THE ATLANTA UNIVERSITY CENTER GREEN INFRASTRUCTURE PLAN

QUANTIFYING THE BENEFITS OF GREENWAYS, CISTERNS, AND TREES

TECHNICAL REPORT

ENVIRONMENTAL COMMUNITY ACTION, INC

EARTH ECONOMICS

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Earth Economics acknowledges that we operate on the lands of the Coast Salish peoples, specifically the ancestral homelands of the Puyallup Tribe of Indians, and the 1854 Medicine Creek Treaty.

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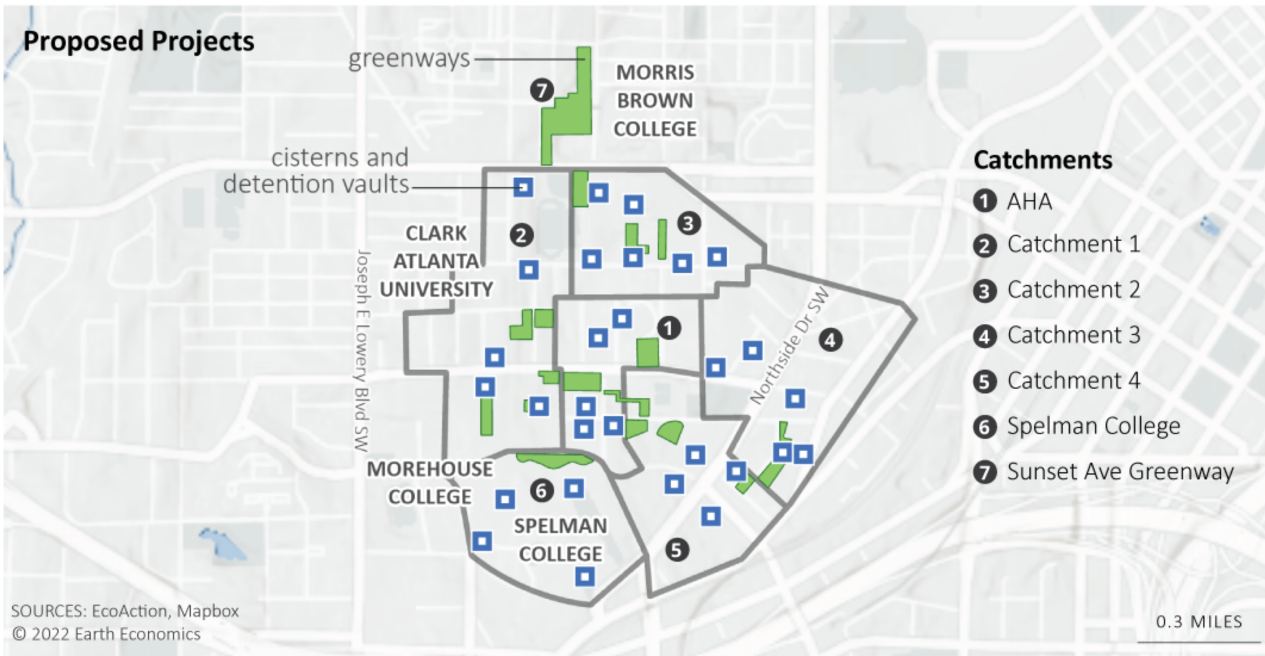
Introduction

Environmental Community Action, Inc. (ECO-Action) helps vulnerable communities in Georgia prevent, confront, and resolve environmental health threats. ECO-Action has been using green infrastructure to address frequent flooding in collaboration with Clark Atlanta University, the Interdenominational Theological Center, Morris Brown College, Spelman College, and owners of adjacent private properties that drain onto the campuses, including the Atlanta Housing Authority site, the Friendship Baptist Church development, and the Villages II affordable housing redevelopment.[1] They developed nine conceptual plans to capture 40 million gallons of stormwater runoff per year through the construction of 27 cisterns, three detention vaults, and 14 greenways for the Atlanta University Center (AUC) area. The plans also include planting 656 trees along streets and in greenways. Figure 1 maps the location of these projects in the AUC.

Figure 1. Map of Proposed Green Infrastructure Solutions



ECO-Action partnered with Earth Economics to analyze the public economic benefits of the proposed Green Infrastructure Conceptual Plans. This research highlights the dollar value of a few selected benefits; further work is needed to value additional benefits. This technical report provides additional details to support the accompanying fact sheet.

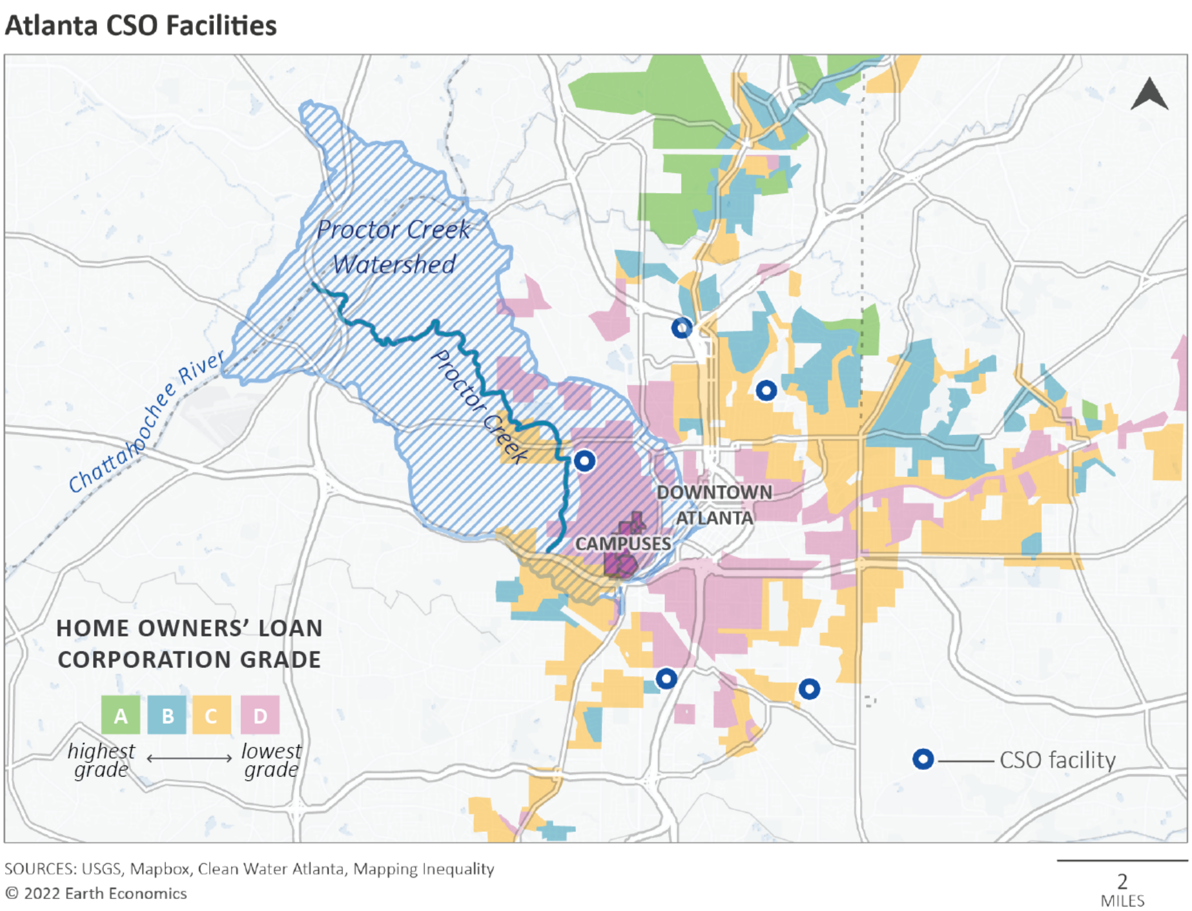
[1] For more information, see ECO-Action's website at https://eco-act.org/giauc/

Site Overview: Flooding in Atlanta, GA

The proposed green infrastructure sites are located within Atlanta's upper Proctor Creek watershed, which flows west to the Chattahoochee River (Figure 2). The area's rocky geology and clay soils limit the infiltration of stormwater into the ground.[i] Development and impervious surfaces in the historic drainage areas of the watershed also contribute to frequent flooding. Stormwater runoff generated in the Atlanta University Center (AUC) flows north to impact the Vine City and English Avenue neighborhoods then west into Proctor Creek.[ii]

Many of these neighborhoods on Atlanta's near westside were subject to redlining (Figure 2), a federally supported process of residential segregation that denied fair access to credit and mortgages based on a prospective home buyer's race or the perceived quality of the neighborhood. Redlining contributed to a relative lack of public and private investment in the area. Today, the legacy of this history reveals itself through higher levels of vulnerability among residents of the neighborhoods around the AUC. These vulnerabilities hinge on multiple factors, including higher rates of poverty, unemployment, overcrowding, and lack of access to transportation—all of which affect a community's ability to respond to and recover from the effects of natural disasters, like flooding.

Figure 2. The Proctor Creek Watershed in Relation to the AUC and Historically Redlined Neighborhoods



The Proctor Creek watershed faces significant and increasing risks from flooding. Stormwater runs off the hard surfaces on and around the AUC, contributing to flooding across the watershed during major rainfall events. Even during smaller rain events, the highly urbanized nature of the surrounding area can concentrate stormwater runoff and drive localized flooding that blocks roadways and damages commercial and residential buildings.[iii] When excessive amounts of stormwater runoff enter the area's combined sewer systems, both nearby sanitary sewer overflows and downstream combined sewer overflows (CSO) occur, exposing people and property to untreated sewage that poses serious health risks.

Urban flood damage often happens at a scale too small to trigger the disaster declarations that release state and federal recovery funds, which means that damages must be covered by individual insurance claims. The ability to do so remains an issue for area households, as those outside of FEMA-designated Special Flood Hazard Areas are not required to hold National Flood Insurance Program (NFIP) policies.

Because flood insurance is optional and expensive, many households cannot afford to purchase or retain flood insurance. This is particularly true for renters, who are often less financially secure than homeowners since they typically lack home equity—the foundation from which wealth is built. Renters are thus more vulnerable to flood damage.

American Community Survey data reveals that 71 percent of residents in the Proctor Creek watershed rent.[iv] Of those renters, 46 percent reported paying more than a third of their income for housing, which classifies this group as rent burdened. This population is particularly vulnerable to flooding damage and displacement risks without sufficient resources to effectively respond to the aftermath of a flood event.

Average costs per household from property flooding can surpass $36,000 (2021 USD)[v] based on a survey from Cook County, IL, adjusted for inflation and cost of living comparisons. Some of the other expenses and income categories below may include healthcare costs, lost use of property, and impacts on business income, among other factors[vi]. Specific costs can include:

- Damages to structures: $7,858
- Lost valuables: $4,664
- Other expenses: $4,562
- Lost wages: $3,375
- Lost other income: $10,553

Costs to the individual include:

- Damage to structures and property
- Lost wages or business income due to missed work
- Time and money spent on cleanup
- Longer commutes due to flood closures
- Health-related costs from mold-induced respiratory issues
- Stress and mental health impacts of repeated flooding
- Reduced access to emergency services, public transit, schools, etc.[vii]
- Increased risk of injury and death (slips, falls, drownings)[viii]

Costs to the public include:

- Decreased economic activity[ix]
- Decreased real estate value[x]
- Business closures[xi]
- Discharge of contaminants (heavy metals, nutrients like nitrogen and phosphorus) to adjacent water bodies[xii]

Background: Green Infrastructure for Stormwater Management

Green infrastructure installations mimic natural processes to slow and reduce the amount of stormwater flowing into sewers. Planners and community groups nationwide are increasingly turning to diverse green infrastructure solutions to mitigate urban flooding because of their cost savings, efficacy, cross-compatibility with existing infrastructure, and other co-benefits.[xiii]

By continuing to complement existing gray infrastructure with additional green infrastructure installation, the need for investments in large-scale projects to increase drainage pipe size or treatment capacity can be minimized. As the following examples show, green infrastructure reduces the stormwater runoff entering over-burdened drainage systems, thereby providing savings for the broader public:

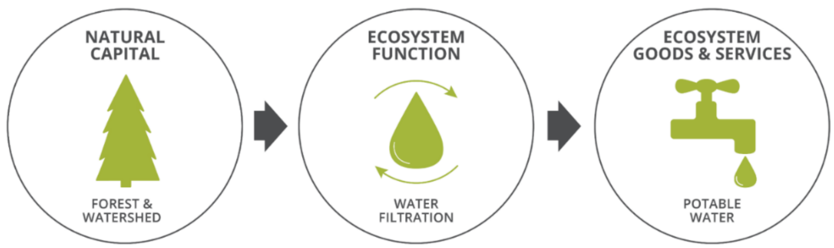
- In Providence, Rhode Island, green infrastructure projects have removed nine million gallons of stormwater annually from a combined sewer system. The subsequent reduction in CSO saves the utility up to $9,000 each year in operating costs for CSO abatement.[xiv] Similarly, utilities in Portland, Oregon have saved $100,000 per year in conveyance demands by managing stormwater with green infrastructure.[xv]
- New York City (NYC) has already saved $1.5 billion, 22 percent less than a gray infrastructure only approach, by incorporating green infrastructure into its municipal stormwater infrastructure planning.[xvi] An important benefit is that these investments encourage water infiltration into the ground, which reduces the need for pumping and saves energy costs. The resulting surplus funds are redistributed to contract labor and supplies, creating additional jobs.[xvii, xviii]
- Earth Economics conducted a benefit-cost analysis (BCA) of the Well Farm Project, a green infrastructure stormwater management installation in Peoria, Illinois. The study found that stormwater farms will capture 1.3 million gallons of stormwater per year, save at least $197,340 in stormwater costs over the next 30 years, sequester 840 metric tons of carbon dioxide (CO_2), and save $8,000 in public health expenses by filtering out harmful air pollutants.[xix]
- In Germantown, Wisconsin, low-impact design—which incorporates green infrastructure elements—generates around $600,000 in savings compared to conventional stormwater management design.[xx] Similarly, adopting pervious asphalt in Greenland, New Hampshire saved developers $930,000 in costs for piping and storage, a 26 percent difference compared to conventional design.[xxi]

Green infrastructure can be a cost-effective solution from both a capital investment and O&M (operations & maintenance) perspective, particularly when planned with existing gray infrastructure systems. By capturing and slowing water where it lands, green infrastructure reduces downstream strain on centralized conveyance and treatment systems. Green infrastructure projects tend to store more gallons of stormwater per dollar invested than conventional gray infrastructure.[xxii] Additionally, O&M costs tend to be similar or lower than gray infrastructure as a percentage of capital costs.[xxiii] Compared to making select investments in several large-scale, expensive gray infrastructure upgrades, distributed green infrastructure projects can be financed and installed incrementally over time and space while prioritizing a city's most pressing areas of flooding concern.[xxiv]

Ecosystem Services Valuation

Nature provides a wide range of goods and services that benefit individuals and communities at local, regional, and global scales. In economics, the minerals, plants, animals, and other life forms that form ecosystems are known as "natural capital." The natural function of these ecosystems—including managed ecosystems, such as farms and gardens—produce flows of benefits known as ecosystem goods and services, such as air and water filtration, food production, disaster risk reduction, climate stability, and cultural and recreational experiences.[xxv] The economic value of many ecosystem services can be estimated based on how much it would cost to replace them with substitutes (e.g., commercial produce), costs they may help avoid or mitigate (e.g., flood damage), or what people pay—or are willing to pay—to ensure their ongoing presence (e.g., conservation, preservation).

Figure 3: Relationship Between Natural Capital and Ecosystem Services



A Framework for Ecosystem Goods and Services

The Millennium Ecosystem Assessment (MEA)[xxvi] framework is a common approach that organizes ecosystem goods and services into four main functional groupings:

- **Provisioning services** provide useful materials and energy, such as food, medicines, and ground and surface water.
- **Regulating services** produce benefits through natural biological and chemical processes, such as forming soils, converting atmospheric carbon to biomass, and filtering air and water.
- **Supporting services** provide habitat and refugia for living organisms—plants, animal, microorganisms, and fungi.
- **Information services** support meaningful human-nature interactions, including spiritually and aesthetically significant natural features, and opportunities for recreation, scientific research, and education.

Services	Example Benefits
Provisioning	
Energy and Raw Materials	Fuel, fiber, fertilizer, minerals, and energy
Food	Livestock, crops, fish, wild game
Medicinal Resources	Traditional medicines, pharmaceuticals, assay organisms
Ornamental Resources	Clothing, jewelry, handicrafts, decoration
Water Storage	Usable surface or ground water, stored reliably
Regulating	
Air Quality	Ability to create and maintain clean, breathable air
Biological Control	Disease, pest and weed control
Climate Stability	Ability to support a stable climate at global and local levels
Disaster Risk Reduction	Ability to prevent or mitigate flood, wildfire, drought, and other natural disasters
Pollination, Seed Dispersal	Dispersal of genetic material via wind, insects, birds, etc.
Soil Formation	Soil creation for agricultural and/or ecosystem integrity
Soil Quality	Soil quality improvement due to decomposition and pollutant removal
Soil Retention	Ability to retain arable land, slope stability, and coastal integrity
Water Quality	Water quality improvement due to decomposition and pollutant removal
Water Supply	Ability to provide natural irrigation, drainage, and other water flows
Navigation	Ability to maintain necessary water depth for recreational and commercial vessels
Supporting	
Habitat	Ability to sustain species and maintain genetic and biological diversity
Information	
Aesthetic Information	Sensory enjoyment and appreciation of natural features
Cultural Value	Use of nature in art, symbols, architecture, or for religious or spiritual purposes
Science and Education	Use of natural systems for education and scientific research
Recreation and Tourism	Hiking, boating, travel, camping, and more

Adapted from Daly and Farley 2004, de Groot 2002, and Boehnke-Henrichs et al. 2013.

Economic Valuation

The full value of ecosystem goods and services are rarely fully reflected in market prices. For instance, the ability of forests to intercept and store water can moderate the effects of heavy rain events on downslope properties, yet assessments of a forest's value are commonly limited to its ability to produce timber, or its possible conversion to other land uses, such as development. By estimating the capacity of a forest to reduce flood damages to downstream communities, economists can identify another benefit of retaining healthy upstream forests. Several techniques for estimating the value of such nonmarket benefits have been developed in recent decades. These include: avoided costs, replacement costs (the price of providing substitute goods), travel costs (how much people pay to experience nature), hedonic pricing (the contribution of a natural amenity to property values), and contingent valuation (also known as "willingness to pay" to protect or conserve a natural feature).

There is a large and growing body of primary research on the value of ecosystem services produced by virtually all landscape types, and in all environmental and social contexts. To produce estimates of multiple ecosystem services for sites that have not been studied directly, economists use what is known as the "benefit transfer method" (BTM). By matching the characteristics and environmental and social context of a study site to published primary research, economists are able to "transfer" the unit values of benefits produced by the primary study site (often characterized as $/acre/year) to the secondary site. In this way, BTM is similar to a home appraisal, where the recent sales prices of similar nearby properties with similar features (e.g. number of bedrooms, lot size, proximity to parks and schools) are used to estimate the value of homes not currently on the market. As with home appraisals, BTM is often the most practical option, producing reasonable estimates at a fraction of the cost of a primary study. An additional benefit of applying BTM to estimate the value of ecosystem goods and services is that it is often able to value multiple goods and services by transferring the estimates of multiple primary studies to similar secondary sites, and capturing a broader range of benefits provided by nature.

Earth Economics' Green Infrastructure Valuation

Specifically, the analysis for the 199-acre AUC study area is divided into three sectors: the first shows the stormwater benefits of gallons captured by cisterns; the second highlights the values of proposed greenways and vaults; and the third focuses on the benefits of proposed tree plantings.

Stormwater Removal Benefits of Greenways and Cisterns

The planned cisterns, greenways, and detention vaults will manage stormwater to significantly reduce flooding. These plans will also work with existing combined sewer infrastructure to ease the burden on the system and avoid the need for expensive sewer separation to address overflows. Ultimately, they can conserve potable water thereby saving money and supporting community resiliency.

Table 1 shows the gallons of stormwater runoff managed with cisterns, greenways and vaults. The 27 cisterns have a total capacity of 17.1 million gallons. Atlanta gets 50 inches of rain per year. Runoff from the many individual rain events that occur each year will be captured in the cisterns and then drained down to make room for the next rain event. Over one year, the 27 cisterns will capture 219.14 million gallons of runoff and avoid sewage treatment costs of $235,000 per year. [1, 2]

The objective of the recommended stormwater capture is to prevent flooding with combined sewage and stormwater. Cistern capacity will be coupled with the annual stormwater management capacities of the 14 greenways and 3 detention vaults to further reduce flooding. They will reduce runoff flooding until the storm has passed, but they will not contribute to the avoided stormwater treatment benefit.

Over the long term, stormwater retained in the 27 cisterns across the AUC study area can be treated for multiple uses to conserve potable water and save on the cost of expensive potable water. Capturing all rain events during the year and drawing down the volume for treatment and use can conserve 219.14 million gallons of potable water per year. Long Engineering explored the design of such a system for Spelman College. Water is captured, treated and integrated into the on-site water system.

Table 1. Stormwater Management by Catchment Area

CATCHMENT AREA	CISTERN CAPACITY (MG)	GREENWAY AND VAULT CAPACITY (MG)	STORMWATER MANAGED PER YEAR BY CISTERNS (MG)	ANNUAL AVOIDED STORMWATER TREATMENT COST BENEFIT ($2021 USD)
AHA	1.83	2.37	23.41	$25,100
CATCHMENT 1	4.19	3.83	53.60	$57,500
CATCHMENT 2	2.31	1.71	29.55	$31,700
CATCHMENT 3	4.27	4.92	54.62	$58,600
CATCHMENT 4	3.14	1.89	40.17	$43,100
SPELMAN COLLEGE	1.39	3.19	17.78	$19,100
SUNSET AVE GREENWAY	n/a	5	n/a	n/a
TOTAL	17.13	22.91	219.14	$235,100

Over a 50-year period at a 1.88% discount rate, savings on stormwater treatment will total $7.4 million dollars ($2021 USD).

[2] This is 12.82 times the 17.1 MG cistern capacity, a factor based on the Long Engineering report for Spelman; its 255,916 gallon cistern will capture 3,280,178 gallons per year.

Greenway Benefits

Ecosystem Services Benefits

Green infrastructure offers environmental, social, and economic benefits to urban residents and businesses. By transferring information from valuation analyses of urban greenspaces (i.e., urban grasslands and forests) across the country to Atlanta, we can begin to estimate the benefits of ECO-Action's proposed projects to transform around 20 acres of land. These studies help clarify the potential of these projects. These are conservative estimates, further research should evaluate the full scope of benefits of greening the AUC. Due to data limitations, many ecosystem services have not been included in the ecosystem services valuation of greenways such as water storage, habitat, aesthetics, culture, or education. Additional in-depth analysis at the local level can help to highlight the varied benefits that ECO-Action's proposed projects will provide.

Air quality benefits (avoided costs of cardiac and respiratory health issues)

- The proposed land cover changes will improve local air quality around the project areas as more trees and grasses remove pollutants. One study examines the adverse health effects (morbidity and mortality) caused by ozone, nitrogen oxides, particulates, and sulfur oxides in urban areas across the U.S.[xxvii] The study values the avoided cost of adverse health effects (i.e., respiratory illness, emergency room visits, and hospital admissions) from the removal of pollutants with vegetation. Applying this benefit to the AUC area suggests that the recommended green spaces would produce well over $1,000 dollars in public health benefits each year.

Water quality (pollutant removal)

- Vegetation in the green spaces will help clean polluted stormwater and floodwater, reducing pollutant loads. These water quality benefits can be measured in terms of the avoided cost of a runoff treatment for pollutants. By applying avoided water treatment costs from a Seattle, Washington-based water quality valuation to the proposed project site, we estimate the water quality improvements from these green spaces provide around $10,000 in benefits each year.[xxviii]

Physical Activity Benefits

Physical activity provides benefits in the form of avoided health costs. One co-benefit of green spaces is that they serve as recreational amenities where people can be active; adding the proposed projects to the AUC campuses can provide between $8,800 and $18,400 in benefits per year.

These values were calculated using park visitation estimates, local demographic information, state physical activity levels, and the avoided cost of medical care associated with engaging in physical activity.[xxix] Based on the distributed acres of green spaces the project will provide, we estimate around 68,000 visitors a year based on a study scaling park size with visitation.[xxx] The CDC (Centers for Disease Control and Prevention) estimate of Georgia activity level approximates the proportion of those visitors who met the recommended activity guidelines.[xxxi] These valuations were based on estimated average exercise periods of 15, 30, and 60 minutes per visit, respectively. Shown above are estimates for 15 to 30 minutes of exercise. Minutes of exercise were valued using research on the healthcare cost and avoided costs of physical inactivity in individuals over 15 years old. The value was used to determine the avoided healthcare and lost productivity cost of physical activity per adult.

Street Tree Benefits

Across the entire Proctor Creek watershed, 9,860 existing trees provide economic and environmental benefits.[xxxii] For example, the cooling effect of trees helps to save lives and reduce hospitalizations. However, comparing tree canopy by census tract shows that the AUC area has one of the lowest areas of tree coverage.

Planting and maintaining street trees in the AUC area will provide multiple benefits at local, regional, and global scales. Applying values from other studies, Earth Economics estimated the value of some of these benefits for the proposed 656 trees (see Table 2 below). Source studies for the calculations are appended.

Table 2. Value of 656 Trees (At Maturity)

BENEFIT CATEGORY	TOTAL VALUE PER YEAR OF MATURE TREES
HEAT RISK REDUCTION	$387,200
HABITAT PROVISION	$34,900
PROPERTY VALUE IMPROVEMENT	$26,400
STORMWATER VOLUME AND QUALITY	$13,200
BUILDING ENERGY COST SAVINGS	$11,200
CARBON SEQUESTRATION	$4,100
AIR POLLUTANT REMOVAL	$1,600
AVOIDED CARBON EMISSIONS	$100
TOTAL VALUE	**$478,700**

As these trees grow to maturity, so does their ability to provide community benefits. Using a 1.88% discount rate over a 50-year period, they will provide a total of $11.3 million (2021 USD) in benefits, which accounts for their increased ability to provide benefits as they grow.

The 656 trees are the planned minimum, but opportunities for adding more trees exist. Two proposed nature trails would connect the greenways and add an additional 158 trees to the project area.

Heat Risk Reduction

- The cooling effects of shade and evapotranspiration from trees mitigate the Urban Heat Island (UHI) effect. This value is based on the public health benefit of reducing that effect for the Atlanta area.[xxxiii, xxxiv, xxxv, xxxvi, xxxvii]

Habitat Provision

- Trees provide habitat and in doing so, support urban biodiversity. This national estimate is based on a function transfer from Bockarjova et al. (2020).[xxxviii]

Property Value Improvement

- Trees improve property values. This estimate is based on home resale values across the nation and isolating the price premium attributed to trees after controlling for the effects of other influencing variables.[xxxix]
- Beyond improving property values, planting trees offers additional aesthetic benefits that are harder to quantify, such as aesthetic enjoyment.[xl]

Stormwater Volume and Quality

- Urban trees reduce stormwater runoff and improve water quality. This value is based on national estimates of savings from tree rainfall interception and stormwater reduction.[xli]

Building Energy Cost Savings

- Tree shade cools buildings and streets, thus reducing energy consumption for cooling. This estimate comes from the value of energy savings as detailed in McPherson and Simpson (1999).[xlii]

Carbon Sequestration

- Trees sequester and store CO_2. This estimate is based on tree growth and maintenance and the price of CO_2 reductions.[xliii, xliv, xlv]

Air Pollutant Removal

- Trees help to improve air quality in terms of volatile organic hydrocarbons (VOCs), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM_{10}). This value is based on national estimates of meeting air quality standards.[xlvi, xlvii]

Avoided Carbon Emissions

- Urban trees reduce the burden on stormwater and wastewater utilities, including the costs of pumping, as valued here. This value was calculated based on national estimates of tree stormwater reduction, the carbon emissions of stormwater and wastewater pumping, and the social cost of carbon.[xlviii, xlix]

Trees provide additional benefits not measured in this study such as stress relief and social cohesion. Trees also help improve productivity, reduce crime, and support economic stability. Burying power lines can enhance these tree benefits, support better tree maintenance, and enable more tree planting.

Investing in Green Infrastructure

Green infrastructure is a cost-effective solution from both a capital investment and O&M perspective, particularly when designed alongside existing gray infrastructure systems. By capturing and slowing water where it lands, green infrastructure reduces downstream strain on centralized conveyance and treatment systems. Green infrastructure projects tend to store more gallons of stormwater per dollar invested than conventional gray infrastructure.[l] Investing in green infrastructure can address flooding in already developed areas while supporting the City's site-specific stormwater management requirements for new developments and redevelopments.

As this technical report highlights, the AUC study area's Green Infrastructure Initiative will provide benefits beyond stormwater management for immediate flood relief. Plans to install cisterns, greenways, and street trees will generate public health benefits as shown by values calculated for physical activity, water quality, air quality, and heat risk reduction. These plans also provide aesthetic benefits and improve property values. This technical report has also highlighted habitat, carbon storage and sequestration, and building energy savings benefits. While most of these benefits will be realized by residents and local businesses, services, and campuses, many extend across the broader region. Moreover, the proposed green infrastructure plans will provide many other benefits not described or valued in this report. For example, these green infrastructure sites can provide educational benefits, from field trips to teacher training. As green infrastructure plans for the AUC area are further defined as stakeholders commit to individual projects, additional analysis can highlight a wider range of benefits in relation to capital and O&M costs.

Appendix

Source Studies

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