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EXPLORING URBAN AGROFORESTRY AS MULTIFUNCTIONAL GREEN INFRASTRUCTURE

IN ATLANTA, GEORGIA

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Introduction

Stormwater management is a crucial challenge for most cities in the United States. Flooding, increasingly less isolated to riverine or coastal cities, has become an increasingly daunting challenge in recent years because of a myriad of different factors. Urban flooding refers to flooding that is exacerbated in specific ways by the built environment. Cities are filled with impervious structures that reduce the local watershed's ability to absorb and move water around according to the natural hydrology of the land prior to its development (University of Maryland Center for Disaster Resilience and Texas A&M University Galveston Campus Center for Texas Beaches and Shores, 2018). Roads, sidewalks, and buildings all contribute to this issue which can result in drainage systems becoming overwhelmed during rain events. Additionally, the removal of native forests and vegetation in cities reduces the land's ability to absorb rainfall. Exposed soil allows water to slowly percolate into the ground under natural circumstances; however, land development interrupts this process (Holm et al., 2014).

Traditional stormwater management prioritizes gray infrastructure (i.e., gutters, culverts, pipes, etc.) channelizing rain into drainage or sewage systems to carry further downstream and away from the city. However, traditional stormwater management techniques can produce unintended externalities on an urban watershed. For example, channelization cuts urban streams off from their natural floodplain which can have dire environmental and ecological consequences (Holm et al., 2014). Additionally, many municipalities have aging stormwater systems and lack the funds to upgrade critical components like drains and pipes (University of Maryland Center for Disaster Resilience and Texas A&M University Galveston Campus Center for Texas Beaches and Shores, 2018). While gray infrastructure has traditionally been used to manage stormwater in urban environments, more cities are adopting green infrastructure to support their distressed drainage and sewage systems. Green infrastructure refers to various nature-based solutions designed to reduce the amount of stormwater runoff entering the natural or artificial waterways through absorption and retention. These systems can also treat stormwater runoff to improve water quality before rain seeps into groundwater (City of Atlanta Department of Watershed Management, 2018).

While this need for stormwater management exists across urban neighborhoods, residents in economically distressed neighborhoods also face food insecurity because they lack access to fresh and nutritious produce or similar groceries. The impacts of food insecurity are especially prominent in low-income, low-access areas (LILA – colloquially termed "food deserts"). Low income is defined as any census tract where: 1) the poverty rate is 20 percent or higher; 2) the median family income equal or less than 80 percent of the state's median family income; or 3) the median family income of equal or less than 80 percent of the metro area's median family income. Low access is characterized by the number of households in an area without access to a vehicle and are more than half a mile from the nearest grocery store. Nineteen million U.S. residents were estimated to live in LILA areas in 2019, a decrease from the estimated 39.4 million in 2015 (USDA Economic Research Service, 2019). While this decrease likely reflects actual progress at reducing food insecurity in households, this number may be exaggerated by changes to census tract boundaries (and thus LILA areas) and other methodological factors. Regardless, many cities are piloting programs and adopting policies that are designed to elevate food access as a planning priority (American Planning Association, n.d.). In this new paradigm, urban agriculture has emerged as a community-driven strategy that empowers residents to participate in the development of sustainable local food systems.

While superficially unrelated, both flooding and food insecurity pose critical threats to the stability and wellbeing of urban communities. For city planners and policy makers alike, these "wicked problems" require an equally wicked, novel solution in the form of urban agroforestry (UAF)[1]. UAF has recently emerged as a unique tool for tackling these urban problems while serving as a bridge between food systems and hazard mitigation planning. Specifically, UAF complements and enhances traditional green infrastructure by adding an additional food production component. Integrating "working trees" into existing green infrastructure or developing new sites with forms of edible green infrastructure can become a crucial step in creating multifunctional landscapes in urban environments.

This research paper explores agroforestry as a novel, multifunctional green infrastructure solution in urban environments by determining the stormwater absorption, filtering, and interception capacities of different agroforestry practices, assessing their food production potential, and then identifying suitable sites for pilot projects through the study area.

Where are ideal sites in Atlanta to implement agroforestry interventions as green infrastructure to increase fresh food access and manage stormwater's impact on private property, public infrastructure, and the urban watershed?

The following chapter reviews academic and gray literature for examples of UAF systems to examine different stormwater management techniques that incorporate food-producing plants. Specifically, the chapter explores the extent to which UAF is utilized as green infrastructure, and how those UAF systems perform in terms of food production, flood mitigation, runoff infiltration, pollutant filtering, and stormwater retention. The paper will then analyze contextual information about Atlanta and assess land suitability for different UAF systems using GIS. The paper will conclude with a discussion of findings and provide policy recommendations to support the implementation and siting of novel UAF green infrastructure projects. City planners, landscape designers, and residents can benefit from this research by increasing their knowledge of ways to integrate food production with other planning priorities in a multifunctional and cohesive system.

[1] UAF systems are interchangeably referred to as urban food forestry and occasionally referred to as edible or food-producing green stormwater infrastructure across sources. While I primarily use UAF as an umbrella term to encompass all agroforestry practices in an urban environment, all of these terms are functionally interchangeable and will be used without distinction for the remainder of the paper.

Literature Review

UAF Systems

Agroforestry refers to a set of interrelated but distinct practices that link traditional agriculture with forest management (USDA National Agroforestry Center, N.D.). In temperate environments, the most common methods of agroforestry that are practiced are windbreaks, riparian forest buffers, alley cropping, silvopasture, and forest farming. Additionally, there are less common or novel methods, such as waterbreaks. Table 1 provides more information on the five most common agroforestry practices in temperate environments. As a practice, UAF seeks to intentionally and strategically integrate woody perennial food-producing species into urban environments to create sustainable and resilient edible landscapes for urban communities. The emphasis on perennial woody fruit and nut-producing species distinguishes UAF from conventional forms of both urban agriculture and urban forestry (Clark and Nicholas, 2013).

Table 1. Temperate Agroforestry Practices

Type	**Definition**
Alley cropping	Trees or shrubs planted in rows that form alleys where traditional crops can be cultivated
Forest farming	Crops cultivated under a managed tree canopy
Riparian forest buffers	Vegetated buffers adjacent to streams, lakes, or wetlands integrating trees, shrubs, and wood perennial plants
Silvopasture	Working trees and grazing livestock operating on the same land
Windbreaks	Linear arrangements of trees and shrubs primarily designed to buffer livestock and crops from the impact of fast winds (e.g., erosion).

Some agroforestry practices may not be feasible in the urban context. For example, land access is a major concern in many cities, particularly in areas with high property values or anticipated development (Lovell, 2020; Lovell et al., 2021). This access precarity can heavily impact the viability of UAF systems since long-term land tenure is a necessity for the success of perennial plants. Water access is also a major concern in an urban environment for food growers, particularly for larger systems like alley cropping or silvopasture (Romanova and Lovell, 2021). Additionally, zoning ordinances and tax policies may restrict the production or foraging of food or medicinal plants from public green space (Lovell, 2020). Ordinances may prohibit residents from raising livestock in a city as well, along with a host of other restrictions that make particular practices unfeasible.

Outside of policy barriers, UAF systems can face other implementation and suitability challenges. Community orchards and other larger projects, for example, may require immense initial costs to acquire the woody and herbaceous transplants needed to start the systems (Lovell et al., 2021). Indeed, large systems will require significant maintenance, especially in the early stages of a project. Fortunately, there is an abundance of volunteers available in urban environments that can be leveraged to support large UAF projects (University of Maryland Center for Disaster Resilience and Texas A&M University Galveston Campus Center for Texas Beaches and Shores, 2018). Sufficiently large systems would, however, likely require at least one full-time worker for support and financing that role may be a challenge in some communities. Properties with UAF systems can quickly become a nuisance if they are not well-maintained because hazards and waste created by fallen or unharvested products (Lovell et al., 2021). Additionally, some agroforestry practices may not be functionally suitable for urban environments. For example, windbreaks are specifically designed as an intervention to reduce the impact of winds on agricultural soil and livestock, both of which are uncommon in cities. Despite these shortcomings, UAF's potential to alleviate food insecurity by increasing access to food production sites while simultaneously generating environmental protection benefits make it an attractive for implementation in cities. Table 2 ranks the suitability of different agroforestry practices in UAF systems and highlights prominent barriers for implementation and success. These practices are ranked relative to one another based on the severity of barriers and ease of designing and upkeeping a particular practice in a UAF system.

Table 2. Agroforestry Practice Suitability for UAF Systems

Name	**Suitability for UAF**	**Barriers**
Alley cropping	Medium	Long-term land access, maintenance demands
Forest farming	High	Long-term land access, ordinances preventing foraging
Riparian forest buffers	High	Lack of appropriate locations, water contamination issues
Silvopasture	Medium	Long-term land access, ordinances prohibiting livestock raising
Windbreaks	Low	Functionally obsolete

Several communities around the world have used UAF systems to extract various benefits from their environmental hazards. For example, a heritage system in Huzhou, China was designed in the 12th century to mitigate the impact of floods on the city (Santoro et al., 2022). The system consists of earthen dykes and ponds. The dykes are used for cultivating mulberries, and they form the boundaries of small ponds across the system that support different aquatic life, such as black carp, and the cultivation of silkworms. Another project in Burkina Faso transformed vacant lands within the city into a multifunctional UAF system as "green corridors" with food-producing trees that reduced surface runoff and increased resilience to food insecurity and economic precarity (Borelli et al., 2017).

Despite many examples of UAF as a land management strategy across time and geographies, UAF systems are relatively new in the United States, particularly as green infrastructure. However, more communities in the U.S. are finding novel ways to develop these systems in their neighborhoods. For example, an ambitious project for stormwater management at a school in Philadelphia seeks to improve the water quality of Cobbs Creek and the Delaware River by reducing the amount of runoff that will drain into the sewer and watershed via a food forest. The project addresses environmental justice issues impacting the local community and food insecurity (University of Pennsylvania, 2022). As another example, the Urban Food Forest at Browns Mill in Atlanta, Georgia is the largest publicly owned food forest in the United States. The project was only designed to address food insecurity in a food-distressed neighborhood, but the park now consists of working trees, raingardens, and bioswales that support stormwater management objectives. Another urban food forest project in Portland, Oregon uses gravel pathways and bioswales to redistribute water around the site to plants in the forest's understory (Munsell et. Al, 2021).

UAF and the Urban Watershed

UAF systems have great potential for use as green infrastructure. Different components of these systems perform various roles to intercept, absorb, and collect stormwater effectively. Research shows that tree canopies can intercept rainfall at a rate of between 15 – 60 percent depending on the trees species and surrounding climate (Udawatta, 2021). Additionally, individual canopies can absorb as much as 79 percent of 20-mm, 24-hour rainfall under optimum, full-leaf conditions (Bartens et al., 2008). Indeed, trees in bioswales can be responsible for between 46 and 72% of total water use by these systems, thereby greatly reducing runoff and discharge from impervious urban catchments (Livesley, McPherson, and Calfapietra, 2016).

Integrating understory plants with woody roots would complement the canopy since water would flow preferentially along tree roots in an UAF setting, potentially increasing infiltration speeds by 2 to 17 times in flooded impoundments with trees (Bartens et al., 2008). These roots disrupt compacted subsoils, which are common in urban environments. Tree species with high stomatal conductance and the capacity to grow well under fluctuating saturated and dry conditions are likely to perform best in UAF systems (Livesley, McPherson, and Calfapietra, 2016). This form of forest farming could provide vital stormwater absorption especially when combined with interventions like raingardens (Asleson et al., 2009). For example, the community food forest project in Philadelphia integrated several raingardens in its design. The plants and soils in these raingardens were specifically chosen to maximize stormwater infiltration and retention. The project also integrated permeable pavers, green roofs, and raised beds across the food forest to increase stormwater absorption on the property (University of Pennsylvania, 2022). Research has also shown that small food forests (also known as "homegardens") are effective at absorbing stormwater at the household-scale (Toensmeier, 2022).

In addition to stormwater absorption and infiltration, UAF systems that integrate forest riparian buffers, windbreaks, forest farming, and silvopasture reduce stormwater flow velocity and peak while managing runoff water volumes (Udawatta, 2021). Raingardens are recognized for their ability to slow runoff intensity as well (Asleson et al., 2009). In an urban setting, well-designed raingardens can helping establish hydrological flows across a site that more closely resembles the underlying watersheds prior to urbanization. Green roofs and vertical greening systems on buildings also show potential for reducing stormwater volumes and intensity before it enters a site's catchment basin (Taylor and Lovell, 2021). Additionally, UAF systems can be used to filter pollutants from stormwater runoff. Tree canopies can increase evapotranspiration in a UAF system to facilitate the removal of pollutants and remove some heavy metals from stormwater (Livesley, McPherson, and Calfapietra, 2016; Udawatta, 2021). Similar nature-based solutions have been shown to treat different sources of pollution including riparian buffers, artificial wetlands, biofiltration ponds, and food forests (Delgado-Lemus and Moreno-Calles, 2022).

While UAF systems can reduce the stress placed on urban watersheds and sewer systems, it is important not to overstate the ability of UAF systems in supplanting the role of gray infrastructure in cities because of various limitations. For example, green roofs or vertical green systems on buildings may not be viable to implement because of the costs associated with retrofitting (Lovell et al., 2021). The rooftops of many commercial and industrial buildings also do not have the depth to support the substrates required to grow trees or other woody perennials. Many buildings may not be able to support the additional weight of the plants safely as well. As another example, tree canopies are rarely full in urban environments which can have a drastic impact on the canopy's effectiveness at intercepting and absorbing rainfall. Even for large species with higher interception and absorption, storage capacity is often exceeded during many rainfall events exceeding 30 minutes (Livesley, McPherson, and Calfapietra, 2016). Additionally, the roots of the trees in these canopies do not produce infiltration benefits until several years after planting (Bartens et al., 2008). For these reasons and others, it is important to recognize that UAF must complement and support existing gray infrastructure as a part of a holistic hazard mitigation strategy.

In addition to stormwater management, UAF systems offer several different kinds of environmental services. For example, UAF systems provide defense against the urban heat island effect. Specifically, tree canopies from these systems absorb heat without re-emitting as much as buildings or concrete roads. UAF systems also sequester carbon and can be a vital tool in a city's climate resilience or net-zero strategy (Clark and Nicholas, 2013; Romanova and Lovell, 2021). These systems can be used to foster ecological restoration for local wildlife and plants as well (Clark and Nicholas, 2013; University of Pennsylvania, 2022). Indeed, many communities, like Huzhou, China, have already used UAF systems as an urban corridor to support native animal and plant life.

UAF and the Urban Foodshed

UAF systems have also shown great potential to increase local food access and production. For example, one case study in Burlington, Vermont revealed that 108 % of the city's daily recommended minimum intake of fruit could be achieved using exclusively apple trees (Clark and Nicholas, 2013). Another study explored an orchard project in Pawhuska, Oklahoma that is expected to increase the local indigenous community's access to the tree nuts, fruits, and berries. These foods historically contributed to their diets substantially prior to colonization and displacement from their ancestral homelands (Lovell et al., 2021). Crucially, the orchard is within walking distance of both an elementary and high school whose young population are at risk of food insecurity. The orchard is also centrally placed near many different civic institutions as well.

Food safety and profitability are pertinent topics connected with UAF systems. Firstly, the quality of food crops grown in UAF systems faces potential exposure to pollutants from the urban environment. Studies have revealed that there is indeed a perception that food grown in urban environments is highly susceptible to contaminants from the air or soil (Lovell, 2020;

Romanova and Lovell, 2021; Lovell et al., 2021). Unfortunately, food safety remains under researched in the context of UAF systems. What research exists suggests that fruits and nuts from woody species are very likely safe for consumption unless grown too close to an excessively pollutant source or contaminated site. This concern is amplified in large cities with heavy traffic values or near places hazardous or toxic places like mines (Romanova and Lovell, 2021; Lovell et al., 2021). Secondly, any yield analysis to predict the productivity (and thus profitability) of UAF systems is complicated by a variety of site-specific factors. Soil quality, climate, rootstock, cultivar, shade, and management, as well as annual fluctuations, play an important role in a system's food production (Clark and Nicholas, 2013). Indeed, this uncertainty and variability makes the profitability of food trees in urban places hard to predict (Lafontaine-Messier, Gelinas, and Olivier, 2016). Despite these unknowns, UAF systems are able to support a wide range of common and rare edible products. Table 3 details different plant species that are suitable for food production in UAF systems.

Table 3. Edible products suitable for UAF systems

Plant species	Source
Berries	Bentrup & Leininger (2002); Bentrup & Kellerman (2003); Clark & Nicholas (2013); Lovell et al. (2021)
Blackberry	Clark & Nicholas (2013); Lovell et al. (2021)
Blueberry	Bentrup & Leininger (2002); Clark & Nicholas (2013)
Cloudberry	Clark & Nicholas (2013)
Cranberry	Clark & Nicholas (2013)
Currant	Clark & Nicholas (2013)
Dewberry	Lovell et al. (2021)
Elderberry	Clark & Nicholas (2013); Lovell et al. (2021)
Goji berry	Clark & Nicholas (2013)
Lingonberry	Clark & Nicholas (2013)
Honeyberry	Clark & Nicholas (2013)
Huckleberry	Clark & Nicholas (2013)
Mulberry	Clark & Nicholas (2013); Lovell et al. (2021)
Muscadine grape	Clark & Nicholas (2013)
Raspberry	Lovell et al. (2021)
Salmonberry	Clark & Nicholas (2013)
Seaberry	Clark & Nicholas (2013)
Serviceberry	Clark & Nicholas (2013)
Strawberry	Clark & Nicholas (2013)
Sour cherry	Clark & Nicholas (2013)
Wild grape	Lovell et al. (2021)
Fruits	Clark & Nicholas (2013); Lovell et al. (2021)
Apple	Clark & Nicholas (2013)
Apricot	Clark & Nicholas (2013)
Figs	Clark & Nicholas (2013)

Guava	Clark & Nicholas (2013)
Jujube	Clark & Nicholas (2013)
Kiwi	Clark & Nicholas (2013)
Maypop	Clark & Nicholas (2013)
Nectarine	Clark & Nicholas (2013)
Pawpaw	Clark & Nicholas (2013); Lovell et al. (2021)
Peach	Clark & Nicholas (2013)
Pear	Clark & Nicholas (2013)
Persimmon	Clark & Nicholas (2013); Lovell et al. (2021)
Plum	Clark & Nicholas (2013); Lovell et al. (2021)
Prairie rose	Lovell et al. (2021)
Shipova	Clark & Nicholas (2013)
Honey	Bentrup & Leininger (2002)
Plum	"
Wildflower	"
Mushrooms	Bentrup & Leininger (2002); Bentrup & Kellerman (2003)
Nuts	Bentrup & Leininger (2002); Bentrup & Kellerman (2003); Clark & Nicholas (2013); Lovell et al. (2021)
Almond	Clark & Nicholas (2013)
Chestnut	Bentrup & Leininger (2002); Clark & Nicholas (2013)
Gingko	Bentrup & Kellerman (2003)
Hazelnut	Bentrup & Leininger (2002); Clark & Nicholas (2013); Lovell et al. (2021)
Pecan	Bentrup & Leininger (2002); Clark & Nicholas (2013); Lovell et al. (2021)
Pine nut	Bentrup & Leininger (2002); Clark & Nicholas (2013)
Walnut	Bentrup & Leininger (2002); Clark & Nicholas (2013); Lovell et al. (2021)
Saps	Bentrup & Leininger (2002)
Boxelder	"
Maple	"

Outside of food production, UAF systems offer an array of social and economic benefits. For example, the large number of concentrated trees in a UAF systems can reduce noise contamination from surroundings (Romanova and Lovell, 2021). This can have an extremely positive effect, particularly in noisy cities. Additionally, research has shown that properties adjacent to urban food forests tend to have higher property values than other properties in the vicinity (Clark and Nicholas, 2013). Communities may be able to use these systems as community gathering spaces to foster additional social and placemaking benefits as well (Munsell et al., 2021; Delgado-Lemus and Moreno-Calles, 2022). Overall, research suggests that implementing UAF systems in cities provides immense ecological, economic, environmental, and social benefits while producing minimal stress on the built environment.

Expanding Existing Research

This research project expands upon existing scholarship by identifying appropriate sites for new UAF systems in Atlanta using a GIS methodology that can ideally be applied to other urban environments. Previous studies have outlined appropriate design parameters and potential tools to use for assessing sites and landscapes for agroforestry, but these studies are largely limited to rural contexts (Bentrup & Kellerman, 2003; Bentrup & Leininger, 2002; Dosskey, Bentrup, and Wells, 2009; Ellis, Bentrup, and Schoeneberger, 2004; Lovell, Bentrup, and Stanek, 2021). Additionally, these assessment methodologies have outlined urban conditions (e.g., commercial areas, neighborhoods, etc.) as a factor for exclusion in their respective studies. In response, this research project will integrate established rural agroforestry knowledge and assessment methodologies around site and landscape suitability into urban contexts for applications such as stormwater management and food production. As such, the following UAF suitability assessment will represent a novel direction for scholarship on agroforestry as a whole and provide a specific framework for future research on UAF systems using GIS. Additional information regarding the methodologies of any of the aforementioned studies will be provided in the “Methods” chapter, as relevant to the current research endeavor.

Data & Methods

This study's GIS analysis is aimed at identifying suitable locations in food-insecure neighborhoods to site new UAF systems as green infrastructure. The proposed workflow builds upon a framework established by the Food and Agriculture Organization (FAO) for evaluating land suitability for agroforestry. (FAO, n.d.) The FAO framework demands that a land evaluation procedure answers two key questions: 1) for any specified kind of land use, which areas of land are best suited; and 2) for any given area of land, for which kind of use is it best suited? UAF systems will comprise our only land use for consideration and, as we have already determined a universe of appropriate land uses to respond to the second question (Tables 2 and 3), this study's analysis will primarily focus on responding to the first question with more specific land use recommendations for each site being explored afterwards. In its simplified form, the procedure for answering these questions must first describe the promising land-use types; then, for each of those land-use types, determine the suitability and siting requirements. Once we have determined our suitability and siting requirements, we can then map the necessary land units to describe physical characteristics as appropriate for our study area. Finally, the land-use type requirements can be compared with the properties of the land units to come to a land suitability classification from "best" to "worst." This study utilizes an established basic suitability assessment procedure to compare land units. (Bentrup and Leininger, 2002)

Land units will be scored based on their physical characteristics, with positive attributes awarding higher scores, for a possible total of 13 points. The physical characteristics of interest for any given site are its slope, the soil's drainage capacity, and the frequency of flooding. Additionally, since this project aims to address flooding concerns alongside food access in an urban context, there are also suitability and siting requirements based on social and regulatory factors. For example, ordinances in Atlanta prevent urban gardens and farms in some zoning districts so these districts would be deemed ineligible, regardless of any positive physical characteristics of the site. With these considerations and the given context, the workflow for this analysis is as follows:

1) Obtain relevant data for physical and social suitability assessments from the following sources:

- City of Atlanta GIS
- USDA

2) Map physical characteristics in spatial units to conduct suitability assessment.

2a) Conduct physical suitability assessment and score map units according to Table 5:

Value	**Slope (%)**	**Soil Drainage**	**Flood Frequency**
5	0 – 3	Well drained	N/A
4	4 – 6	Moderately well drained	N/A
3	7 – 9	Excessively drained	Frequent
2	10 – 12	Somewhat poorly drained	Occasional

1	13 – 15	Poorly drained	Rare
Ineligible	> 15	Data unavailable	None

3) Map social and regulatory landscape in spatial units to conduct suitability assessment.

3a) Conduct social suitability assessment for spatial units and determine eligibility according to Table 6:

Eligibility	**Census Designation**	**Current Zoning District**
Eligible	Low-income and low-access tract using vehicle access and at 20 miles	• Commercial • Historical and Cultural Conservation (Cabbagetown, Druid Hills, Martin Luther King Jr., Baltimore Block, Castleberry Hill) • Industrial • Live Work • Mixed Residential Commercial • Multifamily Residential • Neighborhood Commercial • Office-Institutional • Planned Development • Residential • Special public interest (SPI-1, 5, 6, 7, 9, 11, 12, 15, 16, 17, 18, 20, 21, 22)
Ineligible	Any other tract	• Airport • Beltline Overlay • Buckhead Parking Overlay • Fulton County R-3 • Historical and Cultural Conservation (Washington Park, Oakland Cemetery, West End, Adair Park, Whittier Mill, Grant Park, Inman Park, Oakland City, Atkins Park, Sunset Avenue, Collier Heights, Means Street, Briarcliff Plaza, Pratt-Pullman, Bonaventure-Somerset) • Special Public Interest (SPI-2, 8, 14) • Westside Affordable Workforce Housing Overlay

4) Overlay eligible spatial units from social suitability assessment with eligible map units from physical suitability assessment to identify potential sites

4a) Rank remaining map units in tabular format and map highest ranking sites

5) Explore potential UAF system designs for most suitable sites

6) Explore policy recommendations for professional and community-based planners

Physical Suitability Assessment

The data for the physical suitability assessment comes from the USDA's Soil Survey Geographic Database (SSURGO). The SSURGO database contains soil information collected through the National Cooperative Soil Survey and covers most areas in the United States, as well as its outlying territories. The database uses map units (MUs) to outline areas and describes soil properties along with other components that impact its productivity. These components include available water capacity, soil composition, electrical conductivity, yield potential for various uses (e.g., pastures, crops, timber, etc.), and limitations that may impact site development. SSURGO acknowledges that using soil data in a GIS can be challenging because of the need to convert the data into MUs, which may or may not align to geographic features or jurisdictional boundaries, and that many of the attributes are not necessarily attributes of the MUs itself but of an entity which can be found in repeating quantities within the corresponding map unit (e.g., different soil types). MUs themselves are typically comprised of more than one soil type and may include different land types and natural features such as lakes or streams. The components for each of these MUs are explicitly aggregated at that level for map visualization. SSURGO utilizes seven methods of aggregation: dominant component, dominant condition, most limiting, least limiting, weighted average, all components, and presence/absence. Table 4 details these aggregation methods to provide context as to how they will inform the components selected for this study.

Table 4. SSURGO Aggregation Methods

Type	Definition
All Components	Highest or lowest soil property value for all of the components
Dominant Component	Rating class or soil property value of the soil component with the largest percent composition
Dominant Condition	Rating class or soil property values of the group with the largest percent composition
Least Limiting	Least limiting interpretation rating used for all components
Most Limiting	Most limiting interpretation rating used for all components
Presence/Absence	Whether a certain condition is present or absent for all components
Weighted Average	Average soil property value weighted by percent composition

This study utilizes three main components across the MUs: slope gradient, drainage class, and flooding frequency. First, the slope gradient variable expresses the weighted average elevation difference between points as a percentage of the distance between those points for all components in the MU. MUs with a slope of between 0 – 3 percent will be scored highest for this evaluation criteria and map units with slopes of greater than 15 percent will be deemed ineligible. Second, the soil drainage variable ("drainage class") expresses the dominant natural drainage conditions of the soil in a MU regarding the frequency and duration of wet periods. Well-drained MU will be scored highest for this evaluation criteria whereas poorly drained MUs will be scored lowest. Lastly, the flood frequency variable[2] expresses the annual probability of a flood event based on the dominant condition of 15 percent or more of the MU. MUs that frequently experience flooding will be scored highest for this evaluation criteria whereas MUs that do not experience flooding will be deemed ineligible. Additionally, MU types "W" (Water), "Ub" (Urban land), and "Ud" (Urban land) will be deemed ineligible because these MUs do not have soil data. All eligibility criteria and scoring values for the physical suitability assessment are summarized in Table 5.

Table 5. Physical Suitability Assessment Evaluation Criteria

Value	**Slope (%)**	**Soil Drainage**	**Flood Frequency**
5	0 – 3	Well drained	N/A
4	4 – 6	Moderately well drained	N/A
3	7 – 9	Excessively drained	Frequent
2	10 – 12	Somewhat poorly drained	Occasional
1	13 – 15	Poorly drained	Rare
Ineligible	> 15	Data unavailable	None

Social Suitability Assessment

The data for the social suitability assessment comes from two sources: USDA and City of Atlanta GIS. The USDA's Economic Research Service created the Food Access Research Atlas (FARA) to describe food access indicators in low-income census tracts based on supermarket proximity and accessibility. In addition to census-tract level information about local food access, this data also allows users of the Atlas to analyze food access at the state or county level as well as additional information such as food access by race or ethnicity and other demographic factors. FARA was developed in response to a 2008 ERS study on "food deserts" – a term that has since been dropped in favor of "low-income and low-access." LILA thus designates areas with limited or no access to nutritious food options from supercenters, supermarkets, and large grocery stores. It is important to note that this designation does not make considerations for smaller grocery stores (drug stores, dollar stores, and convenience stores – colloquially referred to as "neighborhood markets" by the City of Atlanta Department of City Planning), farmers markets, or other sites with incidental or inconsistent fresh food availability. FARA excludes these sites in its analysis because of a dearth of data on where these sites are located, what foods are carried, and standard hours of operation. Additionally, locations that are only accessible to particular groups of people, such as military commissaries and club stores with membership fees/requirements, are also excluded from this access analysis.

FARA measures the low income and low access statuses separately for each census tract and thus a tract can be designated LI/LA/LILA based on a number of factors. FARA uses the U.S.

[2] This variable is used to determine flood risks for this study, in lieu of the 100-year flood plain delineation typically used to determine a property's flood risk for insurance and regulatory purposes, because SSURGO captures areas outside of the natural flood plain which allows for a wider range of potential sites.

Department of Treasury’s New Markets Tax Credit program criteria to identify low-income census tracts. These criteria designate a tract as low-income when its poverty rate reaches or exceeds 20 percent or if its median family income is less than or equal to 80 percent of the state’s median income or 80 percent of its metropolitan area’s median. Low access is typically defined by the number (at least 500) or share (at least 33 percent) of residents more than 0.5 mile from a fresh food access point; however, this distance widens substantially in rural contexts versus metropolitan areas and cities. FARA uses four different measures to map low access to food in census tracts based on distance from stores and household vehicle access: low access at 1 mile (urban) and 10 miles (rural); low access at 0.5 mile (urban) and 10 miles (rural); low access at 1 mile (urban) and 20 miles (rural); and low access using vehicle access. The first three measures use the standard criteria for low access. The fourth measure defines low access as any tract with more than 100 households without consistent access to a vehicle as well as a 0.5 and 20 mile foodshed for urban and rural settings respectively. Vehicle availability as a factor in food access is important because access to a personal vehicle results in more reliable and less burdensome access to fresh food access points relative to public transportation or other modes of transportation like walking. Around 37 percent of Atlanta’s census tracts are designated as a LILA area based on this fourth measure. LILA areas also correspond to areas of the city with the highest concentrations of Black residents and have a larger share of seniors and children than Atlanta as a whole. (AgLanta, 2021)

The second data source for the social suitability assessment comes from the City of Atlanta’s GIS Department in the form of zoning districts. Zoning has long played a role in determining land use patterns across cities and Atlanta is no exception. However, as it relates to food systems, the zoning paradigm in Atlanta shifted dramatically in 2014 with the adoption of the Urban Agriculture Ordinance by then Mayor Kasim Reed. Prior to ordinance, urban gardens and farms (referred to as "market gardens" in the ordinance) were only allowed in retail or commercial districts throughout the city. Atlanta’s zoning now also allows for urban agriculture in nearly all residential zones (including mixed commercial and multifamily), office-institutional zones, and industrial zones, as well as other planned development and special public interest zones, with different restrictions placed on each individual zoning district. Additionally, the adopt of the Farm Stand Ordinance in 2021 now permits urban farms in residential areas to sell produce on-site for better consumer access. Specific siting and operation restrictions in these zones will become important to this study when recommending potential UAF systems on specific sites; however, this level of detail is not relevant to the social suitability assessment.[3] All eligibility criteria for the social suitability assessment are summarized in Table 6.

[3] Details on these siting restrictions and other relevant information as it relates to specific UAF recommendations for the identified sites will be included in Appendix A.

Table 6. Social Suitability Assessment Evaluation Criteria

Eligibility	Census Designation	Current Zoning District
Eligible	Low-income and low-access tract using vehicle access and at 20 miles	• Commercial • Historical and Cultural Conservation (Cabbagetown, Druid Hills, Martin Luther King Jr., Baltimore Block, Castleberry Hill) • Industrial • Live Work • Mixed Residential Commercial • Multifamily Residential • Neighborhood Commercial • Office-Institutional • Planned Development • Residential • Special public interest (SPI-1, 5, 6, 7, 9, 11, 12, 15, 16, 17, 18, 20, 21, 22)
Ineligible	Any other tract	• Airport • Beltline Overlay • Buckhead Parking Overlay • Fulton County R-3 • Historical and Cultural Conservation (Washington Park, Oakland Cemetery, West End, Adair Park, Whittier Mill, Grant Park, Inman Park, Oakland City, Atkins Park, Sunset Avenue, Collier Heights, Means Street, Briarcliff Plaza, Pratt-Pullman, Bonaventure-Somerset) • Special Public Interest (SPI-2, 8, 14) • Westside Affordable Workforce Housing Overlay

Once the physical and social suitability assessments have been conducted, the remaining (i.e., overlapping) MUs be ranked in tabular format based on the aforementioned criteria. As these MUs do not easily conform to parcel, subdivision, or neighborhood boundaries, the “most suitable sites” will be discussed in groups or clusters within the context of neighborhood planning units (NPU), city council districts, or anchoring institutions (e.g., universities, parks, etc.). This selection of most suitable sites will be qualitatively assessed for potential UAF systems based on site-specific factors (e.g., proximity to water, size of site, zoning restrictions, existing land uses, etc.). We will then explore recommendations for professional policy makers and community-minded planners to implement similar systems on those sites and other suitable locations in Atlanta and other communities.

Analysis

Physical Suitability Assessment

After clipping Georgia's SSURGO data to the City of Atlanta's boundaries, there were a total of 2,368 MUs of varying sizes and component properties. As mentioned in the Data and Methods section, we are interested in three specific components for the physical suitability assessment: slope, soil drainage, and flood frequency. Several conditions across these components can render any MU ineligible. After screening out MUs with greater than 15 percent slopes, no flood risk, and no data available, 207 MUs remained eligible. Predictably, the eligible MUs largely adhere to areas along existing floodplains and creeks throughout the city. Map 1 visualizes the eligible MUs and Map 2 visualizes the results of the physical suitabilty assessment.

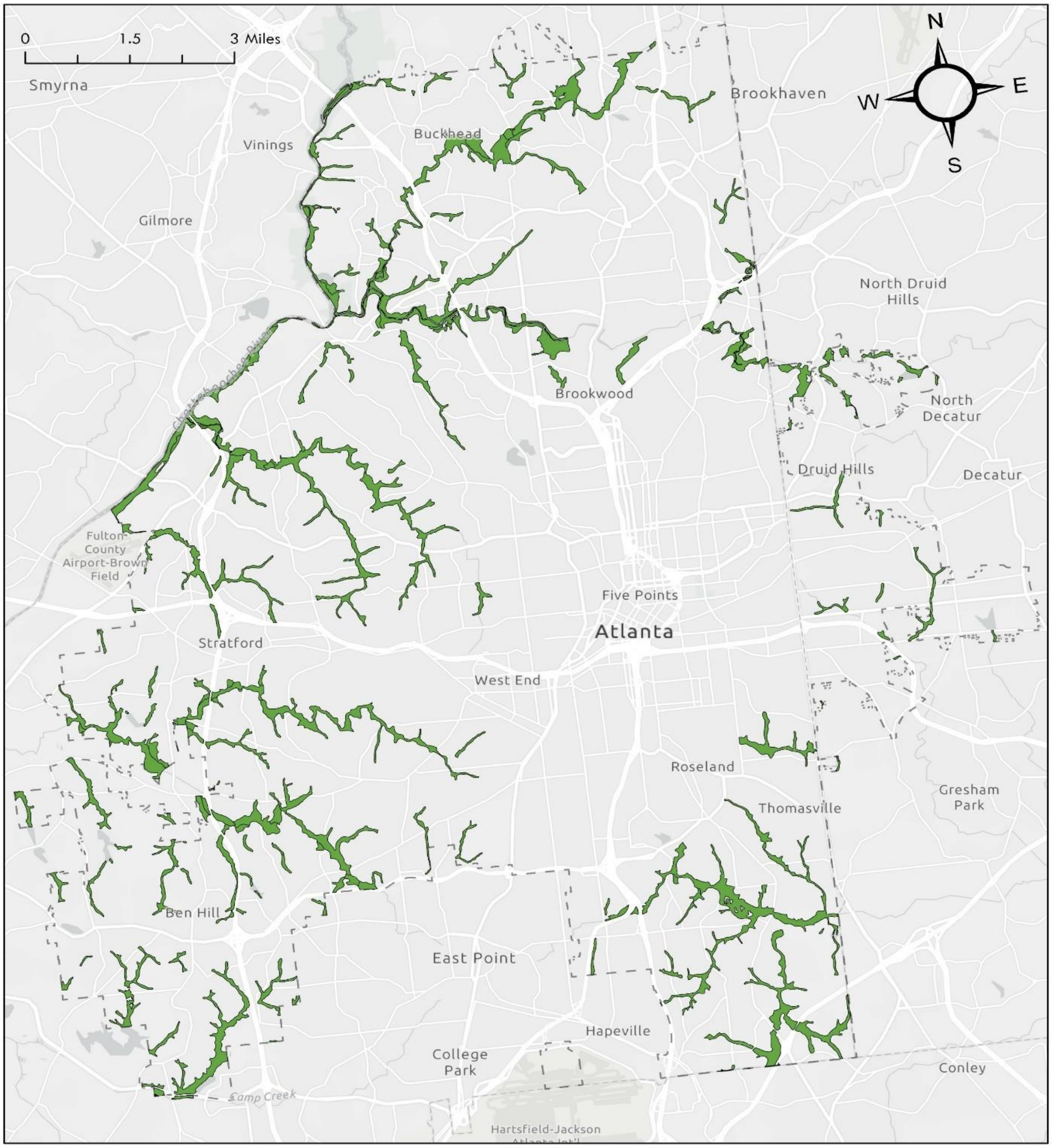
About 84 percent (n = 173) of the eligible MUs experience occasional flooding, whereas 9 percent (n = 19) experience frequent flooding and the remaining 7 percent (n = 15) rarely experience flooding. The 19 MUs with the most frequent flooding are all located in DeKalb County or along Atlanta's eastern/southeastern border with DeKalb County. The 15 MUs that rarely experience flooding are interspersed with the remaining 173 MUs but cluster towards the periphery of the city boundaries. Interestingly, all 207 eligible MUs have an average slope that falls into the most favorably scored category: 0 – 3 percent slope. Nearly 96 percent (n = 198) of the MUs have an average slope between 0 - 1 percent. The remaining 4 percent (n = 9) of MUs have an average slope between 1 - 2 percent. Additionally, all of the latter MUs are concentrated in DeKalb County. 65 percent of eligible MUs had poorly (n = 13) or somewhat poorly (n = 121) drained soil. MUs with the worst soil drainage are concentrated near the northern and southwestern boundaries of the city. Less than one percent (n = 2) of MUs had excessively drained. Well-drained MUs (n = 59) comprise around 29 percent of eligible MUs and are primarily concentrated along the creeks draining into the Chattahoochee River in the northwestern portion of the city. The remaining 12 MUs (~6 percent) are moderately well-drained. These MUs are mostly located in DeKalb County.

Social Suitability Assessment

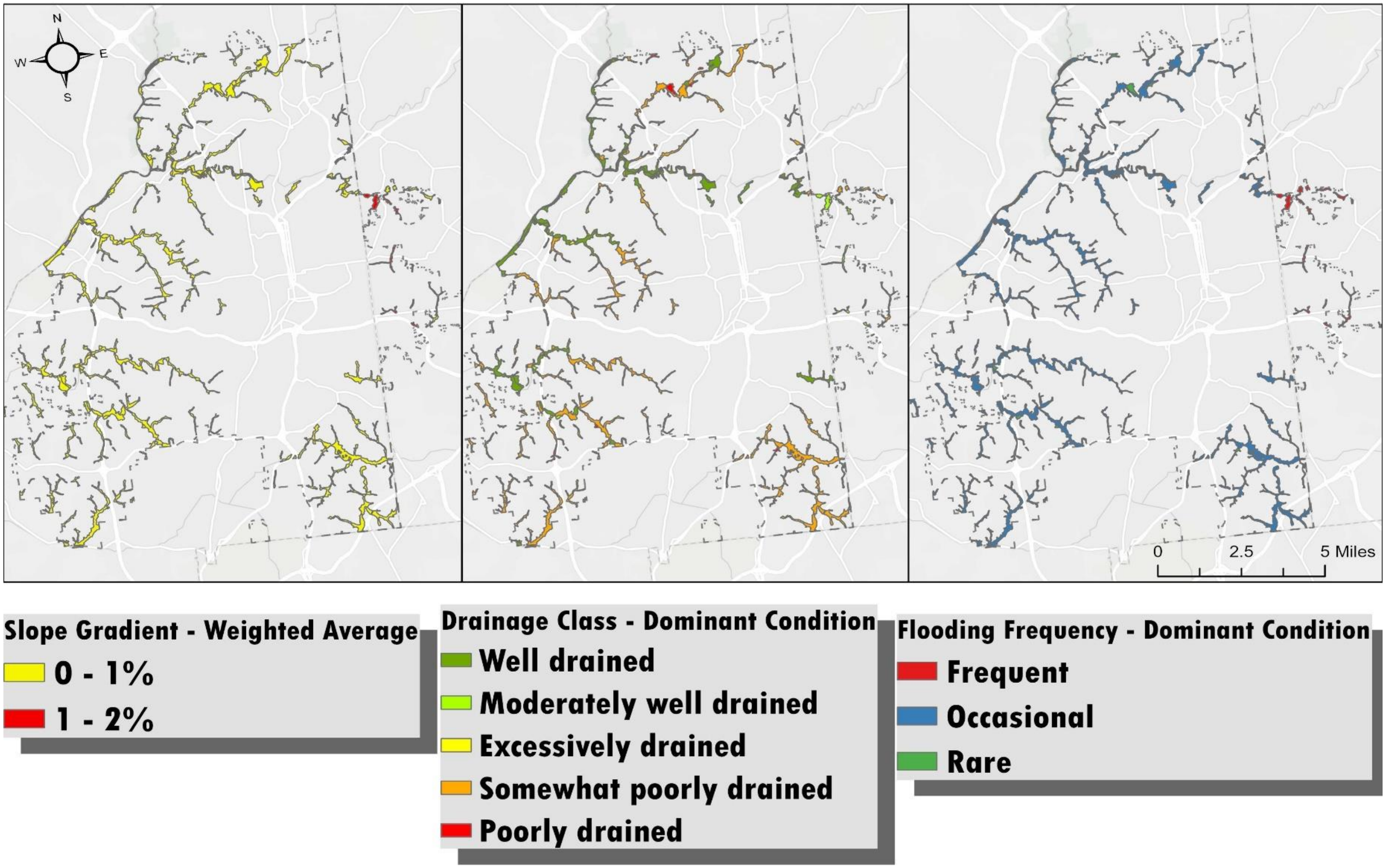
As mentioned in the data and methods section, 37 percent (n = 59) of the 158 census tracts in Atlanta are designated as LILA and are largely concentrated in the southern and western parts of the city, with a few notable exceptions in the northern and eastern areas such as Emory University. Additionally, LILA areas are largely populated by Black residents. Map 3 portrays the racialized landscape of food insecurity across the city.

There are 2,794 active zoning districts across the City of Atlanta of varying size and extent. Part 16 of Atlanta's City Ordinance contains the zoning regulations for all of the regular and special district types that exist in law. On paper, 20 types of districts are ineligible for UAF systems because of siting restricts. However, in practice, only 12 extant zoning districts are zoned as one of the ineligible district types and are thus excluded from consideration based on the city's zoning data. A total of 2,782 districts remain where urban agriculture is allowed as either a primary or accessory use on lots within the district. Map 4 visualizes the location of ineligible areas in red. There are 1,152 eligible zoning districts within the 59 LILA-designated census tracts remaining after overlapping the eligible zoning districts with the LILA census areas. Map 5 portrays the results of the social suitability assessment.

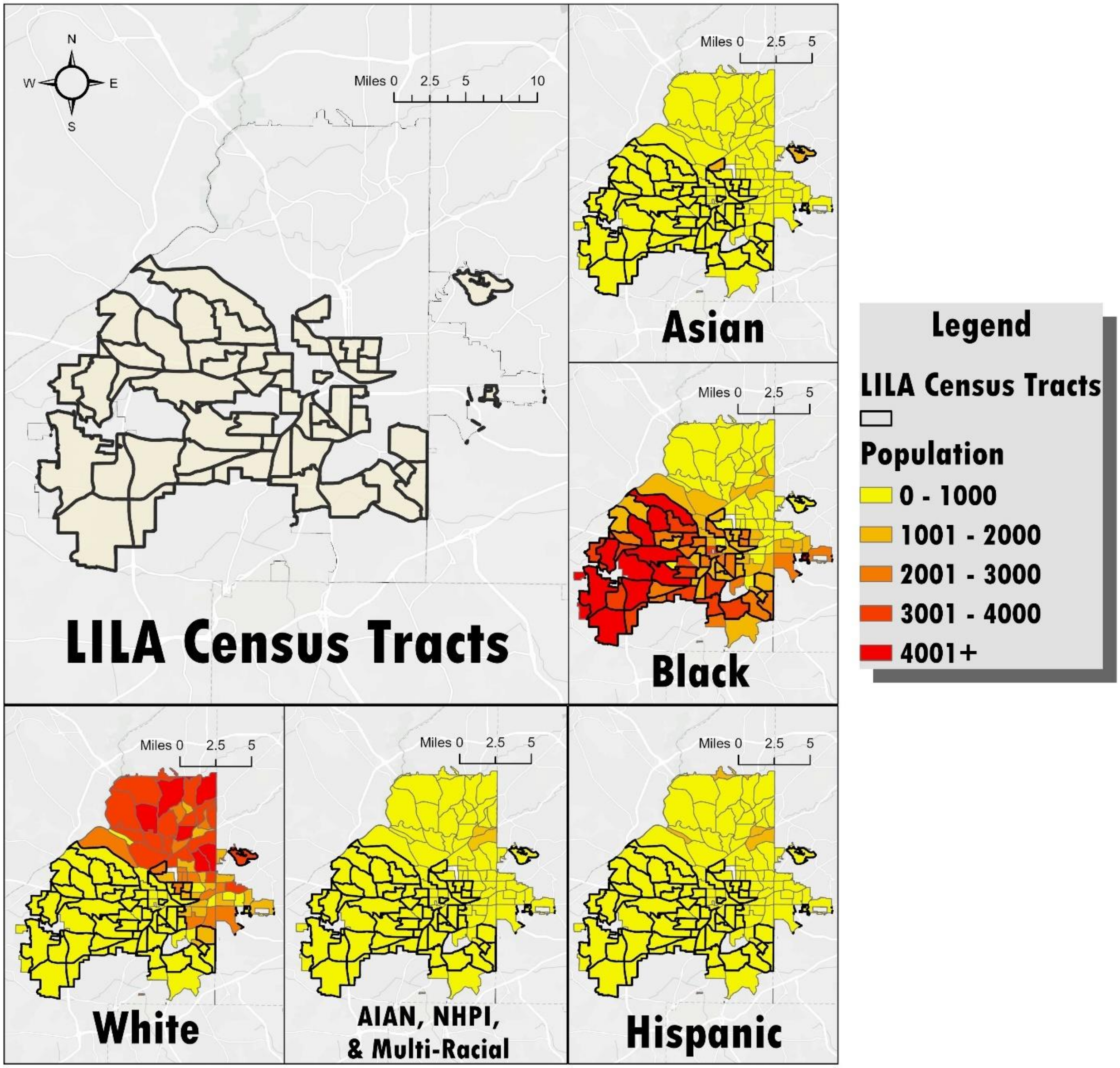
Map 1. Eligible MUs (Physical Suitability Assessment)



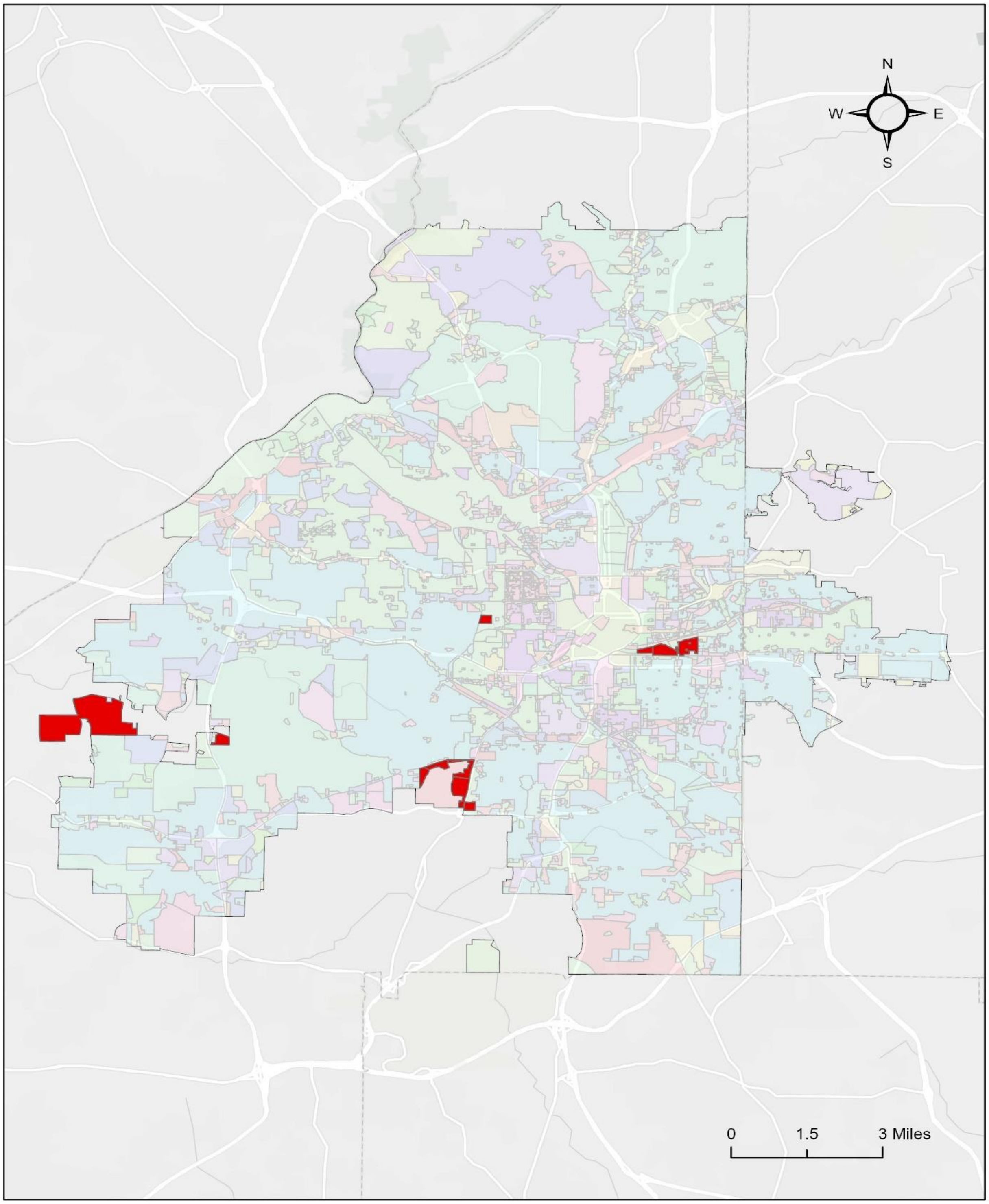
Map 2. Physical Suitability Assessment Results



Map 3. LILA Census Tracts and Ethno-Racial Concentrations

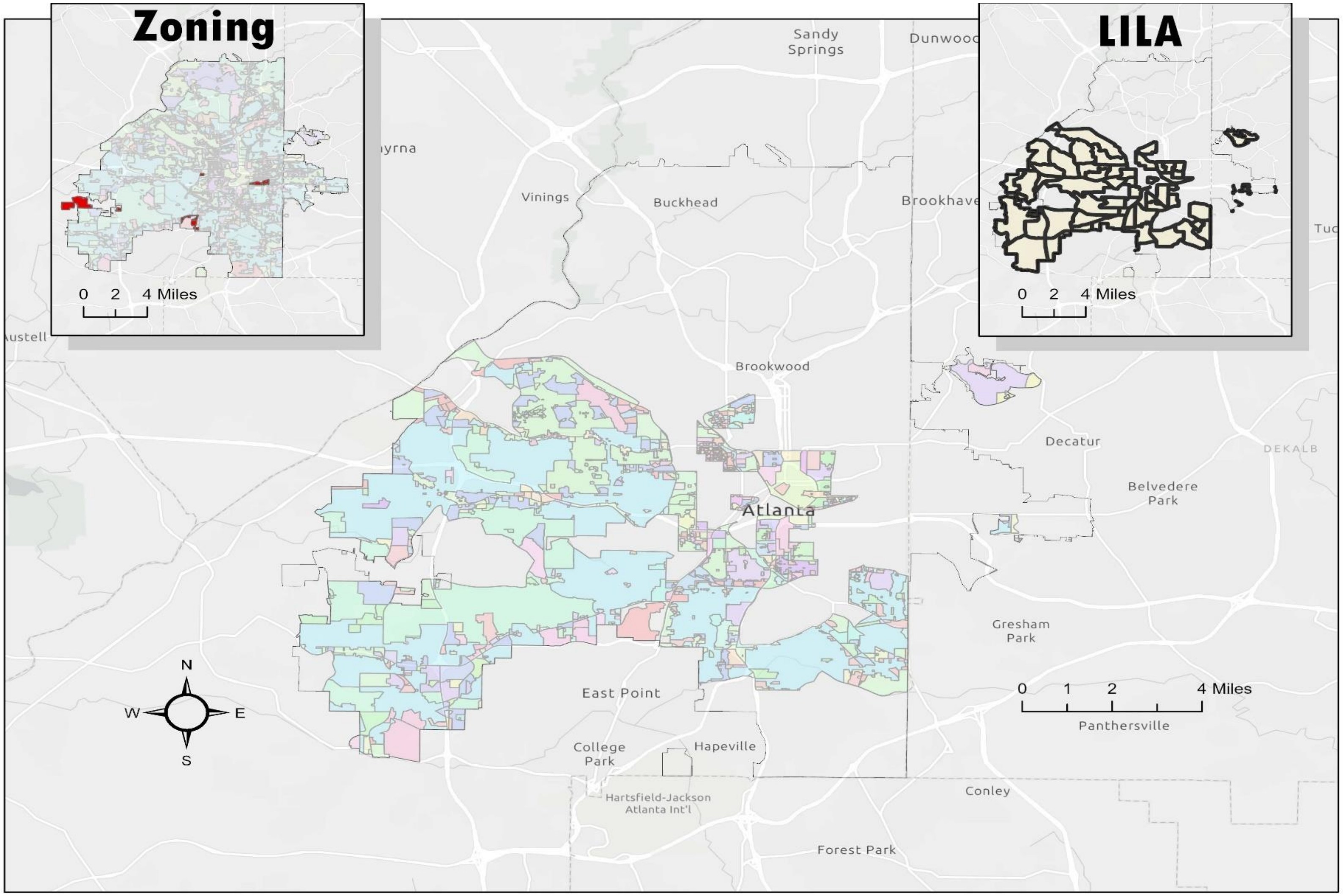


Map 4. Extant Zoning Districts[4]



[4] The various colors on this map denote zoning districts of different types. Please refer to Appendix B for a full legend of eligible zoning district classifications.

Map 5. Social Suitability Assessment Results[5]

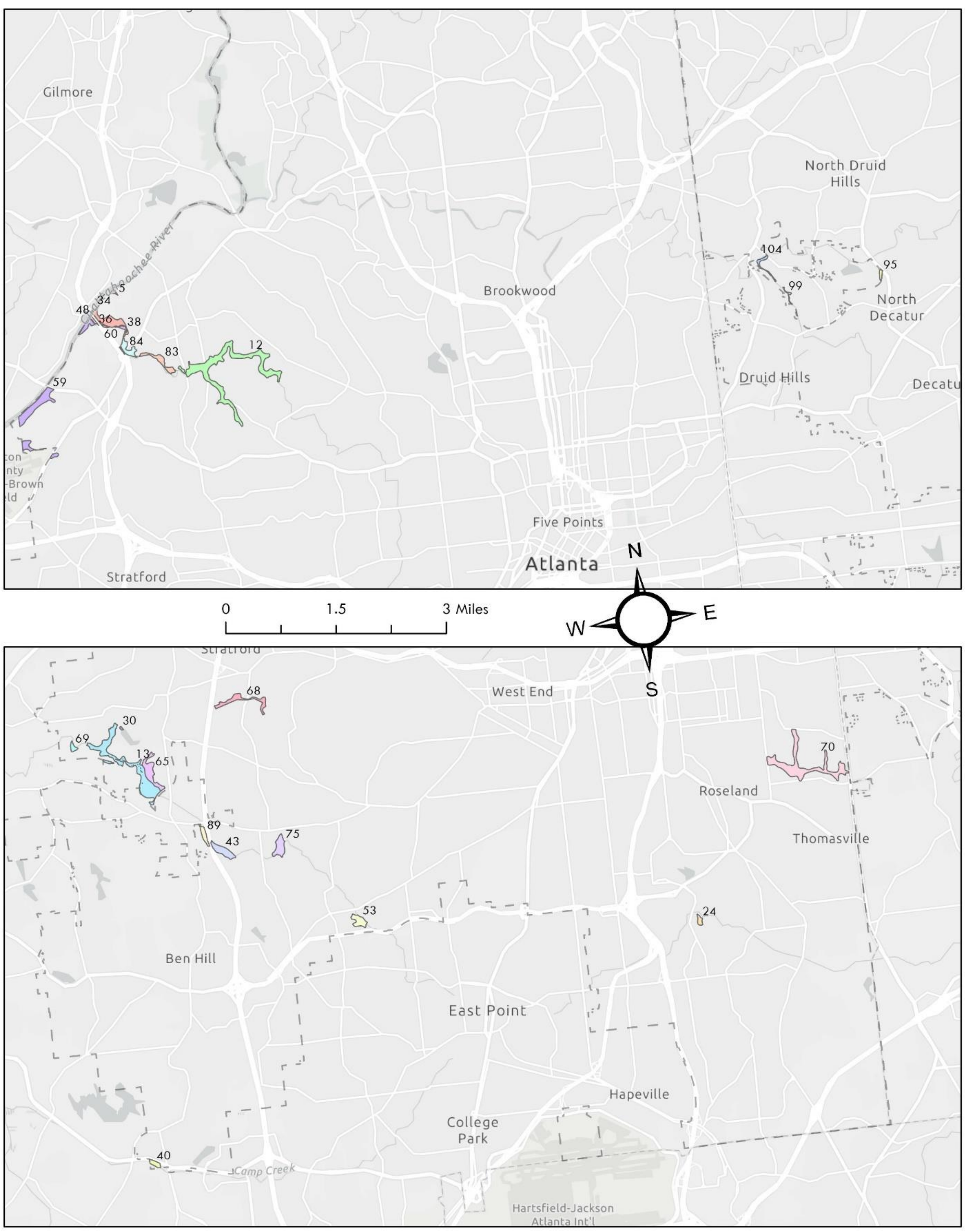


[5] The various colors on the zoning map denote zoning districts of different types. Please refer to Appendix B for a full legend of eligible zoning district classifications.

Results

The physical suitability assessment resulted in 207 MUs after excluding ineligible MUs and the social suitability assessment resulted in 1,152 zoning-eligible locations across Atlanta's 59 LILA-designated census tracts. After overlapping the eligible spatial areas from both assessments, 95 MUs remained for scoring based on physical qualities. Twenty-five MUs tied for first place at a score of 12 and are thus the most suitable MUs based on the established criteria in the physical and social suitability assessments.[6] Unfortunately, the MUs are not spatially grounded in any meaningful reality on the ground in their current state and thus Map 6 visualizes these 25 MUs for better portrayal. The following section will provide additional spatial context and discuss specific UAF system ideas for each resulting "site."

Map 6. Most Suitable MUs in Atlanta for UAF systems



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[6] Details on the physical assessment scores across categories for all eligible MUs are summarized in Appendix C.

Discussion

The most suitable sites identified by this analysis are not currently bound by relevant spatial or institutional boundaries since the data in the MUs were aggregated for the purposes of the SSURGO dataset. However, many of the MUs cluster around particular local institutions or features that spatially grounded them within Atlanta's built environment and provide for more fruitful context to discuss the types of UAF systems that may be appropriate for development. These sites are discussed in this section in four groups based on their geography: DeKalb County; Proctor Creek; Utoy Creek; and Outliers. Table 8 provides additional information on these groups and their associated sites. Similarly, Table 9 summarizes the information presented about these designated anchor sites and their associated MUs at the end of the section.

Table 7. Local Sites and Recommendations

Site	Location	Number of Map Units
DeKalb County		
Emory University	NE Atlanta	3
Proctor Creek		
Chattahoochee River and surrounding residential neighborhoods	NW Atlanta	7*
Hollywood Cemetery/Hollywood Rd	NW Atlanta	1
Lillian Cooper Shepherd Park/Proctor Creek and surrounding residential neighborhoods	NW Atlanta	3*
Utoy Creek		
Cascade Road Driving Range and surrounding residential neighborhoods	SW Atlanta	2
Cascade Springs Nature Preserve	SW Atlanta	1
North Utoy Creek and surrounding residential neighborhoods	SW Atlanta	1
South Utoy Creek and surrounding residential neighborhoods	SW Atlanta	1
Wilowood Lake and CSX Transportation Railroad	SW Atlanta	4
Outliers		
Army National Guard Base and surrounding residential neighborhoods	SE Atlanta	1
Camp Creek and surrounding residential neighborhoods	SW Atlanta	1
South River and surrounding residential neighborhoods	SE Atlanta	1

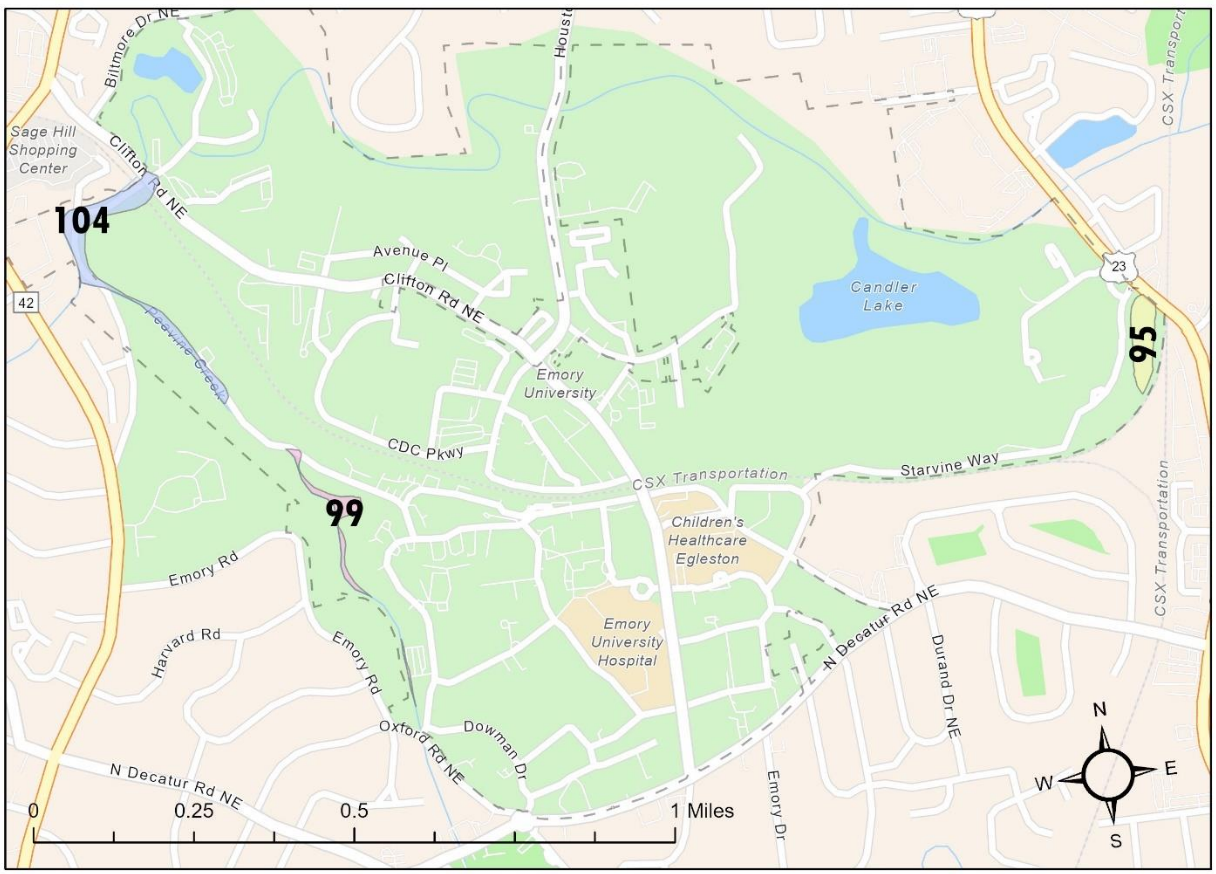
**One MU is shared between these two sites based on its shape and geography.*

DeKalb County Site

Emory University – This site consists of three MUs (95, 99, and 104). All three MUs are small in land area and and sit on three separate parcels owned by Emory University in DeKalb. MU 95 is oval-shaped and situated on a mostly undeveloped space next to a campus recreation center on the eastern edge of Emory's campus adjacent to railroad tracks. MU 99 has a snake-like spindly shape, running along Peavine Creek and overlapping with a baseball field on campus. MU 104 has a similar shape and also runs along Peavine Creek, heading northwest away from campus and intersecting a soccer field on campus.

The overall development pattern of the surrounding areas are typical of university campuses with a unique blend of residential, commercial and educational space. Considerations should therefore be made for the unique functions of the existing land uses within the university context when recommending potential UAF systems. MU 95 could support a community garden with alley cropping because of its shape, size, and proximity to commonly visited student locations. MUs 99 and 104 could support riparian buffers along Peavine Creek or integrate working trees into the existing treescape.

Map 7. Emory University Sites (MUs 95, 99, 104)

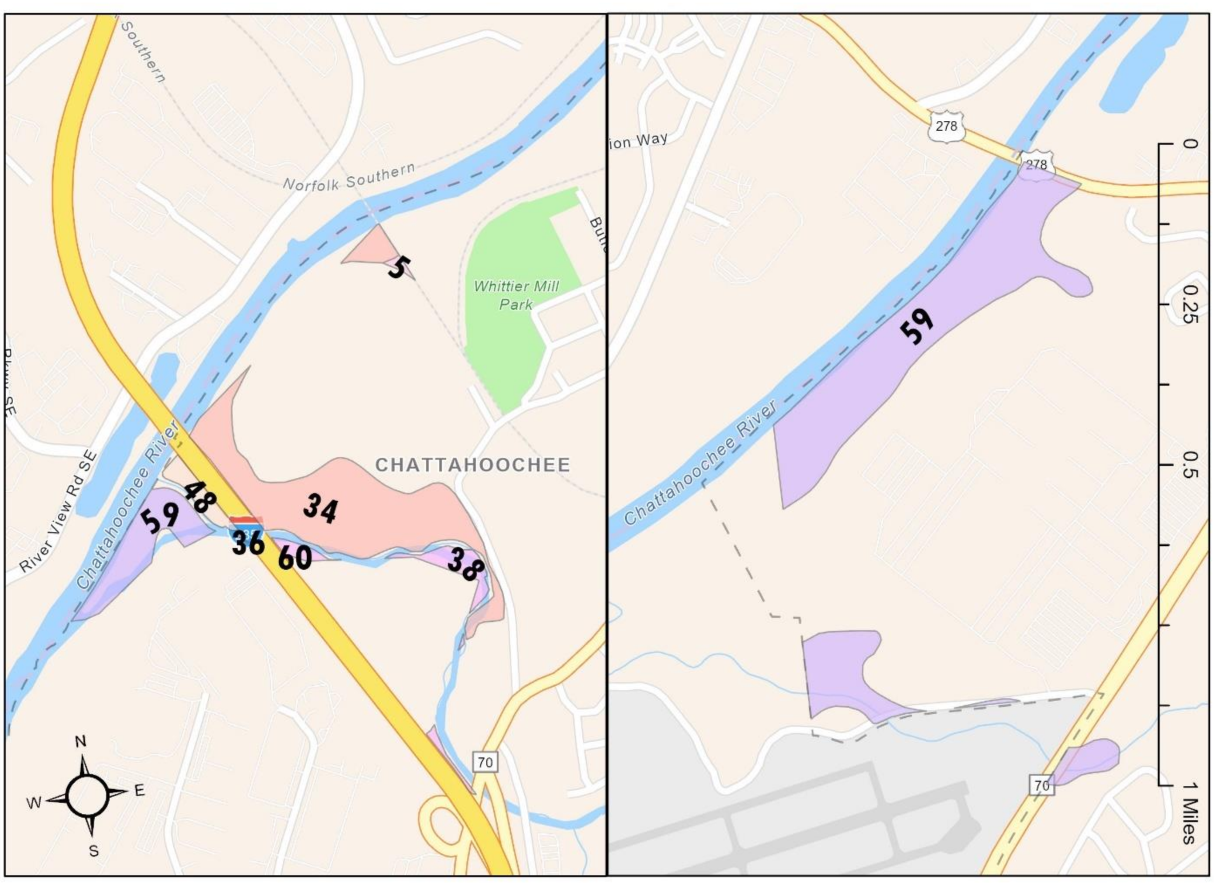


Proctor Creek Sites

Chattahoochee River – This site consists of six full MUs (5, 34, 36, 48, 59, and 60) and partially contains one additional MU (38). MU 5 is small and triangular, sitting on a city-owned parcel near the Chattahoochee River but not bordering it. This MU is also separated from Whittier Mill Park and the surrounding residential areas by a railroad. MU 34 covers a large, discontinugous area that is adjacent to the river as well as Interstate 285 and Proctor Creek. This MU is situated on five parcels, the largest of which is owned by the city and designated as a vacant industrial park. Additionally, a small piece of this MU shares a border with MU 5. MU 36 is a tiny site adjacent to I-285 that shares a border with MU 59, which covers a much larger, discontiguous area. Both portions of the latter MU connect with the Creek and River, but is separated from I-285 by MU 48. MU 48 is a medium-sized polygon sandwiched between I-285, the River, and the previously mentioned MU. MUs 36, 48, and 59 are all separated from the nearest residential areas by I-285 and various industrial uses. MU 60 is small and triangular, running along the south bend of the Creek. The entirety of this MU is within a single, city-owned tax parcel. The Chattahoochee River site also contains a portion of MU 38 that also follows the south bend of the Creek nestled within the curve of MU 34. MU 38 continues eastward until it reaches the Lillian Cooper Shepherd Park further along the Creek.

Unfortunately, MU 5 is not suitable for any UAF systems recommendations because of its separation from residential areas that would benefit from improvements. Additionally, the MU does not enjoy the same proximity to Proctor Creek and the Chattahoochee River. However, this proximity is favorable for MUs 34, 36, 38, 48, 59, and 60 which could all support extensive riparian buffers with food-producing trees. MU 60 would also be a prime candidate for participation in AgLanta's Grows-a-Lot program[7] because of its size and current vacancy. MU 34 may also be able to support a large community garden or food forests; however, these options may not be optimal given the anticipated future uses of most of the land where it is situated.

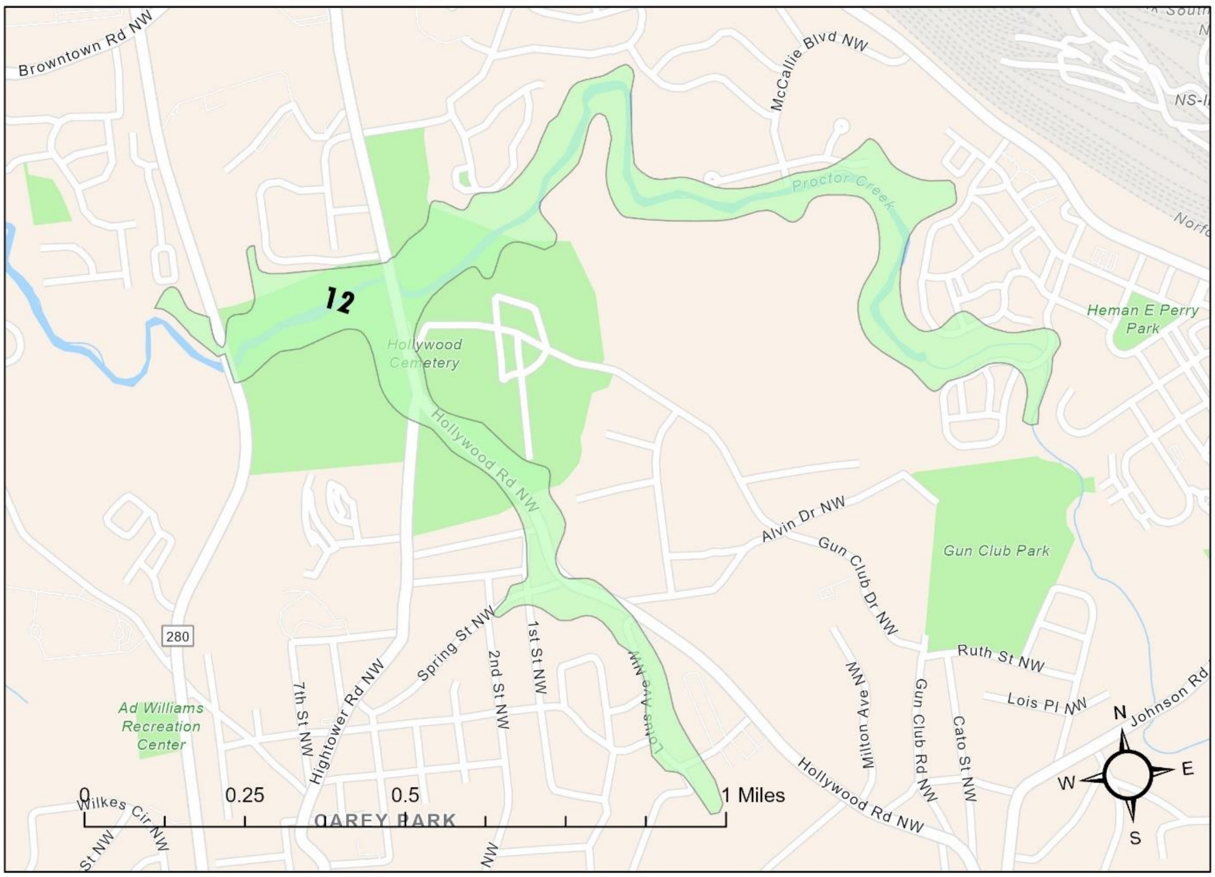
Map 8. Chattahoochee River Sites (MUs 5, 34, 36, 38, 48, 59, 60)



[7] Additional details on the AgLanta Grows-a-Lot program are included in the Recommendations chapter.

Hollywood Cemetery/Hollywood Road and Surrounding Residential Neighborhoods – This site only consists of MU 12. MU 12 has a large, spindly shape that snakes through mostly undeveloped parcels along Proctor Creek before reaching the outskirts of residential neighboorhoods. This MU also follows Hollywood Road NW until it reaches Hollywood Cemetery, although it does not actually overlap with the burial grounds. Riparian buffers would be the most appropriate UAF system for this MU because of adjacency to the Creek and sensitive existing land uses. Homegardens could also be appropriate for portions of the MU within residential areas near Heman E Perry Park to the east.

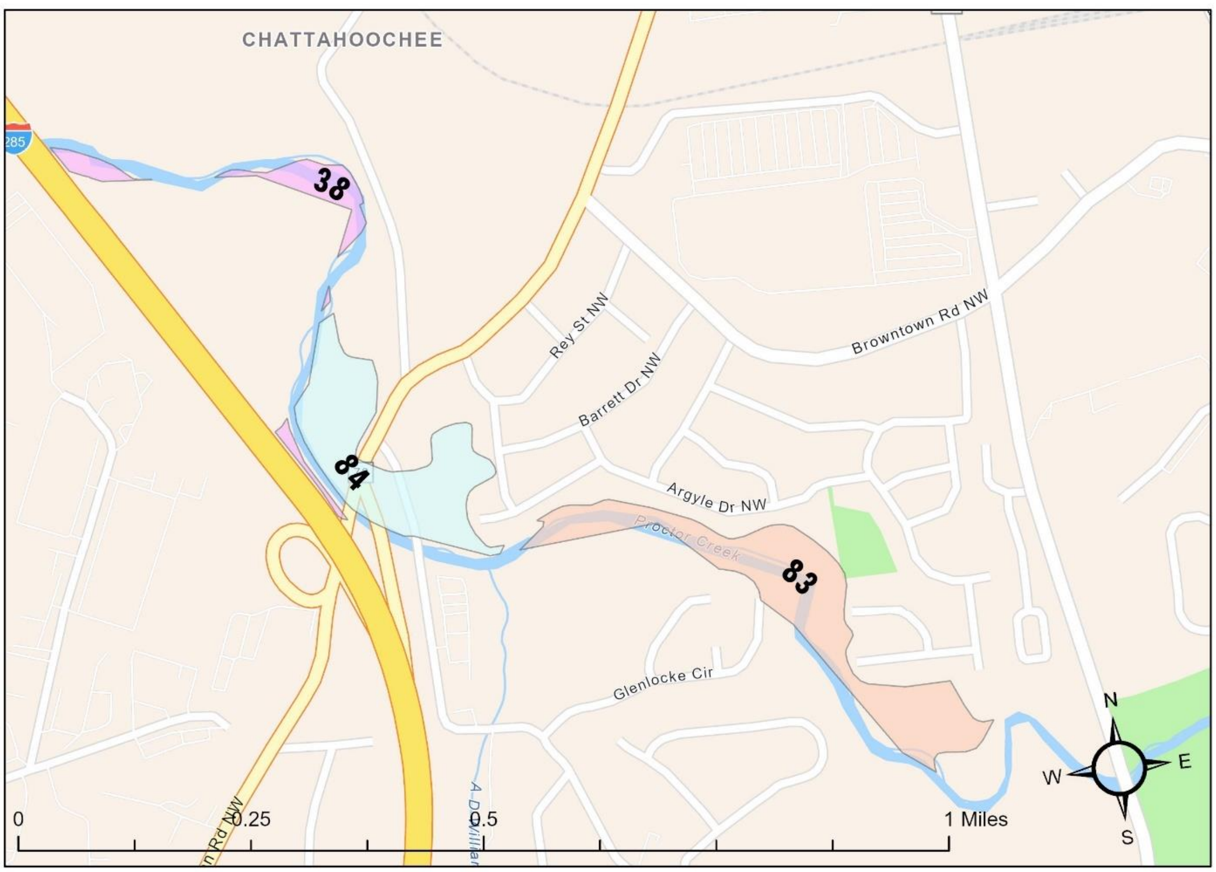
Map 9. Hollywood Cemetery/Hollywood Road Site (MU 12)



Lillian Cooper Shepherd Park and surrounding residential neighborhoods – This site consists of two full MUs (83 and 84) and partially contains one additional MU (38). MU 83 is a large polygon that follows the north bend of Proctor Creek and straddles several residential lots and connects to a Lillian Cooper Shepherd Park. However, the largest portions of this MU's land area situated on city-owned tax parcels. MU 84 is a medium sized area that wraps around the western outskirts of the residential neighborhood that contains the Park. This MU also abuts the Atlanta Bolton Pumping Station, indicating that the area has already been identified for its importance in watershed management for the city. This site also contains a section of MU 38 that blocks MU 83 from I-285 and snakes along the south bend of the Creek. As mentioned in a previous section, this discontiguous MU continues westward along the Creek until it reaches the Chattahoochee River sites.

All three of the MUs for this site could easily support extensive food-producing riparian buffers by integrate working trees into the existing treescape. Similarly, portions of MU 84 could also support development into a full food forest via the same strategy because of its size and proximity to residents. Residential neighborhoods within MU 83 and MU 84 could also be suitable for developing homegardens on indiviual lots.

Map 10. Lillian Cooper Shepherd Park Sites (MUs 38, 83, 84)

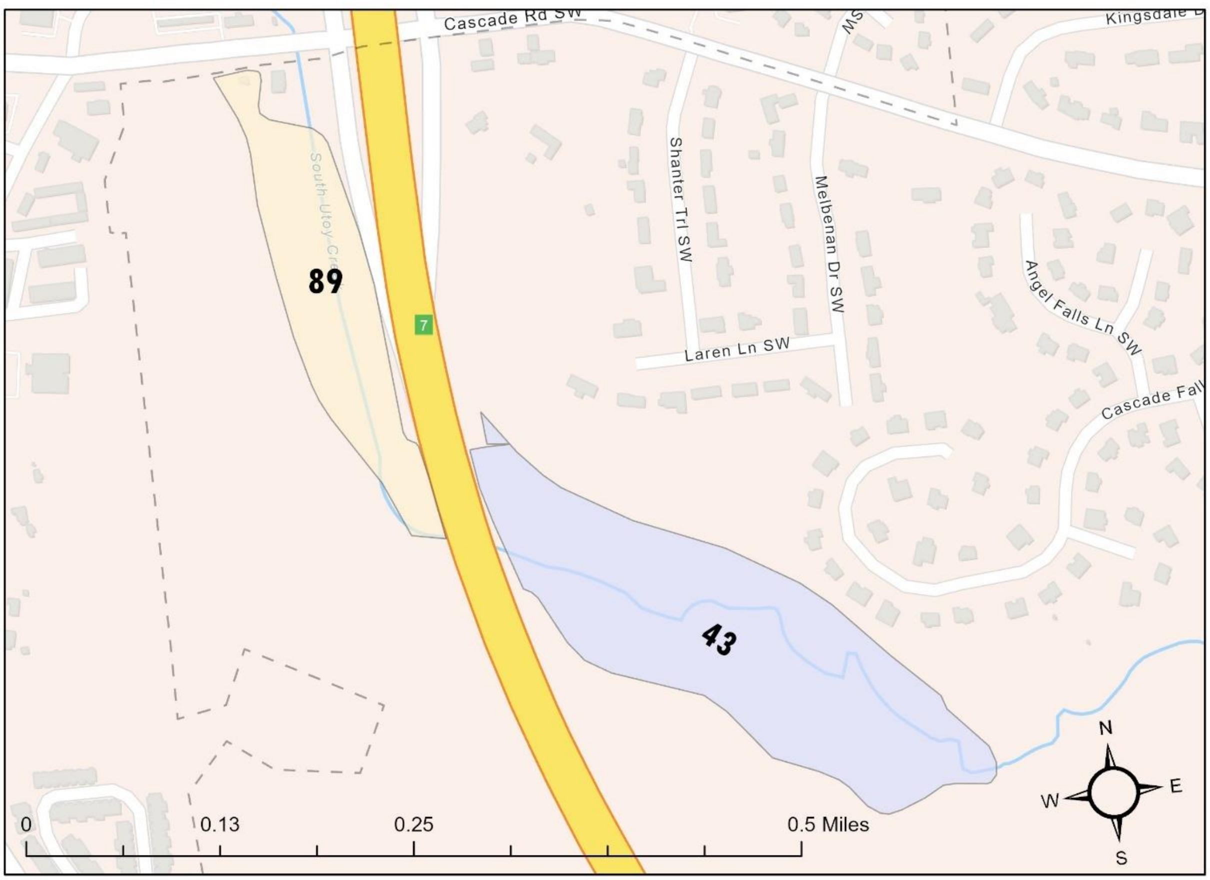


Utoy Creek Sites

Cascade Road Driving Range and surrounding residential neighborhoods – This site consists of two MUs (43 and 89). MU 42 is a medium-sized polygon that straddles the South Utoy Creek directly to the east of I-285 on the outskirts of residential neighborhoods. Most of this MU is situated atop a nearly 37-acre city-owned parcel with the remainder falling on a handful of residential lots. MU 89 follows the Creek on the outside of I-285 until the border of the city. This MU is split between two tax parcels, one of which is a driving range that dominates most of the MU's extent.

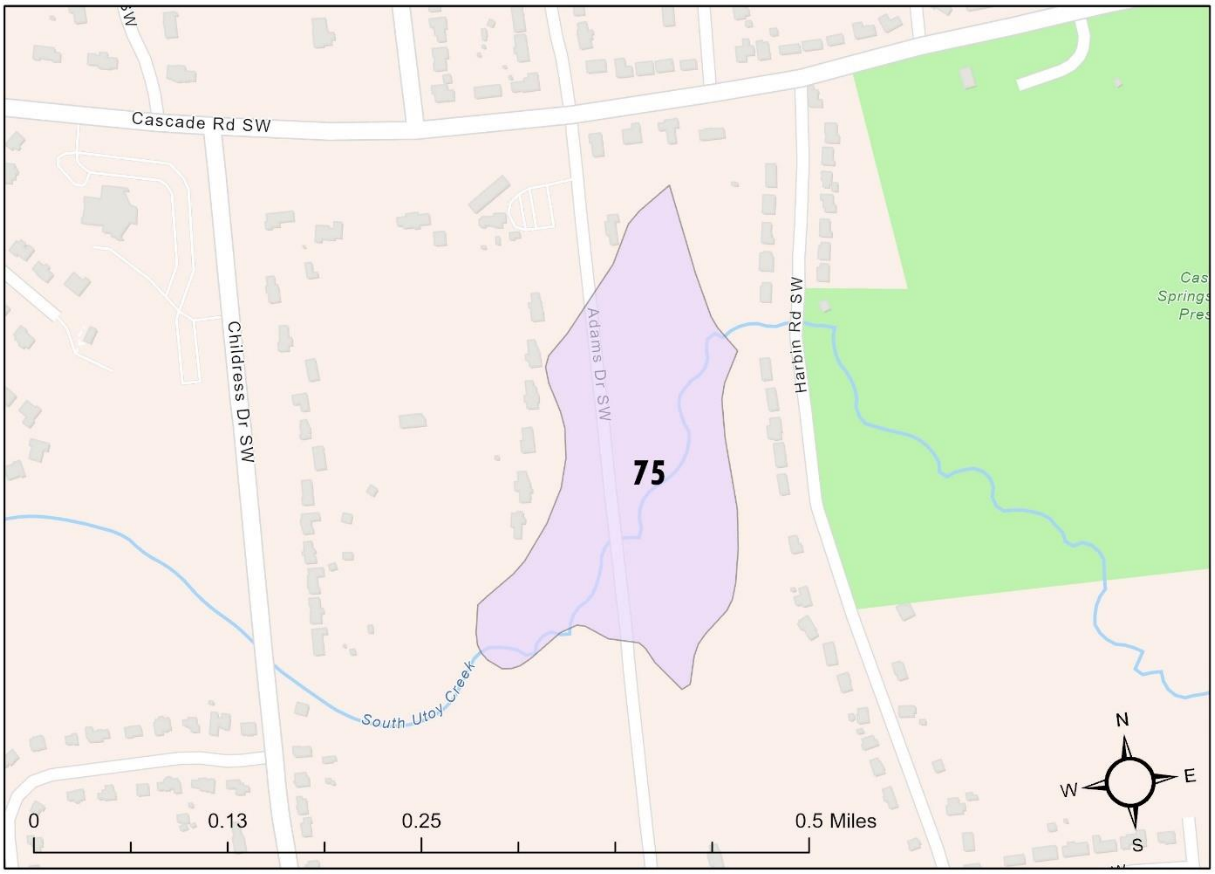
Unfortunately, MU 89 is not suitable for UAF recommendations because of existing land use on site and its adjacency to concentrated commercial development on its western edge. MU 42 could easily support extensive food-producing riparian buffers by integrate working trees into the existing treescape because of its proximity to South Utoy Creek. Similarly, this MU could also support development into a full food forest via the same strategy because of its size and adjacency to residential neighborhoods.

Map 11. Cascade Road Sites (MUs 43, 89)



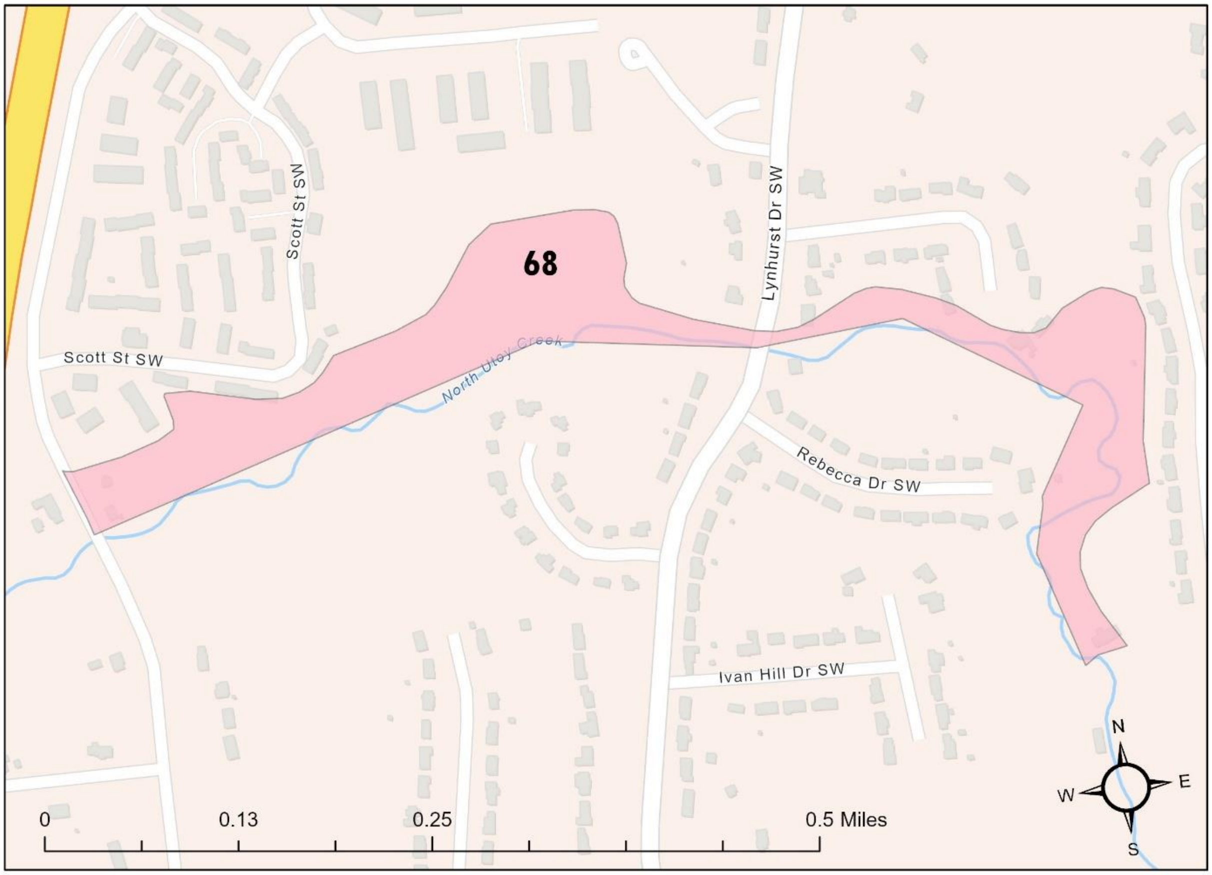
Cascade Springs Nature Preserve – This site only consists of MU 75. The medium-sized MU lies to the west of Cascade Springs Nature Preserve along South Utoy Creek. This MU spans 19 parcels that are mostly private households; however, two parcels adjacent to the Creek are owned by the city. MU 75 could support a community garden that utilizes alley cropping because of its location and size. This MU could also support a tradtional food forest with additional riparian features along the Creek. Residential lots could also be suitable for developing homegardens.

Map 12. Cascade Springs Site (MU 75)



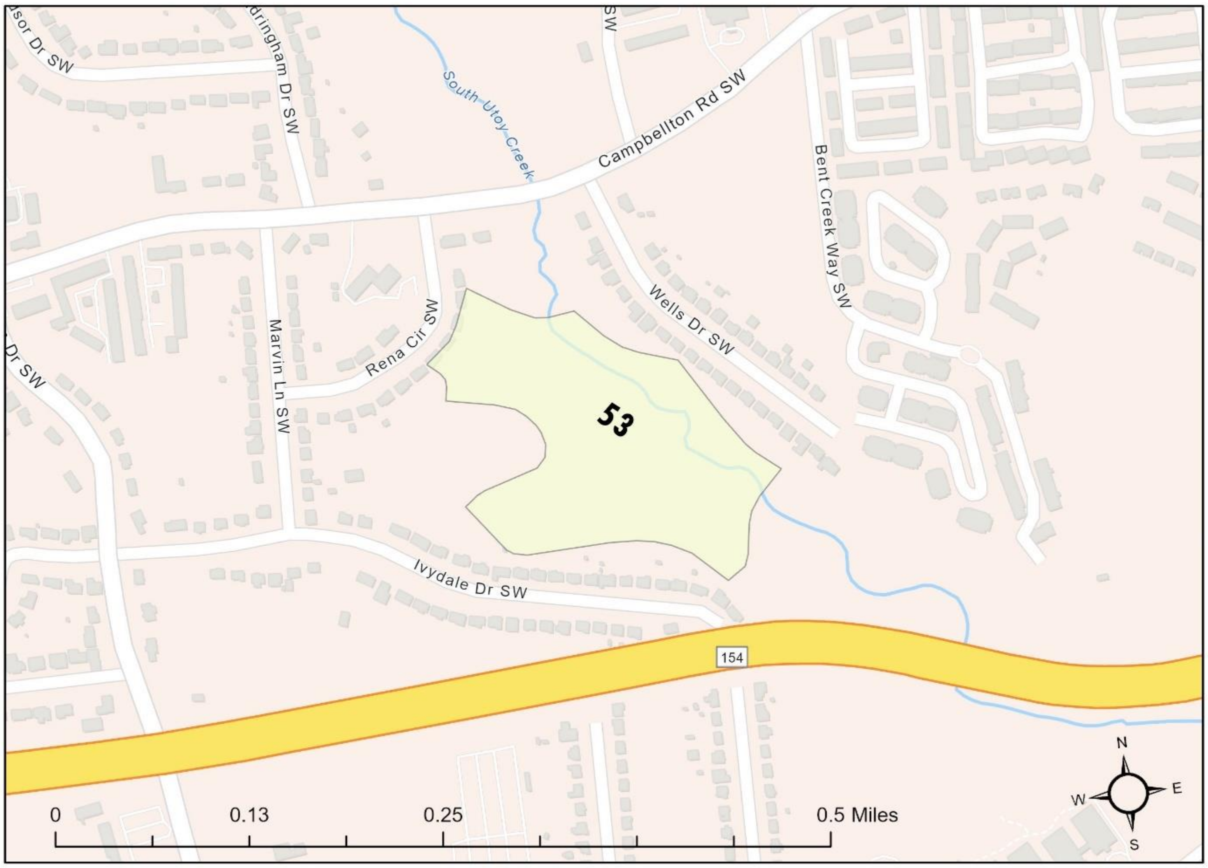
North Utoy Creek and surrounding residential neighborhoods – This site only consists of MU 68. MU 68 has a large, horizontal shape of the North Utoy Creek through 37 parcels that contain mostly private households. This MU also contains several city-owned parcels on its eastern extrimity. A private equity firm owns a large parcel within this MU that is a sufficiently large site to support a food forest. MU 68 could easily support the development of food-producing riparian buffers along the Creek. Residential lots within the MU could also be suitable for developing homegardens.

Map 13. North Utoy Creek Site (MU 68)



South Utoy Creek and surrounding residential neighborhoods – This site only consists of MU 53. MU 53 is a small MU situated north of Arthur B. Langley Parkway and sandwiched between residential subdivisions in South Atlanta. This MU also contains a portion of the South Utoy Creek. MU 53 covers 45 parcels of mostly private households, although the city owns four tiny parcels intersperced between larger ones. Additionally, the oblong parcel containing the creek is privately owned. This MU has the potential to support UAF systems in the form of homegardens on residential lots and riparian buffers along the Creek; however, most of these developments would need to take place on private property since public land ownership is scarce in this site.

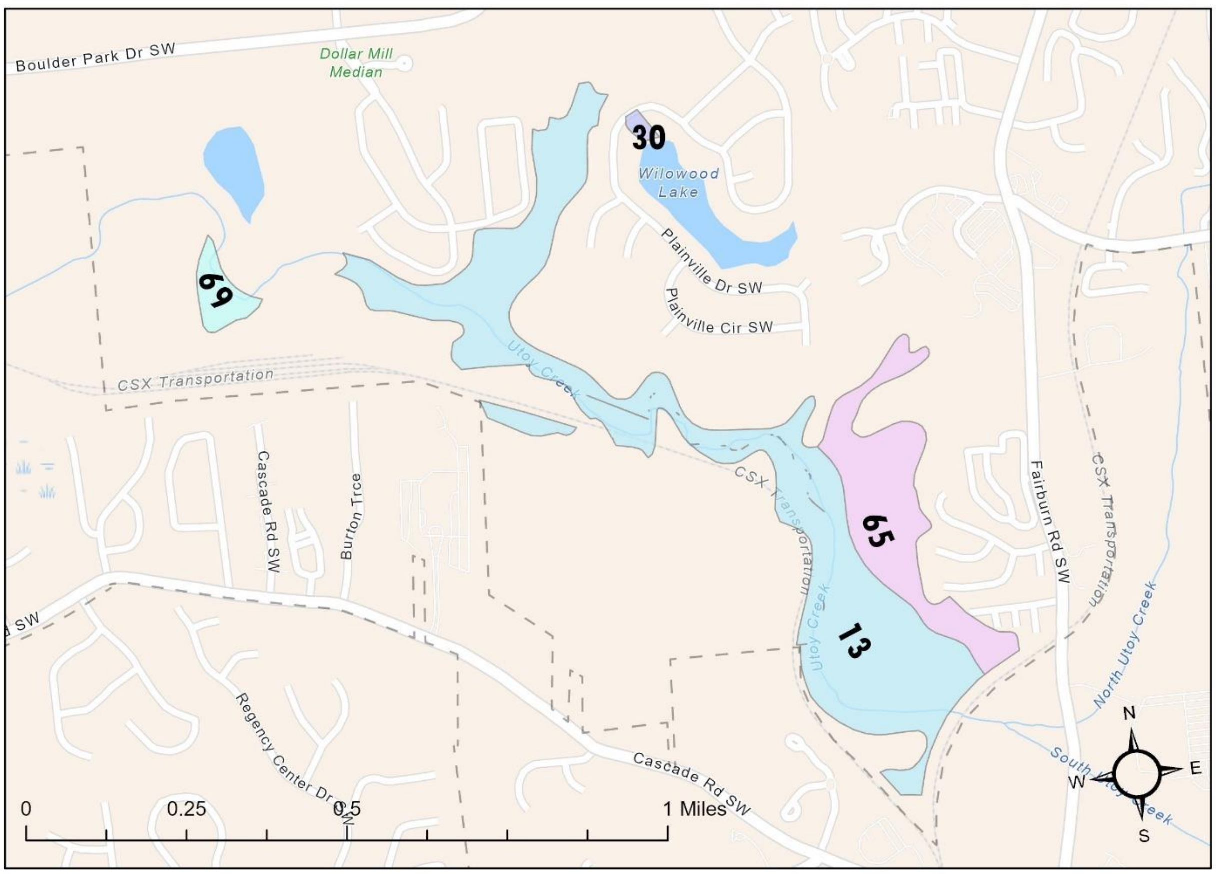
Map 14. South Utoy Creek Site (MU 53)



Wilowood Lake/CSX Transportation Railroad and surrounding residential neighborhoods – This site consists of four MUs (13, 30, 65, and 69). MU 13 is a large, horizontal polygon that borders the CSX railroad and contains Utoy Creek after the convergence of its north and south forks. This MU has poor access to the surrounding residential areas because of the railroad and runs into the western border of the city. MU 30 has a small, box-like shape and is situated on a single undeveloped parcel next to Wilowood Lake in a residential neighborhood. MU 65 has a vertical, wide shape and outlines an apartment complex on Fairburn Road. MU 69 is a small MU that contains Utoy Creek lying to the west of MU 13. This MU has no access to surrounding roads, streets, or neighborhoods.

MUs 13 and 69 would best support extensive food-producing riparian buffers because of their proximity to Utoy Creek. These MUs are hard to access via roads or sidewalks so community gardens or food forests that require extensive maintenance and frequent access may not be appropriate. MUs 30 and 65 could easily support their surrounding residential areas as the sites of community gardens. Additionally, residential lots within MU 65 could be suitable for developing homegardens.

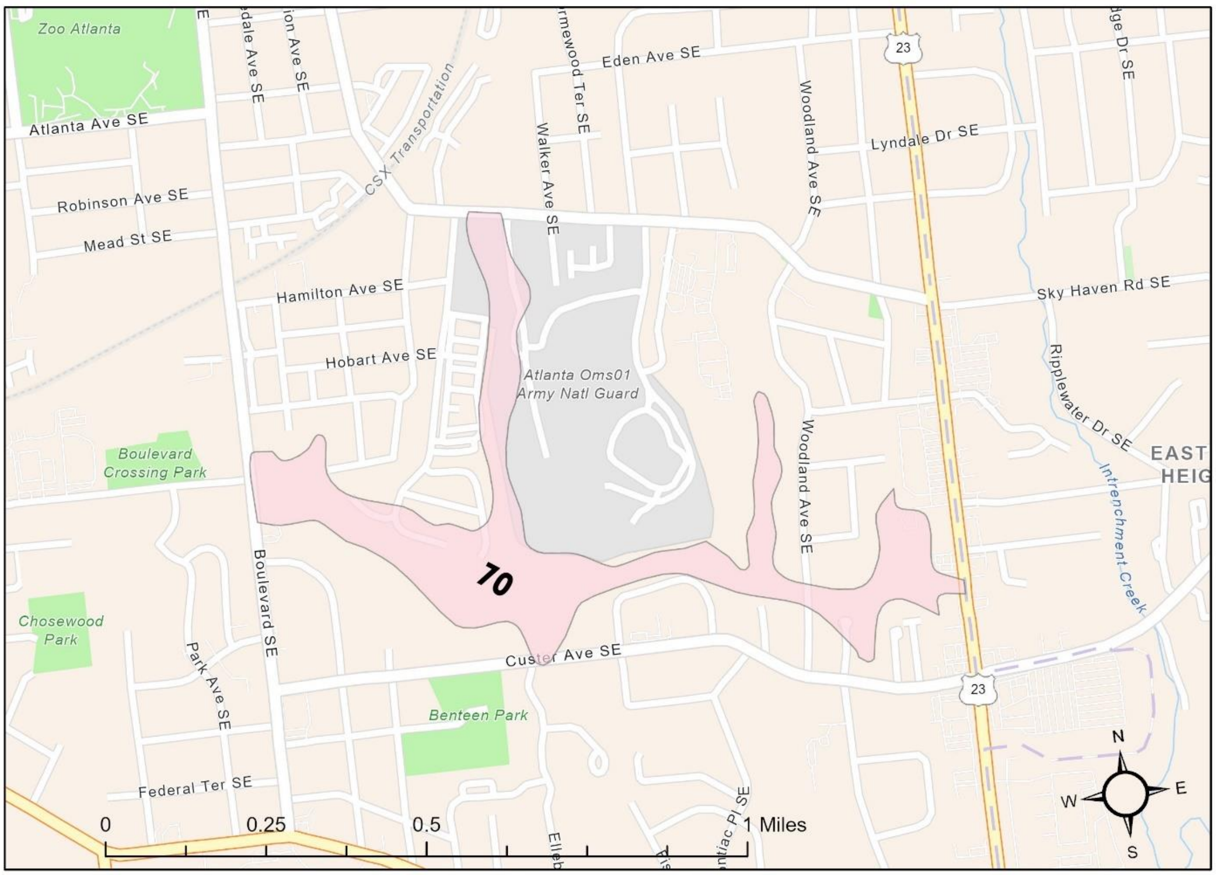
Map 15. Wilowood Lake Sites (MUs 13, 30, 65, 69)



Outlier Sites

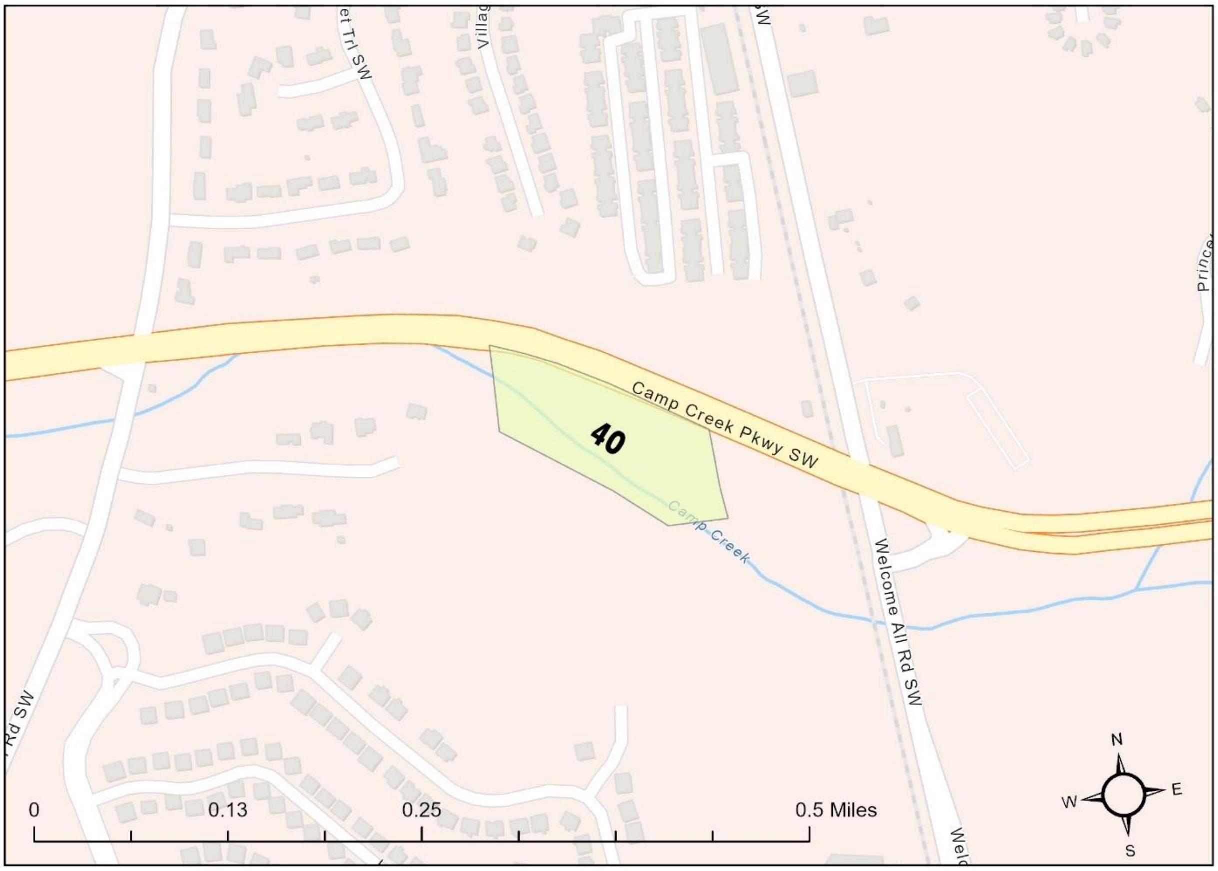
Army National Guard Base and surrounding residential neighborhoods – This site only consists of MU 70. MU 70 has a large, irregular shape that cups the Atlanta Oms01 Army National Guard Base and spans a handful of residential areas. This MU covers over 170 parcels of mostly private residences, with the notable exception of the Base and a thin strip of land abutting one of the neighborhoods which is owned by the city. There are no creeks or rivers connected to this MU for riparian buffers. Additionally, the high number of small, privately-owned lots could be unsuitable for community gardens or food forests. However, residential lots within MU 70 could be suitable for developing homegardens.

Map 16. Army National Guard Base Site (MU 70)



Camp Creek and surrounding residential neighborhoods – This site only consists of MU 40. MU 40 is a small, irregular pentagon situated along a relatively undeveloped strip of Camp Creek Parkway SW. This MU contains Camp Creek and spans two tax parcels, one owned by the homeowner's association of the neighborhood to the south, Lakeside Preserve and the other owned by Fulton County. MU 40 would serve as an ideal site for a neighborhood community garden for nearby residents. The areas along the Creek could also easily support food-producing riparian buffers. Both of these options could be pursued as a part of a conservation easement for the neighborhood or through more traditional ownership dynamics.

Map 17. Camp Creek Site (MU 40)



South River and surrounding residential neighborhoods – This site only consists of MU 24. MU 24 is a small polygon situated along the south bend of the South River nestled between residential areas. While the MU itself does not touch South River, it sits atop a city-owned parcel that extends to the River and a handful of lots with private households. MU 24 could likely support a community garden with alley cropping because of its size and proximity to residential areas. Additionally, residential lots within MU 24 could be suitable for developing homegardens.

Map 18. South River Site (MU 24)

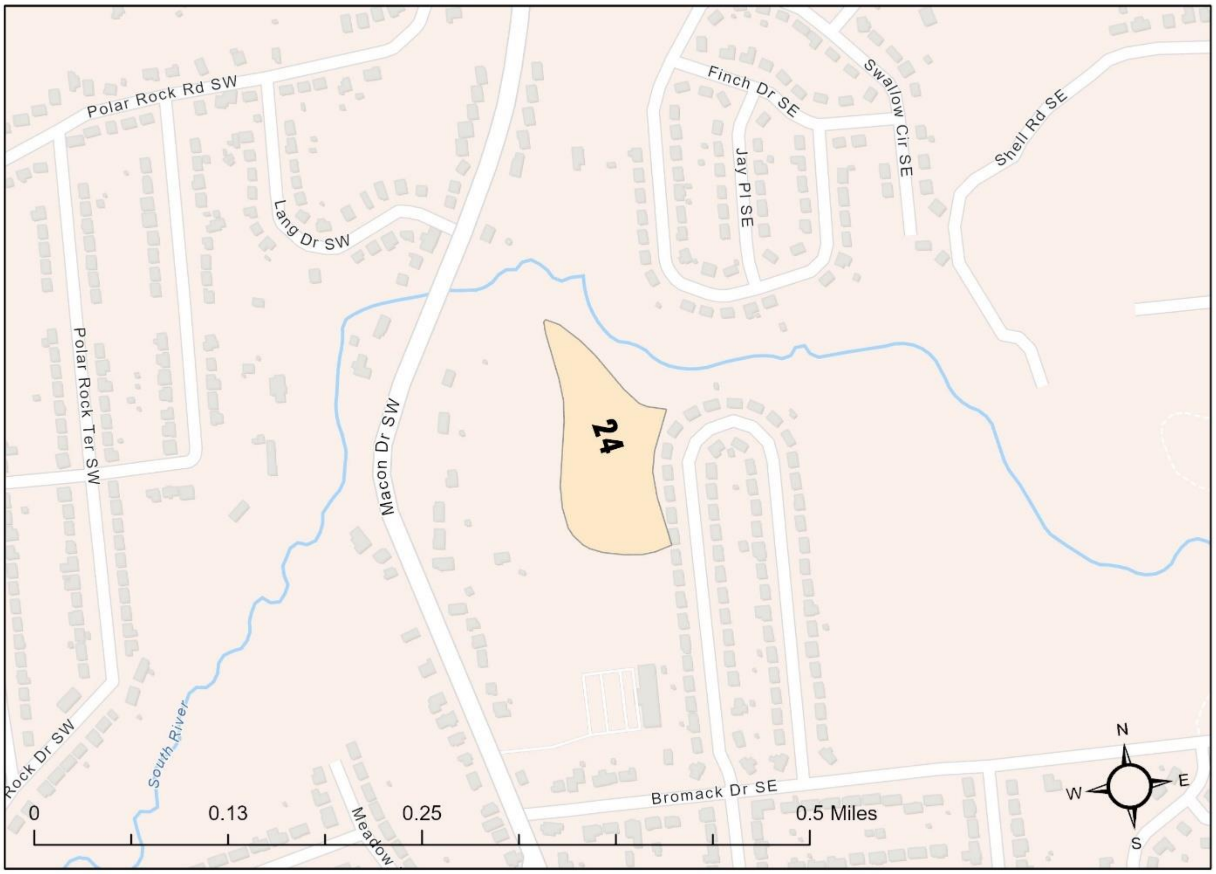


Table 8. Local Sites and Recommendations

Site	Map Units	Recommendation
DeKalb County		
Emory University	95	Community garden
	99	Riparian buffers
	104	Riparian buffers
Proctor Creek		
Chattahoochee River and surrounding residential neighborhoods	5	Unsuitable
	34	Riparian buffers
	36	Riparian buffers
	38*	Riparian buffers
	48	Riparian buffers
	59	Riparian buffers
	60	Community garden
Hollywood Cemetery/Hollywood Rd	12	Riparian buffers
Lillian Cooper Shepherd Park/Proctor Creek and surrounding residential neighborhoods	38*	Riparian buffers
	83	Homegardens; riparian buffers
	84	Food forest; homegardens; riparian buffers
Utoy Creek		
Cascade Road Driving Range and surrounding residential neighborhoods	43	Food forest; riparian buffers
	89	Unsuitable
Cascade Springs Nature Preserve	75	Community garden; food forest; riparian buffers
North Utoy Creek and surrounding residential neighborhoods	68	Food forest; homegardens; riparian buffers
South Utoy Creek and surrounding residential neighborhoods	53	Homegardens; riparian buffers
Wilowood Lake and CSX Transportation Railroad	13	Riparian buffers
	30	Community garden
	65	Community garden; homegardens
	69	Riparian buffers
Outliers		
Army National Guard Base and surrounding residential neighborhoods	70	Homegardens
Camp Creek and surrounding residential neighborhoods	40	Community garden; riparian buffers
South River and surrounding residential neighborhoods	24	Community garden; homegardens

Recommendations

As a bridge between food systems and stormwater management, sustainable UAF development requires coordination from a wide range of policy actors, including local and state agencies, planners, and community members. Local recommendations focus on the role of the city and the county to increase the availability of publicly owned property for urban agriculture and UAF systems, prioritizing food systems into local planning efforts, and building upon existing city-programming. State recommendations highlight the role of the state in creating new supports and incentives for the development of green infrastructure and UAF systems. Together, these recommendations can further the adoption and implementation of UAF systems in Atlanta and also catalyze the expansion of agroforestry in other contexts as a multifunctional tool for various social and environmental services.

Local Recommendations

Encourage Household and Neighborhood-Scale UAF Systems – As discussed in the previous chapter, many of the most suitable areas for UAF systems as green infrastructure are situated in/adjacent to residential areas. The city should seek to unlock its UAF potential by encouraging neighborhoods and homeowners to develop UAF systems in their yards or neighborhoods. Specifically, the city could empower residents to develop these systems on their residential lots by creating city-sponsored programs and initiatives aimed at providing technical assistance for home growing. These programs could also give residents direct material assistance by providing containers or materials for raised bed construction, seeds or seedlings, or physical educational materials such as flyers. AgLanta has previously supported local growers in coordinating knowledge sharing events; however, these events were largely driven through local growers' interest in sharing this knowledge as opposed to any formal city-led initiative. For related reasons, this approach may face challenges in terms of the longevity and maintenance of UAF systems on privately-owned parcels. Primarily, the lack of public jurisdiction over these lots means that publicly led implementation and maintenance strategies will be difficult to pursue, and private landowners will have varying interest in using their land for these particular environmental or social services. While publicly held lands should be prioritized for UAF systems, the potential of privately-owned sites could still be considered as a part of holistic approach to maximize viable spaces across Atlanta.

Atlanta can look to its neighboring communities for examples of similar initiatives that have been successful. For example, South Fulton launched "South Fulton Grows" to increase local food access by providing resources to residents. These resources included not just technical expertise but also free grow boxes, lumber for raised bed construction, and starter plants. Similarly, the City of East Point has partnered with local non-profit organizations, such as Food Well Alliance, to prepare bucket gardens for food-insecure households across the city. Atlanta could support and facilitate a similar program through partnerships with Food Well Alliance, Georgia Organics, or other local organizations interested in home growing. Additionally, the city should seek support from the NPUs to ensure that new UAF systems and homegardens are aligned with its residents' desires for their neighborhood.

Prioritize Food Systems in Local Planning Efforts – Atlanta has made many positive strides towards integrating and prioritizing food systems into local planning efforts over the past decade. However, there are still many opportunities to incorporate food access and production priorities into ongoing planning efforts. For example, the city is undergoing a massive revision of its zoning code that has the potential to alter the development landscape of the city. Local planners could use this opportunity to expand simplify regulations regarding urban garden and farm siting. The current city ordinance paints a complicated regulatory picture for developing new urban agriculture sites. Fortunately, the reality on the ground is more simplistic as few areas of the city are still zoned as an incompatible district. This simplification will remove unnecessary regulatory hurdles for new UAF system development and clarify regulations.

There are several other ways the city can activate areas of the city for urban agriculture and UAF systems. For example, the Urban Enterprise Zone (UEZ) program designates districts in economically depressed areas of the city and gives a tax abatement with the goal of encouraging new private development or redevelopment. The city can promote the use of UEZs to provide tax incentives to local growers for new UAF system development as a part of infill development strategies in most of the city. Additionally, the city should look to adopt a food systems master plan that highlights the role of UAF systems in environmental management and establish best practices for their development within the city. This master plan could also highlight the importance of connecting food systems priorities with other planning initiatives, such as affordable housing, economic development, and placekeeping.

Expand "Grows-A-Lot" Program – The AgLanta "Grows-A-Lot" program allows residents, non-profits, and entrepreneurs to adopt a vacant property owned by the City of Atlanta to start a new urban garden, farm, or food forest. As of 2022, eight properties throughout Atlanta have been adopted through the program. After identifying a property and going through the adoption process, applicants are committed to a 5-year renewable lease to foster and maintain a food production site. However, while the process has been delineated for urban gardens and farms, AgLanta has not formalized the requirements for adopting a property for development as a food forest. Consequently, none of the eight properties currently leased under the Grows-A-Lot program are food forests, and only one is an urban farm. Several of the MUs in this study's analysis are situated on city-owned parcels and would be suitable for development into either food forests or urban farms/gardens. The city should continue to promote this program through community events, such as AgLanta Eats, and engagement with NPUs, non-profit organizations, community members, and other stakeholders. Additionally, Grows-A-Lot has shown success in expanding the use of city-owned vacant properties for fresh food production. Both Fulton and DeKalb County own undeveloped parcels of land with suitable environmental characteristics (e.g., tree coverage, adjacency to water, etc.), so the city could also explore partnerships with Fulton and DeKalb Counties to include appropriate county-owned land into the program and further expand public land availability.

State Recommendations

Additional Funding for Sustainable Community Forest Program – The Georgia Forestry Commission (GFC) provides technical assistance to local governments, schools, non-profits, and homeowners through its Sustainable Community Forest Program (SCFP). The program allows GFC to help with tree ordinance drafting, tree care training, conservation recognition, event coordination, and storm mitigation planning. Crucially, the program also provides technical support for mapping, auditing, and managing green infrastructure. SCFP could support property owners develop UAF systems that function as green infrastructure and provide care information and management support throughout the implementation process. This program is currently funded through the United States Forest Service only and lacks the state funding for robust promotion and expansion. Additional funding for SCFP will allow GFC to better support communities as they expand their tree canopies via UAF systems. The City of Atlanta could also work with GFC and the state to develop novel financing mechanisms and ensure that this program expansion is inclusive of UAF systems in highly urbanized areas.

Adopt Additional Conservation Practice Standards – The USDA Natural Resource Conservation Service (NRCS) hosts a database of agroforestry conservation practice standards adopted by every state. Unfortunately, Georgia has only adopted conservation practice standards for riparian forest buffers, silvopasture, and windbreaks meaning that Georgia does not currently maintain a standard of practice for alley cropping or forest farming. These standards provide property technical guidance to property owners for implementing agroforestry practices. For example, Georgia's Field Office Technical Guide for silvopasture includes information related to spring development, treating sinkholes, controlling stormwater runoff, tree and shrub planting, and a host of other valuable information for successfully preparing and establishing a UAF system. Based on examples given in the literature review as well as the previous section's discussions, food forests and community gardens with alley cropping appear to be the most suitable UAF systems in urban contexts given a myriad of regulatory and environmental factors that may hinder the implementation of the other modes. By adopting conservation practice standards for those forms of agroforestry, the state will not only provide property owners with functional guides for developing future sites, but also legitimize all common agroforestry practices as effective methods of environmental conservation in urban and rural settings. The state should work with local governments and environmental organizations to ensure that standards do not apply undue burden on property owners while also providing adequate environmental functionality.

Adopt Cost Share or Support Programs – Currently, Georgia's Soil and Water Conservation Commission does not provide direct technical or financial to farmers for maintaining or improving their properties. Georgia could benefit from following the example of neighboring North Carolina by adopting an Agricultural Cost Share Program (ACSP). The North Carolina program is aimed at helping landowners address nonpoint source pollution on farms through technical and financial support. Crucially, the program is not limited to livestock farmers and the technical and applicants can be reimbursed for up to 75 percent for installing various best management practices, including riparian forest buffers, to improve water quality. While ACSP is limited in its application, Georgia could adopt a similar program and provide cost-matching for new agroforestry systems that perform environmental services, such as stormwater mitigation. The state can partner with local governments or farming-oriented organizations throughout the state to ensure successful implementation.

Conclusion

Food insecurity and flooding are, unfortunately, common problems for urban communities around the globe and Atlanta is certainly no exception in this regard. This study sought to provide local planners and policymakers with a potential solution to address these wicked problems through novel multifunctional UAF systems. Several sites have been identified through this study as suitable areas to support new UAF system development. Design recommendations have also been explored for each site, as well as policy recommendations to support the development of these systems in Atlanta and across the state. By pursuing these recommendations, developing new UAF systems as green infrastructure, and further integrating food systems planning and stormwater management, Atlanta and Georgia can better align planning priorities across multiple departments and local governments, ultimately providing better environmental and social functionality to communities across the state.

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Appendix A. Zoning District Restrictions

Zoning		Urban Gardens		Market Gardens	
Description	District	Permitted?	Restrictions	Permitted?	Restrictions
Single-Family Residential	R-1	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-2	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-2A	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-2B	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-3	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-4	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-4A	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	R-4B	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
	FCR-3	No	No	No	No
Two-Family Residential	R-5	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
Residential General	R-G	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
Residential-Limited Commercial	R-LC	Yes	No	Yes	No
Office-Institutional	O-I	Yes	No	Yes	No
Community Business	C-1	Yes	No	Yes	No
Commercial Service	C-2	Yes	No	Yes	No
Commercial Residential	C-3	Yes	No	Yes	No

Central Area Commercial	C-4	Yes	No	Yes	No
Central Business	C-5	Yes	No	Yes	No
Light Industrial	I-1	Yes	No	Yes	No
Industrial Mixed Use	I-MIX	Yes	No	Yes	No
Heavy Industrial	I-2	Yes	No	Yes	No
Downtown Special Public Interest	SPI-1	Yes	Subareas 1, 2, 3, 4, 5, 6, & 7 only	Yes	Subareas 1, 2, 3, 4, 5, 6, & 7 only
Fort McPherson Special Public Interest	SPI-2	No	N/A	No	N/A
Inman Park Special Public Interest	SPI-5	Yes	No	Yes	Schools and places of worship only
Poncey-Highland	SPI-6	Yes	No	Yes	Schools and places of worship only
Candler Park	SPI-7	Yes	Cannot co-site with multi-family, two-family, or supportive housing	Yes	Schools and places of worship only
Home Park	SPI-8	No	N/A	No	N/A
Buckhead Village	SPI-9	Yes	Subareas 1, 2, 3, & 4 only	Yes	Subareas 1, 2, 3, & 4 only
Vine City & Ashby Station Special Public Interest	SPI-11	Yes	Subareas 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12 only	Yes	Schools and places of worship only
Buckhead/Lenox Stations Special Public Interest	SPI-12	Yes	Schools and places of worship only	Yes	Schools and places of worship only
Berkley Park	SPI-14	No	N/A	No	N/A
Lindbergh Transit Station Area Special Public Interest	SPI-15	Yes	SAP required for primary use on an undeveloped lot	Yes	Schools and places of worship only
Midtown Special Public Interest	SPI-16	Yes	No	Yes	No
Piedmont Avenue Special Public Interest	SPI-17	Yes	Schools and places of worship only	Yes	Schools and places of worship only
Mechanicsville Neighborhood	SPI-18	Yes	SAP required in Subareas 4, 5, & 6	Yes	Accessory use only in

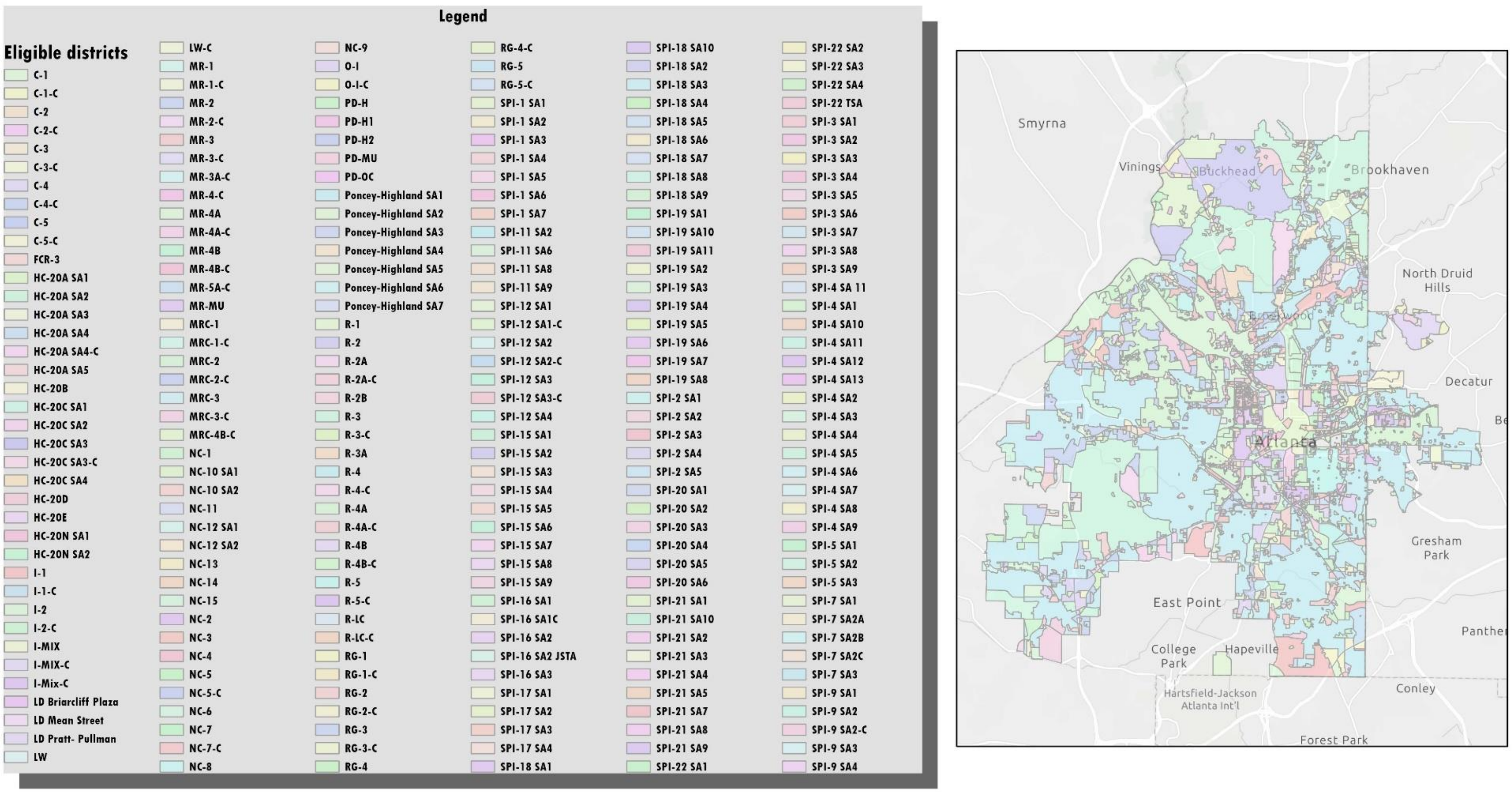
Special Public Interest					Subareas 4, 5, & 6
Greenbriar Special Public Interest	SPI-20	Yes	SAP required in Subareas 4, 5, & 6	Yes	Schools and places of worship only
Historic West End/Adair Park Special Public Interest	SPI-21	Yes	SAP required in Subareas 6 & 7	Yes	Schools and places of worship only
Memorial Drive/Oakland Cemetery Special Public Interest	SPI-22	Yes	Subareas 1, 2, 3, & 4 only	Yes	Subareas 1, 2, 3, & 4 only
Planned Development – Housing	PD-H	Yes	No	Yes	No
Planned Development – Mixed Use	PD-MU	Yes	No	Yes	No
Planned Development – Office-Commercial	PD-OC	Yes	No	Yes	No
Planned Development – Business Park	PD-BP	Yes	No	Yes	No
Planned Development – Conservation Subdivision	PD-CS	Yes	No	No	N/A
Cabbagetown Landmark	HC-20A	Yes	SAP required in Subareas 2 & 3	Yes	Subareas 1, 4, & 5 only
Druid Hills Landmark	HC-20B	Yes	SAP required	Yes	Schools and places of worship only
Martin Luther King Jr. Landmark	HC-20C	Yes	SAP required	Yes	Schools and places of worship only
Washington Park Landmark	HC-20D	No	N/A	No	N/A
Oakland Cemetery Landmark	HC-20E	No	N/A	No	N/A
Baltimore Block Landmark	HC-20F	Yes	No	Yes	No

West End Historic	HC-20G	No	N/A	No	N/A
Hotel Row Landmark	HC-20H	No	N/A	No	N/A
Adair Park Historic	HC-20I	No	N/A	No	N/A
Whittier Mill Historic	HC-20J	No	N/A	No	N/A
Grant Park Historic	HC-20K	No	N/A	No	N/A
Inman Park Historic	HC-20L	No	N/A	No	N/A
Oakland City Historic	HC-20M	No	N/A	No	N/A
Castleberry Hill Landmark	HC-20N	Yes	No	Yes	No
Atkins Park Historic	HC-20O	No	N/A	No	N/A
Sunset Avenue Historic	HC-20P	No	N/A	No	N/A
Collier Heights Historic	HC-20Q	No	N/A	No	N/A
Means Street Landmark	HC-20R	No	N/A	No	N/A
Briarcliff Plaza Landmark	HC-20S	No	N/A	No	N/A
Pratt-Pullman Landmark	HC-20T	No	N/A	No	N/A
Bonaventure-Somerset Historic	HC-20U	No	N/A	No	N/A
Little Five Points Neighborhood Commercial	NC-1	Yes	No	Yes	No
East Atlanta Village Neighborhood Commercial	NC-2	Yes	No	Yes	No
Kirkwood Neighborhood Commercial	NC-3	Yes	No	Yes	No
Cheshire Bridge Road North Neighborhood Commercial	NC-3	Yes	No	Yes	No

Cheshire Bridge Road South Neighborhood Commercial	NC-5	Yes	No	Yes	No
Cascade Heights Neighborhood Commercial	NC-6	Yes	No	Yes	No
Existing Traditional Neighborhood Commercial	NC-7	Yes	No	Yes	No
Dill Avenue-Sylvan Road Neighborhood Commercial	NC-8	Yes	No	Yes	No
Amsterdam Neighborhood Commercial	NC-10	Yes	No	Yes	No
Virginia-Highland Neighborhood Commercial	NC-11	Yes	No	Yes	No
Atkins Park Neighborhood Commercial	NC-12	Yes	No	Yes	No
Inman Park Neighborhood Commercial	NC-13	Yes	No	Yes	No
Cascade Avenue-Beecher Street Neighborhood Commercial District	NC-14	Yes	No	Yes	No
Westview Neighborhood Commercial	NC-15	Yes	No	Yes	No
Live Work	LW	Yes	No	Yes	No
Multi-Family Residential	MR-1	Yes	No	Yes	Schools and places of worship only
	MR-2	Yes	No	Yes	Schools and places of worship only

	MR-3	Yes	No	Yes	Schools and places of worship only
	MR-3A	Yes	No	Yes	Schools and places of worship only
	MR-4	Yes	No	Yes	Schools and places of worship only
	MR-4A	Yes	No	Yes	Schools and places of worship only
	MR-4B	Yes	No	Yes	Schools and places of worship only
	MR-5	Yes	No	Yes	Schools and places of worship only
	MR-5A	Yes	No	Yes	Schools and places of worship only
	MR-MU	Yes	No	Yes	Schools and places of worship only
Mixed Residential Commercial	MRC-1	Yes	No	Yes	No
	MRC-2	Yes	No	Yes	No
	MRC-3	Yes	No	Yes	No
	MRC-4B	Yes	No	Yes	No

Appendix B. Eligible Zoning Districts Map



Appendix C. Eligible Site Scoring

MUID	Slope Score	Flooding Score	Drainage Score	Aggregate Score
5	5	2	5	12
12	5	2	5	12
13	5	2	5	12
24	5	2	5	12
30	5	2	5	12
34	5	2	5	12
36	5	2	5	12
38	5	2	5	12
40	5	2	5	12
43	5	2	5	12
48	5	2	5	12
53	5	2	5	12
59	5	2	5	12
60	5	2	5	12
65	5	2	5	12
68	5	2	5	12
69	5	2	5	12
70	5	2	5	12
75	5	2	5	12
83	5	2	5	12
84	5	2	5	12
89	5	2	5	12
95	5	3	4	12
99	5	3	4	12
104	5	3	4	12
77	5	2	3	10
92	5	3	2	10
93	5	3	2	10
94	5	3	2	10
96	5	3	2	10
101	5	3	2	10
102	5	3	2	10
103	5	3	2	10
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2	5	2	2	9
3	5	2	2	9
6	5	2	2	9
8	5	2	2	9
9	5	2	2	9
10	5	2	2	9
11	5	2	2	9

14	5	2	2	9
15	5	1	3	9
16	5	2	2	9
17	5	2	2	9
19	5	2	2	9
20	5	2	2	9
21	5	2	2	9
22	5	2	2	9
23	5	2	2	9
26	5	2	2	9
27	5	2	2	9
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31	5	2	2	9
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41	5	2	2	9
42	5	2	2	9
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86	5	2	2	9
87	5	2	2	9
88	5	2	2	9

90	5	2	2	9
91	5	2	2	9
4	5	1	1	7
7	5	1	1	7
29	5	1	1	7
54	5	1	1	7
55	5	1	1	7
62	5	1	1	7
73	5	1	1	7