fremont Ave	0.7	0.5	No			2	4	2			3	1	2	4				3	4	3				342 students, PK-5, 100% hispanic and AA				Soccer for Success. School Site -only painted asphalt area.	
7	Park	**Northgate Park**	0.7		No			2	2	3			4	3	2	4				4	4	3								Nice little park, needs upkeep but not in dire need of repairs. Soccer for Success.	
8	Sch	**Rafael Cordero Mollina Elem. School** 601 Vine St	0.7	3.1	No			4	4	4			3	4	3					4	4	3				512 students, PK-6, 66% Hispanic				Soccer for Success. Operated by Mastery.	
9	Park	**Judge Robert B. Johnson Park**	0.1	12.4	Yes - Whitman Park			3	3	4			4	4	3	4				3	4	3								Soccer for Success.	
10	Sch	**Sumner Elem. School** 1600 S 8th St, Camden	0.7	1.0	Yes - Whitman Park			2	3	4			3	1	4	4				2	4	2				427 students, PK-8, 100% Hipsanic and AA					
11	Park	**Veterans Park**	0.1	2.2	No			2	2	4			NA	4		4				3	4	3									
12	Sch	**Veterans Memorial Family School** 800 N 26th St	0.3	2.0	No			2	2	2			NA	1		4				2	4	3				518 students, PK-8, 100% American Indian and Asian				Soccer for Success	
13	Park	**Whitman Park**	0.3	6.3	Yes - Whitman Park			3	2	4			4	4	4	4				2	3	3								Approx to Cemetary	
14	Sch	**Brimm Medical Arts HS** 1667 Davis St	0.3	1.5	Yes - Whitman Park			2	4	2			NA	1	4	4				1	3	2								Approx to Cemetary	
15	Vac	**Camden Labs**	0.3	3.7	Yes - Whitman Park			1	3	4			2	1	4	1				2	3	2		yes		210 students, 9-12, 48% graduation rate, 71% AA				Privately held site. Approx to Cemetary	
16	Vacant	**Vacant Land at E. State St. and River Ave.**	0.7	3.9	No			2	4	4			NA	1		1				4		3		yes						Mastery Charter to build a Renaissance School on the site. Site still needs to be remediated.	
17		**Vacant Land at Vine and Willard**	0.9	0.4	No			3	4	2			NA	1	4	1				2		3								0.4 acres Owned by city, potential to expand. One block from from Cooper River. Potential future link to bike/ped trails	
18		**Vacant Land at 16th and Wayne Ave**	0.7	0.8	No			1	4	4			NA	1		1				2		3		yes						Steed Scrap Metal and Paper, across from River and State site.	

NOTES:

** Known regulated site - basis of what is known at the time of this study, hazardous conditions may exist.

Resources: Combined Ecosystem Service Score map by TPL, Google Earth, publicscoolreview.com, Site Assessment

TABLE 2-2: SITE ASSESSMENT MATRIX

Further refinement of the 18 sites was performed through field investigations conducted by the project team. These field investigations focused both on the specific ecosystem service opportunities and the "park development impact," a metric used by TPL to assess GI potential in other jurisdictions. During this process, the following factors were qualitatively assessed and compared:

- Potential community impact. By determining the number of people who live within a ten-minute walk of the site, and reviewing patterns of pedestrian and vehicular circulation, sites with the potential to affect the greatest number of people were identified.
- Potential volume of stormwater managed. The field investigation focused on sites that could manage the largest volumes of stormwater based on topography, infrastructure, and other factors.
- Potential for site improvements. Sites with the greatest need for physical improvement were ranked higher than those that were already in reasonable physical condition.
- Potential for 'eyes-on-the-site.' à la Jane Jacobs, sites that were most visible and therefore most likely to be safe and secure were prioritized in the site selection process.
- Qualitative review of social conditions on and around the site. Sites that provided greater opportunities for partnership were favored over those offering fewer possible synergies.

The matrix provided in Figure 2-2 documents the results of the ecosystem service impact and park development impact activities. Green sites were deemed the best candidates, followed by yellow, with red sites the least favorable, as outlined in Section 3.2. The top four sites were selected for conceptual design development.

2.5 Ecosystem Service Driven Conceptual Design Process

The conceptual design process involved first quantifying the volume of stormwater generated on directly connected and adjacent impervious surfaces. Directly connected surfaces are defined as impervious spaces already graded towards the site; stormwater from adjacent surfaces, by contrast, could theoretically be conveyed to the site using trench drains, pipes, or other hydraulic appurtenances, even if the surfaces themselves were not graded towards the future GI site. The second step of the conceptual design process was to identify the potential site features that could help to address the top three ecosystem service gap scores of the respective sub-basin. Multiple features were incorporated into each site so as to demonstrate the range of options that could be considered in a future participatory process focused on developing final designs. Concept drawings, renderings, estimated initial and recurring costs and benefits, as well as ecosystem service diagrams were produced for each of the four demonstration sites, as is described below.

3 Results

3.1 Area Level - Ecosystem Service Gap Score Model Results

The composite service gap scores (with equal weighting of the services) are presented in Figure 3-1 and can be utilized as a general indicator of the portions of the city that could benefit most from multifunctional GI projects. The individual gap scores are presented (with equal interval categories, 0-0.20, 0.21-0.40, 0.41-0.60, 0.61-0.80, and 0.81-1.00) in Figure 3-2 to Figure 3-8 for the seven individual ecosystem services. All of the scores can also be accessed in digital form through TPL's GI Opportunity Mapping GIS Viewer (access information included in References).

Visible differences in individual ecosystem service gap scores across the city's sub-basins suggest that the model algorithms successfully identified gradients in conditions. The ecosystem service gap scores were normalized and thus represent a relative ranking of ecosystem service needs. Lower scoring sub-basins are not necessarily without need, but rather are less in need of a particular service than other portions of the city. By contrast, the highest ranked sub-basins are estimated to benefit most from GI designed to maximize specific services.

Table 3-1 displays the individual service gap scores for the top 16 ranked sub-basins (20th percentile, combined score). The table shows that the highest ranked services vary for each basin. In the conceptual design process, the composite scores were utilized in site selection, while the top three individual gap scores were used to guide development of the key site design features.

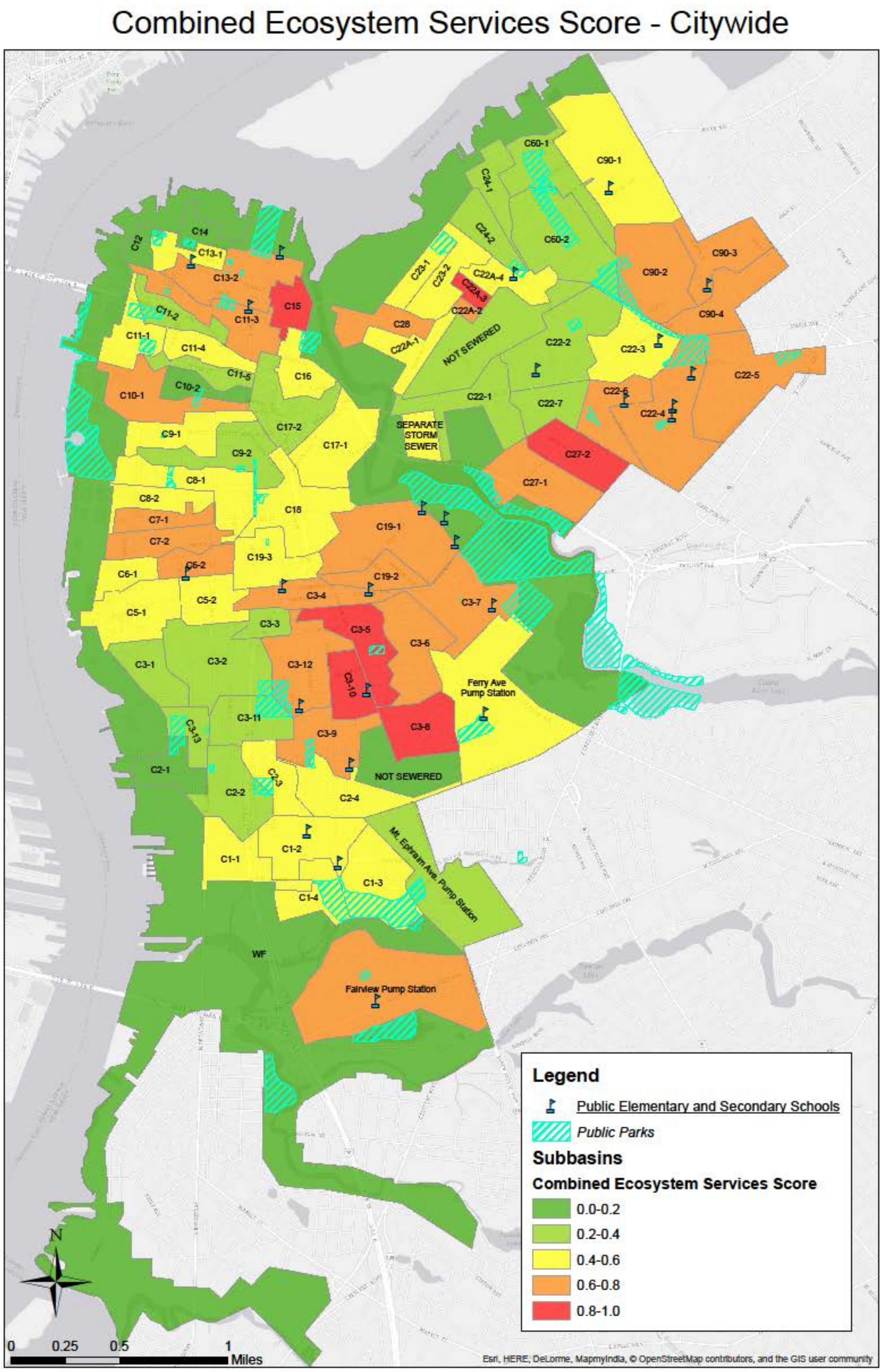


FIGURE 3-1: COMBINED ECOSYSTEM SERVICE GAP SCORE MAP

		Service Gap Score							
Sewer Sub-Basin ID	Sewershed Area (ACRE)	Combined	Urban Agriculture Expansion	CSO Reduction	Heat Island Reduction	Flooding Reduction	Capacity Building / Green Jobs Expansion	Fitness Expansion	Stress Reduction
C15	25	1.00	0.67	0.85	0.93	0.49	1.00	0.79	0.84
C3-8	53	0.92	0.89	0.86	0.66	0.38	0.60	0.88	0.99
C27-2	51	0.90	1.00	0.83	0.75	0.54	0.28	0.89	0.92
C3-10	35	0.82	0.56	0.93	0.85	0.41	0.71	0.76	0.69
C22A-3	10	0.81	0.77	1.00	0.94	0.48	0.24	0.73	0.71
C3-5	57	0.80	0.58	0.89	0.77	0.39	0.61	0.81	0.79
C6-2	28	0.80	0.43	0.76	0.70	0.36	0.76	0.83	0.98
C90-3	53	0.80	0.67	0.82	0.60	0.37	0.53	0.85	0.98
C13-2	70	0.79	0.63	0.59	0.90	0.48	0.82	0.63	0.72
C3-6	71	0.78	0.69	0.81	0.68	0.39	0.51	0.82	0.87
C11-3	57	0.77	0.62	0.46	0.82	0.48	0.73	0.79	0.82
C90-4	58	0.77	0.58	0.93	0.73	0.37	0.61	0.70	0.80
C3-9	57	0.77	0.53	0.56	0.60	0.43	0.97	0.76	0.83
C10-1	60	0.76	0.93	0.60	0.81	0.66	0.60	0.69	0.39
C22A-2	5	0.74	0.00	0.97	0.89	0.44	0.31	1.00	1.00
C22-6	48	0.73	0.56	0.65	0.83	0.43	0.70	0.71	0.68

TABLE 3-1: TOP 20TH PERCENTILE SUB-BASINS FOR COMBINED SERVICE GAP SCORE

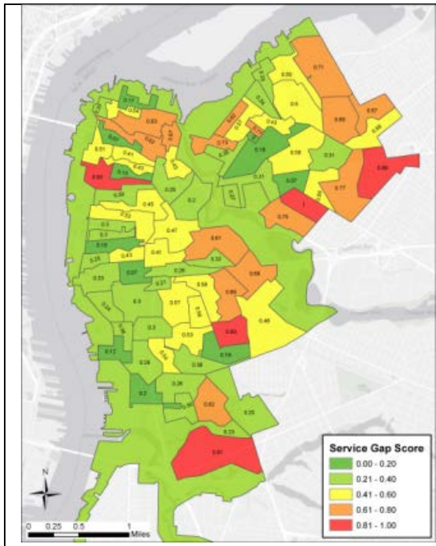


FIGURE 3-2: URBAN AGRICULTURE EXPANSION SERVICE GAP SCORE

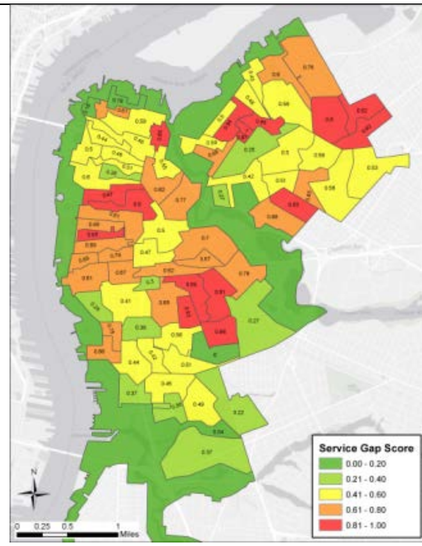


FIGURE 3-3: CSO REDUCTION SERVICE GAP SCORE

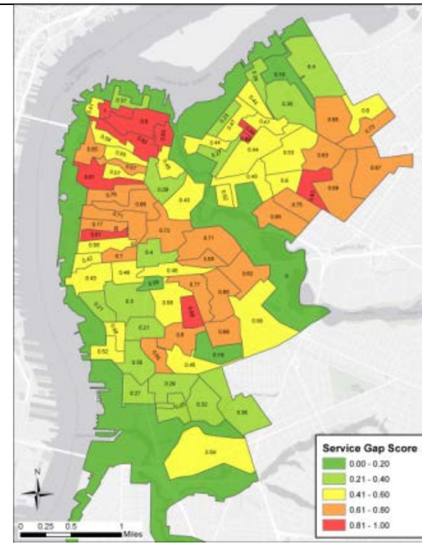


FIGURE 3-4: HEAT ISLAND REDUCTION SERVICE GAP SCORE

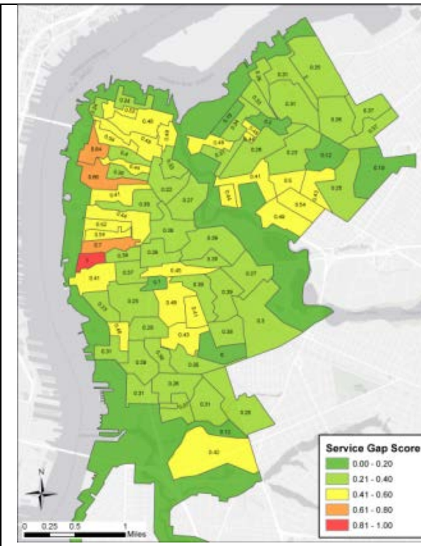


FIGURE 3-5: FLOODING REDUCTION SERVICE GAP SCORE

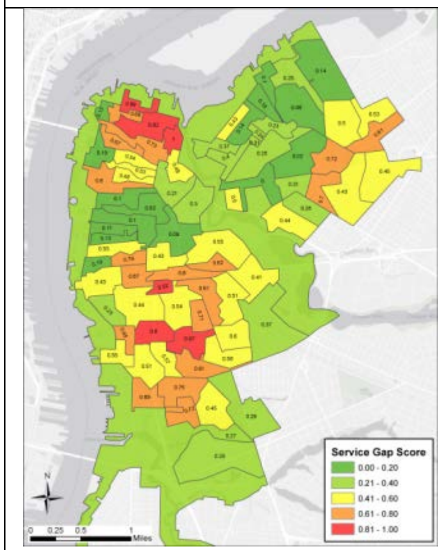


FIGURE 3-6: CAPACITY BUILDING / GREEN JOBS EXPANSION SERVICE GAP SCORE

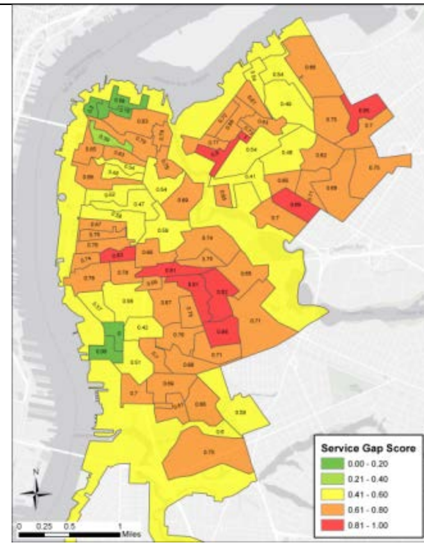


FIGURE 3-7: FITNESS EXPANSION SERVICE GAP SCORE

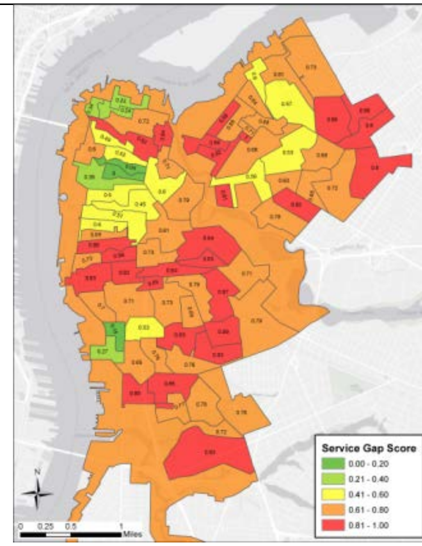


FIGURE 3-8: STRESS REDUCTION SERVICE GAP SCORE

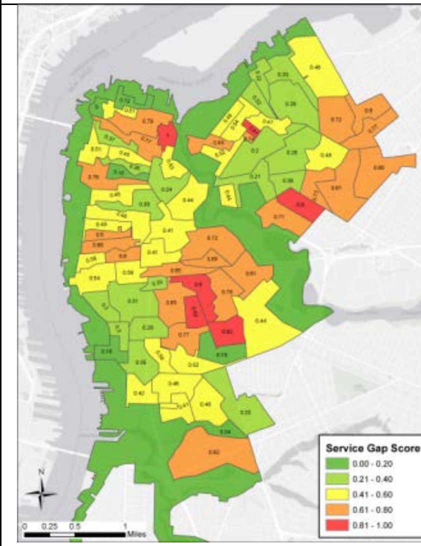


FIGURE 3-9: COMBINED SERVICE GAP SCORE

3.2 Site Level - Site Selection and Prioritization Results

The composite gap scores and site selection matrix directly informed the choice of sites in each of four site typologies: Parks, schools, vacant lots, and brownfield sites. These are described individually below.

The highest ranked park site was Alberta Woods Park. This site emerged as an exemplary candidate site because of its high visibility and potential ability to manage ROW stormwater within the boundaries of the park. The park is in a densely populated residential area and is adjacent to a well-traveled vehicular route. In addition, the site can be easily accessed by students at the Francis X McGraw Elementary School. The conceptual designs developed for Alberta Woods Park would thus provide a positive example of stormwater management for direct public benefit within an existing park.

The highest ranked schoolyard site was Sumner Elementary School. The site emerged as an exemplary candidate site principally because of its vast impervious surface area, but also because of its potential for increasing recreational opportunities for local students. This school is located within the Whitman Park Choice Neighborhood boundary, making it also potentially eligible for grant funding. The schoolyard currently includes no physical amenities for the children who attend classes. Sumner Elementary was thus selected as an opportunity to demonstrate how stormwater management could be integrated into schoolyard redevelopment.

The highest ranked vacant site was a series of interconnected lots located at the intersection of Vine and Willard in North Camden. These lots could be combined to create a new park that would manage both on-site and ROW stormwater. In addition, this site is located in a park-poor area of Camden with a high number of residents who live within a ten-minute walk, and is adjacent to religious buildings. There are no known zoning or other regulatory conditions that restrict the type of redevelopment possible at this site. A complete Environmental Assessment would, however, be recommended prior to start of work on any site. This collection of lots was selected to demonstrate how vacant land could be transformed into a multifunctional stormwater park with multiple community benefits.

The brownfield site selected for conceptual design development was Camden Labs. While this was not the highest ranked site, there is great potential to integrate GI systems into the proposed redevelopment to be undertaken by the Camden Redevelopment Authority (CRA) and other stakeholders. The site provides a unique opportunity to integrate stormwater management into sustainable housing design, urban homesteading, and a complete sustainable site development as documented in the proposed site development concept and rendering.

4 Discussion

4.1 Area Level - Ecosystem Service Gap Score Model Results

The composite ecosystem service gap score utilized in this analysis assumed equal weighting of the constituent services. Before presenting the resultant conceptual designs, we note that in future analyses the weighting scheme could be informed directly from an ongoing stakeholder engagement processes. It is anticipated that at the outset of this kind of process the different stakeholder groups may have different priorities for each of the services. Dialogue about the ecosystem services could be used to elucidate where stakeholders already agree and where, by contrast, additional debate and fact gathering is necessary to build consensus about neighborhood needs. Such a process is important for GI priority setting, but is also more generally valuable in community goal setting.

A generic example is provided to demonstrate how the ecosystem service weights could be adjusted reflecting this kind of deliberative process. In a particular jurisdiction, the consultants engaged in the LTCP planning process may be principally focused on the regulatory mandates associated with CSO reduction and/or the public nuisance associated with flooding, and be less aware of other community needs that could potentially be addressed by GI. During a meeting with stakeholders the Executive Directors of a local senior center would find the opportunity to articulate the difficulty that the elderly feel waiting for buses in the hot sun, and an individual representing the local planning board could inform the group of a new permit issued to a food industry franchise to open a new supermarket. The resulting deliberation might result in an across-the-board increase in the weight assigned to the heat island service provided by GI, and a localized reduction to the weight given to urban agriculture in the region immediately surrounding the new supermarket. These changes would result in different spatial priorities for GI, and different constituent services guiding their design. In this way, local knowledge and preferences are incorporated directly into the GI planning process, while the deliberation also promotes education, and creates new partnerships between the community and local governmental decision-makers. It could also be instrumental in fostering community support for the GI assets that result from local LTCP planning process.

4.2 Four Demonstration Sites

The four demonstration sites resulting from the present analysis are summarized in Table 4-1 and described below. A conceptual design drawing and a rendering are included for each site, along with an estimate of probable costs (Appendix C). The designs presented are based on the ecosystem service gaps identified in this analysis (e.g. assuming equal weighting of constituent services), and thus represent only one vision of how these sites could be redesigned for multifunctionality. A more elaborate attempt to elicit community and partner preferences, as described in Section 4.1, would be necessary before the finalization of any designs. Operations and maintenance needs, along with potential revenue sources, are presented in the Operations, Maintenance, and Site Benefits section.

				ROW Contributing Area		Onsite Contributing Area		Ecosystem Service Gap Score							
	Site Area (acre)	Site Address	Drainage Sub-Basin	Direct (SF)	Adjacent (SF)	Roof (SF)	Impervious Ground Surface (SF)	Combined	1st Ranked		2nd Ranked		3rd Ranked		Opinion of Probable Cost
Alberta Woods Park	1	S. 30th St and Fremont Ave	C22-4	21,471	115,444	-	-	0.61	Urban Agriculture Expansion	0.77	Stress Reduction	0.72	Heat Island Reduction	0.69	$ 887,523
Charles Sumner Elementary School	3.2	1600 S. 8th St	C3-12	32,913	40,287	37,272	87,643	0.65	Stress Reduction	0.73	CSO Reduction	0.68	Fitness Expansion	0.67	$ 1,718,377
Vine and Willard Vacant Lots	0.6	Vine St & Willard St	C15	12,648	20,696	-	1,197	1	Capacity Building Expansion	1.00	Heat Island Reduction	0.93	CSO Reduction	0.85	$ 1,320,782
Former Camden Labs	3.8	1667 Davis St	Referencing C3-8	20,248	89,339	23,411	36,843	0.91	Stress Reduction	0.99	Urban Agriculture Expansion	0.88	Fitness Expansion	0.88	$ 3,845,257

TABLE 4-1: FOUR CONCEPTUAL SITES SUMMARY

4.2.1 Alberta Woods Park – The Community's Backyard

S. 30th St and Fremont Ave

Alberta Woods Park is a one-acre park owned by the City of Camden Department of Planning and Development Bureau of Parks and Open Spaces. It is located in a residential neighborhood and is adjacent to McGraw Elementary School and East Camden Middle School. The park features a playground, picnic tables, and considerable tree canopy, but mostly consists of degraded open lawn space. The local community utilizes the park for recreation, but the site presents an opportunity to expand programming and to improve overall upkeep.

The park is located at a topographic low point, allowing for the conveyance of stormwater to the park from multiple ROW areas. There is no existing impervious surface onsite, but direct and adjacent ROW contributions total 21,471 and 115,444 square feet (SF) respectively (Figure 4-1). While existing tree canopy along the park edges may restrict excavation areas for onsite infiltration, the abundance of open space within the park allows for future GI placement.

The demonstration concept plan for Alberta Woods Park (Figure 4-2) presents a number of features informed by the top three ecosystem services for the overlying sub-basin (urban agriculture expansion, stress reduction, and heat island reduction). A fruit orchard was included in the middle of the park for food production, and additional fruit trees can be considered in the ROW strips leading to the park. Above ground planters were also included in the stormwater bumpouts for community gardening. Though these urban agriculture features do not directly utilize stormwater runoff, it is possible that the increased infiltration of stormwater will allow for use of on-site groundwater for irrigation purposes in the future. Multiple recreation features were incorporated into the park design to provide stress reduction services including: A walking path, multiple native plant areas, barbecue grills, and an outdoor reading room with concrete benches. Additionally, fruit tree revenue may provide a path towards green jobs opportunities that may be available to assist with the economic components of stress reduction. A market feasibility study investigating the potential revenue from fruit tree production and associated costs would be necessary to assess the viability of green job opportunities generated from the site. However, the intent is not necessarily for revenue to outweigh costs, but to demonstrate the ability of urban green spaces to produce community benefits in unique ways; in this case through education on local agriculture opportunities. Finally, expanded ROW strips leading to the park were included to increase shading within the surrounding neighborhood to aid in reducing the local heat island effect.

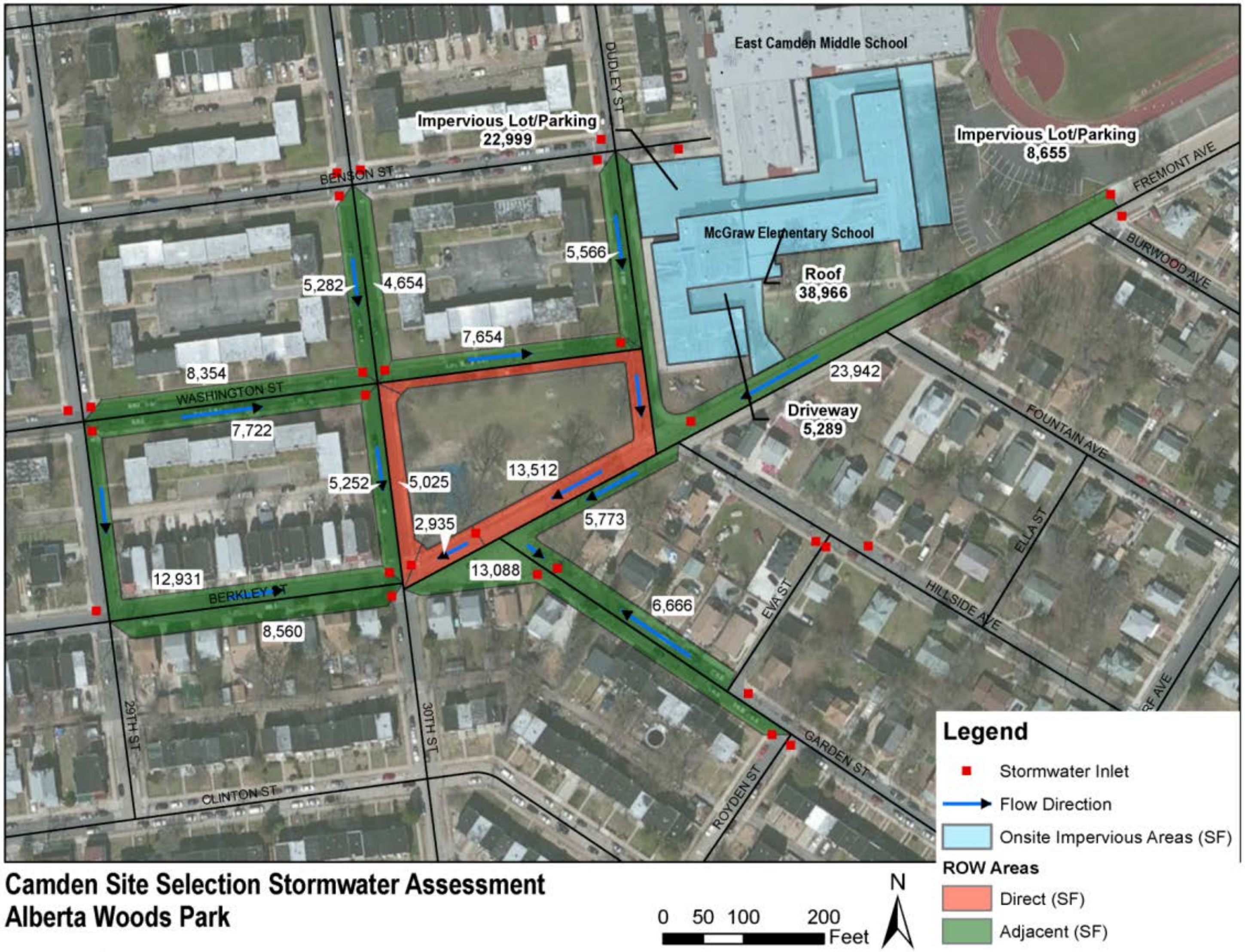


FIGURE 4-1: ALBERTA WOODS PARK - STORMWATER ASSESSMENT

TOP ECOSYSTEM SERVICES	SERVICE GAP SCORE	APPROACH
(1) URBAN AGRICULTURE EXPANSION	0.77	ORCHARDS FOR FRUIT PRODUCTION AND ABOVE GROUND PLANTERS FOR VEGETABLE PRODUCTION
(2) STRESS REDUCTION	0.72	RECREATION AREAS (CHESS TABLES, BBQS, READING ROOM), SEATING AREAS, PLANTED AREAS
(3) HEAT ISLAND REDUCTION	0.69	EXPANDED VEGETATED RIGHT-OF-WAY AREAS, TREES FOR INCREASED SHADING

FIGURE 4-2: ALBERTA WOODS PARK - CONCEPT PLAN

FIGURE 4-3: ALBERTA WOODS PARK - RENDERING, THINKGREEN LLC

4.2.2 Charles Sumner Elementary School – Learning Lab and Marketplace

1600 S. 8th St

Charles Sumner Elementary School is a 3.2-acre public school owned by the Camden City School district. In 2015, the school enrolled roughly 450 students from pre-kindergarten to 8th grade. The school has one playground in the southwest corner of the property, but most of the schoolyard consists of degraded asphalt without any playground features. The existing site can be improved by adding a playground and other recreation features to the schoolyard for use by the students while school is in session, and by children in the neighborhood at other times.

More than half of the site's stormwater management potential is from the onsite impervious areas, both in roof areas (37,272 SF) and ground surfaces (87,643 SF) such as parking lots, sidewalks and play areas. Stormwater from the ROW generally flows in the northwest direction, generating a ROW direct area of 32,913 SF and a ROW adjacent area of 40,287 SF (Figure 4-3). In general, the expansive impervious schoolyard and parking lot, as well as considerable sidewalk width, allow for a number of potential GI options.

The demonstration concept plan for Charles Sumner Elementary School (Figure 4-5) proposes GI features both within the school property and in the adjacent ROW, all of which are informed by the top three ecosystem services (stress reduction, CSO reduction, and fitness opportunity expansion). The proposed garden spaces and tree pits promote overall greening of the site and can reduce stress levels of students and community members through exposure to more vegetated spaces. Benches outside the school were included to provide resting locations for parents waiting to pick up their children and increase access to shaded rest areas. To assist with economic stress reduction, a publically accessible weekend open-air market in the eastern parking lot of the school was proposed to provide retail opportunities for local community members and potential revenue for the school through fees. Flower garden areas were proposed within the schoolyard to provide opportunities for students to grow flowers to be sold at the market while learning gardening and business skills such as accounting and marketing.

Similar to the orchard proposed in the Alberta Woods site, a feasibility study would be necessary to assess the viability of generating revenue from flower gardens, with the understanding that the primary purpose for growing flowers is educational. Stormwater from direct and adjacent ROW areas can be managed through stormwater tree pits and bumpouts, thus reducing the potential for CSOs. Onsite stormwater can be managed through rain gardens and flower garden irrigation as well as through a multi-purpose turf field that infiltrates stormwater while providing a play surface for fitness expansion. Other fitness opportunities include playground pumps that double as environmental education learning labs. Overall, the proposed features within the schoolyard are dual purpose: improving recreation and education opportunities while managing stormwater.

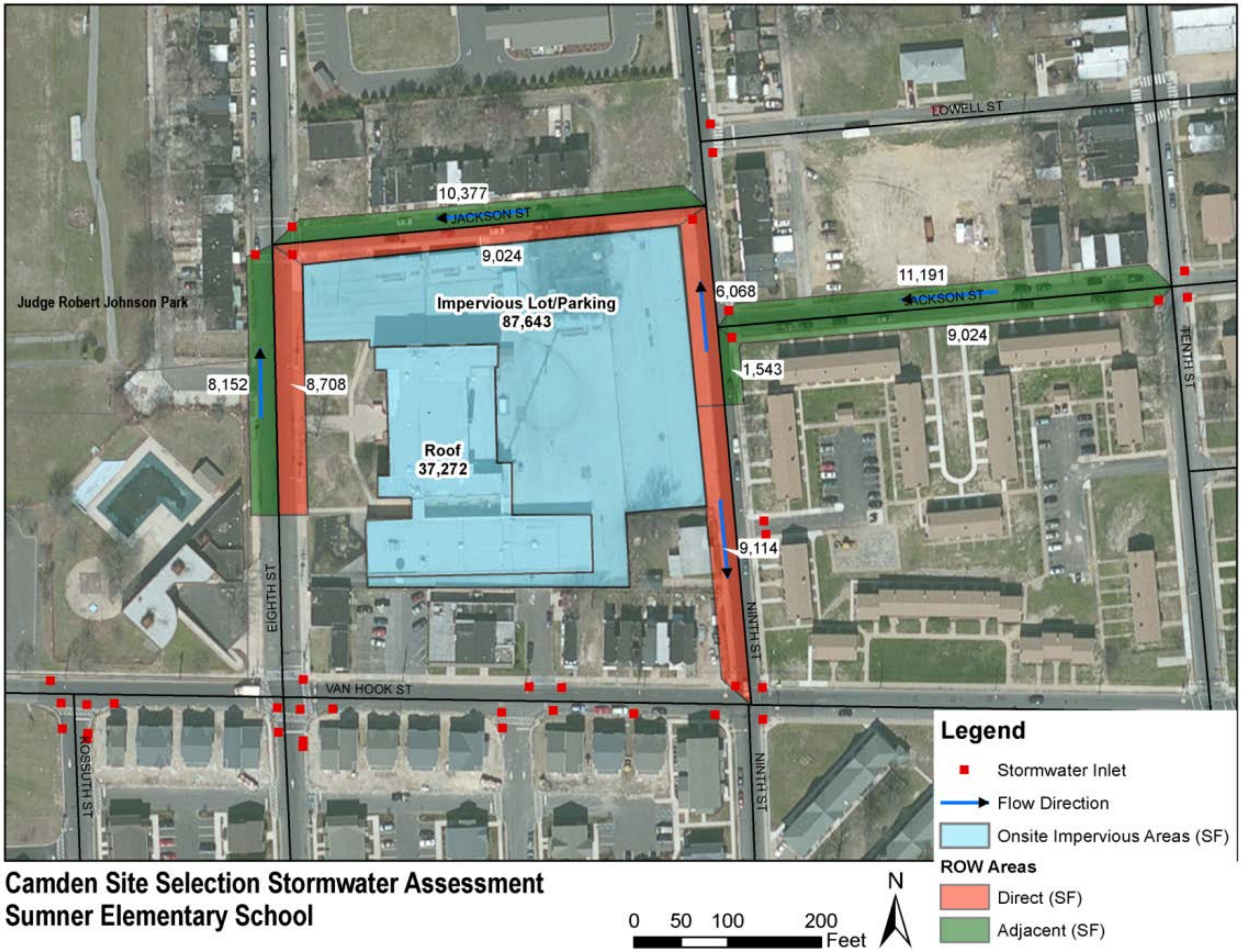


FIGURE 4-4: SUMNER ELEMENTARY SCHOOL - STORMWATER ASSESSMENT

TOP ECOSYSTEM SERVICES	SERVICE GAP SCORE	APPROACH
(1) STRESS REDUCTION	0.73	TREES, GARDEN SPACE, BENCHES IN RIGHT-OF-WAY. FLOWER PRODUCTION AND MARKET SPACE IN PARKING LOT.
(2) CSO REDUCTION	0.68	STORMWATER TREE PITS AND BUMPOUTS, TURF FIELD, RAIN GARDENS
(3) FITNESS OPPORTUNITY EXPANSION	0.67	MULTI-PURPOSE TURF FIELD, BASKETBALL COURT, CAROUSEL AND TREADLE WATER PUMPS

FIGURE 4-5: SUMNER ELEMENTARY SCHOOL - CONCEPT PLAN

FIGURE 4-6: SUMNER ELEMENTARY SCHOOL – RENDERING, THINKGREEN LLC

4.2.3 Vine and Willard Vacant Lots – Neighborhood Infrastructure Hub

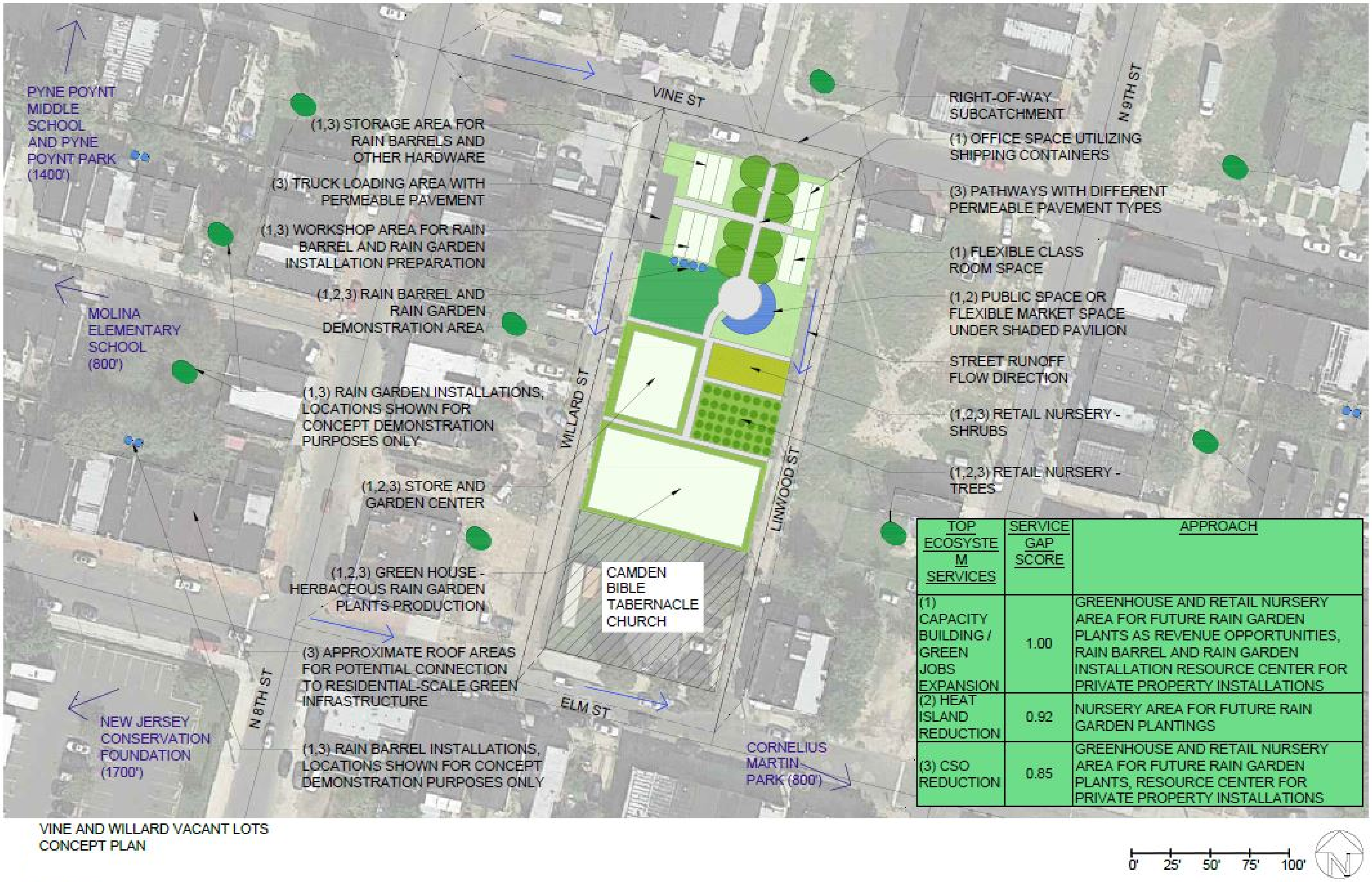
Vine St. & Willard St.

Vine and Willard Vacant Lots is a grouping of twelve vacant lots within the residential neighborhood located between Willard St., Linwood St., Vine St., and Elm St. The Camden Bible Tabernacle Church, located on the southern end of the block, is the only developed parcel within the block. The collection of lots aggregates to 0.6 acres of pervious grass area and is owned by the City of Camden as well as private property owners. While utilization of all of these parcels may require considerable coordination, there are a number of similar vacant or semi-vacant blocks around Camden. Thus, this site can serve as an example of how this condition can be transformed for productive use.

Given that most of the parcels are undeveloped pervious areas (with the exception of a 1,197 SF existing concrete pad), immediate stormwater management potential consists of direct and adjacent ROW areas of 12,648 and 20,696 SF respectively (Figure 4-8). These ROW areas are relatively limited in comparison to the footprint of the site, but the residential location of the site presents an opportunity to indirectly manage stormwater through the facilitation of private property GI installations. While ROW areas are significant contributors to stormwater entering the sewer system, the aggregation of roof areas is substantial as well. Additionally, reconfigurations of rooftop drainage through downspout disconnections are relatively cost effective (USEPA 2013). This site presents an approach for CCMUA to manage stormwater originating on private property. However, it is recognized that property owners would likely require incentives beyond the added environmental benefits to invest the time and resources to reconfigure their rooftop drainage systems.

The overall vision for this site is to serve as a “neighborhood infrastructure hub” that provides any required hardware and instruction for rain garden and rain barrel private property installations (Figure 4-6). Organizations with an interest in revitalizing their neighborhoods by greening, such as the Urban Tree Connection in West Philadelphia, can use the site as a staging ground for workshops and information sessions, potentially leading to long-term partnerships with the community. By training community members to serve as GI installers and by providing retail opportunities for GI components, the site is centered on the capacity building and green jobs expansion services (the sub-basin's top ranked ecosystem service). The site includes a retail garden center and retail nursery to provide plumbing supplies and rain garden plants, and a greenhouse was included for herbaceous rain garden plant production. Training facilities are proposed onsite, including workshop areas with demonstration rain garden and rain barrels (which manage stormwater from onsite and ROW areas), and community spaces can be constructed to provide flexible meeting spaces for events or classes. The site could essentially serve as an extension of CCMUA into the neighborhood, facilitating the expansion of the Camden SMART Initiative's existing rain garden and rain barrel programs. Finally, a shaded pavilion for flexible market space was provided for additional retail opportunities. All of these components promote the expansion of GI, which addresses heat island and CSO reduction (the second and third ranked ecosystem services) throughout the neighborhood.

FIGURE 4-7: VINE AND WILLARD VACANT LOTS - STORMWATER ASSESSMENT



TOP ECOSYSTE M SERVICES	SERVICE GAP SCORE	APPROACH
(1) CAPACITY BUILDING / GREEN JOBS EXPANSION	1.00	GREENHOUSE AND RETAIL NURSERY AREA FOR FUTURE RAIN GARDEN PLANTS AS REVENUE OPPORTUNITIES, RAIN BARREL AND RAIN GARDEN INSTALLATION RESOURCE CENTER FOR PRIVATE PROPERTY INSTALLATIONS
(2) HEAT ISLAND REDUCTION	0.92	NURSERY AREA FOR FUTURE RAIN GARDEN PLANTINGS
(3) CSO REDUCTION	0.85	GREENHOUSE AND RETAIL NURSERY AREA FOR FUTURE RAIN GARDEN PLANTS, RESOURCE CENTER FOR PRIVATE PROPERTY INSTALLATIONS

FIGURE 4-8: VINE AND WILLARD VACANT LOTS - CONCEPT PLAN

FIGURE 4-9: VINE AND WILLARD VACANT LOTS – RENDERING, THINKGREEN LLC

4.2.4 Former Camden Labs – Community Residential and Commercial Revitalization

1667 Davis St.

The former Camden Labs site is a privately owned 3.8-acre brownfield site that was previously a medical facility and industrial laboratory. The site consists of abandoned buildings that appear to be partially demolished and has been used as an illegal dumping ground. Remediation and redevelopment of the site is currently in the planning and assessment phase through the Camden Redevelopment Agency (CRA). While the overall site use has yet to be determined, CRA has expressed interest in expanding commercial activity (especially around the Ferry Avenue Port Authority Transit Corporation station) and affordable housing, as well as promoting public use of the site. These interests drove the larger site planning, with GI components incorporated to meet the ecosystem service goals.

Given that the site will feature new buildings and pathways post remediation, the existing impervious roof and ground surface areas (23,411 and 36,843 SF respectively) may not be as relevant to the future stormwater design. However, the size of the site may allow for not only 100% management of onsite contributions, but ROW contributions as well. Stormwater generally flows in the southeast direction, totaling 20,248 and 89,339 SF for direct and adjacent ROW areas respectively (Figure 4-7). To address these significant onsite and offsite areas, stormwater management served as a central design element for the site layout.

The overall site plan is split into a residential section and a commercial retail section, both of which are connected by a central stormwater management network of rain gardens and emergent wetlands (Figure 4-11). The top three ecosystem services are stress reduction, urban agriculture expansion, and fitness expansion. These scores were referenced from the sub-basin directly west of the site (C3-8) to better align with the area cited by CRA for its redevelopment efforts. Multiple, green, stress reduction features were included throughout the site including: public lawn areas, rain gardens, and a central emergent wetland strip. These areas improve the wellbeing of community members by creating a calm environment within both residential and commercial areas. ROW stormwater street trees were also included along Davis Street, a key street corridor identified by CRA. Rooftop urban farms were incorporated throughout the site for urban agriculture expansion, and a fitness trail with fitness pods was included for fitness expansion. This trail also facilitates the connection to Whitman Park, which lies directly south of the site. The eventual planning of the site may change based on future efforts by CRA, but this concept design demonstrates the ability for a multi-functional stormwater network to manage stormwater contributions and prove a significant asset to the site's development.

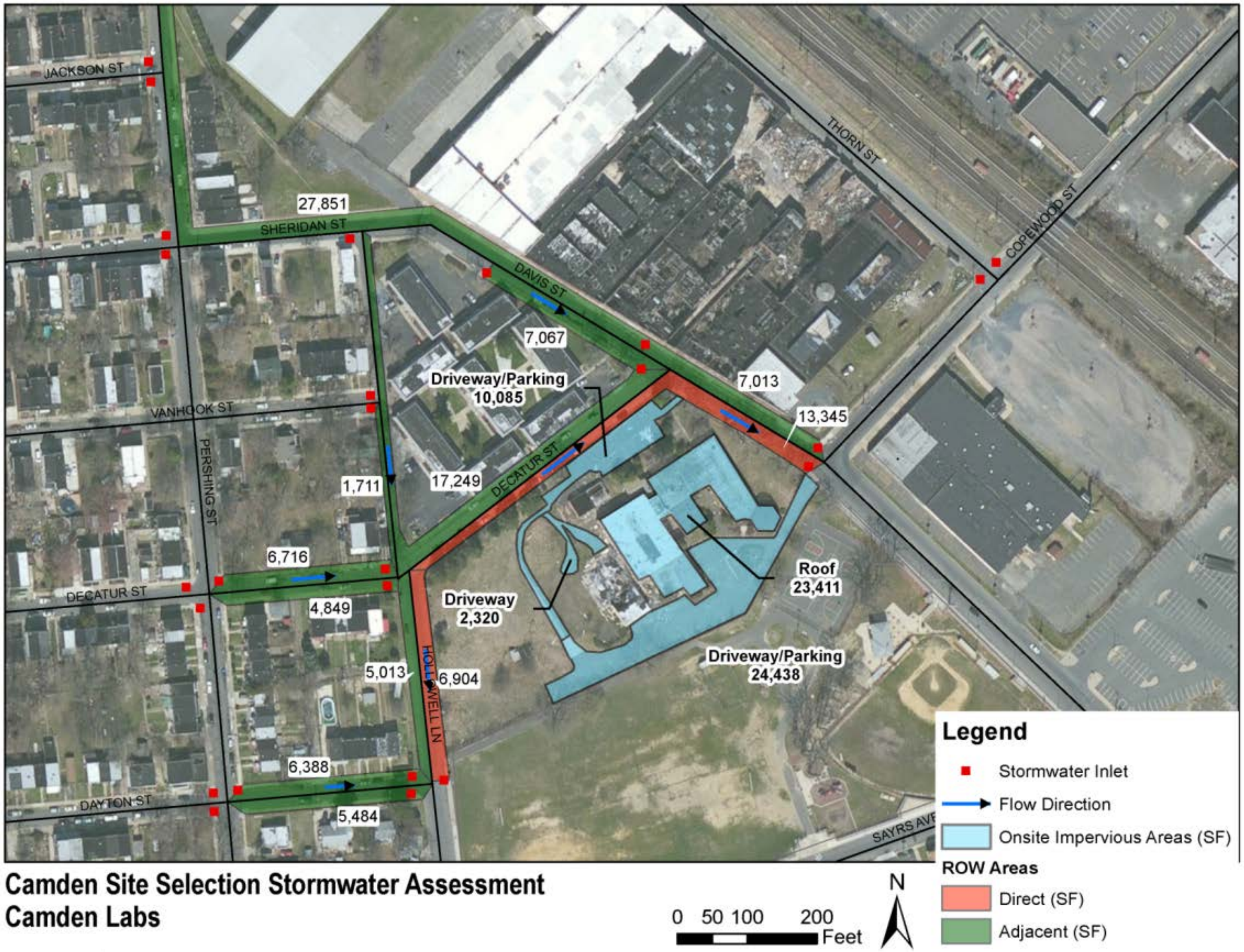


FIGURE 4-10: FORMER CAMDEN LABS - STORMWATER ASSESSMENT

TOP ECOSYSTEM SERVICES	SERVICE GAP SCORE	APPROACH
(1) STRESS REDUCTION	0.99	RAIN GARDENS, WETLANDS, AND PUBLIC LAWN FOR INCREASED NATURAL AREAS. GARDENING AND FARMING OPPORTUNITIES.
(2) URBAN AGRICULTURE EXPANSION	0.88	ROOF TOP URBAN FARMS
(3) FITNESS EXPANSION	0.88	FITNESS TRAIL AROUND SITE WITH FITNESS PODS. GARDENING AND FARMING OPPORTUNITIES.

FIGURE 4-11: FORMER CAMDEN LABS - CONCEPT PLAN

FIGURE 4-12: FORMER CAMDEN LABS – RENDERING, THINKGREEN LLC

4.3 Operations, Maintenance, and Site Benefits

Like all infrastructure, GI facilities need regular maintenance to continue to operate effectively. However, unlike centralized grey infrastructure facilities, GI systems must be distributed throughout urban neighborhoods if they are to collectively engender watershed-scale benefits such as significant reductions in runoff, CSOs, or heat islands. The decentralization embodied in the green approach creates a plethora of new partnership opportunities in urban communities to plan, site, design, operate and maintain GI systems for multiple benefits, especially when it includes innovative ways of engaging residents and community organizations. Previous sections have discussed how a wide range of community needs can be factored into GI siting and design. This section explores the potential benefits of engaging the community in GI operation and maintenance, providing both short and long-term visions.

In the short term, though maintenance of certain GI system components (e.g. catchbasin, inlets, etc.) will likely continue to require trained specialists, other tasks (e.g. maintenance of shrubs, trees, etc.) can be readily undertaken by environmental stewards in the community through a variety of potential partnership arrangements. These could include:

- <u>Concessions</u> through which particular organizations are allowed to grow and sell agricultural commodities such as flowers in a public park, but with harvested stormwater for irrigation and by reducing overall park maintenance costs, for example associated with mowing
- <u>Conservation easements</u> that convert underutilized vacant parcels into neighborhood stormwater capture parks, but also protect them from being developed and eventually increasing the local stormwater load
- <u>Green jobs and citizen scientist programs</u>, wherein local residents regularly monitor soil and plant conditions, prune plants, remove trash, and otherwise maintain GI in the right-of-way, while gaining job training skills and reducing the maintenance burden on the public utility

- Maintenance contracts through which local community organizations (Stapleton MCA in Denver) are formally tasked with performing key tasks within GI systems.

A white paper entitled, *The Need for National Green Infrastructure Training and Certification,* recently produced by the Water Environment Foundation (WEF) in partnership with DC Water includes a useful review of the opportunity GI maintenance represents for communities. For example, the City of Columbus' Blueprint Program addresses poverty and unemployment and leverages the technical knowledge of local academic institutions to develop and deliver a training curriculum structured around livable-wage jobs specifically to construct and maintain green infrastructure practices. Such programs can both reduce the maintenance burden that decentralized GI creates for public utilities, while also generating new sources of revenue that actually help to offset and/or payback GI operation and maintenance costs. For example, Table (4-4) shows the potential revenue that could be generated by urban agriculture activities on the Vine and Willard Site, while apples produced at the orchard proposed at Alberta Woods Park could likely sell at $1.50/lb, given current market conditions.

As multifunctional GI systems, customized to local community needs, become more spatially ubiquitous, more and more of their maintenance could naturally be taken on by the community. In the long term, GI systems are envisioned as critical nodes – infrastructure assets that reduce the stormwater burden associated with urban development while simultaneously becoming the foundation for a new brand of urban revitalization. GI facilities that are regularly used, accessed, and cared for by community stakeholders for other-than-water services can potentially become self-sustaining. From a stormwater management perspective, GI systems manage rainfall where it falls, spatially distributing water management responsibilities throughout urban watersheds. From a community engagement perspective, these same facilities can also generate new recreational, economic, and stewardship opportunities throughout the city, creating new windows for public participation, and bridges between government and community, and between ecological function and economic development.

This kind of an integrated vision for GI requires high levels of community engagement, with volunteers, stewards, community organizations, and individuals folded into GI management through a wide range of different agreements, partnerships, and programs. As examples, both the Alberta Woods Park and Former Camden Labs sites incorporate urban agriculture activities involving orchards and rooftop farms, respectively. These activities require weeding, trash removal, harvesting, and other tasks that will generate revenue, but can also sustain the ability of these same locations to manage water. A more extensive vision of how community engagement can be incorporated into the four case study sites presented here is presented in Figure 4-13 to Figure 4-16.

				Potential Annual Revenue*						Potential Annual Demand	
Top Ecosystem Services	**Components**	**Qty**	**Unit**	**Qty**	**Unit**	**Unit Value**	**Annual Amount**	**Operations and Maintenance Tasks**	**Notes/ Assumptions**	**Annual Hours**	**Annual Cost ($15/Hour)**
Green Jobs Capacity Building Expansion (1.00)	Rain garden plant production (3,922 SF)[1]	196,125	PLUGS			$0.85/ PLUG	$166,706	Tilling, watering, weeding, harvesting.	8 hrs per session, 5 days a week, 10 months per year	1,600	$24,000
	Demonstration rain garden	2,208	SF					Remove trash and sediment. Weeding invasives.	2 hrs per session, twice a month, 8 months per year	32	$480
	Demonstration roof disconnect for rain barrels	3	EA					Remove trash and sediment.	1 hr per session, twice a month, 8 months per year	16	$240
	Retail garden center and retail nursery	5,198	SF			FLEXIBLE		Retail operations and management	DEMAND PAIRED TO REVENUE FROM RETAIL AND CCMUA GI ASSESSMENT		
	Workshop space	720	SF								
	Classroom space	480	SF								
Heat Island Reduction (0.93)	Rain gardens installed on adjacent private parcels	107	EA								
	Trees provided for adjacent rain gardens	107	EA								
CSO Reduction (0.85)	Direct and adjacent ROW	33,344	SF					Remove trash and sediment from pipes, and connections to GI areas.	2 hrs per session, twice a month, 8 months per year	32	$480
	107 parcel level roof disconnects (20% adoption rate for parcels 500' from site)	69,680	SF								
							$166,706			1,680	$25,200

* Revenue values cursory, would require market feasibility study
Note 1: Two growing seasons, 25 plugs grown per SF

TABLE 4-2: VINE AND WILLARD VACANT LOTS - BENEFITS AND OPERATIONS

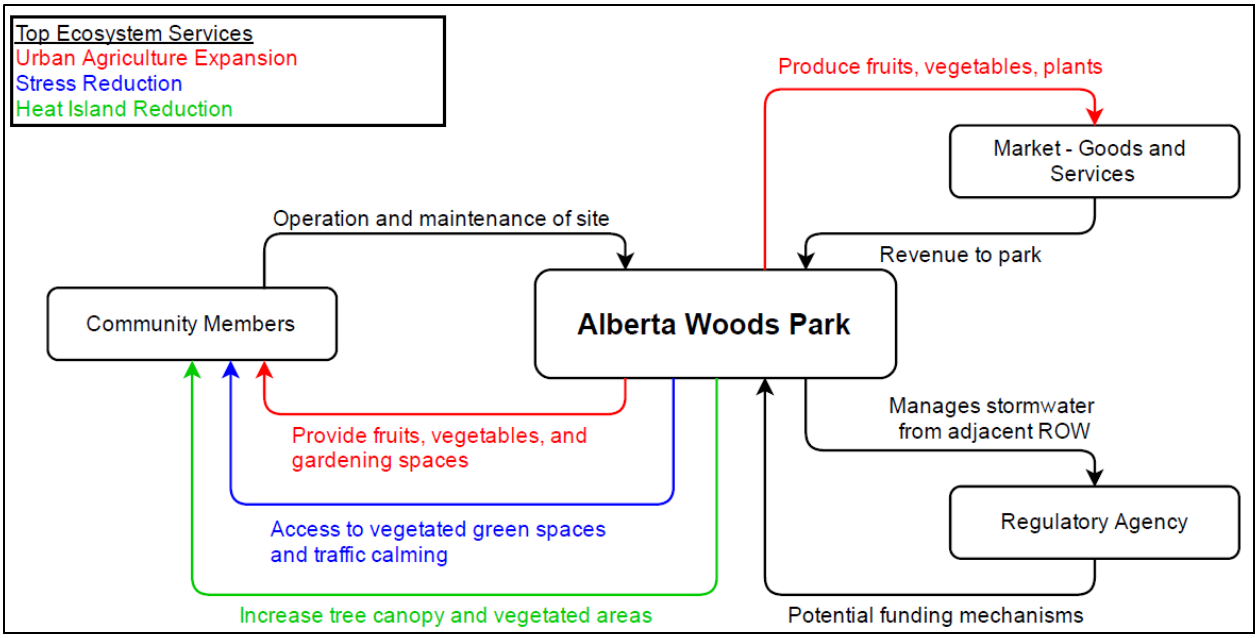


FIGURE 4-13: ALBERTA WOODS PARK - SERVICE FLOW DIAGRAM

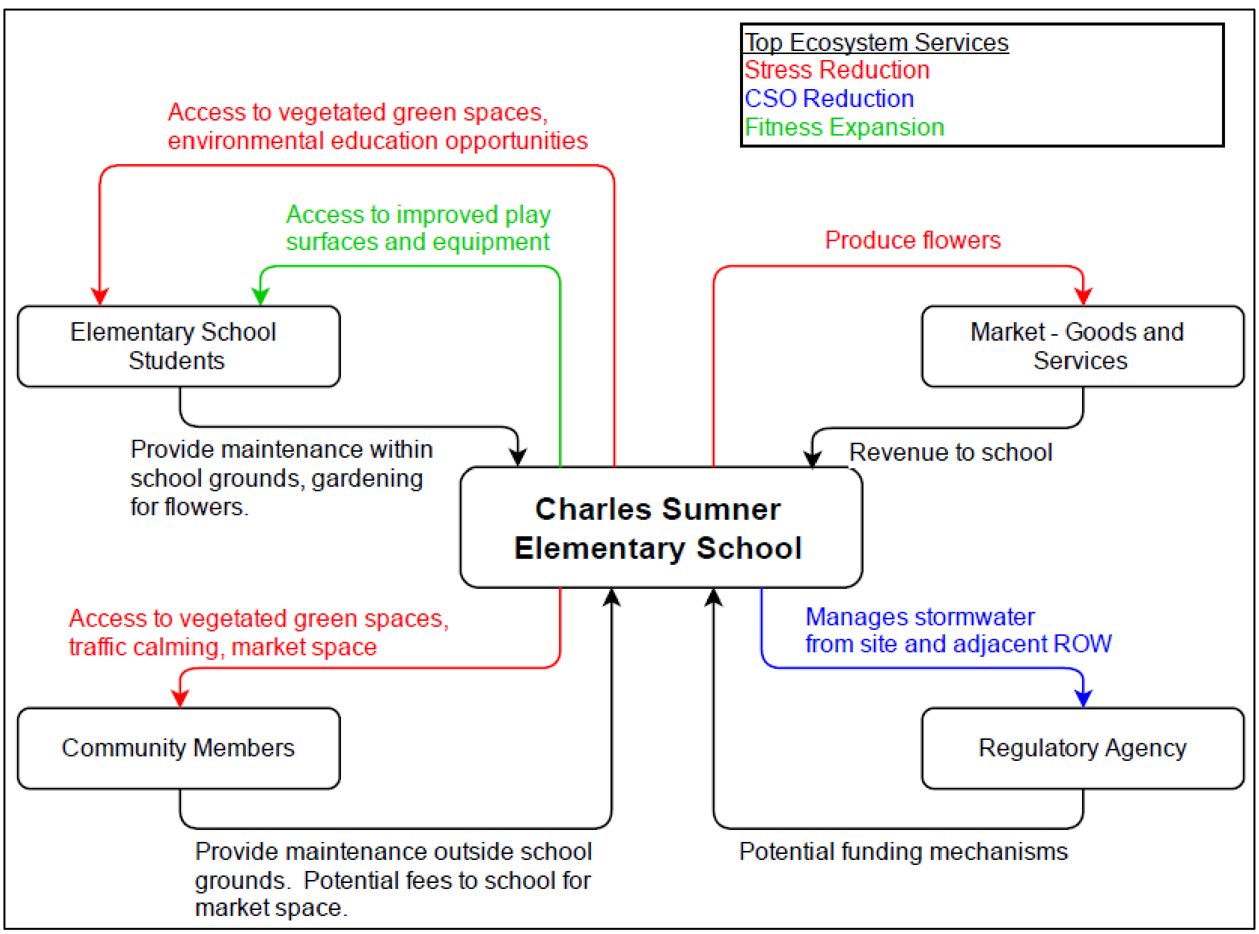


FIGURE 4-14: CHARLES SUMNER ELEMENTARY SCHOOL - SERVICE FLOW DIAGRAM

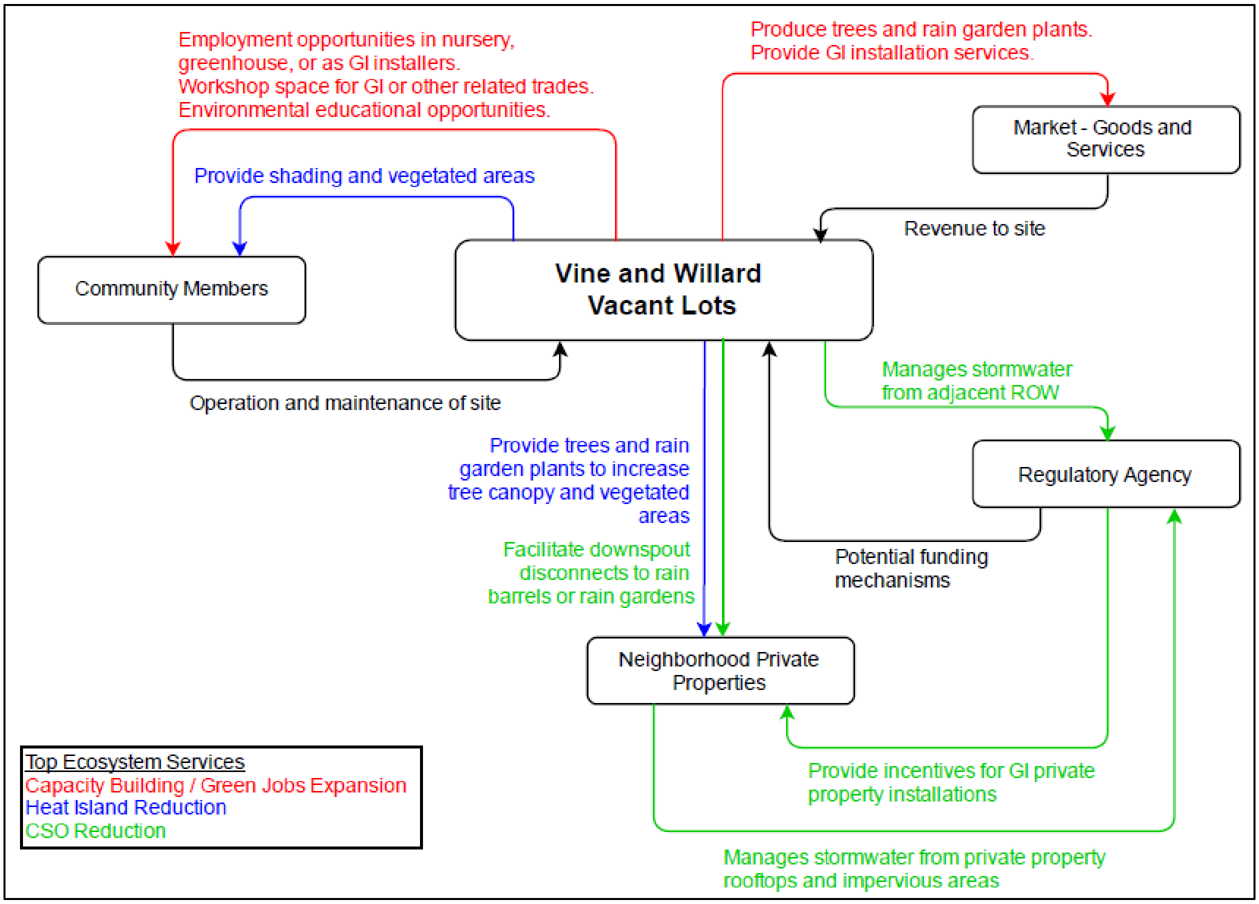


FIGURE 4-15: VINE AND WILLARD VACANT LOTS - SERVICE FLOW DIAGRAM

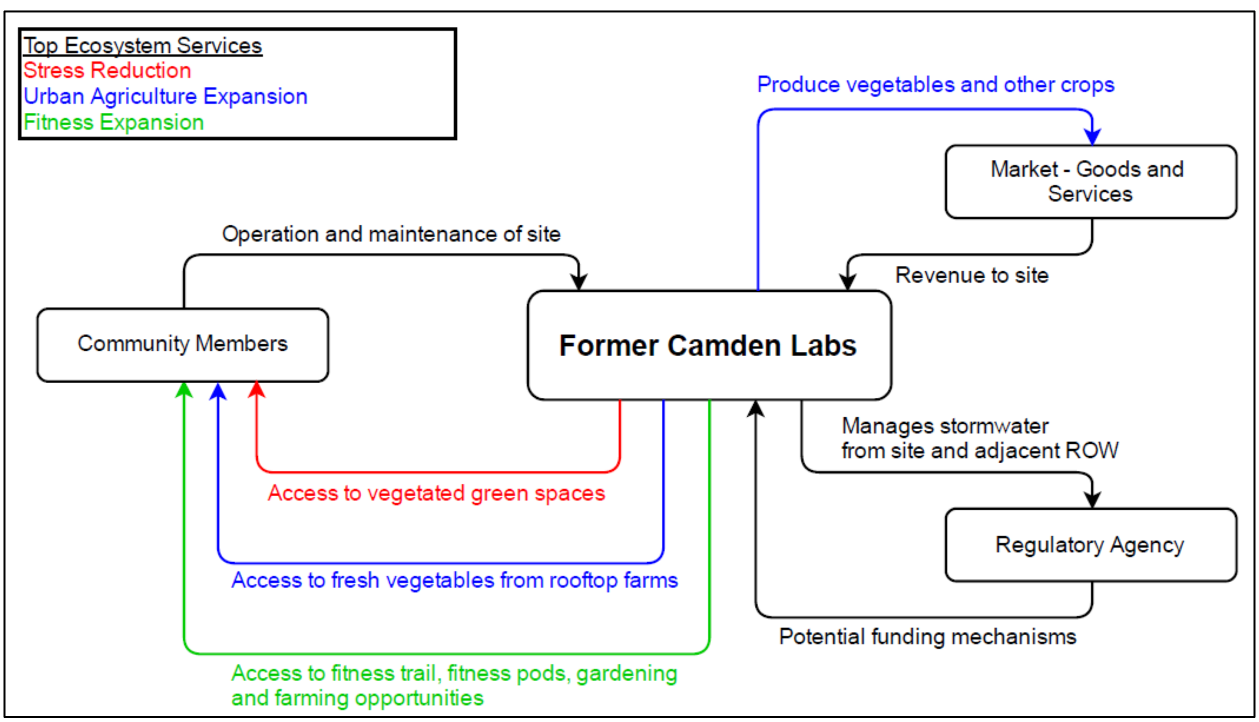


FIGURE 4-16: FORMER CAMDEN LABS - SERVICE FLOW DIAGRAM

4.4 Potential Funding Strategies

The more multifunctional GI systems can become, the greater the number of potential sources of funding for their construction and operation. Currently, CCMUA receives funding for GI development at the federal level through the EPA's Clean Water State Revolving Fund and at the state level through the New Jersey Environmental Infrastructure Trust, administered by the NJDEP. The target for these funds is the Camden City Green and Gray Infrastructure project, which aims to construct a series of green infrastructure and sewer improvement projects that would manage approximately 30 million gallons of stormwater annually.

However, these same federal and state entities also provide funding for projects that address other environmental and community-oriented goals. The EPA's Urban Waters and Brownfield programs, for example, funds projects that address urban runoff pollution and various brownfield remediation activities; its Environmental Education Grants, along with NOAA's Environmental Literacy Grants, can be utilized by educational institutions to promote environmental awareness and stewardship. The National Park Service offers grants to municipalities to expand outdoor park space, like the Outdoor Recreation Legacy Partnership Program. These open space expansion and protection programs also exist at the local level, such as the Camden County Open Space, Recreation, Farmland, and Historic Preservation Trust Fund Referendum.

In the short term, funding obtained through these programs can be used to co-locate specific related activities within GI systems that were principally built by CCMUA for stormwater management purposes. The long term vision, however, is that GI systems would be conceived (and financed) as multifunctional community assets, making them candidates for many different sources of funding from their inception. In this vision, municipalities would gradually recognize that vacant lot stabilization efforts, economic development plans, habitat restoration efforts can all occur while managing stormwater. Stated differently, the federal mandate to manage stormwater could be leveraged to promote a suite of other community improvement goals (e.g. enhanced urban ecosystem services). Multiple functions and services would become truly integrated (as opposed to solely co-located) into the same physical spaces, attracting a wide range of funding sources, and encouraging coordination of the LTCP planning process with concurrent efforts in many other entities of local, state, and county government.

5 Conclusions

The goal of this project was to develop a decision-support framework for planning GI systems that maximize urban ecosystem services. Ecosystem service gaps were evaluated and used to geographically prioritize different kinds of multifunctional GI. Conceptual designs were developed for four site typologies: parks, schools, vacant lots, and brownfield sites. An integrated long-term vision was presented whereby multifunctional GI systems, customized to the needs of different communities, manage stormwater while also creating new opportunities for urban engagement, mobilizing various sources of funding, and contributing to an integrated plan for urban revitalization. Such a strategy would leverage the regulatory requirement to manage stormwater to enable many other community improvements, all through a decentralized network of green infrastructure assets.

As the City of Camden and CCMUA finalize development of their respective LTCPs, a complementary planning effort that, through extensive stakeholder deliberation, seeks to develop GI siting and design configurations specially customized to this city's unique physical, institutional, demographic, and historic conditions, could help to maximize the full spectrum of benefits achievable through GI in Camden. The better GI systems are tailored to local conditions, and the more ecosystem services they are designed to provide, the more support the program will have from the public, the more funding sources they will become candidates for, and the more spatial and institutional opportunities there will be for integrating different kinds of GI facilities into the city's complex urban landscape. With more widespread spatial application, of course, comes greater stormwater capture, helping CCMUA to more efficiently and cost-effectively comply with federally mandated stormwater capture and CSO-abatement goals.

If implemented with broad community participation, the ecosystem services framework presented in this report can help to identify specific geographic opportunities, GI design configurations, and partnership arrangements that can couple flood control, green job growth, heat island mitigation, community engagement, and other ecosystem service targets with stormwater management services. Of course, implementation of this framework at the city scale would require unprecedented levels of interagency coordination, and community outreach and organizing, neither of which are insignificant undertakings. A first step in demonstrating the process might include a few pilot neighborhood planning efforts, and construction of several multifunctional pilot projects such as the four concepts presented here. In the long term, the need to green the city for stormwater capture is seen as a vehicle for promoting a broad-ranging discussion about all the ways urban spaces (both public, private, underutilized, and fully developed) can serve residents of the city, with the LTCP planning process transformed from a plan focused solely on water management to a strategic initiative fostering urban revitalization in Camden, and beyond.

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TPL Web Viewer Access Information
http://tplgis.org/Climate/GI/Camden
Username: CamdenGI
Password: greencities123

Appendices

A. Reference Datasets

Reference Datasets		
Data	**Data Source**	**Methodology**
City Boundary	NJGIN website	
School Properties	Original Point data: NJGIN website TPL created polygon layer from original point layer	This spatial layer consists of point locations of elementary and secondary schools in New Jersey, with minimal attributes. Schools are subdivided into public, charter, and non-public. The collection of schools is based primarily on lists published by the NJ Department of Education (NJDOE), with limited additions from other sources such as county GIS units. Additional information about most schools can be obtained from the NJDOE lists. Users should be aware that not all the locations are of high quality.
Camden Board of Education Properties		Extract from parcel data
Camden Parks	CAMConnect, Delaware Valley Regional Planning Commission, and TPL	TPL (Bob Heuer) compiled data layers provided into one parks layer. This data layer is for general reference only, is subject to change, and is not warranted for any particular use or purpose. Park names and size may not be correct.
Public Owned Properties	City of Camden parcel data	List public owned blocks and lots. The sites are not necessarily vacant. Further onsite investigation is required. This data layer is for general reference only, is subject to change, and is not warranted for any particular use or purpose.
Vacant Properties - CRA owned	Camden Redevelopment Agency	List CRA own vacant sites. The list was obtained in the CRA website and processed by TNC. This data layer is for general reference only, is subject to change, and is not warranted for any particular use or purpose.
CRA Demolition Sites	Camden Redevelopment Agency	List the sites which structures will be demolished until the end of 2014. The information was provided by CRA, and Geo referenced by TNC. This data layer is for general reference only, is subject to change, and is not warranted for any particular use or purpose. Further onsite investigation is required.
Drainage Basin Attributes	CDMSmith Camden County CSO Study	Drainage basin polygons
Drainage Sub-Basin Attributes	CDMSmith Camden County CSO Study	Drainage sub-basins polygon
Collection System Network	CDMSmith Camden County CSO Study	Collection system network pipes
Original Interceptor Sewer System	CDMSmith Camden County CSO Study	Original interceptor system used for small plots
Rain Garden Locations	Rutgers University	Completed project sites
Surface Water Discharge Locations	New Jersey DEP data website (select to City of Camden area)	New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge pipe GIS point coverage compiled from GPSed locations, NJPDES databases, and permit applications. This coverage contains the surface water discharge points and the receiving waters coordinates for the active as well as terminated pipes. Accuracy of the locations is to within 20 feet of the actual discharge.
Combined Sewer Overflows - DRAFT	New Jersey DEP data website (select to City of Camden area)	This version of Combined Sewer Overflow (CSO) is DRAFT. The NJDEP will soon be asking CSO permitees to verify existing data. Information will also be accepted from the interested public. This process will result in more precise data which will subsequently be incorporated into a publically distributed "non-draft" data layer. This is a geographical representation of the locations of CSO points statewide. Combined Sewer Overflows (CSO) are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. This map provides information regarding the location of permitted CSO Points, the applicable NJPDES Permit number, the assigned 3- digit discharge serial number, the latitude and longitude, the name (also the street address) of the CSO point, the CSO water region and a unique identifier for each point consisting of the permit number and outfall number.
Classification Exception Areas	New Jersey DEP data website	This data identifies those sites where groundwater contamination has been identified and, where appropriate, the NJDEP has established a Classification Exception Area (CEA). CEAs are institutional controls in geographically defined areas within which the New Jersey Ground Water Quality Standards (NJGWQS) for specific contaminants have been exceeded. When a CEA is designated for an area, the constituent standards and designated aquifer uses are suspended for the term of the CEA
Permitted Discharge Facilities	New Jersey DEP data website (select to City of Camden area)	The NJPDES layer shows approximate locations of permitted facilities regulated by New Jersey Department of Environmental Protection's Bureau of Nonpoint Pollution Control (BNPC). Permits vary based on discharge type and activity governed by N.J.A.C. 7:14A. This layer includes permitted facilities for having sanitary wastewater and industrial wastewater discharges though various methods such as lagoons, spray irrigation, or overland flow.
Brownfield Areas	Camden Redevelopment Agency	List the Brownfield sites in Camden for which some contamination analyses have been performed. The list was obtained by inspecting CRA reports. The information was Geo-referenced by TNC (Luciana Cunha). The sites will be evaluated as an option for GI. Geographic information (including this data set) provided by TNC-NJ is for general reference only, is subject to change, and is not warranted for any particular use or purpose.
1-foot Contours	WRT Camden SMART Initiative	
2-foot Contours	WRT Camden SMART Initiative	

FEMA Flood Hazard Zones	Federal Emergency Management Agency	The National Flood Hazard Layer (NFHL) data incorporates all Flood Insurance Rate Map (FIRM) databases published by the Federal Emergency Management Agency (FEMA), and any Letters Of Map Revision (LOMRs) that have been issued against those databases since their publication date. It is updated on a monthly basis. The FIRM Database is the digital, geospatial version of the flood hazard information shown on the published paper FIRMs. The FIRM Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk.
Utility Wastewater Service Area	New Jersey DEP data website (select to City of Camden area)	This is a graphical representation of the States Sewer Service Area (SSA) mapping. The SSA mapping shows the planned method of wastewater disposal for specific areas, i.e. whether the wastewater will be collected to a regional treatment facility or treated on site and disposed of through a Surface Water (SW) discharge or a groundwater (GW) discharge.
Flood Risk and Population Density	WRT Camden SMART Initiative	Census 2010 data was used to determine population density—where the highest concentrations of population are in Camden. Overlaying the combined risk of flooding with population density produced an overall opportunity map. On this map, the degree of opportunity was divided using natural breaks into 3 categories: areas with the highest opportunity to effect change, areas with moderate opportunity to effect change, and areas with low opportunity to effect change. Areas with the highest opportunity are those with a high risk of flooding and a high population density. Areas with the lowest opportunity are those with a low risk of flooding and a low population density. Areas with moderate opportunity may have a high risk of flooding and a low population density, a low risk of flooding and a high population density, or a moderate risk of flooding and a moderate population density.
Camden Park Equity		This is the combined park need result from the Camden Park Equity analysis. It uses 2014 forecast census block group data and combines the following weighted demographic variables: > Population density (people per acre) 50% > Density kids age 19 and younger 25% > Density of individuals in low income households 25%
Population Density	2010 TIGER Census Blocks	2010 TIGER Census data was brought into ArcGIS and modified for use in this analysis for Camden. The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.
Median Household Income	2011 American Community Survey 2011 Census Block Groups	2011 ACS Census data was brought into ArcGIS for use in this analysis. The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional population values per income range for the split census blocks were calculated based on area, and the total population values per income range in the sub-basin were calculated by totaling the contributing census block groups. The median household income values were found from the new distributions.
Unemployment Rate	2011 American Community Survey 2011 Census Block Groups	2011 ACS Census data was brought into ArcGIS for use in this analysis. The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional values for total and unemployed population 16 years and over for the split census blocks were calculated based on area, and the total values in the sub-basin were calculated by totaling the contributing census block groups.
Grocery Store Locations	Hopeworks 'N Camden	This data identifies grocery store locations in the City of Camden.
Community Garden Locations	Hopeworks 'N Camden	This data identifies community garden locations in the City of Camden.
Impervious Area	NJDEP 2007 Land Use / Land Cover Update	NJDEP Land Use data was brought into ArcGIS for use in this analysis. The Intersect tool was used to align the impervious coverage with the sub-basins, and total impervious area coverage was calculated for each sub-basin.
Average Annual CSO Stats	CDMSmith Camden County CSO Study - 1986 Annual CSO Stats	CDM Smith conducted an analysis of CSO contributions per drainage basin in Camden, producing annual CSO statistics for based on model year 1986.
Flooding Locations	CCMUA-Compiled Dataset from City of Camden, Traffic Reports, and Remington and Varick Study	CCMUA collected information on flooding locations throughout the City through correspondences with the City of Camden, associated traffic reports, and a Remington and Varick study.
Mean Elevation	NJDEP 2002 Digital Elevation Grid of the Lower Delaware Watershed Management Area (WMA 18)	NJDEP elevation data was brought into ArcGIS for use in this analysis. The Intersect tool was used to align the impervious coverage with the sub-basins, and a mean elevation was calculated for each sub-basin.
Tree Cover	2011 Tree Canopy - USDA Land Cover Dataset	USDA tree canopy data was brought into ArcGIS for use in this analysis. The Intersect tool was used to align the tree coverage with the sub-basins, and a total tree canopy coverage was calculated for each sub-basin.
Environmental Community Organization Locations	Community Gardening in Camden, NJ Harvest Report, University of Pennsylvania, 2009	This data identifies environmental community organization in the City of Camden.
Mental Health Service Center Locations	State of New Jersey Department of Human Services, Mental Health Association in Southwester New Jersey	This data identifies mental health service center locations in the City of Camden.

B. Service Gap Score Algorithms

B.1 Urban Agriculture Expansion

Identify areas with high food demand vs. low food availability

Population Density

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin
A = area of sub-basin

$$\mathrm{PD} = \mathrm{P}/\mathrm{A}$$

PD = population density

$$\mathrm{PDN_i} = \frac{\mathrm{PD_i} - \mathrm{PD_{min}}}{\mathrm{PD_{max}} - \mathrm{PD_{min}}}$$

PDN = population density normalized

Food Desert

Source data:

1. *Hopeworks 'N Camden*
    a. *Grocery store locations*
2. *Community Gardening in Camden, NJ Harvest Report: Summer 2009, University of Pennsylvania*
    a. *Reference document for community garden locations. Additional locations found through Camden Center for Environmental Transformation*

S = count of grocery stores or supermarkets within 0.1 miles of sub-basin
G = count of community gardens within 0.1 miles of sub-basin
A = area of polygon

W_G = community garden weighting
W_G = 25%

$$\mathrm{FD} = (\mathrm{S} + \mathrm{GW_G})/\mathrm{A}$$

FD = food availability density

$$\mathrm{FDN_i} = 1 - \frac{\mathrm{FD_i} - \mathrm{FD_{min}}}{\mathrm{FD_{max}} - \mathrm{FD_{min}}}$$

FDN = food desert density normalized

Service Gap Score

W_{PD} = population density weighting

W_{PD} = 50%
W_{FD} = food desert weighting
W_{FD} = 50%

$$SG_i = (W_{PD} * \ PDN_i) + (W_{FD} \ * FDN_i)$$

SG = service gap score raw

$$SGN_i = \frac{SG_i - SG_{min}}{SG_{max} - SG_{min}}$$

SGN = service gap score normalized

B.2 CSO Reduction Algorithm

Identify areas with high CSO contribution, high impervious cover, and high population density where GI can be beneficial to reducing CSOs.

<u>CSO Density</u>

Source data:

1. *"1986 Annual CSO Stats" document from CDM Smith*
    a. *CSO contribution per drainage basin*
2. *CDM Smith – Drainage Sub-basin Statistics*
    a. *Impervious coverage per sub-basin*

I_s = impervious cover per sub-basin (acres)
I_b = impervious cover per basin (acres)
C_b = CSO per basin (MG)
C_s = CSO per sub-basin (MG)
A = area of sub-basin
CD = CSO Density

$C_s = (I_s/I_b)*C_b$
$CD = C_s / A$

$$\mathrm{CDN_i} = \frac{\mathrm{CD_i} - \mathrm{CD_{min}}}{\mathrm{CD_{max}} - \mathrm{CD_{min}}}$$

CDN = CSO density per sub-basin normalized

<u>Impervious Cover Density</u>

Source data:

1. *CDM Smith – Drainage Sub-basin Statistics*
    a. *Impervious coverage per sub-basin*

I_s = impervious cover per sub-basin (acres)
A = area of sub-basin (acres)

$ID = I_s/A$
ID = impervious cover density

$$\mathrm{IDN_i} = \frac{\mathrm{ID_i} - \mathrm{ID_{min}}}{\mathrm{ID} - \mathrm{ID_{min}}}$$

IDN = impervious cover density normalized

<u>Population Density</u>

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin
A = area of sub-basin

$$\mathrm{PD} = \mathrm{P}/\mathrm{A}$$

PD = population density

$$\mathrm{PDN_i} = \frac{\mathrm{PD_i} - \mathrm{PD_{min}}}{\mathrm{PD_{max}} - \mathrm{PD_{min}}}$$

PDN = population density normalized

<u>Service Gap Score</u>

W_{CD} = CSO density weighting
W_{CD} = 50%
W_{ID} = Impervious cover density weighting
W_{ID} = 25%
W_{PD} = population density weighting
W_{PD} = 25%

$$\mathrm{SG_i} = (\mathrm{W_{CD}} * \mathrm{CDN_i}) + (\mathrm{W_{ID}} * \mathrm{IDN_i}) + (\mathrm{W_{PD}} * \mathrm{PDN_i})$$

SG = service gap score raw

$$\mathrm{SGN_i} = \frac{\mathrm{SG_i} - \mathrm{SG_{min}}}{\mathrm{SG_{max}} - \mathrm{SG_{min}}}$$

SGN = service gap score normalized

B.2 Heat Island Reduction

Identify areas with low tree cover, high impervious cover, and high population density where GI can be beneficial to reducing potential urban heat island effects.

<u>Tree Cover Density</u>

Source data:

1. *2011 Tree Canopy – USDA Land Cover Dataset*
    a. *Raster map of tree cover per grid square*

A coverage file was obtained from the USDA's National Land Cover Dataset and used to calculate summary statistics on tree canopy cover for the city. The Zonal Statistics tool was used to calculate the tree cover density for each of the sub-basins across the city.

T = tree cover per subbasin (count per grid square)
A = area of sub-basin
TD = tree cover density

TD = T /A

$$\mathrm{TDN_i} = 1 - \frac{\mathrm{T_i} - \mathrm{T_{min}}}{\mathrm{T_{max}} - \mathrm{T_{min}}}$$

TDN = Tree cover density per subbasin normalized

<u>Impervious Cover Density</u>

Source data:

1. *CDM Smith – Drainage Subbasin Statistics*
    a. *Impervious coverage per subbasin*

I_s = impervious cover per sub-basin (acres)
A = area of sub-basin (acres)

ID = I_s/A
ID = impervious cover density

$$\mathrm{IDN_i} = \frac{\mathrm{ID_i} - \mathrm{ID_{min}}}{\mathrm{ID} - \mathrm{ID_{min}}}$$

IDN = impervious cover density normalized

<u>Population Density</u>

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin

A = area of sub-basin

$$PD = P/A$$

PD = population density

$$PDN_i = \frac{PD_i - PD_{min}}{PD_{max} - PD_{min}}$$

PDN = population density normalized

<u>Heat-Vulnerable Population Density</u>

Source data:

1. *Census 2010 TIGER Census Blocks*

The above methodology for population density was utilized to identify a population density of those who are most vulnerable to heat-induced stress: young children (<5 years) and older citizens (>65 years).

HP = total heat vulnerable population in subbasin

A = area of subbasin

HPD = heat-vulnerable population density

HPD = HP/A

$$HPDN_i = \frac{HPD_i - HPD_{min}}{HPD_{max} - HPD_{min}}$$

HPDN = heat-vulnerable population density normalized

<u>Service Gap Score</u>

W_{TD} = Tree cover density weighting

W_{TD} = 25%

W_{ID} = impervious cover density weighting

W_{ID} = 25%

W_{PD} = population density weighting

W_{PD} = 25%

W_{HPD} =heat-vulnerable population density weighting

W_{HPD} = 25%

$$SG_i = (W_{TD} * TDN_i) + (W_{ID} * IDN_i) + (W_{PD} * PDN_i) + (W_{HPD} * HPDN_i)$$

SG = service gap score raw

$$SGN_i = \frac{SG_i - SG_{min}}{SG_{max} - SG_{min}}$$

SGN = service gap score normalized

B.3 Flooding Reduction Algorithm

Identify areas with high instances of flooding, high impervious cover, and high population density where GI can be beneficial to reducing flooding.

Flood Location Density

Source data:

1. *CCMUA Flooding Locations*
   a. *Reported locations of flooding*

The buffer tool was used to create a 200 meter buffer (about the length of four city blocks) around each instance of flooding. Flooding locations were tallied per each sub-basin, and any locations in other sub-basins captured by the buffer were added to the count with a weight of 0.5.

FL = count flooding locations per sub-basin (#)
B = count of flooding locations within 200 meters of another flooding location
A = area of sub-basin
FLD = flood location density

FLD = [FL + (0.5)B] / A

$$\mathrm{FLDN_i} = \frac{\mathrm{FLD_i} - \mathrm{FLD_{min}}}{\mathrm{FLD_{max}} - \mathrm{FLD_{min}}}$$

FLDN = Flood location density per subbasin normalized

Mean Elevation

Source data:

1. *New Jersey DEP*
   a. *Digital Elevation Grid of the Lower Delaware Watershed Management Area (WMA 18)*

A Digital Elevation Model (DEM) file was obtained from NJDEP covering the Camden area and used to calculate summary statistics on elevation for the city. The Zonal Statistics tool was used to calculate average elevation values for each of the sub-basins across the city.

E = elevation per grid square
n = number of grid squares per subbasin
ME = mean elevation

ME = ΣE/n

$$\mathrm{MEN}_i = 1 - \frac{\mathrm{ME_i} - \mathrm{ME_{min}}}{\mathrm{ME_{max}} - \mathrm{ME_{min}}}$$

MEN = Median elevation normalized

Impervious Cover Density

Source data:

1. *CDM Smith – Drainage Subbasin Statistics*
   a. *Impervious coverage per subbasin*

I_s = impervious cover per sub-basin (acres)
A = area of sub-basin (acres)

ID = I_s/A
ID = impervious cover density

$$\mathrm{IDN_i} = \frac{\mathrm{ID_i} - \mathrm{ID_{min}}}{\mathrm{ID} - \mathrm{ID_{min}}}$$

IDN = impervious cover density normalized

Population Density

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin
A = area of sub-basin

$$\mathrm{PD} = \mathrm{P/A}$$

PD = population density

$$\mathrm{PDN_i} = \frac{\mathrm{PD_i} - \mathrm{PD_{min}}}{\mathrm{PD_{max}} - \mathrm{PD_{min}}}$$

PDN = population density normalized

Service Gap Score

W_{FLD} = flood location density weighting
W_{FLD} = 40%
W_{ME} = mean elevation weighting
W_{ME} = 20%
W_{ID} = impervious cover weighting
W_{ID} = 20%
W_{PD} = population density weighting
W_{PD} = 20%

$$\mathrm{SG_i} = (\mathrm{W_{FLD}} * \mathrm{FLDN_i}) + (\mathrm{W_{ME}} * \mathrm{MEN}_i) + (\mathrm{W_{ID}} * \mathrm{IDN_i}) + (\mathrm{W_{PD}} * \mathrm{PDN_i})$$

SG = service gap score raw

$$\mathrm{SGN_i} = \frac{\mathrm{SG_i} - \mathrm{SG_{min}}}{\mathrm{SG_{max}} - \mathrm{SG_{min}}}$$

SGN = service gap score normalized

B.4 Capacity Building / Green Jobs Expansion Algorithm

Identify economically depressed areas vs. opportunities for education or capacity building.

Median Household Income

Source data:

1. *American Community Survey 2011 Census Block Groups*

The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional population values per income range for the split census blocks were calculated based on area, and the total population values per income range in the sub-basin were calculated by totaling the contributing census block groups. The median household income values were found from the new distributions.

MHI = median household income

$$\mathrm{MHIN_i} = 1 - \frac{\mathrm{MHI_i} - \mathrm{MHI_{min}}}{\mathrm{MHI_{max}} - \mathrm{MHI_{min}}}$$

MHIN = median household income normalized

Unemployment Rate

Source data:

1. *American Community Survey 2011 Census Block Groups*

The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional values for total and unemployed population 16 years and over for the split census blocks were calculated based on area, and the total values in the sub-basin were calculated by totaling the contributing census block groups.

UP = unemployed population 16 years and over
TP = total population 16 years and over

$$\mathrm{UR} = \frac{\mathrm{UP}}{\mathrm{TP}}$$

UR = unemployment rate

$$\mathrm{URN_i} = \frac{\mathrm{UR_i} - \mathrm{UR_{min}}}{\mathrm{UR_{max}} - \mathrm{UR_{min}}}$$

URN = unemployment rate normalized

Capacity Building Opportunities

Source data:

1. *Community Gardening in Camden, NJ Harvest Report: Summer 2009, University of Pennsylvania*
    b. *Reference document for environmental community organizations*
2. *City of Camden*
    a. *Public elementary and secondary school locations provided by TPL*

CO = count of environmental community organizations within 0.1 miles of sub-basin
S = count of public elementary and secondary schools within 0.1 miles of sub-basin
A = area of polygon

$CB = (CO + S)/A$
CB = capacity building density

$$CBN_i = \frac{CB_i - CB_{min}}{CB_{max} - CB_{min}}$$
CBN = capacity building density normalized

Service Gap Score
W_{MHI} = median household income weighting
W_{MHI} = 25%
W_{UR} = unemployment rate weighting
W_{UR} = 25%
W_{CB} = capacity building weighting
W_{CB} = 50%

$$SG_i = (W_{MHI} * MHIN_i) + (W_{UR} * URN_i) + (W_{CB} * CBN_i)$$
SG = service gap score raw

$$SGN_i = \frac{SG_i - SG_{min}}{SG_{max} - SG_{min}}$$
SGN = service gap score normalized

B.5 Fitness Opportunity Expansion Algorithm

Identify economically depressed areas without access to outdoor destinations

<u>Median Household Income</u>

Source data:

1. *American Community Survey 2011 Census Block Groups*

The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional population values per income range for the split census blocks were calculated based on area, and the total population values per income range in the sub-basin were calculated by totaling the contributing census block groups. The median household income values were found from the new distributions.

MHI = median household income

$$\mathrm{MHIN_i} = 1 - \frac{\mathrm{MHI_i} - \mathrm{MHI_{min}}}{\mathrm{MHI_{max}} - \mathrm{MHI_{min}}}$$

MHIN = median household income normalized

<u>Population Density</u>

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin
A = area of sub-basin

$$\mathrm{PD} = \mathrm{P}/\mathrm{A}$$

PD = population density

$$\mathrm{PDN_i} = \frac{\mathrm{PD_i} - \mathrm{PD_{min}}}{\mathrm{PD_{max}} - \mathrm{PD_{min}}}$$

PDN = population density normalized

<u>Lack of Outdoor Destinations</u>

Source data:

1. *City of Camden*
    a. *Public park locations provided by TPL*
2. *Community Gardening in Camden, NJ Harvest Report: Summer 2009, University of Pennsylvania*
    b. *Reference document for environmental community organizations*

P = count of Camden public parks within 0.1 miles of sub-basin
G = count of community gardens within 0.1 miles of sub-basin
A = area of polygon

$$\mathrm{OD} = (\mathrm{P} + \mathrm{G})/\mathrm{A}$$

OD = outdoor destinations density

$$\mathrm{LODN_i} = 1 - \frac{\mathrm{OD_i} - \mathrm{OD_{min}}}{\mathrm{OD_{max}} - \mathrm{OD_{min}}}$$

LODN = lack of outdoor destinations density normalized

Service Gap Score

W_{MHI} = median household income weighting

W_{MHI} = 25%

W_{PD} = population density weighting

W_{PD} = 25%

W_{LOD} = lack of outdoor destinations weighting

W_{LOD} = 50%

$$\mathrm{SG_i} = (\mathrm{W_{MHI}} * \mathrm{MHIN_i}) + (\mathrm{W_{PD}} * \mathrm{PDN_i}) + (\mathrm{W_{CB}} * \mathrm{LODN_i})$$

SG = service gap score raw

$$\mathrm{SGN_i} = \frac{\mathrm{SG_i} - \mathrm{SG_{min}}}{\mathrm{SG_{max}} - \mathrm{SG_{min}}}$$

SGN = service gap score normalized

B.6 Stress Reduction Algorithm

Identify areas with high risk of stress and lack of mental health support locations.

Population Density

Source data:

1. *Census 2010 TIGER Census Blocks*

The Intersect tool was used to split the census blocks to align with the sub-basins. Proportional population values for the split census blocks were calculated based on area, and the total population in the sub-basin was calculated by totaling the contributing census blocks.

P = population in sub-basin
A = area of sub-basin

$$\mathrm{PD} = \mathrm{P}/\mathrm{A}$$

PD = population density

$$\mathrm{PDN_i} = \frac{\mathrm{PD_i} - \mathrm{PD_{min}}}{\mathrm{PD_{max}} - \mathrm{PD_{min}}}$$

PDN = population density normalized

Median Household Income

Source data:

1. *American Community Survey 2011 Census Block Groups*

The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional population values per income range for the split census blocks were calculated based on area, and the total population values per income range in the sub-basin were calculated by totaling the contributing census block groups. The median household income values were found from the new distributions.

MHI = median household income

$$\mathrm{MHIN_i} = 1 - \frac{\mathrm{MHI_i} - \mathrm{MHI_{min}}}{\mathrm{MHI_{max}} - \mathrm{MHI_{min}}}$$

MHIN = median household income normalized

Unemployment Rate

Source data:

1. *American Community Survey 2011 Census Block Groups*

The Intersect tool was used to split the census block groups to align with the sub-basins. Proportional values for total and unemployed population 16 years and over for the split census blocks were calculated based on area, and the total values in the sub-basin were calculated by totaling the contributing census block groups.

UP = unemployed population 16 years and over
TP = total population 16 years and over

$$UR = \frac{UP}{TP}$$

UR = unemployment rate

$$URN_i = \frac{UR_i - UR_{min}}{UR_{max} - UR_{min}}$$

URN = unemployment rate normalized

<u>Lack of Stress Reduction Services</u>

Source data:

1. *State of New Jersey Department of Human Services, Directory of Mental Health Services*
    a. *Mental health service centers*
2. *The Mental Health Association in Southwestern New Jersey – The Camden County Guide to Mental Health Services*
    a. *Mental health service centers*
3. *City of Camden*
    a. *Public park locations provided by TPL*
4. *Community Gardening in Camden, NJ Harvest Report: Summer 2009, University of Pennsylvania*
    c. *Reference document for environmental community organizations*
    d.

MH = count of mental health service centers within 0.1 miles of sub-basin
P = count of Camden public parks within 0.1 miles of sub-basin
G = count of community gardens within 0.1 miles of sub-basin

A = area of polygon

$$SR = (MH + P + G)/A$$

SR = stress reduction services density

$$LSRN_i = 1 - \frac{SR_i - SR_{min}}{SR_{max} - SR_{min}}$$

LSRN = lack of stress reduction services density normalized

<u>Service Gap Score</u>

W_{PD} = population density weighting
W_{PD} = 16.7%
W_{MHI} = median household income weighting
W_{MHI} = 16.7%
W_{UR} = unemployment rate weighting
W_{UR} = 16.7%
W_{LSR} = lack of stress reduction services weighting
W_{LSR} = 50%

$$SG_i = (W_{PD} * PDN_i) + (W_{MHI} * MHIN_i) + (W_{UR} * URN_i) + (W_{LSR} * LSRN_i)$$

SG = service gap score raw

$$\mathrm{SGN_i} = \frac{\mathrm{SG_i} - \mathrm{SG_{min}}}{\mathrm{SG_{max}} - \mathrm{SG_{min}}}$$

SGN = service gap score normalized

C. Opinions of Probable Cost

C.1 Alberta Woods Park

OPINION OF PROBABLE COST

Site Size: 1.0 Acres

Prepared By: eDesign Dynamics and The Trust for Public Land

Based on Concept Plan 4/6/2016

	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Rain Garden**					**$58,024**
1a)	Excavation and removals	$48.00	300	CY	$14,400	
1b)	Broken stone, placed	$60.00	118	CY	$7,080	
1c)	Imported sand based planting medium, placed	$60.00	146	CY	$8,760	
1d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	3,656	EA	$12,796	
1e)	Cover crop seed, installed	$1.40	3,166	SF	$4,432	
1f)	Overflow structure	$3,000.00	1	EA	$3,000	
1g)	Cleanouts (every 50')	$500.00	5	EA	$2,500	
1h)	Distribution pipes, installed	$16.60	200	LF	$3,320	
1i)	Geotextile fabric	$0.50	3,471	SF	$1,736	
2	**Native Planting Area**					**$30,513**
2a)	Excavation and removals	$48.00	169	CY	$8,112	
2b)	Imported sand based planting medium, placed	$60.00	169	CY	$10,140	
2c)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	3,503	EA	$12,261	
3	**Hard Surface Path**					**$70,344**
3a)	Excavation and removals	$48.00	52	CY	$2,496	
3b)	Grading and concrete paving	$22.00	3,084	SF	$67,848	
4	**Subsurface Runoff Retention**					**$124,057**
4a)	Excavation and removals	$48.00	634	CY	$30,432	
4b)	Geotextile fabric	$0.50	5,706	SF	$2,853	
4c)	Broken stone, placed	$60.00	423		$25,380	
4d)	Backfill and replanting with sod	$11.20	5,035	SF	$56,392	
4e)	Drain structures	$3,000.00	3	EA	$9,000	
5	**Traffic Calming Stormwater Bumpouts**					**$133,736**
5a)	Excavation and removals	$48.00	356	CY	$17,088	
5b)	Broken stone, placed	$60.00	143	CY	$8,580	
5c)	Imported sand based planting medium, placed	$60.00	178	CY	$10,680	
5d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	4,437	EA	$15,530	
5e)	Cover crop seed, installed	$1.40	3,842	SF	$5,379	
5f)	Overflow structure	$3,000.00	10	EA	$30,000	
5g)	Cleanouts (every 50')	$500.00	8	EA	$4,000	

5h)	Distribution pipes, installed	$16.60	365	LF	$6,059	
5i)	Geotextile fabric	$0.50	3,842	SF	$1,921	
5j)	Raised planters	$500.00	11	EA	$5,500	
5k)	6" curb installed	$50.00	580	LF	$29,000	
6	**Stormwater Road Crossings**					**$32,190**
6a)	Sawcut existing pavement	$1.00	474	LF	$474	
6b)	Excavation and removals	$48.00	105	CY	$5,040	
6c)	Broken stone pipe bedding	$60.00	18	CY	$1,080	
6d)	12" reinforced concrete pipe	$60.00	237	LF	$14,220	
6e)	Backfill and repave	$12.00	948	SF	$11,376	
7	**Expanded Vegetated ROW Strip**					**$30,581**
7a)	Sawcut existing sidewalk	$1.00	1,053	LF	$1,053	
7b)	Excavation and removals	$48.00	234	CY	$11,232	
7c)	Imported sand based planting medium, placed	$60.00	234	CY	$14,040	
7d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	1,216	EA	$4,256	
8	**Site Furnishings, installed**					**$154,500**
8a)	Wood bench	$1,500.00	19	EA	$28,500	
8b)	Grill	$500.00	4	EA	$2,000	
8c)	ADA picnic tables with sun shelter	$11,500.00	4	EA	$46,000	
8d)	Game table	$4,000.00	3	EA	$12,000	
8e)	Concrete bench	$2,000.00	6	EA	$12,000	
8f)	Concrete table	$3,000.00	6	EA	$18,000	
8g)	Fruit trees	$2,000.00	8	EA	$16,000	
8h)	Lawn sodding and seeding	$20,000.00	1	LS	$20,000	
					CONSTRUCTION SUBTOTAL	$633,945
					15% General Conditions	$95,092
					25% Contingency	$158,486
					TOTAL	**$887,523**

SITE INVESTIGATION COSTS						
	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Geotechnical Investigation**					**$33,000**
1a)	Soil and infiltration testing (includes Phase 2 soil testing)	$5,500	6	EA	$33,000	
2	**Survey Investigation**					**$15,000**
2a)	Site survey (entire site area)	$15,000	1.0	ACRE	$15,000	
3	**Phase 1 Environmental Assessment**					**$10,000**
3a)	Phase 1 Environmental Assessment	$10,000	1	LS	$10,000	
4	**Phase 2 Environmental Assessment**					**$50,000**
4a)	Phase 2 Environmental Assessment	$50,000	1	LS	$50,000	
					SITE INVESTIGATION SUBTOTAL	$108,000
					15% General Conditions	$16,200
					25% Contingency	$27,000
					SITE INVESTIGATION TOTAL	**$151,200**

C.2 Charles Sumner Elementary School

OPINION OF PROBABLE COST

Site Size: 3.2 Acres
Prepared By: eDesign Dynamics and The Trust for Public Land

Based on Concept Plan 4/18/2016

	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Rain Garden**					**$78,633**
1a)	Excavation and removals	$48.00	240	CY	$11,520	
1b)	Broken stone, placed	$60.00	97	CY	$5,820	
1c)	Imported sand based planting medium, placed	$60.00	120	CY	$7,200	
1d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	4,619	EA	$16,167	
1e)	Cover crop seed, installed	$1.40	4,619	SF	$6,467	
1f)	Overflow structure	$3,000.00	4	EA	$12,000	
1g)	Stormwater inlet	$7,500.00	2	EA	$15,000	
1h)	Cleanouts (every 50')	$500.00	3	EA	$1,500	
1i)	Distribution pipes, installed	$16.60	100	LF	$1,660	
1j)	Geotextile fabric	$0.50	2,600	SF	$1,300	
2	**Flower Gardens**					**$11,459**
2a)	Excavation and removals	$48.00	35	CY	$1,680	
2b)	Imported top soil, placed	$60.00	35	CY	$2,100	
2c)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	2,194	EA	$7,679	
3	**Asphalt Replacement**					**$649,350**
3a)	Excavation and removals	$48.00	1,200	CY	$57,600	
3b)	Grading and asphalt paving	$9.00	65,750	SF	$591,750	
4	**Parking Lot Green Strip**					**$67,661**
4a)	Excavation and removals	$48.00	208	CY	$9,984	
4b)	Broken stone, placed	$60.00	83	CY	$4,980	
4c)	Imported sand based planting medium, placed	$60.00	104	CY	$6,240	
4d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	2,599	EA	$9,097	
4e)	Cover crop seed, installed	$1.40	2,250	SF	$3,150	
4f)	Overflow structure	$3,000.00	1	EA	$3,000	
4g)	Cleanouts (every 50')	$500.00	6	EA	$3,000	
4h)	Distribution pipes, installed	$16.60	216	LF	$3,586	
4i)	Geotextile fabric	$0.50	2,250	SF	$1,125	
4j)	6" curb installed	$50.00	470	LF	$23,500	
5	**Traffic Calming Stormwater Bumpouts**					**$87,719**
5a)	Excavation and removals	$48.00	202	CY	$9,696	

5b)	Broken stone, placed	$60.00	81	CY	$4,860	
5c)	Imported sand based planting medium, placed	$60.00	101	CY	$6,060	
5d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	2,518	EA	$8,813	
5e)	Cover crop seed, installed	$1.40	2,180	SF	$3,052	
5f)	Overflow structure	$3,000.00	8	EA	$24,000	
5g)	Cleanouts (every 50')	$500.00	7	EA	$3,500	
5h)	Distribution pipes, installed	$16.60	280	LF	$4,648	
5i)	Geotextile fabric	$0.50	2,180	SF	$1,090	
5j)	6" curb installed	$50.00	440	LF	$22,000	
6	**Synthetic Turf Field**					**$143,240**
6a)	Excavation and removals	$48.00	255	CY	$12,240	
6b)	Broken stone, placed	$60.00	255	CY	$15,300	
6c)	Turf field - turf/screening/shock pad/adhesive	$19.00	5,300	SF	$100,700	
6d)	6" curb installed	$50.00	300	LF	$15,000	
7	**Play Equipment**					**$102,000**
7a)	Safety surface, installed	$15.00	2,800	SF	$42,000	
7b)	Procure and install play structure	$60,000.00	1	LS	$60,000	
8	**Site Furnishings, installed**					**$87,350**
8a)	Wood bench	$1,500.00	12	EA	$18,000	
8b)	Game table	$4,000.00	3	EA	$12,000	
8c)	Trees	$1,000.00	30	EA	$30,000	
8d)	Rain barrels, installed	$50.00	9	EA	$450	
8e)	Downspout rain chains, installed	$100.00	4	EA	$400	
8f)	Treadle pump, installed	$500.00	2	EA	$1,000	
8g)	Elevated planters, installed	$500.00	15	EA	$7,500	
8h)	Carousel playground pump, installed	$5,000.00	1	EA	$5,000	
8i)	Parking lot and sports striping	$10,000.00	1	LS	$10,000	
8j)	Basketball goal, installed	$1,500.00	2	EA	$3,000	
					CONSTRUCTION SUBTOTAL	$1,227,412
					15% General Conditions	$184,112
					25% Contingency	$306,853
					CONSTRUCTION TOTAL	**$1,718,377**

SITE INVESTIGATION COSTS						
	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Geotechnical Investigation**					**$49,500**
1a)	Soil and infiltration testing (includes Phase 2 soil testing)	$5,500	9	EA	$49,500	
2	**Survey Investigation**					**$48,000**
2a)	Site survey (entire site area)	$15,000	3.2	ACRE	$48,000	
3	**Phase 1 Environmental Assessment**					**$10,000**
3a)	Phase 1 Environmental Assessment	$10,000	1	LS	$10,000	
4	**Phase 2 Environmental Assessment**					**$50,000**
4a)	Phase 2 Environmental Assessment	$50,000	1	LS	$50,000	
					SITE INVESTIGATION SUBTOTAL	$157,500
					15% General Conditions	$23,625
					25% Contingency	$39,375
					SITE INVESTIGATION TOTAL	**$220,500**

C.3 Vine and Willard Vacant Lots

OPINION OF PROBABLE COST

Site Size: 0.6 Acres

Prepared By: eDesign Dynamics and The Trust for Public Land

Based on Concept Plan 4/14/2016

	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Rain Garden**					**$70,062**
1a)	Excavation and removals	$48.00	204	CY	$9,792	
1b)	Broken stone, placed	$60.00	82	CY	$4,920	
1c)	Imported sand based planting medium, placed	$60.00	102	CY	$6,120	
1d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	2,540	EA	$8,890	
1e)	Cover crop seed, installed	$1.40	2,200	SF	$3,080	
1f)	Overflow structure	$3,000.00	1	EA	$3,000	
1g)	Stormwater inlet	$7,500.00	4	EA	$30,000	
1h)	Cleanouts (every 50')	$500.00	3	EA	$1,500	
1i)	Distribution pipes, installed	$16.60	100	LF	$1,660	
1j)	Geotextile fabric	$0.50	2,200	SF	$1,100	
2	**Permeable Pavement Loading Area**					**$9,516**
2a)	Excavation and removals	$48.00	32	CY	$1,536	
2b)	Broken stone, placed	$60.00	18	CY	$1,080	
2c)	Permeable concrete, installed	$12.00	575	SF	$6,900	
3	**Hard Surface Path**					**$57,938**
3a)	Excavation and removals	$48.00	47	CY	$2,256	
3b)	Grading and concrete paving	$22.00	2,531	SF	$55,682	
4	**Shipping Container Workspaces**					**$88,860**
4a)	Excavation and removals	$48.00	45	CY	$2,160	
4b)	Broken stone foundation, placed	$60.00	45	CY	$2,700	
4c)	30 ft shipping containers, delivered	$2,000.00	12	EA	$24,000	
4d)	Container furnishings	$5,000.00	12	EA	$60,000	
5	**Retail Shrub Nursery**					**$65,160**
5a)	Excavation and removals	$48.00	20	CY	$960	
5b)	Concrete pad foundation	$22.00	1,100	SF	$24,200	
5c)	Pavilion roof	$20,000.00	1	LS	$20,000	
5d)	Nursery furnishings	$10,000.00	1	LS	$10,000	
5e)	Initial inventory purchase	$10,000.00	1	LS	$10,000	
6	**Retail Tree Nursery**					**$103,480**
6a)	Excavation and removals	$48.00	35	CF	$1,680	
6b)	Concrete pad foundation	$22.00	1,900	SF	$41,800	
6c)	Pavilion roof	$25,000.00	1	LS	$25,000	

6d)	Nursery furnishings	$15,000.00	1	LS	$15,000	
6e)	Initial inventory purchase	$20,000.00	1	LS	$20,000	
7	**Site Furnishings, installed**					**$548,400**
7a)	Greenhouse, furnished	$100.00	5,200	SF	$520,000	
7b)	Rain barrels, installed	$100.00	4	EA	$400	
7c)	Shaded pavilion	$10,000.00	1	LS	$10,000	
7d)	Permanent trees	$1,000.00	8	EA	$8,000	
7e)	Lawn sodding and seeding	$10,000.00	1	LS	$10,000	
					CONSTRUCTION SUBTOTAL	$943,416
					15% General Conditions	$141,512
					25% Contingency	$235,854
					CONSTRUCTION TOTAL	**$1,320,782**

SITE INVESTIGATION COSTS

	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Geotechnical Investigation**					**$11,000**
1a)	Soil and infiltration testing (includes Phase 2 soil testing)	$5,500	2	EA	$11,000	
2	**Survey Investigation**					**$9,000**
2a)	Site survey (entire site area)	$15,000	0.6	ACRE	$9,000	
3	**Phase 1 Environmental Assessment**					**$10,000**
3a)	Phase 1 Environmental Assessment	$10,000	1	LS	$10,000	
4	**Phase 2 Environmental Assessment**					**$50,000**
4a)	Phase 2 Environmental Assessment	$50,000	1	LS	$50,000	
					SITE INVESTIGATION SUBTOTAL	$80,000
					15% General Conditions	$12,000
					25% Contingency	$20,000
					SITE INVESTIGATION TOTAL	**$112,000**

C.4 Former Camden Labs

OPINION OF PROBABLE COST
Site Size: 3.8 Acres
Prepared By: eDesign Dynamics and The Trust for Public Land
Based on Concept Plan 4/21/2016

	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Rain Garden**					**$255,818**
1a)	Excavation and removals	$150.00	685	CY	$102,750	
1b)	Broken stone, placed	$60.00	274	CY	$16,440	
1c)	Imported sand based planting medium, placed	$60.00	343	CY	$20,580	
1d)	Native plant plugs (installed 12" O.C.) or shrub containers (installed 3' O.C.)	$3.50	8,545	SF	$29,908	
1e)	Cover crop seed, installed	$1.40	7,400	SF	$10,360	
1f)	Trees	$1,000.00	10	EA	$10,000	
1g)	Overflow structure	$3,000.00	3	EA	$9,000	
1h)	Stormwater inlet	$7,500.00	2	EA	$15,000	
1i)	Cleanouts (every 50')	$500.00	7	EA	$3,500	
1j)	Distribution pipes, installed	$16.60	300	LF	$4,980	
1k)	Geotextile fabric	$0.50	7,400	SF	$3,700	
1l)	Impermeable liner, installed	$4.00	7,400	SF	$29,600	
2	**Emergent Wetland Stormwater Conveyance Strip**					**$76,616**
2a)	Excavation and removals	$150.00	259	CY	$38,850	
2b)	Imported sand based planting medium, placed	$60.00	194	CY	$11,640	
2c)	Impermeable liner, installed	$4.00	3,500	SF	$14,000	
2d)	Native plant plugs, installed 12" O.C.	$3.00	4,042	EA	$12,126	
3	**Roadway Paving**					**$498,975**
3a)	Excavation and removals	$150.00	1,084	CY	$162,600	
3b)	Grading and asphalt paving	$11.50	29,250	SF	$336,375	
4	**Walkway Paving**					**$190,850**
4a)	Excavation and removals	$150.00	143	CY	$21,450	
4b)	Grading and concrete paving	$22.00	7,700	SF	$169,400	
5	**Subsurface Runoff Retention/Detention**					**$255,320**
5a)	Excavation and removals	$150.00	611	CY	$91,650	
5b)	Geotextile fabric	$0.50	5,500	SF	$2,750	
5c)	Impermeable liner, installed	$4.00	5,500	SF	$22,000	
5d)	Broken stone, placed	$60.00	407	CY	$24,420	
5e)	Backfill and replanting with sod	$20.00	5,500	SF	$110,000	
5f)	Drain structures	$3,000.00	1	EA	$3,000	
5g)	Cleanouts	$500.00	3	EA	$1,500	
6	**Subsurface Storage Tank**					**$54,300**

6a)	2000 gallon load bearing storage tank with surface access	$10,000.00	3	EA	$30,000	
6b)	Solar pump w/ solar panels, housing, control box	$6,000.00	1	EA	$6,000	
6c)	Excavation and removals	$150.00	10	CY	$1,500	
6d)	Backfill and replanting with sod	$11.20	1,500	SF	$16,800	
7	**Green Roof**					**$195,960**
7a)	Green roof system, installed[1]	$15.00	13,064	SF	$195,960	
8	**Site Furnishings, installed**					**$667,013**
8a)	Fitness pods	$15,000.00	5	EA	$75,000	
8b)	Trees	$1,000.00	72	EA	$72,000	
8c)	Sodding and seeting lawn areas	$1.20	82,600	SF	$99,120	
8d)	Benches	$2,500.00	30	EA	$75,000	
8e)	ADA picnic tables with sun shelter	$11,500.00	12	EA	$138,000	
8f)	Trash receptacles	$1,000.00	10	EA	$10,000	
8g)	Recycling receptacles	$1,000.00	10	EA	$10,000	
8h)	Bike racks	$1,380.00	12	EA	$16,560	
8i)	Compost bins	$500.00	6	EA	$3,000	
8j)	Garden shed	$5,000.00	2	EA	$10,000	
8k)	Earthwork for public lawn hill	$60.00	306	CY	$18,333	
8l)	Lighting allowance	$100,000.00	1	LS	$100,000	
8m)	Water filling station allowance	$20,000.00	2	EA	$40,000	
9	**Remediation**					**$551,760**
9a)	18" clean fill cap	$60.00	9,196	CY	$551,760	
Note 1: Green roof and other architectural improvements not considered in this cost opinion.						
					CONSTRUCTION SUBTOTAL	$2,746,612
					15% General Conditions	$411,992
					25% Contingency	$686,653
					CONSTRUCTION TOTAL	**$3,845,257**

SITE INVESTIGATION COSTS						
	Item	Unit Cost	Qty	Unit	Line Total	Item Total
1	**Geotechnical Investigation**					**$44,000**
1a)	Soil and infiltration testing (includes Phase 2 soil testing)	$5,500	8	EA	$44,000	
2	**Survey Investigation**					**$57,507**
2a)	Site survey (entire site area)	$15,000	3.8	ACRE	$57,507	
3	**Phase 1 Environmental Assessment**					**$10,000**
3a)	Phase 1 Environmental Assessment	$10,000	1	LS	$10,000	
4	**Phase 2 Environmental Assessment**					**$50,000**
4a)	Phase 2 Environmental Assessment	$50,000	1	LS	$50,000	
					SITE INVESTIGATION SUBTOTAL	$161,507
					15% General Conditions	$24,226
					25% Contingency	$40,377
					SITE INVESTIGATION TOTAL	**$226,110**