Columbia | SIPA
School of International and Public Affairs

NYC LOCAL LAW 10 OF 2023

Assessing Potential for NYC Green Spaces

Presented by

MPA-ESP LL10 WORKSHOP TEAM

Summer 2023 Final Report

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EXECUTIVE SUMMARY

Decades of urbanization have drastically changed New York City's physical and ecological systems. Covered centuries ago in forests, meadows, and wetlands, approximately three-quarters of the city's surfaces are now impervious, dominated by built materials such as metal, concrete, and asphalt [1]. This land-use change, in combination with rising anthropogenic pollution from sources like industrial production and vehicle use, has created and exacerbated urban environmental issues that are likely to worsen over time with climate change [2]. These issues include stormwater runoff, the urban heat island effect (UHIE), and air pollution.

The impacts of these issues are inequitably distributed across the city. Low-income and majority Black, Indigenous, People of Color (BIPOC) communities typically face higher vulnerability to heat stress and air pollution, in combination with less access to resources that can be used to mitigate their impacts, such as urban green infrastructure (UGI) and affordable healthcare [3].

In this report, we examine the recently passed New York City Local Law No. 10 of 2023 ("LL10") as a potential first step to mitigating the effects of stormwater runoff, the UHIE, and air pollution in communities with limited green space and facing disproportionate environmental burdens. We also critically analyze the potential unintended consequences of UGI implementation, such as green gentrification, unwanted pests and litter, and rising underground water tables that can flood underground infrastructure.

Empirical evidence demonstrates that urban green spaces can address environmental issues and improve community well-being. Still, methods by which cities measure, track, and compare the success of UGI implementation can vary widely [4]. We, therefore, propose Key Performance Indicators (KPIs) to assess some of the outcomes LL10 intends to achieve, including metrics of success for vacant lot identification and the provision of ecological services by potential green spaces in those lots. Measuring and tracking KPIs over time is critical for assessing the bill's success at achieving desired outcomes in the long term.

To better illustrate the potential impacts of LL10, we present a case study of Mott Haven in the South Bronx, an "Environmental Justice Area" (EJA) that could benefit from the UGI opportunities that LL10 may identify. We assess specific examples of vacant lots in Mott Haven suitable for various types of UGI, as well as UGI's potential efficacy in addressing the neighborhood's most pressing environmental issues.

LL10's site survey is a critical first step toward addressing some of NYC's most pressing environmental issues while at the same time remediating the discrepancy in access to green space between EJA and non-EJA neighborhoods. Still, implementation of these spaces will have its own challenges, including coordinating between agencies, financing the installations, selecting vegetation, and maintaining the spaces over time. In the next stage of our analysis, we will analyze these issues to determine how the city can best proceed with the implementation phase of LL10 and mitigate potential risks.

Tree Canopy | Source: Skye Embray

ACKNOWLEDGMENTS

Columbia University recognizes Manhattan as part of the ancestral and traditional homeland of the Lenni-Lenape and Wappinger people. We continue to address issues of exclusion, erasure, and systemic discrimination through ongoing education and a commitment to equitable representation.

This report was developed by MPA candidates in Environmental Science and Policy (ESP) at the Columbia University School of International and Public Affairs (SIPA). Yazan Zafar managed the group, with deputy management from Vasu Jayanthi. Ellie Alter, Ian Kang Choo, Sonali Deshpande, Skye Ashlyn Embray, Tarun George, Tamara Jeffries, Sarah Malott, Clarisa Marambio, and Jeremy Raguain provided research and editorial support. Professor Louise Rosen supervised the research and drafting of this report and accompanying presentations to the '24 ESP cohort at SIPA. Finally, the group extends special thanks to the individuals who provided expert insights during the research process, including Kameron Aroom, Leslie Vasquez, Dr. Matthew Palmer, Dr. Robbie Parks, and Anne Lupsha.

1.0 DEFINING THE PROBLEM

Today, NYC spans 300 square miles and has a population of over 8.3 million people [5]. Centuries ago, this geographic area supported 55 different ecosystems, including islands, wetlands, forests, farms and grasslands, which were the ancestral homelands of the Lenni-Lenape and Wappinger indigenous people [6] . Following European settlement, rapid urbanization and industrialization dramatically changed the area’s land cover. Between 1790 and 1900, NYC's population increased over a hundredfold [7], and population growth continued at a slower but steady pace during the 20th century and beyond. The industrial and commercial activities that accompanied this growth have heralded tremendous, though inequitably distributed, economic benefits. However, these benefits have come at the expense of various ecosystem services that natural lands provide, as impervious and heat-absorbing surfaces such as cement and asphalt have replaced the city’s vegetated areas over time. By disrupting natural biogeochemical systems, urbanization has not only introduced environmental problems such as stormwater runoff and the UHIE, but also increased the prevalence of toxic air, water, and land pollution from industrial activities such as fossil fuel-powered manufacturing and transportation.

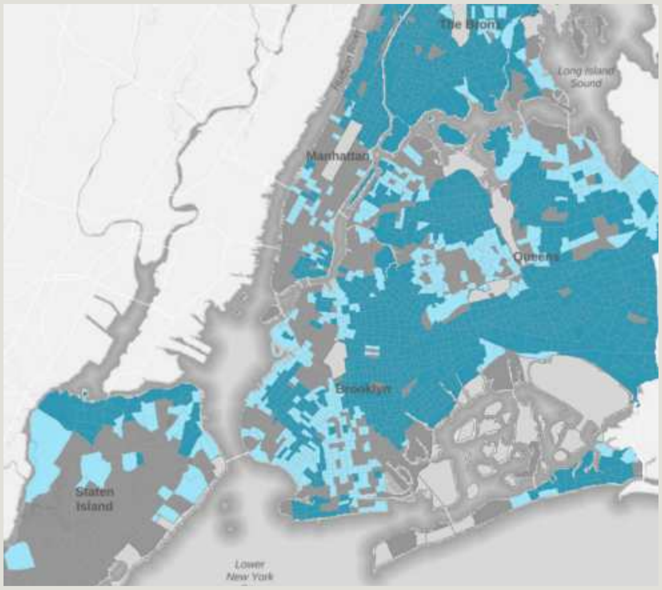
(Source: NY Times)

1.1 ENVIRONMENTAL JUSTICE

Environmental justice (EJ) is a key aspect of NYC's efforts to address these challenges. In 2017, the City passed Local Law 64 (LL64) which defines EJ as [8]:

[T]he fair treatment and involvement of all persons, regardless of race, color, national origin or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, policies and activities, and with respect to the distribution of environmental benefits (such as financial assistance for environmental projects).

LL64 directs an Interagency Working Group (IWG) to develop a comprehensive Environmental Justice Plan that will: 1) provide guidance on incorporating EJ concerns into City decision-making, 2) identify possible citywide initiatives for promoting EJ, and 3) provide specific recommendations for City agencies to bring their operations, programs, and projects in line with EJ concerns [9]. In addition to updating the EJ Plan every five years, the IWG will work with an advisory board of City officials to ensure that the plan incorporates the needs of the public and findings from the City's first comprehensive EJ study.



EJAs in NYC (Source: NYC DOHMH)

This study will supplement the City's current definition of EJAs by identifying the communities that are most impacted by environmental issues and least served by existing UGI [10]. The City also passed Local Law 60 (LL60) in 2017 [11], which requires the IWG to identify the locations and boundaries of EJAs within the City, describing environmental concerns affecting these areas and identifying potential mechanisms to address them. A draft interactive map of NYC's EJAs is publicly available, and this report uses it to illustrate examples where UGI that LL10 surveys may be particularly impactful [12].

(Source: WE ACT For Environmental Justice)

2.0 LEGISLATIVE SUMMARY

2.1 Summary of the Law
LL10 declares an agency, to be determined by the Mayor in coordination with other appropriate departments, to survey sites in residential zones owned by the City suitable for the creation of small parks, bioswales and other green spaces. Potential sites include streets with dead ends and vacant land near highway entrances and underpasses. The contributing agencies are the Department of Environmental Protection (DEP), Department of Transportation (DOT), Department of Parks and Recreation ("Parks"), and Department of Citywide Administrative Services (DCAS).

The designated agency will develop a methodology for selecting which sites to review, while incorporating requests from various stakeholders, including members of the public. Additionally, LL10 notes that sites in "environmental justice areas" (EJAs) will be prioritized. According to the Administrative Code of the City of New York [14], an EJA is defined as "a low-income community located in the city or a minority community located in the city."

The lead agency will submit a report of all sites reviewed to the Mayor and Speaker of the Council no later than April 1, 2024. This report will include analysis for each site on the feasibility of planting vegetation or implementation of a green space, steps needed to install features, time needed to install features, and the estimated costs.

New York City Council (Source: NYC.gov)

NYC Local Law No. 10 of 2023 (LL10) [13] is one lever that aims to address the environmental challenges that city residents face and their inequitable distribution.

Septuagesimo Uno Park, Manhattan (Source: Untapped Cities)

2.2 Legislation Sponsorship & Status
Council Member Krishnan introduced LL10 in September 2022, and 38 Council Members sponsored the bill: Louis, Yeger, Riley, Restler, Hanif, Hudson, Ung, Won, Gutiérrez, Holden, Gennaro, Menin, Narcisse, Brannan, Cabán, Bottcher, Abreu, Brooks-Powers, Farías, Velázquez, De La Rosa, Avilés, Nurse, Ayala, Joseph, Brewer, Schulman, Powers, Rivera, Marte, Dinowitz, Ossé, Williams, Mealy, Moya, Hanks, Stevens and Carr.

The NYC Council passed LL10 on December 21, 2022. Mayor Eric Adams neither approved nor disapproved the legislation after thirty days, thereby enacting it into law on January 20, 2023.

As of August 2023, the mayor has yet to designate a lead agency. However, the NYC Office of Management and Budget (OMB) included the law in the City's Fiscal Year 2024 budget which they submitted in June 2023, and work to select a lead agency will commence after summer recesses.

2.1 MEASURING THE SUCCESS OF URBAN GREEN INFRASTRUCTURE SITE IDENTIFICATION

Target Outcome:

Identify suitable sites for UGI implementation [15].

Develop a process for lot selection in NYC by assessing the number of City-owned lots that fall under the purview of LL10.

Baseline

KPIs

1. Review sites owned by the City in residential zones on street ends and land that abuts highway entrances, underpasses, and exits that are suitable for UGI.
2. Identify each neighborhood's most pressing environmental and social needs.
3. Map the spatial patterns of vacant land considering both environmental characteristics (ecological, biological, chemical, and physical) and community demographics.
4. Identify patterns and clusters of vacant lots in EJAs that experience similar environmental challenges to help target intervention more effectively [16].

2.2 KEY STAKEHOLDERS

We identified three groups of stakeholders who will assist with the planning and implementation of LL10, including:

i) government agencies,
ii) environmental justice communities and activists, and
iii) industry professionals.

Below, we have synthesized their roles and insights, which address different dimensions of the solution that LL10 proposes and can ensure a comprehensive approach to implementing the bill.

Government Agenices	Environmental Justice Communities & Activists	Industry Professionals
Department of Parks and Recreation (Parks)	South Bronx Unite	Urban Planners
Department of Environmental Protection (DEP)	WE ACT for Environmental Justice	Landscape Architects
Department of Citywide Administrative Services (DCAS)	NY Renews Coalition	Environmental Scientists
Department of Transportation (DOT)	UPROSE	Public Health Experts
NYC Mayor’s Office of Climate and Environmental Justice	The Point Community Development Cooperation	Horticulturists & Arborists

Table 2.2.1: Key stakeholders consulted

2.2 KEY STAKEHOLDERS

NYC's DEP, Parks, DOT, and DCAS are jointly involved in the review of potential sites in order to tackle the issues of stormwater management and UHIE through UGI. These sites are City-owned vacant lots in NYC that fall under the scope of LL10's category for development.

The NYC Mayor's Office of Climate & Environmental Justice is responsible for identifying EJAs that could benefit from this law.

The NYC Mayor's Office of Management & Budget is developing a tool to help track the climate benefits of various City investments.

Figure 2.2.2 Relevant stakeholders

2.2 KEY STAKEHOLDERS

South Bronx Unite brings together neighborhood residents, community organizations, academic institutions and allies to improve and protect the social, environmental, and economic culture of Mott Haven and Port Morris [17].

WE ACT's mission is to build healthy communities by ensuring that people of color and/or low-income residents participate meaningfully in the creation of sound and fair environmental health and protection policies and practices [18].

NY Renews is a coalition of over 360 environmental, justice, faith, labor, and community groups [19].

UPROSE promotes sustainability and resiliency in Brooklyn's Sunset Park neighborhood through community organizing, education, indigenous and youth leadership development, and cultural/artistic expression [20].

Industry professionals provide valuable scientific and economic insights regarding the assessment of vacant sites for various types of infrastructure. Their expertise spans zoning, types of vegetation and their benefits, bedrock identification processes, permitting processes, health impacts, and other considerations that government agencies can overlook when reviewing sites.

Figure 2.2.3 Relevant stakeholders (continued)

3.0 KEY PROBLEMS ADDRESSED

3.1 Overview of Environmental Problems

Climate change, land use change, and industrial activities have disrupted the ability of NYC's natural landscape to maintain stable precipitation, temperature, and air patterns. As climate change increases rainfall in the city, widespread impervious urban surfaces raise the risk of flooding, damaging urban infrastructure, and contaminating local waterways. Climate change also raises temperatures across NYC which urban surfaces exacerbate, increasing the risk of heat-related illness in the city. Finally, activities like fossil fuel combustion and industrial production create air pollution that the built environment can amplify, harming human health. The distribution of these effects is inequitable across NYC, as are their impacts on people and the environment. LL10 surveys opportunities for UGI to address the following environmental problems in NYC:

Flooding & Combined Sewer Overflows

Urban Heat Island Effect

Urban Air Pollution

(Sources: Natural Resources Defense Council, Gothamist, Inside Climate News)

3.2 Flooding and Combined Sewer Overflow Events

Anthropogenic climate change is increasing global temperatures, thereby producing more frequent and intense rainfall events [21]. A natural forested landscape can absorb 50% of incoming rainwater, while 40% evaporates and 10% flows on the surface as runoff [22]. Urbanization changes an area's land cover to impervious surfaces such as asphalt and concrete, which reduce the ground's infiltration capacity. Changing 75-100% of an area's land cover to impervious surfaces reduces the ground's infiltration capacity to 15% and increases runoff to 55%. 72% of NYC's land cover is impervious, rendering the city vulnerable to increased surface runoff that impacts water quantity, quality, and temperature.

Peak flows during heavy precipitation can overwhelm storm drains and contaminate waterways by collecting and transporting pollutants from city surfaces and untreated wastewater. NYC's 150-year-old combined sewage system covers 60% of the city and is

Figure 3.2.2 Sewer systems in NYC (Source: NYC DEP)

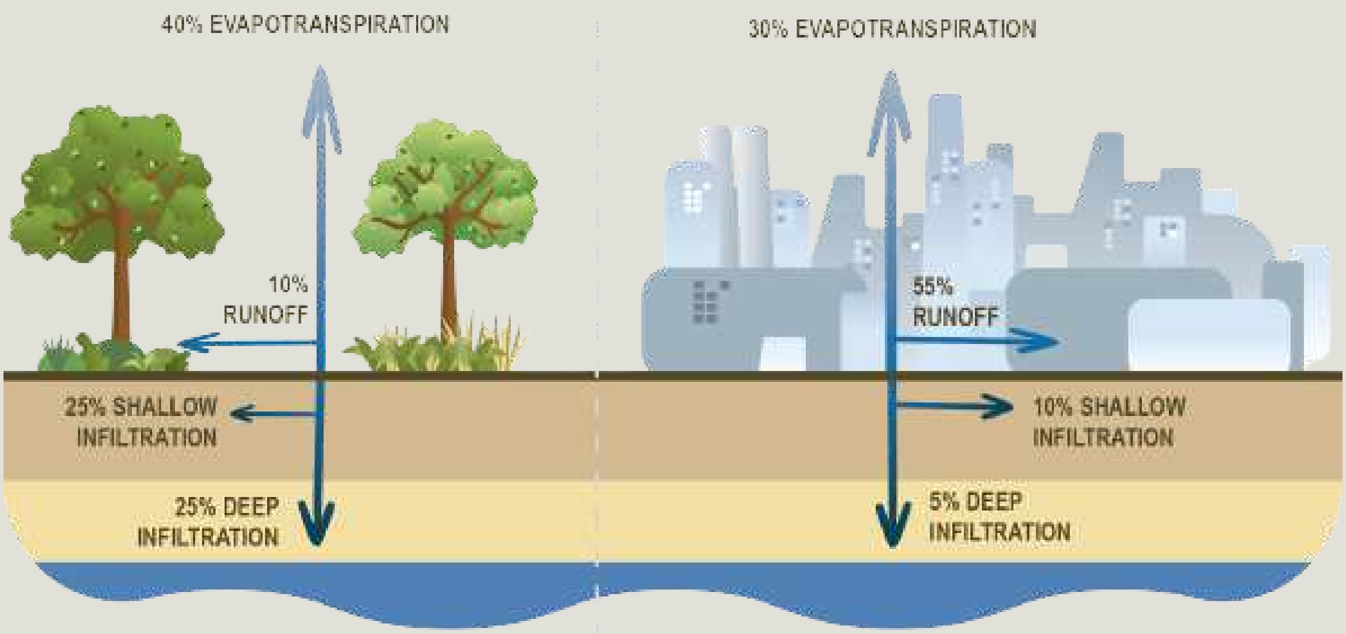
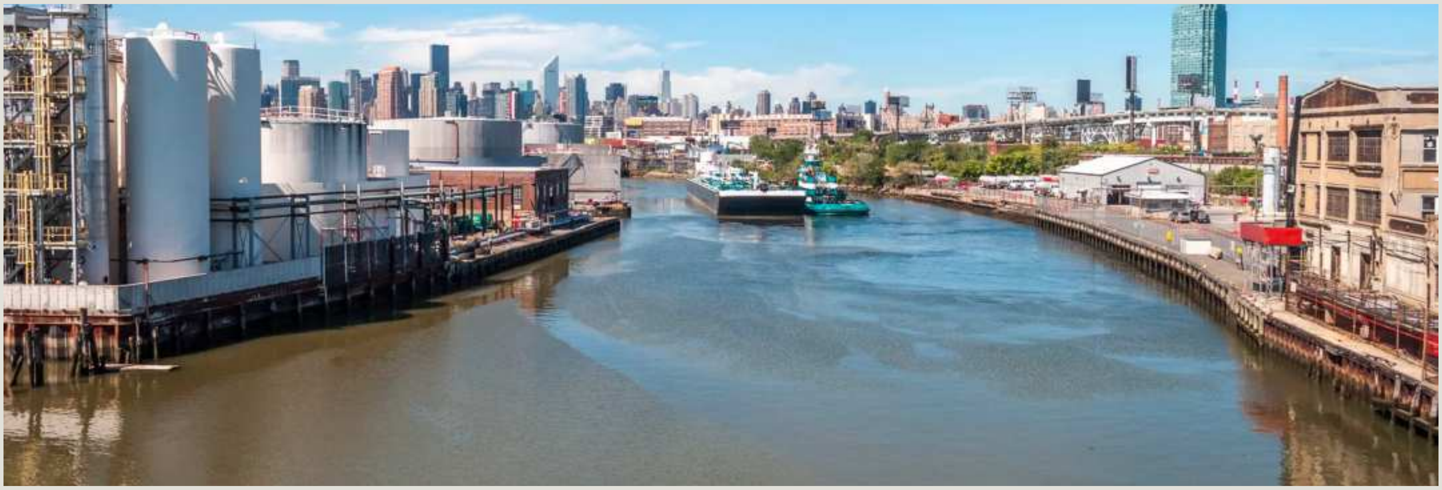


Figure 3.2.1 Infiltration Capacity of Natural vs Urban Lands (Source: Iowa State University)



Newtown Creek Source: Curbed NY

ill-equipped to handle the increasing volume of rainfall, storm surge, and sea-level rise [23]. Combined sewers are primarily found in areas of the city that were developed earliest, such as Manhattan, Bronx, and parts of Brooklyn and Queens. In contrast, separate sewers are found in newly developed low-lying areas of the city, such as southeast Queens, south Brooklyn, and Staten Island [24]. In dry weather, NYC's wastewater treatment plants treat the water before depositing it in local waterways such as the Hudson River Estuary. In NYC, a precipitation rate of 0.1 inches of rain per hour can overwhelm the combined sewer system and lead to a CSO in vulnerable areas such as Newtown Creek, Bronx River, Flushing Bay and Coney Island Creek [25] [26]. During heavy rainfall, CSOs discharge 30 billion gallons of sewage into the city's watershed annually [27]. Untreated human sewage negatively impacts human health through the spread of pathogenic bacteria and viruses, and is particularly harmful for the elderly, young children, and the immuno-compromised [28]. Furthermore, toxins such as chlorine or pesticides may enter NYC's waterways during CSOs and harm aquatic life [29]. Intense rainfall not only contributes to SOs but also flooding and physical damage to infrastructure and local ecosystems.

Stormwater runoff floods streets and erodes the banks of natural streams. Additionally, the impervious surfaces over which the water flows may transfer heat to stormwater, harming aquatic life [30]. Intense and frequent floods can also damage critical urban infrastructure such as homes and hospitals, which threatens human safety and health especially in low-lying neighborhoods and those with reduced drainage capacity, like Mott Haven.

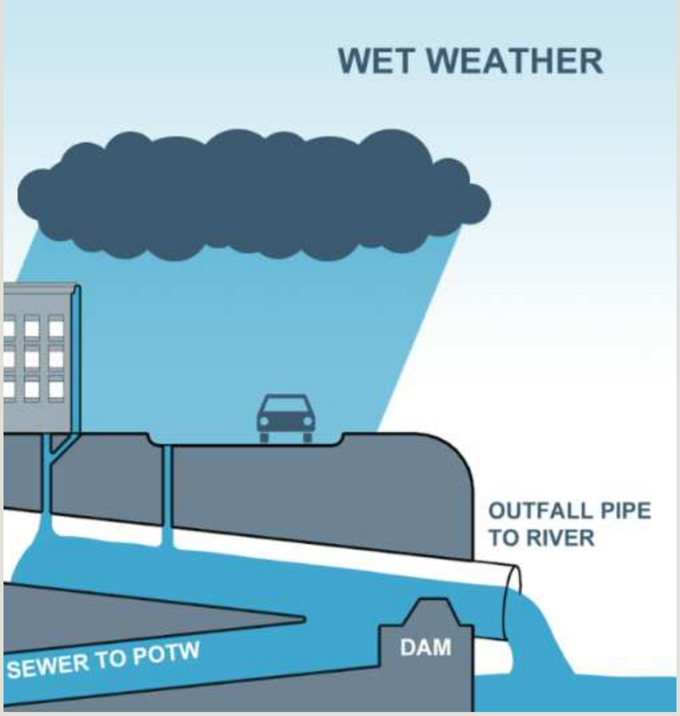


Figure 3.2.3 Combined Sewer Overflow
(Source: Daniel Overbay)

3.3. The Urban Heat Island Effect

The abundance of low-albedo surfaces like concrete and lack of vegetation in urban areas produces the UHIE, rendering NYC an average of 9.5 degrees F hotter than surrounding areas [31]. Climate change-induced rising temperatures further exacerbate the burden of heat stress on NYC residents and wildlife. The design and use of specific infrastructure in NYC lead to the UHIE (see map below) as dark surfaces like pavements, rooftops, and building walls absorb sunlight and slowly re-emit it as heat into the near-ground atmosphere, unlike natural surfaces, which reflect more sunlight back into space. Areas with tall, compact buildings exacerbate this effect by trapping the heat that urban surfaces radiate and creating a “canyon effect” that blocks wind currents [32, 33].

Exposure to heat stress varies across the city partly depending on the amount of canopied

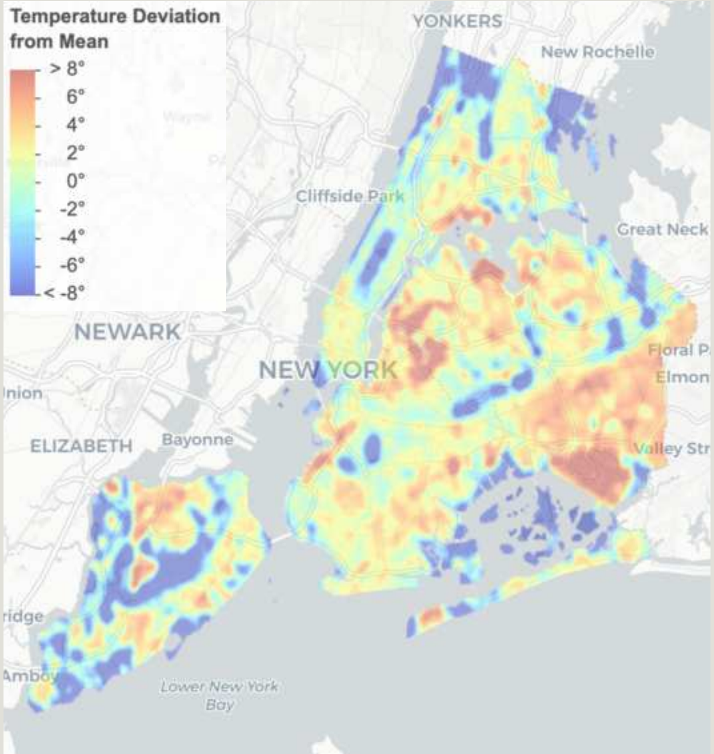


Figure 3.3.1 Urban Heat Island Effect in NYC (Source: Columbia Climate School)

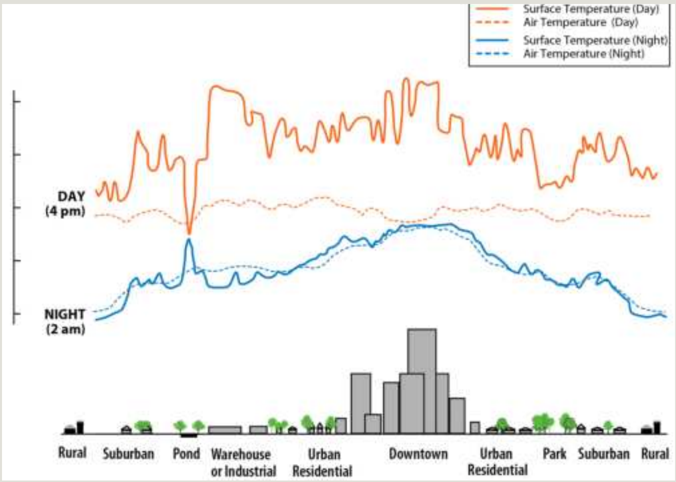


Figure 3.3.2 Urban Heat Island Effect (Source: USGS)

and ground-level vegetation present [34]. UHIE is particularly severe in several EJAs across NYC’s boroughs, including in Brooklyn (e.g., Canarsie, Spring Creek, and Bushwick), Queens (e.g., Sunnyside, Maspeth, and Jamaica), the Bronx (e.g., Hunts Point), and Staten Island (e.g., Port Richmond) (Figure 3.3.1) [35]. Rising temperatures and extreme heat events can cause a variety of adverse human health impacts, ranging from acute reactions such as nausea, heat stroke, and seizures, to exacerbation of longer-term chronic health issues such as cardiovascular, kidney, and respiratory illness [36]. In the summer of 2022 alone, 370 people in NYC died due to heat [37]. Heat and sunlight also support chemical reactions in the atmosphere, which may increase health-harming air pollution like ozone [38]. These risks are higher for vulnerable populations, including older adults, young children, health-compromised individuals, and low-income individuals [39]. In NYC, there is a significant correlation between the distribution of heat in NYC and that of vulnerable populations [40].

3.4 Urban Air Pollution

PM2.5 and O3 are the most prevalent health-harming pollutants in NYC. PM2.5 refers to airborne particles that are 2.5 μm or less in diameter, enabling them to enter a person's lungs and even bloodstream. The combustion of fossil fuels, production of industrial products, and other human activities in and near the city emit both particulate matter and precursors such as nitrogen oxides (NOx) and sulfur oxides (SOx) into the city's atmosphere. NYC's built environment then traps these pollutants and encourages additional pollutant reactions by raising local temperatures, creating temperature inversion in the atmosphere, and blocking wind currents [41] [42]. In sunlight and heat, NOx reacts with volatile organic compounds (VOCs) to produce ozone (O3). This type of O3 can harm human health, unlike stratospheric O3, which occurs naturally and protects humans from harmful UV radiation. As light and heat encourage its production, O3 pollution is highest in the summertime and in areas where the UHIE is strong [43].

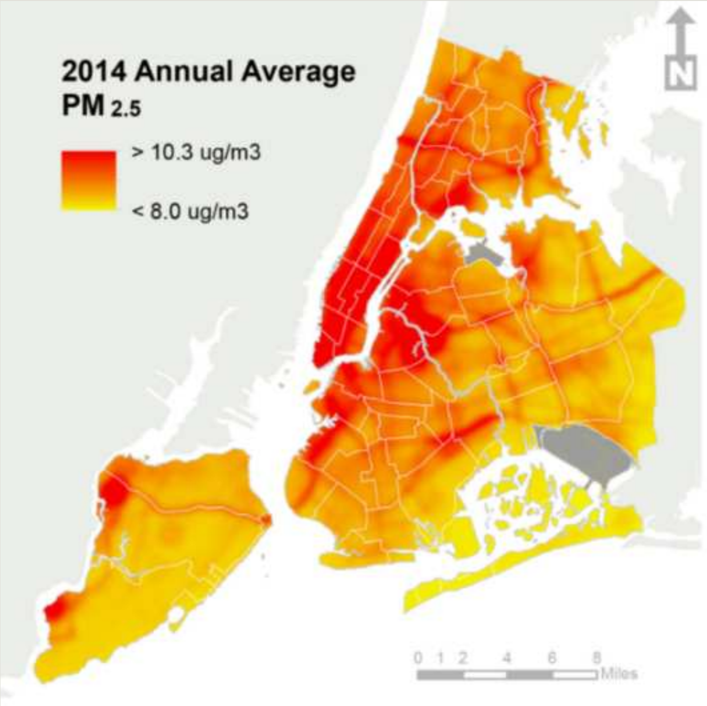


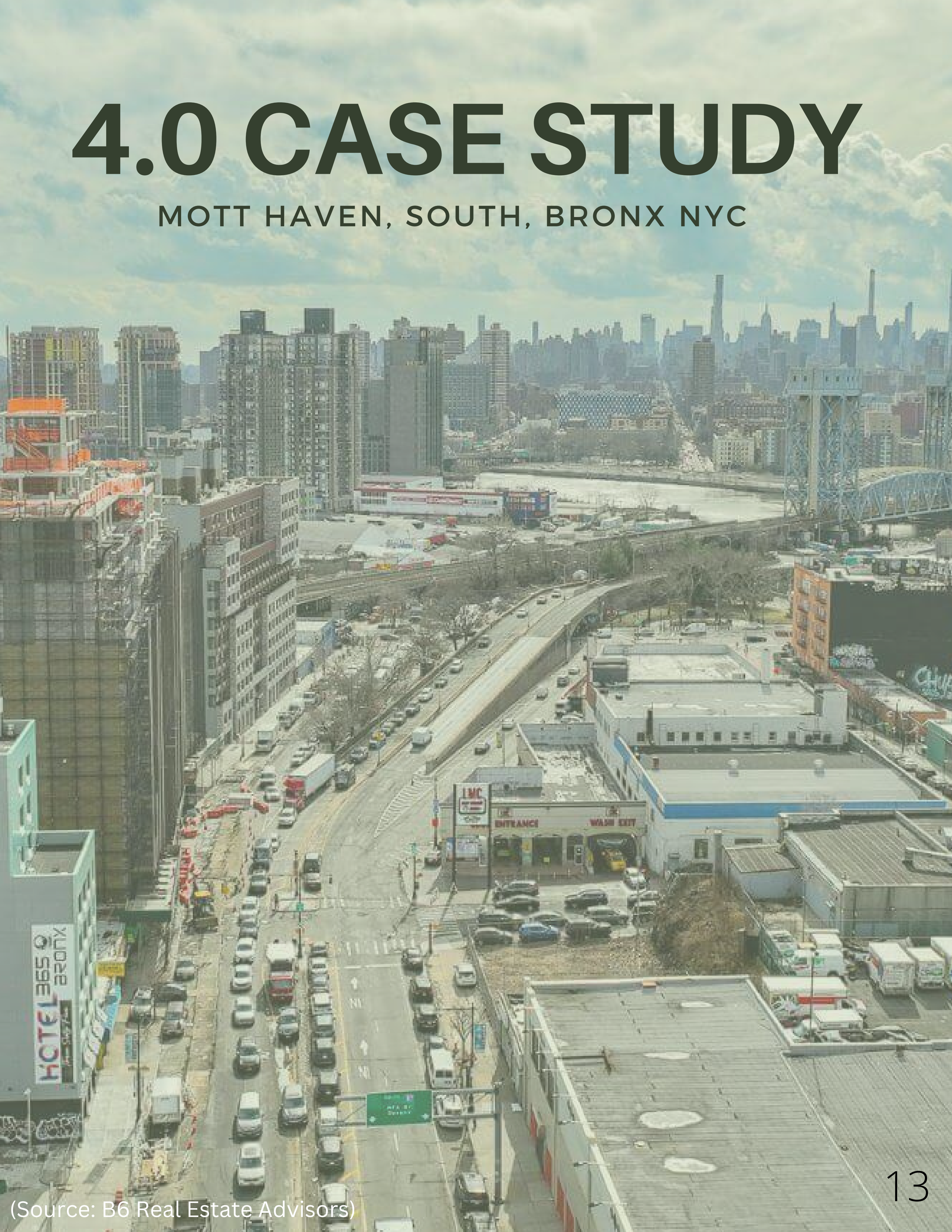
Figure 3.4.1 Map of the Urban Heat Island Effect in NYC (Source: Kheribek et al., 2016)

NYC has an abundance of sources for PM2.5 and despite significant measures to reduce air particulate matter air pollution, in 2022, PM2.5 rates in NYC exceeded the World Health Organization's (WHO) limit of >5 μg/m3 for a "safe environment" [44]. Each year PM2.5 and O3 cause 2,500 deaths in NYC [45], which are distributed unevenly across the city [46]. Every year in NYC, PM2.5 causes around 2,000 hospital admissions for lung and heart disease, around 6,000 emergency asthma events, and over 3,000 premature deaths. O3 likely causes approximately 800 hospital admissions for lung and heart disease, 4,000 emergency asthma events, and 400 premature deaths (See Appendix C) [47]. Fine particulate matter is especially important to address as the airborne particles are able to penetrate deep into the lungs and heart 48]. While NYC annual PM2.5 levels (approximately 12 μg/m3) meet national standards, the WHO recommends annual levels not exceed 5 μg/m3 to protect long-term health, meaning NYC's PM2.5 concentrations remain at unhealthy levels [49].

The health burden of air pollution is disproportionately concentrated in EJAs like Northern Manhattan and the South Bronx. For example, in East Harlem, children are hospitalized for asthma at three times the city rate [50]. A 2021 study by Scientific American revealed that Asian, Black, and Hispanic individuals are exposed to higher concentrations of air pollution, especially PM2.5, compared to White individuals [51].

4.0 CASE STUDY

MOTT HAVEN, SOUTH, BRONX NYC



(Source: B6 Real Estate Advisors)

MOTT HAVEN, SOUTH BRONX, NYC

Population (2021): 45,000 [52]

Demographics (2021): 66% Hispanic, 27% Black, 4% White, 1% Asian [53]. The median household income is $32,000. The poverty rate is 37%. Designated as an EJA by the Mayor's Office of Climate & Environmental Justice.

Topography: Mott Haven is a relatively flat, low-lying neighborhood bordered by two waterways, East 149th St, and I-278. It is sparsely vegetated (11% tree cover compared to 21% in NYC overall) and is served by just one major park, St. Mary's Park.

Environmental Issues: Due to its topography, Mott Haven is a designated flood zone by the NYC Department of Planning [54]. In the map to the left, Mott Haven's current floodplains are shaded in light blue. This area is expected to increase over the next several decades due to the impacts of climate change. Mott Haven's proximity to major highways and industrial facilities, including waste transfer stations, fossil fuel peaker plants, and warehouses increase local diesel emissions, which produce adverse health impacts for community residents.

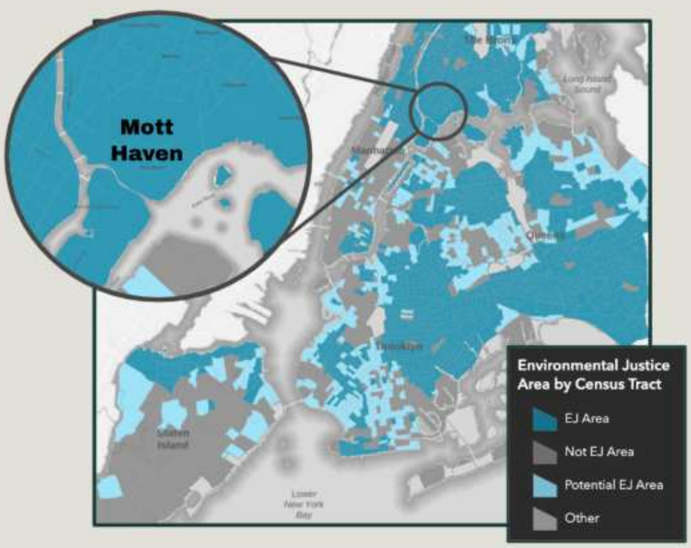


Figure 4.1. Mott Haven and Environmental Justice
(Source: NYC MOCEJ)

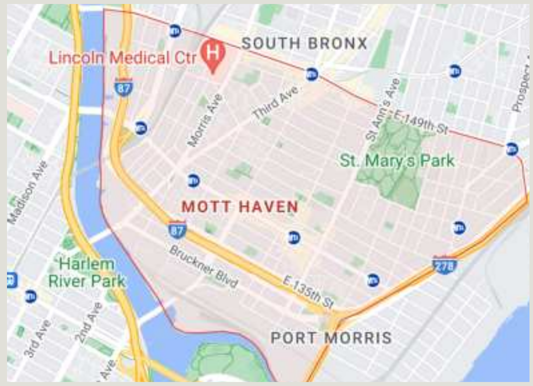


Figure 4.2 Mott Haven Area
(Source: Google Maps)

Higher-than-average asthma rates in the area, driven by these high pollution levels, have led it to be known colloquially as "Asthma Alley" [55]. Mott Haven receives a score of 5 (highest risk) on NYC's Heat Vulnerability Index, which assesses where residents are more at risk of death during and immediately following extreme heat, defined in NYC as two or more days with a heat index reaching 95 °F, or 1 or more days reaching 100 °F [56]. This can be seen in the map below which displays neighborhood-based heat vulnerability. Mott Haven is outlined in light blue. Neighborhoods are scored from **1 (lowest risk)** to **5 (highest risk).**

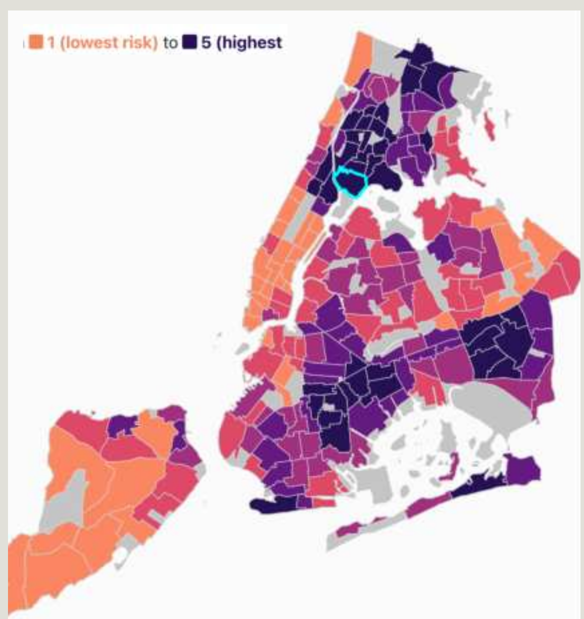


Figure 4.3. Heat Vulnerability in NYC
(Source: NYC.gov)

5.0 THE PROPOSED SOLUTION

Reintroducing nature to the built environment can reverse some of the disruption that urbanization has caused to NYC's natural systems. Specifically, if designed and maintained effectively, green infrastructure as proposed in LL10 can restore the land's ability to manage multiple environmental issues, such as higher risks of flooding, CSOs, urban heat, and local air pollution, while also improving urban residents' health and wellbeing.

Side of Highway in Hunts Point, South Bronx (Source: Ian Choo)

5.1 Overview of the Solution in LL10

Amid the scarcity of land for development in the city, LL10 identifies opportunities for UGI to address the environmental problems that different parts of NYC disproportionately face. In neighborhoods with extensive impervious surfaces and flood-prone topographies, UGI can reduce and slow runoff that enters into combined sewer systems. Small parks and street trees can reduce the temperature of adjacent built environments, and their shade can serve as critical places of respite during heat waves. Finally, trees can act as a barrier between highways and neighborhoods, reducing the exposure of communities to pollutant emissions. While City agencies have already installed UGI in many high-income neighborhoods to address these problems, UGI is severely lacking in many EJAs, which are especially vulnerable to the impacts of environmental problems. LL10 is a key first step in correcting this environmental injustice, as it prioritizes the survey of City-owned vacant lots in EJAs. The NYC Department of Finance defines vacant lots as "land parcels on which no lawful structure exists and not otherwise being used for any lawful purpose" [57]. The solution capitalizes on the higher frequency of vacant lots in EJAs as a result of community disinvestment, to provide space for additional UGI and correct the inequitable distribution of UGI.

5.2 Key Considerations for UGI Implementation in Environmental Justice Areas

To ensure any potential UGI implementation adequately addresses the appropriate environmental issues, it is important to appropriately select the type of UGI and vegetation to utilize for a given vacant lot. This analysis should focus on the following factors, among others:

- What are the primary environmental issues faced by the neighborhood?
- What are the key demographics of the neighborhood?
- How large is the vacant site? Is it suitable for trees, or are low-lying plants more appropriate?
- Which direction does stormwater runoff typically flow?
- What are typical precipitation levels?
- How close is the site to major sources of pollution?
- What is the depth of the bedrock and water table? How permeable is the soil?
- What types of vegetation are both native to the area and approved by the City for planting?

5.3 The Science of the Solution

In the following sections, we discuss the scientific principles behind UGI as a solution to key environmental problems that burden EJAs across NYC. We critically examine the effectiveness of these solutions according to the scientific literature and government reports, and we detail KPIs by which to measure their effectiveness.

5.3.1 Stormwater Management

UGI reduces stormwater runoff by replacing urban surfaces such as pavement and concrete, which water can only minimally penetrate, with permeable natural systems such as soil and vegetation [58]. Water can infiltrate through soil at rates of around 0.8-1.6 inches per hour, depending on factors like its porosity, the amount of space between soil particles [59]. This is more than enough to mitigate runoff from a typical rain event in NYC, which delivers 0.15 inches of rain per hour to the city's surfaces [60]. In the case of extreme storms which deliver two or more inches of rain per hour, UGI lightens the load on any existing gray infrastructure [61]. However, it is not especially effective for addressing flooding due to coastal surge, where the flux of incoming water is much higher. UGI is most effective for stormwater management when placed in locations that are susceptible to rainfall-related flooding due to the land's topography (e.g., a low-lying and flat city block, or a block located at the bottom of a hill) and inadequate existing drainage infrastructure, whether "green" (natural) or "gray" (human-built) [62]. Its placement should also consider the direction in which stormwater is likely to flow. By mitigating flooding, UGI mitigates both damage to local infrastructure and the frequency and magnitude of CSOs [63].

(Source: NYC MOCEJ)

When surface runoff enters UGI, gravity pulls some of the stormwater through the soil to the water table [64]. This is a critical process for recharging underground stores of water, which are gradually depleted through the natural hydrological process where groundwater flows into local waterways. Infiltration through the soil also improves water quality by depositing or precipitating contaminants into the soil, thereby limiting further contamination of groundwater. The rate at which water exits the soil at the water table is determined by the suction force of the soil, which depends on how saturated the soil is (e.g., drier soil exerts a higher suction force) as well as the soil type (e.g., small soil particles and high electrostatic attraction between soil particles and water molecules both increase suction force). The rest of the water that enters UGI remains in the soil until plants take it up via osmosis and transpire it into the atmosphere, or until it evaporates directly from plant and soil surfaces [65]. Together, these processes are known as evapotranspiration. Examples of green nfrastructure include rain gardens or bioswales, which are fenced-in vegetated areas located on streets and sidewalks, which have curb cuts and are depressed in the center to allow water to flow in and collect [66]. They may include trees to maximize their potential for mitigating runoff through evapotranspiration [67]. A typical NYC DEP rain garden is approximately 20 feet by 5 feet and can store up to 2,250 gallons of stormwater during a storm [68].

One assessment found that rain gardens in NYC can retain inflows from storms with around an inch of rainfall, and one rain garden in Shoelace Park, Bronx retained 78% of all inflows from 26 storms between October 2014 and July 2015 [69]. Infiltration basins are portions of street or sidewalk that aim to more closely mimic their surroundings, such as a strip of grass [70]. While they are less effective at mitigating stormwater than rain gardens and bioswales due to their relative lack of vegetation, infiltration gardens may be more suitable for high-density areas where plants may not thrive, either due to lack of sunlight or potentially damaging human activity.

Figure 5.3.1.1 How a Bioswale Works (Source: NYC DEP)

The suitability of a particular site for UGI depends not just on flood risk but also on the infiltration capacity of the soil that exists below the surface, which is higher when soil is less compacted, more porous, and stable enough to prevent erosion and collapse [71]. It also depends on the capacity of the site to store stormwater, which is maximized by a deeper bedrock, the impermeable geologic layer beneath groundwater [72]. Sites with a shallow water table relative to the bedrock depth may not be suitable for UGI without the installation of additional drainage infrastructure, as it may risk flooding of groundwater which can damage critical underground infrastructure such as the subway system [73]. The soil should be wide enough to allow for vegetation in the UGI to establish mature root systems, which can also improve soil stability [74]. Finally, evapotranspiration in UGI can be maximized through high vegetation density and the selection of native plant species that are acclimated to local storm patterns and can consume high amounts of water. Some urban trees, for example, can reduce stormwater runoff by up to 17% [75].

MEASURING THE SUCCESS OF STORMWATER MANAGEMENT

Target Outcome: Identify suitable sites for UGI implementation.

Baseline

- Track CSOs by monitoring their occurrence each year, conduct water quality sampling at various CSO outfalls to determine oxygen, nutrient, and pollutant concentrations, and assess the effectiveness of different types of existing UGI in improving water quality.
- Quantify stormwater interception of different types of UGI, such as trees, by cross-referencing NYC DEP data on the historic performance of existing UGI with U.S. Forest Service data on stormwater interception capacity by tree type [76].

KPIs

- Removal of the first inch of rain from 10% of impervious surfaces [77]
- Reductions in frequency and intensity of flooding events
- Reduction of flood-related damages (e.g., cost of damage)
- Reduction in frequency of CSO events in relevant watershed

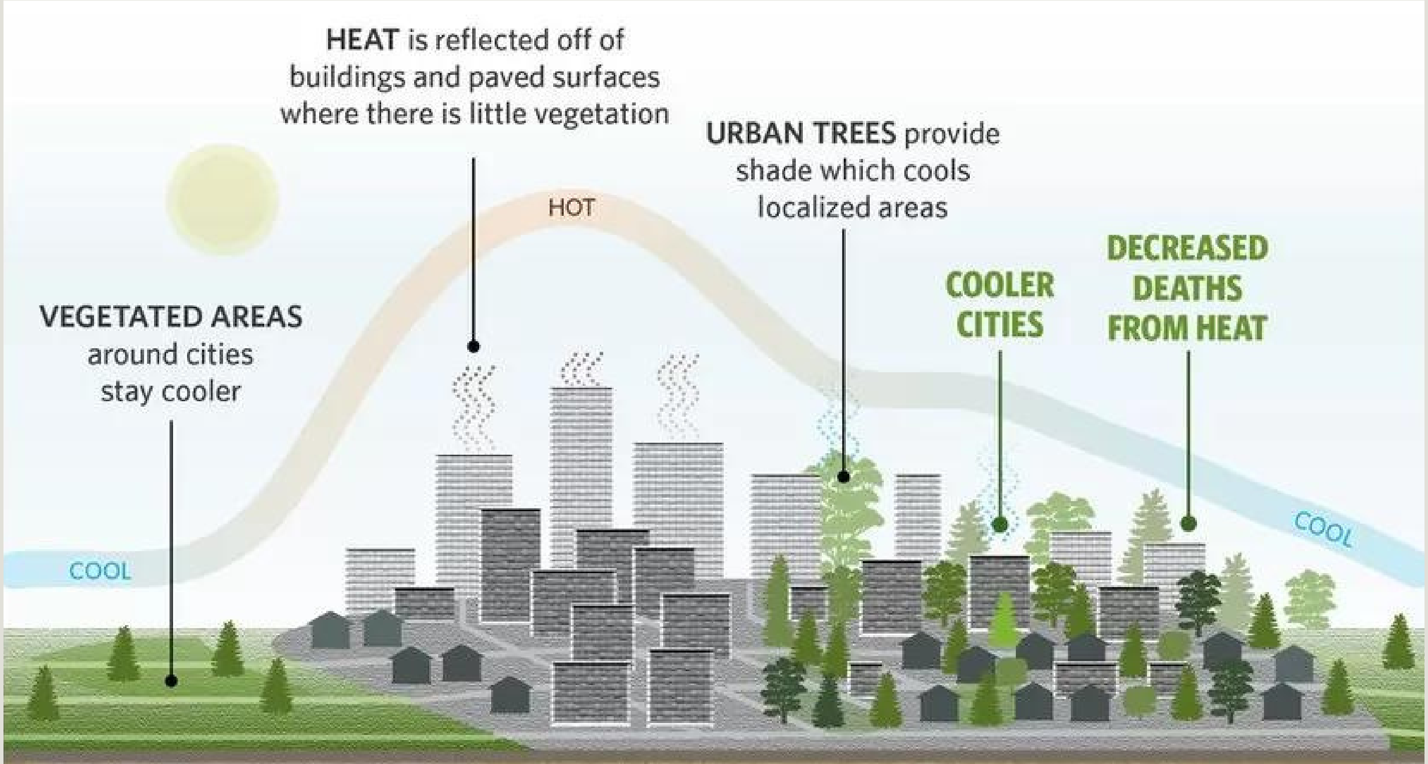


Figure 5.3.2.1 How UGI Mitigates Urban Heat (Source: BBC)

5.3.2 Urban Heat Mitigation

Green infrastructure may also reduce urban heat, though these impacts are more difficult to measure and model than stormwater. UGI can prevent sunlight from reaching dark urban surfaces like asphalt, which absorb high portions of incoming shortwave radiation and re-radiate it into the atmosphere as heat energy [78]. Trees, for example, block 70-90% of incoming sunlight during the summer and 20-90% of incoming sunlight during the winter, depending on the amount of tree canopy coverage. Vegetation reflects between 5-25% of incoming sunlight back into the atmosphere [79] and it uses the remaining light for photosynthesis, the process by which plants use sunlight to convert water and carbon dioxide (CO_2) to oxygen and usable energy [80]. Plants also reduce atmospheric heat through evapotranspiration, as they intake heat energy from the surrounding air to convert liquid water to water vapor. Because the intermolecular forces keeping water molecules together are strong, the amount of latent heat required to break these bonds is relatively high [81]. Modeling studies demonstrate that vegetation may reduce near-surface temperatures in NYC by up to 2.6°F at the hottest time of day in the summer [82], and surface temperatures can be 20-45°F cooler when shaded [83]. For example, the neighborhood of Forest Hills in Queens, which has a high tree canopy cover of 25.7%, is 1.88°F cooler than the neighborhoods of Corona and Elmhurst, which have a low tree canopy of 14.3% despite all being adjacent to one another [84].


Upper West Side, Manhattan (Source: NYT)

MEASURING THE SUCCESS OF URBAN HEAT MITIGATION

Target Outcome: **Reduce ambient temperatures in and near green spaces.**

Baseline

- Use surface-temperature monitoring, continuous recording of peak temperatures, and thermal imaging to assess ambient temperatures of vegetated versus non-vegetated areas, leveraging models of vegetation density such as Normalized Difference Vegetation Indices (NDVIs), which use geographic information systems (GIS) and satellite imagery [85].
- Measure the difference between surface temperatures in shaded versus non-shaded areas.
- Determine the number of hospitalizations and deaths related to heat stress in a given neighborhood.

KPIs

- Reductions in ambient temperatures of at least 2˚F during the hottest time of day before and after UGI installation.
- Reductions in heat-related deaths and hospitalizations before and after green space installations [86].

Figure 5.3.3.1 Trees & Air Pollution (Source: BBC)

5.3.3 Air Pollution Reduction

UGI can also reduce local air pollution to some extent. In addition to CO2, plants absorb short-lived gaseous pollutants like ground-level ozone (O3), nitrogen oxides (NOx), sulfur dioxide (SO2), and carbon monoxide (CO) through their stomata, which are small openings primarily located on their leaves [87]. Once absorbed, these compounds undergo chemical reactions inside plants and are temporarily fixed until the plants die and decompose. Plants may also reduce airborne particulate matter (PM) by intercepting it in the atmosphere, after which it either adheres to the plant or falls to the ground.

Trees in NYC reduce local concentrations of these pollutants by less than 0.5%, meaning the overall impact is likely negligible [88]. Trees can also exacerbate air pollution if placed in urban canyons, as they obstruct wind flow [89]. Some tree species also emit VOCs, an important component of ozone formation, at the same rate as they remove other air pollutants from the atmosphere. While scientists lack the tools and methodologies to directly and precisely attribute reductions in heat and air pollution to UGI, they broadly agree that the overall quantity of UGI is the biggest determinant of its impact on those issues. For this reason, green spaces with a wider spread (e.g., large parks, or small parks in close proximity to one another) and taller, large-leaf vegetation (i.e. trees and hanging plants) are more effective than other UGI for reducing heat and air pollution [90].

MEASURING THE SUCCESS OF AIR POLLUTION REDUCTION

Target Outcome: **Reduce ambient concentrations of air pollution [91].**

[This outcome should be weighted less than others due to challenges and uncertainties around its measurement.]

Baseline

- Use on-ground monitors and satellite remote sensing to determine ambient concentrations of CO2, O3, NOX, VOCs, and other air pollutants in vegetated versus non-vegetated areas [92].
- Determine the number of annual deaths and hospitalizations related to each air pollutant measured.
- Calculate differences in air pollution mitigation depending on the amount and type of UGI.

KPIs

- Reductions in air pollution concentrations of some amount (likely less than 1%) before and after UGI installation [93]
- Reductions in air-pollution-related deaths and hospitalizations

Bronx River Park (Source: Vasu Jayanthi)

5.3.4 Mental and Physical Health

Exposure to green space is also highly correlated with improved mental and physical health outcomes [94]. This may occur through a variety of biological and chemical mechanisms, as well as through the encouragement of health-promoting behaviors like increased physical activity and meaningful social interaction [95]. For example, one study found a relationship between exposure to green spaces and slower biological aging in older adults [96]. Increasing the presence of UGI in EJAs can help to alleviate the disproportionate health burden that these communities often face, whether due to the lack of resources needed to adapt to extreme storms and heat, or due to other factors like income and poor local air quality that drive underlying health conditions such as heart disease, lung disease, and weakened immune systems. This is particularly true if the City implements UGI in a way that increases citizens' access to green space and aligns with how the local community is most likely to use it [97].

5.3.5 WORKING TOWARDS A SOLUTION IN MOTT HAVEN, SOUTH BRONX

UGI as a Solution: NYC can leverage native plants in Mott Haven that are already adapted to the local climate and seasonal precipitation patterns. The thornless honey-locust tree is an example of a tree that may be suitable for sites prioritizing stormwater management. It is a hardy tree tolerant to high water saturation, drought, wind, pollution, and high pH levels – factors that can commonly be found in urban settings. The thornless honey-locust is the most commonly planted tree in Mott Haven and currently comprises approximately 8% of trees in the neighborhood [98].

According to the United States Department of Agriculture (USDA) Forest Service, a mature medium-sized tree has the potential to intercept nearly 2400 gallons of stormwater every year [99]. The ability to leverage this potential in an urban setting would be dependent on several key factors including soil depth and the direction of stormwater runoff. If a tree is not planted in an adequately sized tree pit, its roots will likely be unable to mature to full size, thereby retarding its ability to absorb stormwater.

Vacant Lot, 626 St. Ann's Ave., Bronx (Source: Google Maps)

Vacant Lot, 195 E 138th St, Bronx (Source: Google Maps)

UGI in Vacant Lots: Currently, according to data from DCAS, there are 39 City-owned vacant lots in Mott Haven. Of these 39 lots, seven fall within the scope of Local Law 10 and are potentially suitable for siting additional green infrastructure. For example, the City-owned vacant lot in the image (above) is located in the floodplain and near a major highway entrance, which makes it well-suited for a green space aimed at addressing stormwater management and air pollution sequestration. Planting in layers, such as by surrounding trees with shrubs and ferns, increases a green space's stormwater retention and evapotranspiration potential.

Other vacant sites in Mott Haven near schools may be suitable candidates for small parks, such as the lot adjacent to University Prep Charter High School in the image (left). Given the frequent pedestrian traffic, a small park with large-leaf trees can potentially provide additional canopy, alleviating heat stress and serving as a refuge from extreme heat. In addition, it could generate additional co-benefits by serving as a community space for residents, particularly the students and their families.

6.0 SCIENTIFIC ISSUES & CONTROVERSIES

Despite the documented benefits of UGI in cities like NYC, there are controversies regarding UGI's effectiveness in mitigating environmental problems and the potential benefits they may provide for communities in EJAs. This section outlines key controversies that may limit or counter the benefits of Local Law 10 by highlighting potential tradeoffs for implementing UGI. Additionally this section highlights considerations the City should take into account when surveying UGI opportunities in vacant lots, which may help to prevent unintended consequences of UGI implementation down the line.

Standing water in Brooklyn street (Source: NYT)

6.1 UGI May Not Solve Environmental Problems

Ample research has demonstrated UGI's effectiveness at addressing stormwater management problems [100]. However, controversies and uncertainties remain regarding its ability to mitigate the UHIE and air pollution:

1) *Attributing environmental impacts to UGI*: Because stormwater flows in predictable ways that scientists can clearly model and measure, it is relatively simple to attribute water flow changes to UGI installments using empirical methods [101]. However, it is harder to attribute heat- and air-pollution related outcomes to specific UGI installations due to the complexities of measuring hyperlocal heat and air pollution levels while also accounting for the effects of confounding variables like local wind patterns [102]. While some studies have observed air pollution reduction in the presence of UGI, the exact pathways linking these benefits are unclear and experts dispute the duration of these effects [103]. Additional research finds stronger correlations between the air convection patterns and urban heat compared to evapotranspiration rates and urban heat, suggesting that patterns of the built environment may affect the UHIE more than the lack of vegetation [104]. Nevertheless, measurement difficulties do not necessarily indicate UGI has no cooling effect, and more research is needed to quantify the various cooling mechanisms of UGI.

Rain Garden in Brownsville, Brooklyn (Source: NYT)

Resident points out trash build-up in a bioswale in Flushing, Queens (Source: NYT)

2) *Sufficient scale of UGI:* The environmental benefits of UGI vary depending on the scale of installations. Given that the benefits of UGI for heat- and air-pollution mitigation are directly correlated with their height and breadth, the small-scale UGI considered under LL10 may have little or no measurable effect on air pollution and the UHIE. Therefore, gray or gray-green infrastructure may be a more efficient and effective solution to these environmental challenges, even if such infrastructure lacks the co-benefits of UGI [105].

Bioswale in NYC (Source: NYT)

3) *Types of UGI:* Despite UGI being marketed as a multifunctional solution, it is difficult to design UGIs to address multiple environmental problems simultaneously [106]. Evaluating which problem is most urgent in a particular area may spur disputes regarding the recommended type of UGI, given that the severity of different environmental problems varies by location, and different types of UGI may be better suited to solve different problems [107]. For example, NYC's UGI often prioritizes stormwater management to fulfill the City's obligation to comply with clean water laws, with $3.5 billion dedicated to the NYC Green Infrastructure Program since 2012 [108]. Without implementing similar incentives to address other environmental problems, the City risks overlooking areas in need of different ecosystem services [109]. Additionally, LL10's limited purview of land use considerations excludes key types of vacant land that may also be suitable for UGI, including rooftops, parking lots, and commercially or institutionally owned lands.

6.2 UGI May Not Solve Health and Social Problems

Studies suggest that UGI can improve physical and mental wellbeing by contributing to lower rates of certain health conditions [110]. However, the mechanisms underlying these associations are not fully understood.

1) *Attributing health/social impacts to UGI:* It is difficult to attribute health and social outcomes such as quality of life, stress levels, and life expectancy to UGI implementation. Besides epidemiological factors known to impact human health outcomes, other community variables such as crime rates, poverty, food security, and access to healthcare or other social services also make it difficult to attribute direct health benefits to UGI installations [111].

2) *Scales and Types of UGI:* Specific health benefits, such as reductions in rates of asthma or heat related illness, vary widely by the type of UGI, how it is integrated into the urban environment, its maintenance over time, and its alignment with the unique needs of the communities it aims to serve [112]. For example, UGI lot size is strongly correlated with the degree of health benefits to elderly populations [113]. However, knowledge gaps between different scientific disciplines that study different scales of natural processes can result in UGI designs that do not produce their intended health effects [114].

"We see on a daily basis how New Yorkers rely on their parks... and we deal on a daily basis with the aftermath. Our crews regularly are met with piles of trash, bathrooms that are beyond disgusting, litter throughout the parks, bathrooms that look like war zones, and human feces in parks that don't don't have bathrooms. And more and more needles and homelessness... We spend half our time in traffic. The model isn't working."

- **Dilcy Benn**, Vice President, District Council 37
1% for Parks: Impact Report, New Yorkers For Parks

6.3 LL10 May Not Solve Disproportionate Environmental Burdens

The solution proposed in LL10 may not sufficiently address the disproportionate environmental burden that EJAs face, as indicated by the following challenges:

1) *Definition of EJA:* NYC's definition of EJAs does not require communities to demonstrate disproportionate environmental burdens to qualify as an EJA [115]. If NYC does not specify additional criteria for identifying EJAs, LL10 may not prioritize communities which need UGI the most [116].

2) *Community preferences:* UGI designed and implemented without community consultation may conflict with the needs and preferences of local residents. For example, local backlash to bioswales in Flushing, Queens, demonstrates how inadequate engagement between city planners and local communities can lead to UGI which local residents do not appreciate, especially if they come at the expense of valuable land uses like recreation and social services [117].

3) *Allocation of resources:* Resources required to implement and maintain UGI in EJAs may be more effective at addressing communities' problems if the City allocates them to different solutions [118]. For example, measures to increase food or housing security and decrease poverty may have more direct and substantial impacts on health and social wellness. Moreover, the City often allocates funding to build UGI without increasing funding for its maintenance. As a result, installations are unable to fully provide their projected social and/or environmental benefits on long-term scales. UGI that is not properly maintained can also incur high costs for restoration long-term [119].

6.4 Unintended Consequences of UGI

Implementing UGI in EJAs can negatively impact the environment and local residents' health and wellbeing, which can limit, outweigh, or undo its benefits. Potential negative impacts that policymakers should consider include:

1) Negative Human Health Effects: UGI may worsen some health outcomes by spreading vector-borne disease and increasing VOCs, the latter of which can contribute to ground-level-ozone formation and exacerbate health conditions like asthma [120]. Planting certain types of male trees can also worsen allergies. In NYC, four species of trees make up 93% of airborne pollen production [121].

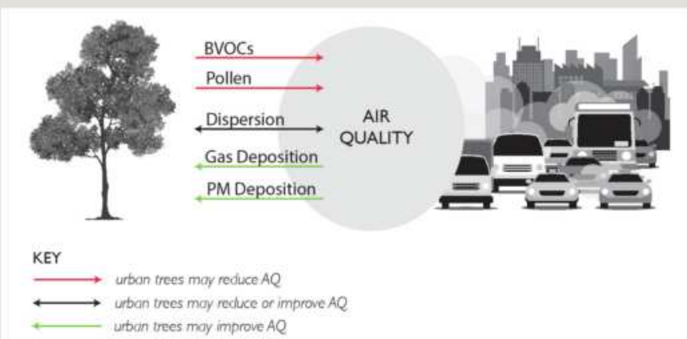


Figure 6.4.1. Potential negative health impacts of UGI (Source: Eisenman 2019)

2) Waste & Pest Accumulation: UGI can attract litter and naturally accumulate waste via stormwater flow. Without proper maintenance residents may lament the aesthetic, hygienic, and pest burden, leading to local opposition for certain types of UGI as in the case of Flushing [122]. For example, water accumulated in bioswales can take 48 hours to drain which can create breeding grounds for mosquitoes [123]. Homogeneous tree planting can also render UGI more vulnerable to climate change and pest damage [124].

3) Rising Groundwater Table: Increasing the infiltration rate of NYC's surfaces with UGI an raise the underground water table, an impact that may be exacerbated by extreme storms, which are increasing in frequency due to climate change. Rising water tables are a risk in areas with high bedrock levels, which flood and corrode underground infrastructure including basement apartments, underground electrical lines, and the subway system [125].

4) "Green Gentrification": Increasing the density of green space in an area has been associated with raising housing prices and the displacement of low-income and minority residents [126]. Coupled with rising housing prices associated with different types of UGI, studies have demonstrated that communities of color may also be displaced due to degraded feelings of belonging after UGI implementation and the changes in neighborhood demographics that often follow [127]. Policymakers can mitigate this effect by considering the risk of housing displacement during potential sitings for UGI in a given area and consult with local communities to gain insights on the factors that contribute to their displacement.

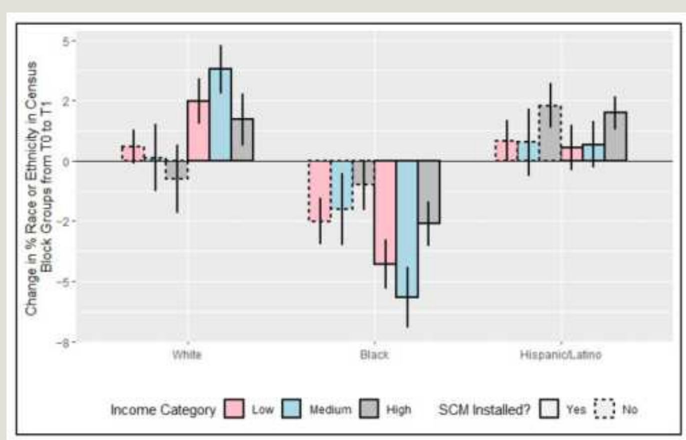


Figure 6.4.2. Installation of UGI in a Washington, D.C. neighborhood was correlated with increased number of white residents (left) and decreased number of Black residents (middle). (Source: Chen et al, 2021)

CONCLUSION

Decades of urbanization and land-use change have catalyzed several environmental problems in NYC, which burden some areas of the city more than others. Urban green spaces may mitigate some of these challenges and enhance the overall well-being of city residents. Scientific literature and evidence from past City initiatives demonstrate that green infrastructure can limit environmental issues like stormwater runoff and heat in cities, while also providing co-benefits such as reduced levels of stress among residents. Despite its potential benefits, urban green space is lacking in many neighborhoods that need it the most. By surveying opportunities for such spaces in Environmental Justice Areas, Local Law 10 of 2023 may facilitate a more equitable distribution of green space across NYC.

However, proper planning and implementation is necessary to ensure that new urban green space implemented through this law is effective and avoids unintentional consequences that negatively impact surrounding communities. Measuring and tracking key performance indicators (KPIs) over time is critical to assess the policy's success at achieving its desired social and environmental outcomes in the long-term, and early engagement between policymakers and community representatives can ensure that KPIs incorporate and align with the needs of environmental justice communities. Robust collaboration with communities as well as scientific and industry experts can help to ensure that Local Law 10 addresses structural inequality and improves environmental health and quality of life for historically underserved residents of NYC.

La Salle Apartments Greenery, Manhattan (Source: Skye Embray)

GLOSSARY

Albedo: The proportion of the incident light or radiation that is reflected by a surface.

Anthropogenic: Originating in human activity, chiefly related to pollution or environmental change.

Bioswale (or Rain Garden): Fenced-in vegetated areas, typically found on streets and sidewalks, which collect polluted stormwater runoff, allow it to infiltrate it into groundwater, and filter out pollution. [128]

BIPOC: Black, Indigenous, and People of Color

Canyon Effect: The creation of an artificial canyon by the dense concentration of tall buildings in an urban area. [129]

Combined Sewer System (CSS): Predominant sewer system in NYC, which collects rainwater runoff, domestic sewage, and industrial wastewater in one pipe. In typical weather conditions, a CSS transports wastewater and any runoff to a treatment plant. Sometimes the amount of runoff exceeds the capacity of the system. [130]

Combined Sewer Overflow (CSO): Outfalls of untreated wastewater and stormwater into urban waterways, which occur when the amount of stormwater runoff exceeds the capacity of a city's combined sewer system (CSS). [131]

Carbon Dioxide (CO2): A greenhouse gas that comes from the extraction and burning of fossil fuels, wildfire events, and natural events such as volcanic eruptions. [132]

GLOSSARY

Department of Citywide Administrative Services (DCAS): the agency responsible for making city government work for all New Yorkers and providing City agencies with the resources and support needed to succeed. [133]

NYC Department of Environmental Protection (DEP): the agency responsible for protecting public health, critical quality of life issues, and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous materials pollution. [134]

NYC Department of Parks and Recreation ("Parks"): the agency responsible for stewarding more than 30,000 acres of land — 14 percent of New York City — including more than 5,000 individual properties ranging from Coney Island Beach and Central Park to community gardens and Greenstreets. [135]

NYC Department of Transportation (DOT): the agency responsible for planning and coordinating federal transportation projects. It also sets safety regulations for all major modes of transportation. [136]

Environmental Justice (EJ): "The fair treatment and involvement of all persons, regardless of race, color, national origin or income, with respect to the development, implementation and enforcement of environmental laws, regulations, policies and activities, and with respect to the distribution of environmental benefits (such as financial assistance for environmental projects)," as defined by NYC Local Law 64 of 2017.

GLOSSARY

Environmental Justice Area (EJA): “Low income or minority communities located in the City of New York,” as defined by NYC Local Law 60 of 2017. [137]

Environmental Science and Policy (ESP): A one-year masters program for future environmental sustainability leaders at the School of International and Public Affairs at Columbia University. [138]

Geographic Information Systems (GIS): A computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. [139]

Green Gentrification: The process by which expansion of green space leads to increases in perceived desirability of an urban area, resulting in higher property values and rents. [140]

Greenhouse Gasses (GHGs): Gasses that trap heat in the Earth’s atmosphere and can contribute to climate change if they exceed their natural concentrations. Common examples include carbon dioxide, methane, nitrous oxide, and fluorinated gasses. [141]

Green Roof: A roof that is completely or partially covered with vegetation and/or plant materials. [142]

Interagency Working Group (IWG): A group of representatives from various City agencies tasked with implementing NYC’s Environmental Justice Plan, as mandated by NYC Local Law 64. [143]

Key Performance Indicators (KPIs): Critical and quantifiable indicators of progress toward an intended result. [144]

GLOSSARY

Lenni-Lenape Indigenous People: An indigenous group of people who originally resided in the Delaware (or Lenni Lenape or Lenape) confederation in eastern North America. This group of Algonquian-speaking North American Indians originally occupied the Atlantic seaboard from Cape Henlopen, Delaware, to western Long Island. [145]

Local Law 10 (LL10) of 2023: New York City law that codifies a feasibility assessment study of creating small parks and green spaces on public streets with dead ends and City-owned vacant land. [146]

Local Law 60 (LL60) of 2017: New York City law that amends NYC administrative code to require a study of “environmental justice areas” and establish an environmental justice portal. [147]

Local Law 64 (LL64) of 2017: New York City law that amends NYC administrative code to include definitions and concerns for environmental justice. [148]

Nitrogen Oxides (NOx): A group of molecules composed of nitrogen and oxygen atoms such as NO (nitric oxide) and NO2 (nitrogen dioxide). [149]

Normalized Difference Vegetation Indices (NVDIs): A measurement used to quantify the amount and density of vegetation in a geographic area. [150]

NYC Mayor’s Office of Climate and Environmental Justice (MOCEJ): An office in the NYC government created in 2022 by Mayor Eric Adams that aims to address climate change issues in NYC with a focus on equity, justice, and public health. [151]

GLOSSARY

NY Renews Coalition: An organization comprising over 360 environmental, justice, faith, labor, and community groups that advocate for climate justice. [152]

Ozone (O3): A highly reactive substance composed of three oxygen atoms. [153]

pH: An expression of hydrogen ion concentration in water. [154]

Particulate Matter (PM2.5): Tiny particles of solids or liquids in air that may include dust, dirt, soot, smoke, or drops of liquid. [155]

Runoff: Land precipitation that flows over a surface towards streams

South Bronx Unite (SBU): An environmental justice organization originally established with the goal to improve the social, environmental and economic wellbeing of neighborhoods located in the Bronx, New York City such as Mott Haven and Port Morris. [156]

School of International and Public Affairs (SIPA): The international affairs and public policy graduate school housed within Columbia University in the City of New York. [157]

Sulfur Oxides (SOx): Group of molecules made of sulfur and oxygen atoms such as SO2 (sulfur dioxide) and SO3 (sulfur trioxide). [158]

United States Department of Agriculture (USDA): Department in the US government with the responsibility to provide leadership on food, agriculture, natural resources, and related issues to US citizens. [159]

GLOSSARY

Urban Green Infrastructure (UGI): Man-made infrastructure that aims to provide ecosystem services and other benefits by increasing amounts of vegetated land in urban areas.

Urban Heat Island Effect (UHIE): refers to the creation of “urban heat islands” in densely populated cities, which are urbanized areas with higher temperatures than outlying regions due to increased building structures and less natural landscapes such as forests and water bodies. [160]

Urbanization: The concentration of human populations into discrete and densely populated areas. [161]

Volatile Organic Compounds (VOCs): Compounds that have high vapor pressure and low water solubility, which are used in a variety of products such as paint, cleaning supplies and pesticides, and emitted into the atmosphere as gases that contribute to the formation of harmful secondary air pollutants. [162]

Wappinger Indigenous People: An indigenous group of people who originally resided in the Wappinger Confederacy in eastern North America. This group of Algonquian-speaking Indians originally settled along the east bank of the Hudson River during the 17th Century. [163]

WE ACT for Environmental Justice: A Northern-Manhattan environmental justice organization founded in 1988 by environmental activist Peggy Shepard, with the mission to ensure that people of color and/or low income residents meaningfully contribute to the creation of environmental health and protection policies. [164] [165],

World Health Organization (WHO): An organization within the United Nations agency founded in 1948 that aims to connect nations, partners, and people to expand universal health coverage globally. [166]

APPENDIX

Appendix A: Text of Local Law 10 of 2023

LOCAL LAWS OF THE CITY OF NEW YORK FOR THE YEAR 2023

No. 10

By Council Members Krishnan, Louis, Yeger, Riley, Restler, Hanif, Hudson, Ung, Won, Gutiérrez, Holden, Gennaro, Menin, Narcisse, Brannan, Cabán, Bottcher, Abreu, BrooksPowers, Farías, Velázquez, De La Rosa, Avilés, Nurse, Ayala, Joseph, Brewer, Schulman, Powers, Rivera, Marte, Dinowitz, Ossé, Williams, Mealy, Moya, Hanks, Stevens and Carr

A LOCAL LAW

In relation to a survey to determine the feasibility of creating small parks and green spaces on public streets with dead ends and vacant city-owned land near streets with dead ends

Be it enacted by the Council as follows:

Section 1. An agency or office designated by the mayor, in consultation with the department of environmental protection, the department of parks and recreation, the department of transportation, the department of citywide administrative services and any other appropriate agency, shall review sites, owned by the city of New York in residential zones in each borough, on streets with dead ends and vacant land in close proximity to such streets, and land that abuts highway entrances, underpasses and exits, that are suitable for the planting of trees or other vegetation, or for establishing bioswales, small parks or other green spaces. Such designated agency or office shall develop a methodology to identify which such sites to review, provided that in identifying such sites, such agency considers requests from council members, community boards and members of the public to review a site, and prioritizes the review of identified sites that are in environmental justice areas, as defined in section 3-1001 of the administrative code of the city of New York.

Appendix A: Text of Local Law 10 of 2023

§ 2. No later than April 1, 2024, the designated agency shall submit to the mayor and speaker of the council a report of all sites reviewed pursuant to section one of this local law. Such report shall also include: an analysis of the condition of each such site; the feasibility of planting trees or other vegetation or the installation of bioswales, small parks or other green spaces; a description of the necessary steps associated with installing any such feature; an estimated length of time that would be needed to install such features; and an estimate of the overall cost to do so.

§ 3. This local law takes effect immediately.

THE CITY OF NEW YORK, OFFICE OF THE CITY CLERK, s.s.:
I hereby certify that the foregoing is a true copy of a local law of The City of New York, passed by the Council on December 21, 2022 and returned unsigned by the Mayor on January 20, 2023.

MICHAEL M. McSWEENEY, City Clerk, Clerk of the Council.

CERTIFICATION OF CORPORATION COUNSEL
I hereby certify that the form of the enclosed local law (Local Law No. 10 of 2023, Council Int. No. 680-A of 2022) to be filed with the Secretary of State contains the correct text of the local law passed by the New York City Council, presented to the Mayor and neither approved nor disapproved within thirty days thereafter.

STEPHEN LOUIS, Acting Corporation Counsel.

APPENDIX

Appendix B: Stakeholder Engagement

Date	6/21/23
Interviewee	Kameron Aroom
Role	Landscape Architect, MV Landscape Architects, Ltd.
Takeaways	**Goal:** Assess how the vacant lots identified in LL10 can feasibly provide ecosystem services and the various considerations involved in achieving that goal through UGI construction and maintenance. • For stormwater management, start by identifying sites using GIS to identify suitable locations (e.g., city-owned, right-of-way), taking into account topographic features that increase flood risk, and existing drainage infrastructure (e.g, pipes, waterholes) • Assess bedrock via boring and core-drilling to identify water level, condition of soil, worst case scenario for soil management (incl. depths needed for vegetation, existing electric utility lines, fiber optic cables) • Focus on trees (usually no community pushback) and native plants to maximize environmental benefits • Use online databases (e.g., ASLA green infrastructure) to conduct historical analysis of green spaces in NYC and their effectiveness/drawbacks

APPENDIX

Appendix B: Stakeholder Engagement

Date	6/26/23
Interviewee	Leslie Vasquez
Role	Clean Air Program Coordinator, South Bronx Unite (SBU)
Takeaways	**Goal:** Hear the perspective of one community in a city-designated EJA to understand LL10's intent and contextualize the solution it proposes. • SBU represents people of Mott Haven and Port Morris in the South Bronx. Historic injustices include the construction large industrial facilities and a major expressway leading to pollution which negatively impacts the majority-BIPOC community • Insufficient action from state government (lack of funding, prioritization, resilience plans) despite their verbal commitments • 60,000 total residents share one small park • Waterfront Plan (developed collaboratively within community) would increase access to public land, bring community members together, & provide ecosystem services. NYC govt has not dedicated funding for this.

APPENDIX

Appendix B: Stakeholder Engagement

Date	6/28/23
Interviewee	Dr. Matthew Palmer
Role	Senior Lecturer of Ecology, Evolution, and Biology (E3B), Columbia University
Takeaways	**Goal:** Better understand the science behind UGI for providing ecosystem services, its effectiveness, and challenges that NYC has faced in their implementation (specifically with regards to ecosystem services), given Dr. Palmer's previous collaborations with the NYC DEP around their green infrastructure plan. • UGI receives funding for installation but not maintenance, attracting pests and trash • Impacts of UGI on heat and air pollution are difficult to measure, and vegetation must be tall to impact air pollution • There are tradeoffs to installing green infrastructure, which can be aesthetic, practical, and political. Sometimes, ecological considerations are not the priority (there are winners and losers). • Planners must take unintended consequences into account

APPENDIX

Appendix B: Stakeholder Engagement

Date	7/6/23
Interviewee	Dr. Robbie Parks
Role	Assistant Professor, Mailman School of Public Health, Columbia University
Takeaways	**Goal:** Understand the health impacts of stormwater runoff, urban heat, and air pollution, their distribution across the city, and the potential role of UGI in mitigating those impacts among communities most in-need. • Dr. Parks cross-references data on physical and mental health outcomes (e.g., deaths, hospitalizations, suicide hotline calls) with modeling data on environmental conditions (e.g., heat waves, cyclones, wildfire smoke). • Both PM2.5 exposure and heat are associated with heart and lung disease, but the former is an order of magnitude more attributable to deaths in NYC. Even though PM2.5 levels have improved in NYC, there are few ways to manage/avoid it. • Green space is lacking in the South Bronx, and UGI has appreciable impacts on surrounding temperatures, PM2.5, and ozone.

APPENDIX

Appendix B: Stakeholder Engagement

Date	8/2/23
Interviewee	Anne Lupsha
Role	Supervising Analyst, NYC Mayor’s Office of Management and Budget (OMB)
Takeaways	**Goal:** Understand the City’s intent behind LL10 and its approach to implementing it, including the city’s progress thus far and challenges they are facing. • OMB, Law, DCAS, DOT, and DPR redlined the bill based on what is realistic in the context of the city’s budget and operations. Several agencies own different lots, so the mayor will designate a lead agency and DCAS will submit a list of lots under its jurisdiction. A lead agency has yet to be designated. • As is required in the legislation, the City plans to conduct a high-level survey (using mapping/existing city data) of existing lots and the feasibility of turning them into a green space (consider costs with a grain of salt, as they vary significantly over time). The goal of the legislation is for agencies to use this survey to inform future green projects. • Different agencies have different priorities – will likely collaborate to collectively account for different benefits that UGI can provide • Survey will be a useful tool in PlaNYC, which focuses on economic justice and EJ, and the next city budget will include climate budgeting (e.g., emissions, resiliency), a new initiative that will help the City track its investments in sustainable and resilient projects • Community will probably be consulted in later phases when implementation considerations get more granular. Assembly members will advocate for green spaces in their communities based on consultation with community boards and leaders.

APPENDIX

Appendix C: Air Pollution Health Impacts

Health Effect	Age Groups Affected (in years)	Annual Health Events Attributable to Current $PM_{2.5}$ Levels	Annual Health Events Avoided If $PM_{2.5}$ Levels Were Reduced by 10%	Annual Health Events Avoided If $PM_{2.5}$ Levels Were Reduced to Cleanest Air of Any Large City
Premature mortality	30 and above	3,200	350	760
Hospital admissions for respiratory conditions	20 and above	1,200	130	280
Hospital admissions for cardiovascular conditions	40 and above	920	100	220
Emergency department visits for asthma	Under 18	2,400	270	580
Emergency department visits for asthma	18 and above	3,600	390	850

$PM_{2.5}$=particulate matter
* Based on 2005-2007 data on air pollution, mortality and illnesses

Figure A.1. Health impacts of PM2.5 exposure and potential reductions of PM2.5 exposure in NYC (Source: NYCDOHMH)

Health Effect	Age Groups Affected (in years)	Annual Health Events Attributable to Current O_3 Levels	Annual Health Events Avoided If O_3 Levels Were Reduced by 10%
Premature mortality	All ages	400	80
Hospital admissions for asthma	Under18	420	90
Hospital admissions for asthma	18 and above	450	90
Emergency department visits for asthma	Under18	1,800	370
Emergency department visits for asthma	18 and older	2,900	600

O_3=ozone
* Based on 2005-2007 data on air pollution, mortality and illnesses

Figure A.2. Health impacts of ground-level ozone exposure and reductions in ground-level ozone exposure in NYC (Source: NYC DOHMH)

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