TOWARD A RAINPROOF NEW YORK CITY

TURNING THE CONCRETE JUNGLE INTO A SPONGE

JULY 2022

REBUILD BY DESIGN

one architecture
new york city amsterdam

REBUILD BY DESIGN

As the world faces rising populations, mass migration, climate change, social injustices, and economic challenges, communities can't afford to wait until after the next crisis to plan for the future. Through regional competitions, local engagements, research, and policy, Rebuild by Design is reimagining the way communities find solutions for today's large-scale, complex problems by creating collaborations across communities and governments. Rebuild convenes global expertise with regional leadership and community stakeholders to gain a better understanding of how overlapping environmental and human-made vulnerabilities leave communities at risk. Rebuild's core belief is that through collaboration our communities can grow stronger and better prepared to stand up to whatever challenges tomorrow brings.

Contact us at info@rebuildbydesign.org.

ONE ARCHITECTURE AND URBANISM

One Architecture & Urbanism (ONE) is an award-winning design and planning firm with offices in Amsterdam and New York. Established in 1995, the firm is known for its unique approach in which financial, technical, and organizational issues are addressed and resolved through design. ONE is a global leader in large-scale climate adaptation and waterfront infrastructure planning. Under the leadership of founding principal Matthijs Bouw, ONE has been instrumental in the development of complex, multi-actor planning processes in the US, Europe, Latin America, and Southeast Asia. In their studios, designers work with engineers, policymakers, and communities to shape joint narratives, develop strategies, and implement projects.

Contact us at office@onearchitecture.nl

THANK YOU

Thank you to everyone who has shared their knowledge and insights throughout this process:

AECOM
Amsterdam Rainproof
ARCADIS
Centre for Liveable Cities, Singapore
Cloudburst Copenhagen
Natural Areas Conservancy
New York City Department of Environmental Protection
New York City Department of Transportation
New York City Housing Authority
New York City Mayor's Office of Climate and Environmental Justice
New York City Office of Emergency Management
New York City Office of the Comptroller
The Ramboll Group
The Trust for Public Land
The Water Center, University of Pennsylvania

Special thank you to the NorthLight Foundation for supporting this work.

GLOSSARY

BLUE-GREEN INFRASTRUCTURE (BGI) - Connects urban hydrological functions (blue) with vegetation systems (green). (NYC DEP)

CLOUDBURST EVENT - A 'cloudburst' is a sudden, heavy downpour where a lot of rain falls in a short amount of time. Cloudbursts can cause flooding, damage property, disrupt critical infrastructure, and pollute New York's rivers and Harbor. (NYC DEP) Note: "cloudburst" is often used interchangeably with "rainbomb," "extreme rainstorm," "extreme rainfall," or "extreme precipitation." This report uses the term extreme rainstorm to describe events like Hurricane Ida.

CONVEYANCE SYSTEM - A system such as drainage pipes, streets, and bluebelts that directs water flow to be retained or detained by permeable surfaces, detention sites, or retention sites.

DAYLIGHTING - an approach that exposes some or all of a previously buried river, stream, or stormwater drainage. (American Rivers)

DETENTION SYSTEM - An integrated approach to store water temporarily during a high precipitation event, such as green roofs, green-blue roofs, park space, bioswales, berms, sunken basketball courts, and sunken playgrounds.

GREEN INFRASTRUCTURE (GI) - The range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters. (Water Infrastructure Improvement Act). Green infrastructure systems can reduce stormwater flooding.

NATURAL INFRASTRUCTURE - Uses existing, restored, or enhanced ecosystems to generate infrastructure outcomes either on its own or in combination with built infrastructure. (International Institute for Sustainable Development)

NATURE-BASED SOLUTIONS - Sustainable planning, design, environmental management and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience. (FEMA)

SMART INFRASTRUCTURE - Uses real time data to inform and deploy systems using sensors, cameras, and other monitoring devices.

STORM SURGE - The rise in seawater level caused solely by a storm. (NOAA)

RETENTION SYSTEM - An area that stores water on a more permanent basis, such as ponds, reservoirs, and streams.

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"It is evident to anyone who opens their eyes that we are in the midst of a climate crisis in this city and around the world, so it's time to think outside the box and determine how we can handle the crisis before it's too late."
- Mayor Adams

Subway entrance in Queens during Hurricane Ida. Photo by Anthony Behar/Sipa USA.

INTRODUCTION

On September 1st, 2021, New Yorkers were confronted with a new reality. Across the five boroughs, communities were inundated with heavy rain, causing massive flooding in places that have never flooded previously. Cars, bikes, and pedestrians were stuck in floodwaters; rain poured into subway stations, turning staircases into waterfalls and disrupting service; floodwaters gushed into basements and ground floor apartments. Over 3.15 inches of rain fell during a single hour, breaking a record set only ten days prior by Hurricane Henri.[1]

Twenty-four hours after Hurricane Ida, the water seemingly vanished, but the psychological imprint of the storm will last for years to come. The flooding caused between $16 - $24 billion in property damage in the Northeast,[2] leaving 150,000 homes in NY, NJ, PA, and CT without power and over 18,800 tons of debris.[3] Most shockingly were the 43 deaths in the New York Area – 11 of whom drowned in their own homes, trapped by flood waters in basement apartments.[4] New York City was simply not equipped to handle the intensity and duration of the rainfall.

Since the launch of PlaNYC in 2007, the City has made great strides in preparing for climate change through aggressive carbon reduction targets and a portfolio of projects funded with both city and federal Hurricane Sandy recovery dollars. However, the City's infrastructure is far from being able to handle record-breaking events like Hurricane Ida, which, in coming years, will only happen with more frequency.

To advance the use of natural solutions to address increased climate threats, Rebuild by Design partnered with One Architecture & Urbanism, alongside other stakeholders and experts, to better understand how NYC Government could adapt its current practices and leverage collaborator input into a comprehensive program to address the impacts of increasingly extreme rainstorms while achieving social, health, ecological, and economic benefits. If we were to start with the goal of addressing all future flooding through green or multi-benefit infrastructure, then there is a mix of governance, budgetary, and leadership challenges that will need to be addressed to scale and expand current practices and to institutionalize a co-benefit approach across every City agency.

New Yorkers have never shied away from going big, and we will not this time either. New Yorkers engineered and built an aqueduct to ensure a dependable source of clean water; had the foresight to set aside a final swath of land to create a central park in a rapidly growing city; and, in 1931, the whole world was wowed by the opening of the tallest building in the world - the Empire State building. That building kept the title for forty years until New Yorkers topped their own record with the World Trade center. Now, over 100 years later, it's up to us to take on a new challenge – to develop new and exciting ways to enhance our city while creating opportunities to adapt to climate change. In the case of extreme rainfall, we will need to create systems to retain or detain the equivalent volume of 32 Empire State Buildings filled with water. We met the challenge then, and we will meet this one too – if we all play our part.

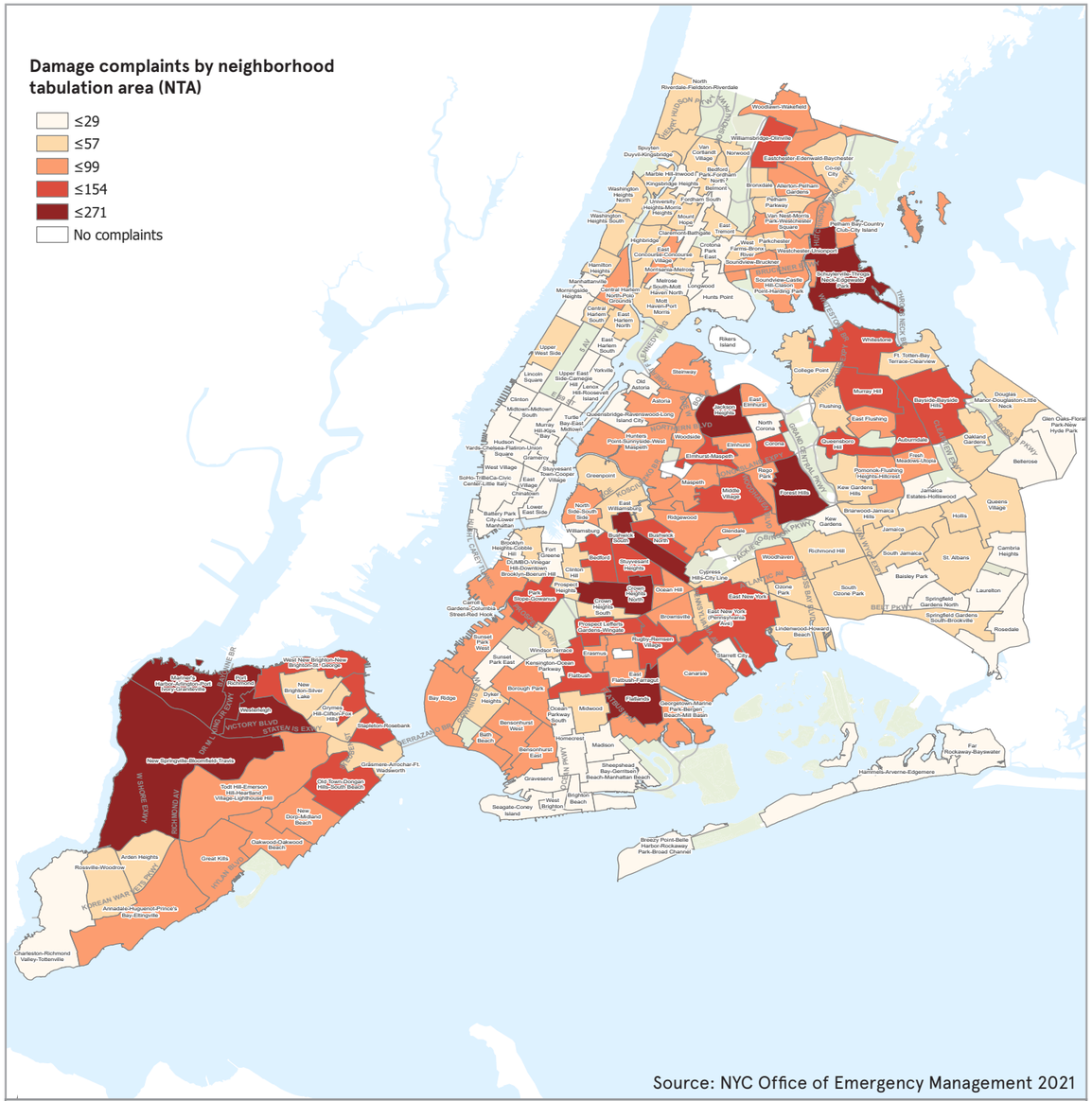
DAILY NEWS

NYC CRIME

Hurricane Ida NYC death toll rises to 13, including infant and senior citizen, after record rains and lethal flooding

By **Brittany Kriegstein**, **Wes Parnell**, Theodore Parisienne, **Molly Crane-Newman**, **John Annese**, **Thomas Tracy** and **Larry McShane**
New York Daily News • Sep 02, 2021 at 6:18 pm

HURRICANE IDA DAMAGE REPORTS BY NEIGHBORHOOD



Source: NYC Office of Emergency Management 2021

Figure 1. Building impact report was generated using the following information: 311 damage survey calls (pre 9/6 2200hrs; self-reported); 311 Mold complaints (self-reported); DEP SBU flood complaints; DOE flood reports; DEP dewatering requests (generators); DEP basement dewatering requests.

THE CHALLENGE

CLIMATE CHANGE MAGNIFIES THE THREAT

Climate change is here, and storms that feel extreme now will only become more frequent and more intense. The New York City Panel on Climate Change (NPCC) anticipates that by the end of the century, the city could experience as much as 25% more annual rainfall than today, and a 50% increase in the number of days with more than one inch of rain.[5] The most conservative climate change projections estimate approximately eight inches of sea level rise by the 2050s.[6] However, the worst case scenario projections estimate about 28 inches of sea level rise. Where will all of this water go?

New York City has over 7,500 miles of sewers that, on most rainy days, go unnoticed. However, during an extreme rainfall event like Hurricane Ida, they can become the focal point of our health and safety, as well as environmental integrity. Every drop of rain that lands on our buildings, our vehicles, our sidewalks, and our streets eventually makes its way to the sewer system or our waterways, or evaporates. As the population has grown in NYC, we have continued to expand and pave over the City's surface area. Simultaneously, we have been filling in waterways and eliminating our wetlands, which served as natural buffers from flooding – placing more and more pressure on the sewer system.

As sea levels rise, it will surpass the height of sewer outfalls, leaving nowhere for the water to discharge, thus increasing the frequency of sewer backups leading to flooding in NYC's communities (see Figure 2). While building up our coastlines with raised esplanades and seawalls will help reduce the impacts of storm surge and coastal flooding on neighborhoods, they need to be integrated into a larger system of flood infrastructure that simultaneously address inland flooding.

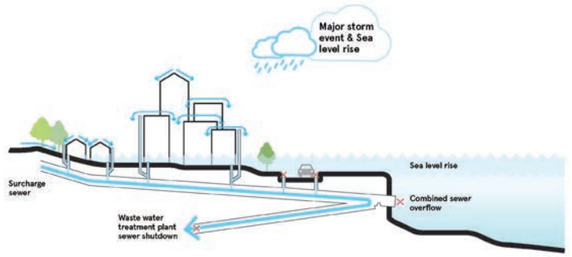


Figure 2. Sea level rise will block sewer outfalls and result in more stormwater flooding upstream, unless we take action.

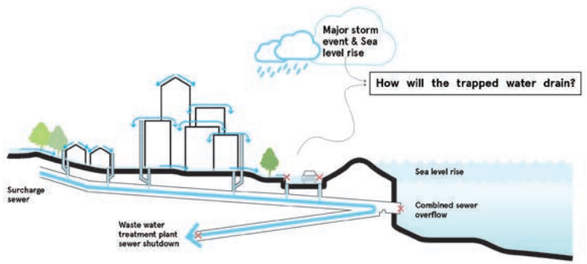


Figure 3. More stormwater retention areas are needed behind coastal protection as all rainwater will need to be pumped out of the new polders.

STORMWATER RISKS TO HEALTH

Exposure to flood waters poses significant threats to health and safety. In addition to the imminent risk of injury or drowning, flood waters carry the risks of electrocution if powerlines go down, and adverse health effects due to contamination from sewage, pollution, oil, and other chemicals in the streets. These waters can become toxic, carry diseases, and cause infection.[7]

After a storm, tenants, homeowners, and business owners are often left to deal with the byproducts of rain: mold and mildew. The map of NYC damage reports (Figure 1, p.9), which includes calls made to 311 for mold or damage, DEP dewatering requests, and DOE flood complaints,[8] provides some indication of where the damages were most severe; however, without a better system for tracking and modeling the effects of Ida-like events, we will never know the extent of their impact. The City is now installing flood sensors to have a more accurate understanding of flooding across the five boroughs. In addition to using the sensors to monitor flood damage, they should be used to identify where targeted health interventions may be needed after an extreme rainsotrm.

LOOKING AHEAD: A FUTURE WITH FLOODING

Since Hurricane Sandy devastated New York City in 2012, the City's flood adaptation work has largely focused on its 520 miles of coastline. Hurricane Ida showed us how vulnerable every NYC neighborhood is to heavy rain inland, and that we need an integrated plan to address storm surge, heavy rainfall, and sea level rise - and that the most vulnerable suffer the most. NYC's sewer system does not meet the needs of the current climate reality and future climate projections for extreme rainfall. This will require a three-pronged approach:

1. Start with the most socially and physically vulnerable communities.

2. Go green before gray. Green solutions are faster and less expensive to implement, and they provide multiple benefits, such as reducing the urban heat island effect, cleaning air, offsetting carbon emissions, creating mental health benefits, and providing space to improve physical health.

3. Prioritize co-benefits. Where we cannot go fully green, we must look for opportunities where existing and new infrastructure could serve multiple purposes, such as capturing and storing water in athletic courts or playgrounds and so allowing streets to flood to a safe level, while keeping our sidewalk and homes clear, allowing emergency vehicles to pass, and benefiting the surrounding infrastructure by holding additional rainwater until the sewer system can catch up.

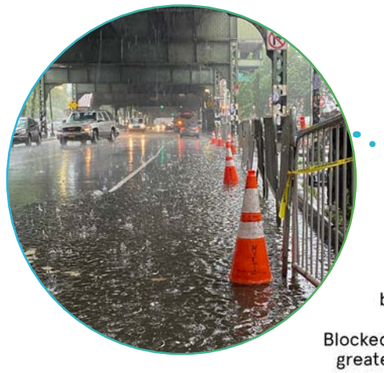
4. Expand sewer infrastructure in select strategic areas, only after we have exhausted all other measures.

Every neighborhood in New York City is susceptible to flooding to some extent, and every New Yorker will experience disruptions to their lives and livelihoods – but how much disruption is within our control. By enacting a citywide integrated plan that prioritizes green solutions – from the tops of skyscrapers to the depths of sewers – by educating stakeholders, and by working together, we can turn NYC into a sponge that is prepared for a future with more intense and frequent rainsotrms.

"MOTHER NATURE'S NOT GOING TO WAIT ON US FOR A 20-YEAR PLAN."

- NYC MAYOR ERIC ADAMS

EXTREMIE RAINFALL



Water damage due to roof leaks

Workers not able commute to work

Rainwater entering ground floor apartments

Water damage through facade leaks and rain through the window

Displacement, electrocution risk and property loss due to basement apartment flooding

Loss of merchandise / assets and business closures due flooding and water damage

Blocked rainwater sewer greater due to flooding

Flooded utility box with electrical substation resulting in power outage

Emergency services cannot reach destination

Leakage from internal drainage system creating water damage internally

Limited groundwater infiltration due to soil compaction

Flooded sub-surface parked cars

CSO event polluting the waterway

Combined sewer failure leading to street flooding and water contamination

Rainwater draining to lowest point flooding parking lot

Flooded buses & subways

Collapsed gutters causing water damage to school

Increased mental anguish caused by flooded homes

Loss of heat and hot water due to flooded boilers and basements

Buried watercourses filled to capacity and not receiving stormwater run-off

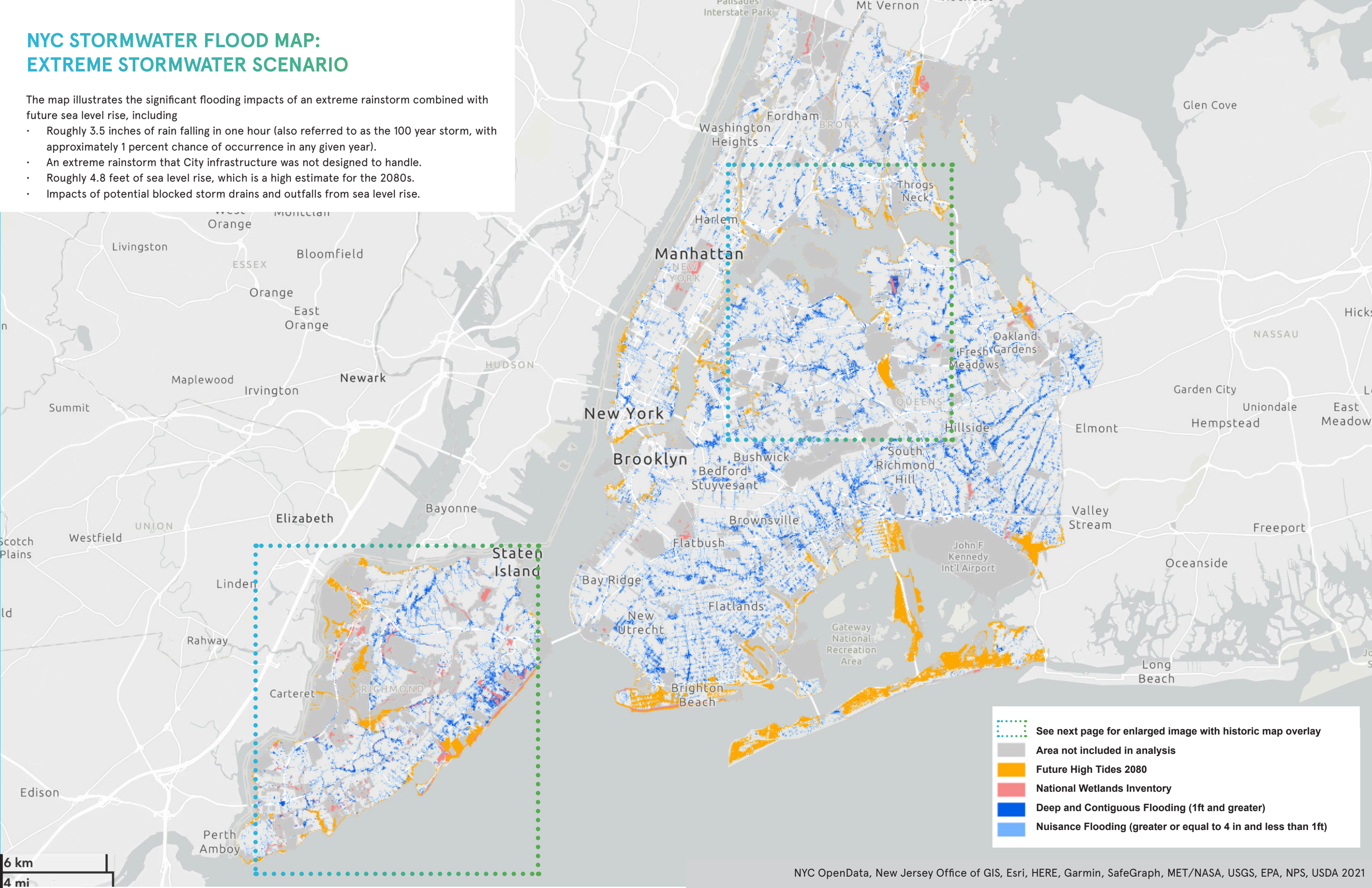
Roof collapse due to detained water loads

Sewer backflow through toilets and other fixtures

NYC STORMWATER FLOOD MAP: EXTREME STORMWATER SCENARIO

The map illustrates the significant flooding impacts of an extreme rainstorm combined with future sea level rise, including

- Roughly 3.5 inches of rain falling in one hour (also referred to as the 100 year storm, with approximately 1 percent chance of occurrence in any given year).
- An extreme rainstorm that City infrastructure was not designed to handle.
- Roughly 4.8 feet of sea level rise, which is a high estimate for the 2080s.
- Impacts of potential blocked storm drains and outfalls from sea level rise.



HISTORICAL CONTEXT

NYC STORMWATER FLOOD MAP OVERLAID ON 1891 HISTORIC WATERWAYS

WHO IS RESPONSIBLE?

In the majority of New York City, stormwater runoff is combined with wastewater and carried through the sewer system to wastewater treatment plants. During a common rain event, the combined system is designed to treat and release this water into adjacent waterways through "sewer outfalls." When there is more rain than the system can handle, untreated water (sewage) travels directly to the waterways; this is commonly referred to as a "combined sewer overflow" or CSO event. During an extreme rain event, or "cloudburst," the sewers get even further backed up, resulting in contaminated water building up in the streets. Pools of water collect above impermeable surfaces, creating a puddle. With every drop, the puddle grows and grows until it becomes "flood water," finding its way to the lowest elevation in the area – a street corner, the bottom of a hill, a basement dwelling, subterranean parking garages, and so on.

Not all of New York City is served by a combined sewer system. About 40% of the city's sewers have separate stormwater and wastewater pipes, meaning they discharge only stormwater into nearby waterways.[9] These sewers are also susceptible to backflows and flooding; however, the risk of water contamination from human waste is lessened. Until recently, the Department of Environment Protection (DEP), the agency responsible for the sewers and what ends up in New York's waterways, has primarily focused on implementing interventions to detain water at locations of frequent CSO events.

Historically, the City has focused on managing CSO events to comply with the federal Clean Water Act, which requires the DEP to minimize the untreated rainwater that reaches the waterways by prioritizing specific geographical areas where the sewer system would likely reach above capacity during a regularly-occurring rain event.[10] New York City's DEP invests in select sewer upgrades in every borough. These investments provide a starting point, but do not encompass a comprehensive solution. Expanding the sewer system is expensive and takes time to implement, creating street construction that is disruptive to everyday life.

More recently, the City has released a number of reports and policies that have united city agencies to collaborate on combating a future with increased rain events. These plans identify goals to reduce the amount of stormwater entering the sewer system in order to keep waterways healthy. They have piloted efforts in select neighborhoods by deploying cloudburst strategies in those neighborhoods, which is a leap in the right direction; however, we have yet to see the necessary investment to build out this program citywide or the commitment to utilize nature-based solutions to leverage co-benefits at the scale that is needed by every agency to truly keep New Yorkers safe.

Though there are many forward-looking planning documents and annual reports identifying progress, the City's plans must go further by:

1. Institutionalizing the urgency of this challenge among City priorities;
2. Commiting the full capital or maintenance budgets needed to address flooding from heavy rain;
3. Amendmending governance structures to determine which agencies are responsible for action and have the budget allocation granted to meet that responsibility;
4. Deploying nature-based and multi-benefit infrastructure to address flooding in non-CSO areas at the scale needed across all five boroughs in order to leverage the benefits to health, safety, job creation, aesthetics, and quality of life; and
5. Determining new structures and sources to adequately maintain nature-based infrastructure to ensure that it is ready to perform as designed.

Now that the City has turned its focus toward addressing heavy rainfall, it has an opportunity to plan differently. The City can create a clear line of accountability by directing a singular agency or point person to address flooding that affects New York's residents and businesses, prioritize multi-benefit infrastructure to bring co-benefits to every neighborhood, and lead on in innovation by implementing an overarching strategy to live with water in ways that do not massively interrupt the lives and livelihoods of New Yorkers- especially those who are most vulnerable.

"MAKING PROGRESS ON CLIMATE REQUIRES NOT ONLY GOOD POLICIES BUT ALSO DRIVING RESILIENCE, DECARBONIZATION, AND ENVIRONMENTAL JUSTICE INTO DAILY CITY OPERATIONS."

– ROHIT T. AGGARWALA, COMMISSIONER OF DEP, AND CHIEF CLIMATE OFFICER, CITY OF NEW YORK

EVERYONE HAS A ROLE TO PLAY

There is no entity within the City government responsible for addressing the City's overall flood risk. If a single person or agency, a department, or a Chief Flood Officer with policy and budgetary oversight were accountable to work with each agency and create an overarching plan, they could lead the City in its flood management goals, ensuring that every agency does their share to move towards a rainproof City.

CURRENTLY, FLASH FLOOD RESPONSE IS SPREAD ACROSS SEVERAL AGENCIES

- **Department of Environmental Protection (DEP):** Maintains the sewer system, monitors sewer outfalls, cleans catch basins (storm drains) before and during a storm.
- **Emergency Management (EM):** EM is responsible for monitoring weather and activating the flash flood emergency plan. The department provides interagency coordination when issues arise during a flash flood event and can monitor 311 flooding complaints.
- **Department of Transportation (DOT):** DOT is responsible for ensuring that the tops of catch basins are clear on major arterial roads during flash flood emergencies, and for keeping the city's roadway network in a state of good repair.
- **Department of Sanitation (DSNY):** DSNY is responsible for ensuring that the tops of catch basins are clear on minor roadways and can deploy equipment to help clear blockages, downed trees, and other hazards using their street sweeping units.
- **Fire Department (FDNY):** FDNY is on call to provide dewatering equipment or personnel to assist in the event of a flash flood emergency, and responds to emergencies.
- **Police Department (NYPD):** NYPD is on call to provide equipment or personnel to assist in the event of a flash flood emergency, such as traffic management for flooded roadways and assistance when public safety is at risk.
- **Metropolitan Transportation Authority (MTA):** MTA is responsible for responding to flash flood emergency issues impacting their subways, buses, commuter rail assets, bridges, and tunnels.
- **Community Affairs Unit (CAU):** The CAU within the Mayor's Office monitors flash flood emergencies to determine whether there will be populations requiring assistance during or after a flash flood emergency due to property damage or other issues.
- **Department of Parks and Recreation (Parks):** Parks responds to flooding in park spaces and along waterways where flooding causes damage to trees.

FLASH FLOOD PLANNING IS CURRENTLY THE RESPONSIBILITY OF JUST A FEW AGENCIES

- **Department of Environmental Protection (DEP):** Builds and maintains the sewer system; monitors sewer outfalls; identifies sites for green + gray stormwater infrastructure, including blue-belts, bioswales, and permeable pavement. DEP is required under a 2005 Order on Consent to reduce combined sewer overflows (CSOs) from its sewer system to improve the water quality of its surrounding waters.
- **Mayor's Office of Climate and Environmental Justice (MOCEJ):** Sets policy and oversees the administration's plans for adapting to climate change.
- **New York City Housing Authority (NYCHA):** Pilots green infrastructure interventions on some NYCHA campuses.
- **Department of Parks and Recreation (Parks):** Determines where stormwater green infrastructure could be utilized in parks.

WE ALL HAVE A ROLE TO PLAY

Rain falls everywhere and everyone can contribute to building a rainproof New York City. While agencies are responsible for flood response and planning, there are numerous measures the private sector can implement on houses, yards, driveways, apartment buildings, schools, campuses, hospitals, retail stores, corporate offices, and the list goes on.


DEP BWSO Field Ops Team in Times Square, NYC 2021


Jack's Pond, Staten Island Bluebelt

RECENT PROGRESS ON STORMWATER POLICY

PLANYC/ONENYC

Mayor's Office of Long-term Planning and Sustainability
(updated in 2011, 2014, 2019)
An agenda to meet the challenges of a growing population, aging infrastructure, a changing climate, and an evolving economy in NYC, to build a greener and greater city. The Plan focuses on the physical city, and the functionality of its infrastructure, as well as housing, brownfields, water quality, transportation, energy, air quality, waste, and carbon emissions.

2007

LOCAL LAW 80

Requires DEP and DOT to study the effects of permeable pavement.

2013

DESIGN AND PLANNING FOR FLOOD RESILIENCY

Department of Parks and Recreation
Guidelines specifically tailored for NYC Parks for the development and renovation of resilient waterfront parks. In addition to coastal resiliency, the guidelines promote ecological and social benefits for communities.

2017

LOCAL LAW 172

Requires the City to produce maps showing areas of the city most vulnerable from the increased flooding due to the anticipated effects of climate change and to publish a long-term plan to prevent or mitigate increased flooding. These are to be updated every four years.

2018

CLIMATE RESILIENCY DESIGN GUIDELINES

Mayor's Office of Cimate and Environmental Justice
The primary goal of the Guidelines is to incorporate forward-looking climate change data into the design of City capital projects.

2020

UNIFIED STORMWATER RULE

Department of Environmental Protection
Requires newly developed or redeveloped properties to more effectively manage stormwater on-site; this rule is projected to reduce CSOs by approximately 360 million gallons annually by 2030 to protect the health of the New York Harbor.

2022

2010

GREEN INFRASTRUCTURE PLAN

Department of Environmental Protection
A detailed framework and implementation plan to improve water quality and sustainability in NYC. The Plan led to the launch of the New York City Green Infrastructure Program, which has three focus areas: Right-of-way (ROW) Green Infrastructure, Public Property Retrofits, and Private Property Initiatives.

GREEN INFRASTRUCTURE PILOTS

NYC Housing Authority
Green infrastructure pilot programs funded by DEP which gave way to a larger set of stormwater projects for CSO mitigation.

2015

CLOUDBURST RESILIENCY STUDY

Department of Environmental Protection and NYC Housing Authority
A case study outlining ways to integrate climate resiliency and traditional stormwater solutions with ongoing urban planning and development projects in order to mitigate inland flooding expected due to future increases in rainfall. This effort led to testing the implementation of cloudburst management at the NYC Housing Authority's (NYCHA) South Jamaica Houses and other select locations.

2019

LOCAL LAWS 92 + 94

Requires new and substantially renovated or enlarged rooftops to incorporate sustainable roofing on all available roof space.

EAST HARLEM RESILIENCY PLAN

Department of Parks and Recreation
A plan to reduce stormwater flooding risk, create resilient public spaces, and integrate the waterfront with the city's drainage infrastructure.

2021

STORMWATER RESILIENCY PLAN

NYC Mayor's Office of Climate and Environmental Justice
Outlines the City's approach to managing the risk of extreme events, including emergency reponse measures and accounting for increased rainfall in standard design and long-term stormwater planning.

THE NEW NORMAL

NYC Mayor's Office of Climate and Environmental Justice
In response to Hurricane Ida, the DeBlasio Administration released a strategy for improving emergency response to extreme weather and for planning for future flood events.

CURRENT IMPEDIIMENTS TO SUCCESS

New York City's more than 100 year-old wastewater treatment system consists of over 7,400 miles of sewer pipes, 135,000 sewer catch basins, 495 permitted outfalls, and over 90 pumping stations that transport wastewater to one of the city's 14 wastewater treatment plants located throughout the five boroughs. It sounds large, but it's not nearly enough. In order to address increasing extreme rainstorm events, storm surge, and sea level rise, the City will need to systematically change this approach at the individual and citywide scale to transform the City into one that can absorb heavy rainfall when we need it the most.

The City's existing infrastructure, built environment, and competing needs makes adapting to climate change challenging and expensive. Informed by City Agencies, City Contractors, and representatives from global cities who have successfully prioritized planning for heavy rain events, Rebuild by Design and One Architecture & Urbanism learned the following:

1. NYC has the most comprehensive climate projections of any US city, yet, its policies, budgets, and incentives do not yet meet the city's increasing vulnerability to climate challenges, meaning much of the infrastructure under construction now will not last to its intended lifespan. There are no unified goals across city agencies and private stakeholders to address the increasing risk of heavy rain events and flash floods, and of the compounding challenges brought on by Sea Level Rise.

2. The City's Agencies plan in silos. Each agency is responsible for ensuring that their own mission is met, not considering how they can contribute to the missions of other agencies, leaving gaps that could be avoided with better collaboration.

3. The management of stormwater risk is spread out among many agencies, without a point person or entity that has the budget and oversight to ensure that we are leveraging the fullest co-benefits from our infrastructure investments.

4. Agencies are reluctant to try new approaches or do not have the resources to do so; as a result, they often choose designs they have used in the past over innovation. The City's toolbox for green and multi-benefit infrastructure focuses on measures that the City has become comfortable with, leaving new innovations aside.

5. Constructing in NYC has its challenges, which leads to higher costs and long delays. Incentives and subsidies are not timed to align well with the permitting process.

6. Co-funding from multiple agencies or the private sector is challenging, leaving behind potential opportunities to leverage private sector expertise or funding.

7. Public entities that control the land where there are opportunities for green are not incentivised to allocate their own budget for either the upfront capital or the increased maintenance costs of green over gray infrastructure. They rely on the DEP to fund and maintain green infrastructure built on the land they control, instead of spreading the responsibility throughout all agencies.

8. Maintenance costs can drive decision-making. Agencies will not plan for what they know they cannot maintain. Further, capital dollars cannot be used for maintenance of green infrastructure, even when maintenance is needed for the system to work as designed. This incentivizes agencies to invest in more expensive capital infrastructure that will require lower maintenance costs.

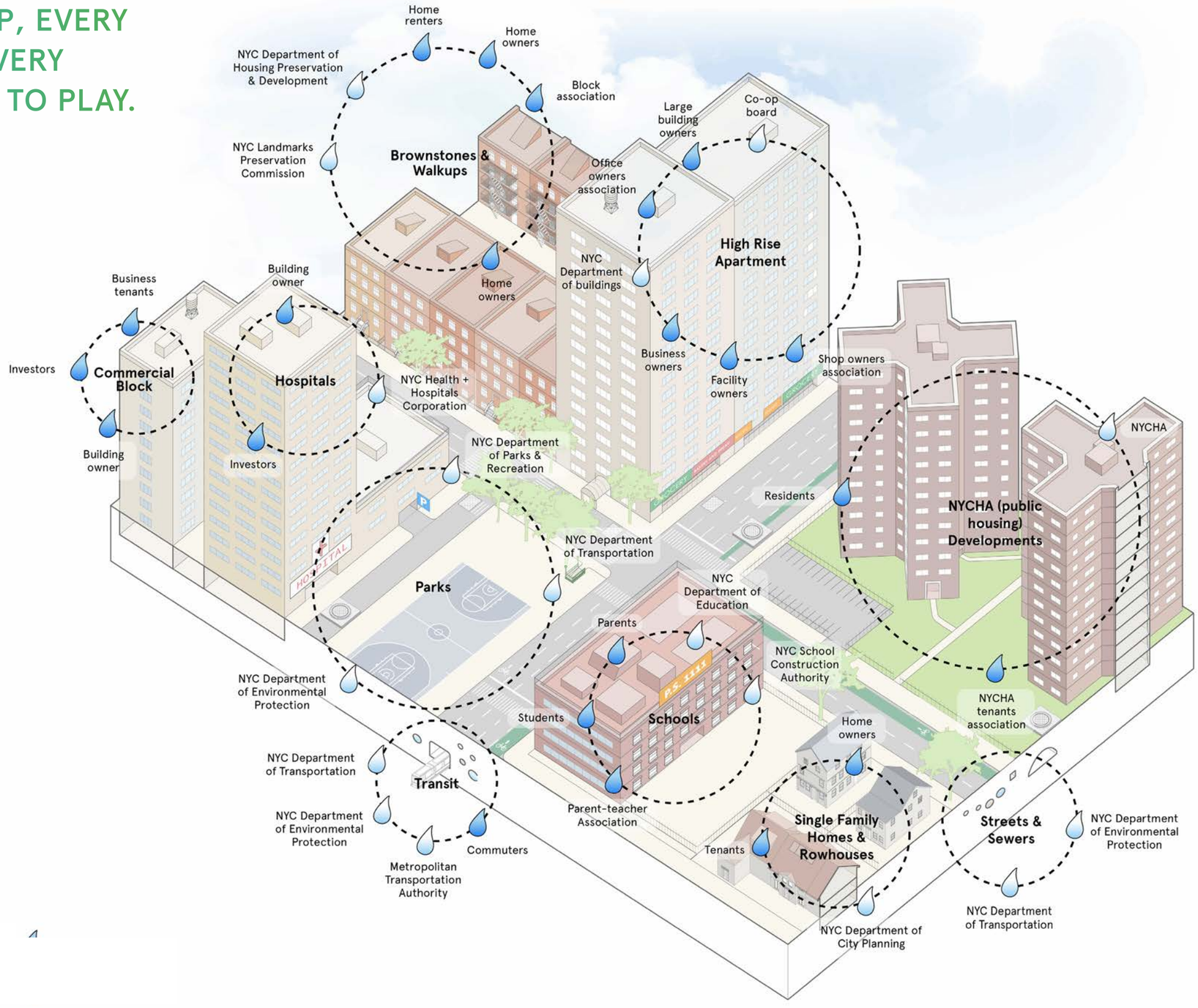
9. The City often assumes that homeowners, community members, or nonprofit partners will take on maintenance, leading to inequity in maintenance and park systems when low-income communities are asked to shoulder an unacceptable financial and labor burden.

10. The public has not been educated on their role in managing increased flooding, and largely does not understand how climate change will affect their neighborhoods. Property owners are also not held financially accountable for the stormwater runoff on their property, leaving the responsibility to managing flooding solely to the City.

11. There is no accessible list of existing data collected, as-built drawings, and/or working models of City infrastructure across all City agencies. When responding to proposals put out by City agencies, consultants and contractors are not always privy to what data/as-builts/models are already available. Consultants could likely recommend add-value scope and services and/or more cost- and time-efficient approaches if they were aware of the information already in-hand.

STAKEHOLDERS

EVERY DROP ADDS UP, EVERY ACTION MATTERS, EVERY PERSON HAS A ROLE TO PLAY.



LIVING WITH WATER

TRANSFORMING THE CONCRETE JUNGLE INTO A SPONGE

As the climate changes, New York City will experience more frequent and more intense rainfall. The standard design criterion in New York City is to use the intensity-duration values based on a storm with a 5-year return period (e.g., 1.75 inches per hour for a one hour storm; 20 percent chance of occurrence in any given year).[11] For the purposes of planning, NYC DEP uses an extreme stormwater flooding scenario that incorporates a 100-year rainfall event (3.5 inches falling in one hour) combined with 4.8 feet of sea level rise. An extreme rainfall event would call for an additional nine billion gallons of water storage. That translates to needing to store the equivalent of the volume of 32 Empire State Buildings across our city.

We must rethink how every piece of the city's infrastructure – both public and private – can adapt to absorb or hold rainwater. By prioritizing green and multi-benefit infrastructure and supplementing with gray infrastructure, we can largely meet the challenge of future expected rainfall with a handful of impactful strategies that will be less expensive and less disruptive than expanding sewers, and will definitely create more benefits for residents. The City already has a robust green infrastructure program that is focused on CSO areas. However, in order to be successful, this program would need to be supported with a robust maintenance plan and expanded to include measures that will help New Yorkers live with water. This will require a major shift from the City's current practices. The City must utilize a comprehensive approach that focuses on detention, reuse, retention, and conveyance of stormwater. To do this successfully, we need a citywide plan that considers the vulnerabilities to increasing heavy rain events in each neighborhood, working with the communities who live there.

Every drop of rain that can be captured and stored, or safely conveyed from where it falls, is one less drop that ends up in the streets, subways, and basements. Instead, this captured water can be reused or "harvested" for other uses, such as watering a garden, washing a car, or flushing the toilet. Just like a sponge, the city could absorb water during extremely wet days that could be reused (or "squeezed") during dry days.

A comprehensive citywide plan will only be successful if every agency prioritizes the use of green infrastructure in every investment. Nature-based infrastructure can hold the water before it adversely affects residents' lives. It also maximizes investments by leveraging the co-benefits of improved public and mental health and enhanced ecologies, all while making NYC a better place to live. DEP's Cloudburst Resiliency Study's benefit-cost analysis found that for every $1 invested in blue-green infrastructure, the City makes $1.8 in return in the local area.[12] Natural solutions could be complemented by gray measures that use subsurface areas to store the water that cannot be detained and safely conveyed elsewhere.

In establishing this plan, we can follow the models of Copenhagen, Amsterdam, Singapore, and Rotterdam which all use innovative approaches: for example, collaborating with the private sector, building aggressive green targets into zoning, and setting a price on gallons of water kept out of the sewer system. New York City can follow suit and create the policy requirements and financial incentives to ensure that public and private spaces are brought to a truly rainproof standard.

The City has already invested and planned for limited green infrastructure in parks, roads, and NYCHA campuses, largely with an eye towards compliance with the Clean Water Act. Those investments are already enhancing lives and livelihoods in New York City; however, they are not enough to help with hazard mitigation in the new climate reality. The City must be an even stronger leader in this effort and comprehensively adapt over the next decade by utilizing a series of regulations, adaptive measures, and incentives to leverage every newly built or rebuilt infrastructure to absorb rainwater. Every time the

Water square in Carlsberg City, Copenhagen, Denmark. During extrememe rainfall events, the square can detain water to reduce the stress on the sewer system and prevent flooding in the surrounding areas. On dry days, the area provides space for recreation, athletics, liesure, and socialization. Source: Ramboll Group

City builds or rebuilds a park, a street, or a building, it must be designed to detain as much rainwater as possible and to link with a rainwater conveyance system, in addition to its primary function. Over time, capturing small drops of rain with every new piece of infrastructure will add up to significant benefits. Additionally, if the city concentrates on scaling measures, such as investing in water squares and absorbent parks that allow certain infrastructure to flood while protecting others, these measures would add up, addressing the entire problem systematically.

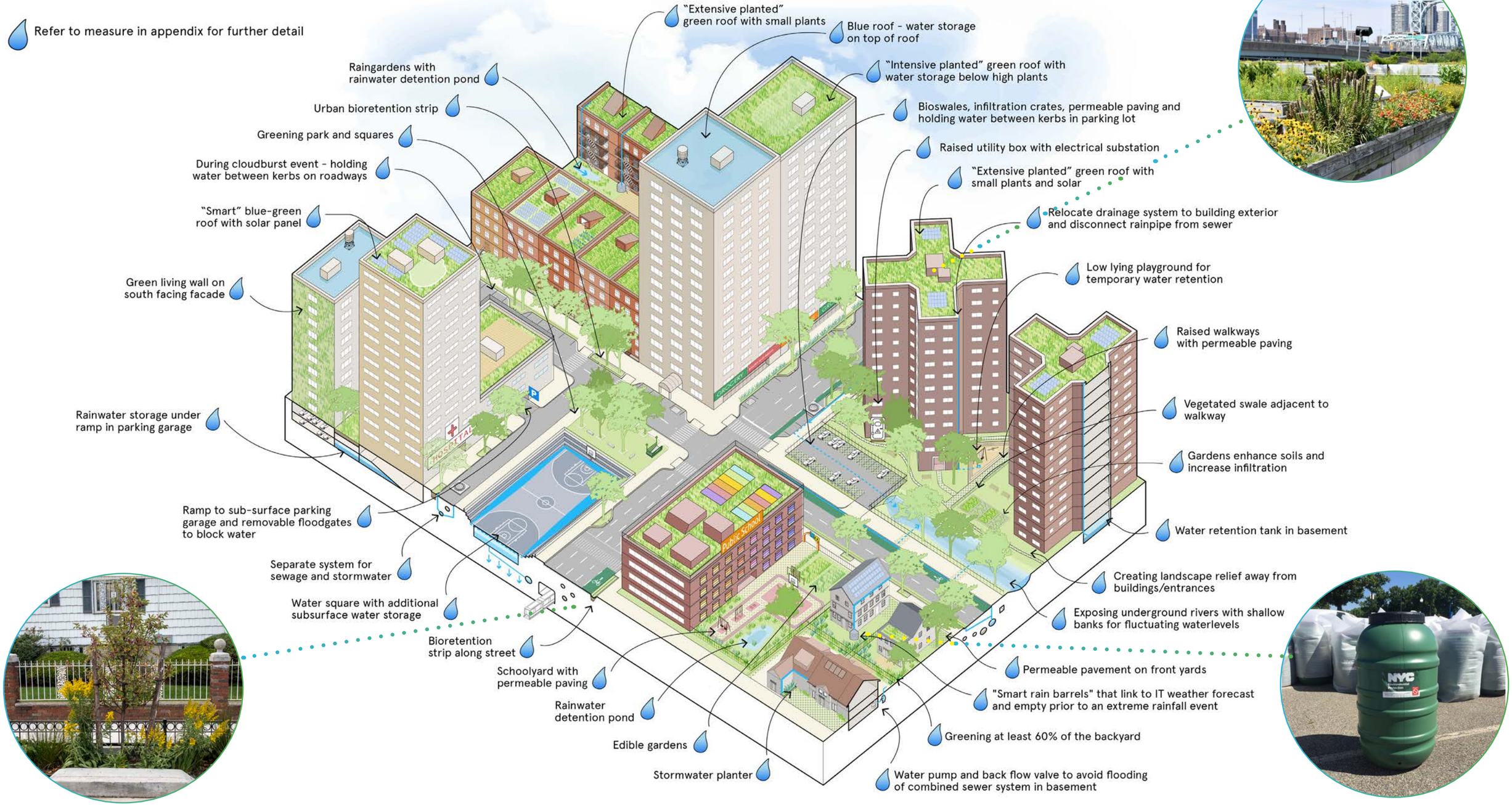
Building on the physical infrastructure, the City can transform the culture around flooding by educating New Yorkers on how to safely live with water. This can include retrofitting existing infrastructure to serve a water detention or conveyance purpose. For instance, the City could design certain streets to be able to flood a few inches and still be safe for cars and emergency vehicles, multiplying their storage capacity. Large big-box parking lots, university campuses, and NYCHA campuses could be designed to hold water from the surrounding neighborhoods. Neighborhood schoolyards and small parks could do double-duty by being available for recreation during dry days, and contain a stormwater flood on wet days. Coupled with an expanded emergency alert system, New Yorkers will understand that these areas are designed to flood and get out of harm's way in advance of storms. By protecting the lives and livelihoods of New Yorkers, these new types of "sponge" infrastructure will over time become a new way of life.

1 START WITH THE MOST SOCIALLY AND PHYSICALLY VULNERABLE COMMUNITIES.

2 CREATE A MASSIVE INVESTMENT IN MULTIBENEFIT "GREEN" AND "BLUE" SOLUTIONS.

3 WHERE WE CANNOT GO FULLY GREEN, PRIORITIZE CO-BENEFIT SOLUTIONS.

TOWARD A RAINPROOF NYC



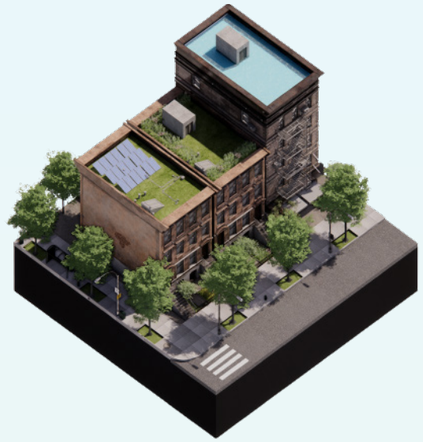
GREEN INFRASTRUCTURE INTERVENTIONS

GREEN & BLUE ROOFS

A Blue Roof temporarily holds a layer of water on the roof.

A Smart Blue-Green Roof with a detention crate under extensive planting connected to the internet will empty prior to a rain event.

Intensive green roof with bigger plants and more soil.



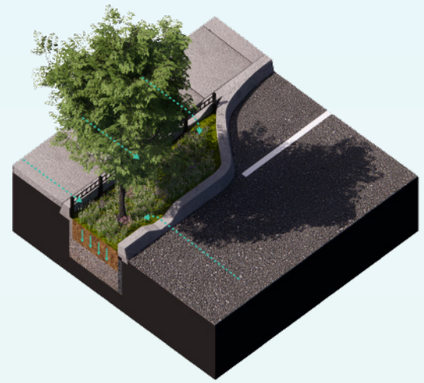
PERMEABLE PAVEMENT

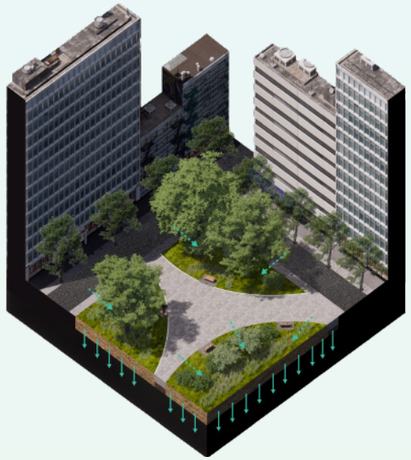
Stormwater infiltrates the ground through permeable pavement in the front yard, driveway, back yard and ROW.

BIORETENTION STRIP

Stormwater run-off from pavement and street is temporarily held in lowered bioretention strip.

Rainwater infiltrates and is detained in gravel zone under the planted area.

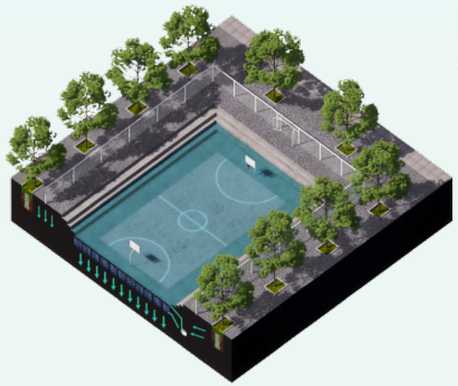




DEPAVING

Add green areas to previously paved squares and pavements.

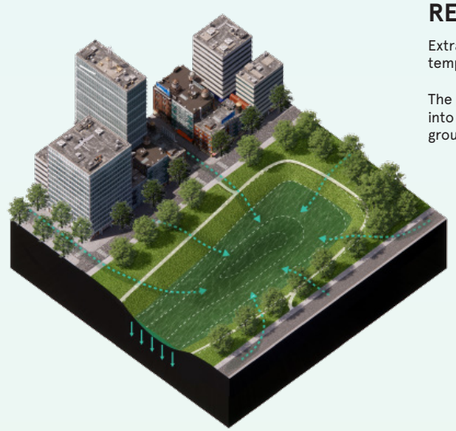
Lowered green areas can temporarily hold stormwater run-off from paved areas.



WATER SQUARE

When sub-surface crates are full, sunken playground fills temporarily with additional stormwater run-off.

Additional infiltration crates.



RETENTION POND

Extra stormwater run-off held temporarily in sunken areas in park.

The pond slowly releases stormwater into the ground for replenishing groundwater.

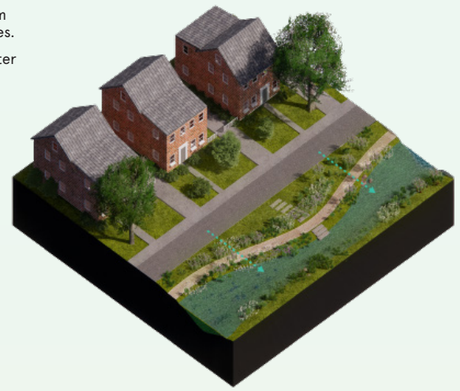
GREEN PARKING LOT

Permeable paving and biorentention strips hold water between curbs during an extreme rain event.

DAYLIGHTING RIVER

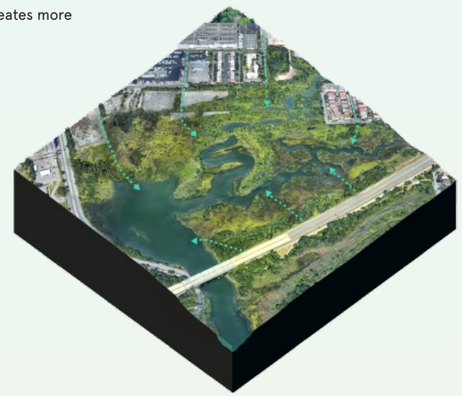
Holds stormwater run-off from adjacent streets and properties.

More space for fluctuating water levels.



WETLAND RESTORATION

Restoring upstream wetlands creates more space for holding stormwater.



INSPIRATION FROM OTHER CITIES

AMSTERDAM RAINPROOF

A citywide initiative that connects and facilitates all public and private actors involved in preparing for heavy rain in all their strategies, policies, and actions, connecting businesses, academics, communities, public servants, and middle-men with each other.

Takeaway: Everyone has a role to play in addressing extreme stormwater flooding. New York City must foster true collaboration between public and private sector stakeholders and appoint people in the City to be responsible for these collaborations. Read more here.

CHINA'S SPONGE CITIES

A multi-billion dollar initiative of the Chinese government to address urban flooding in over 30 cities throughout the country. In the face of exponential urbanization, each city must use natural solutions to reduce the impacts of floods from increasing precipitation.

Takeaway: Retrofitting properties is expensive. Utilizing green in all planning from the start will reduce costs, flooding, heat, carbon emissions, and ultimately, destruction. Read more here.

CLOUDBURST COPENHAGEN

Born in the aftermath of a catastrophic cloudburst event in 2011, this formula is a flexible, universally adaptable model for mitigating increasingly common extreme flood events through Blue-Green solutions that integrate urban planning, traffic, and hydraulic analysis with sound investment strategies to improve the cities' liveability.

Takeaway: By allowing the streets to flood a few inches and educating residents about this measure, the city can shift its approach to safely live with stormwater. Read more here.

SINGAPORE LUSH

The Landscaping for Urban Spaces and High Rises Program (LUSH) requires certain developments to implement green infrastructure in up to 100% of the site's area, by replacing every meter of land that is paved over with vertical greenery and green roofs.

Takeaway: Natural landscapes/surface area can and should be reclaimed in vertical infrastructure. Read more here.

D.C. STORMWATER RETENTION CREDIT

A district-wide green infrastructure program that combines strict regulations with a Stormwater Retention Credit (SRC) trading program to require developers and large private property owners to reduce stormwater runoff through green infrastructure, while creating financial incentives for smaller property owners to implement green infrastructure as well.

Takeaway: Private and commercial development, with the right regulations and economic incentives in place, can become a driver for urban greening and building climate resilience. Read more here.

HOBOKEN NORTHWEST RESILIENCE PARK

A plan focused on creating a framework for green infrastructure on both a citywide and district-by-district basis which is focused on the local needs and future climate predictions, while prioritizing the most critical assets. The park system is designed to manage 1 million gallons of stormwater.

Takeaway: A comprehensive plan must be informed by the typology of the area, soil infiltration types, and the specific vulnerabilities of each neighborhood. Read more here.

PORTLAND WET WEATHER PROGRAM

Since 2002, Portland has been using innovative green infrastructure solutions to capture stormwater runoff as close to the source as possible on private, commercial, and public properties.

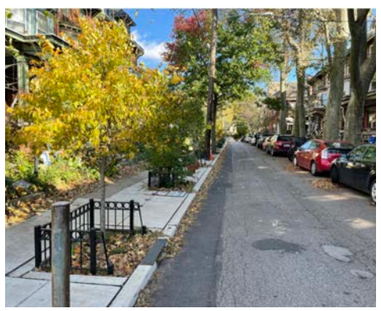
Takeaway: Green infrastructure projects have simultaneously created green spaces for residents, improved traffic issues, and led to reductions in crime.

Read more here.

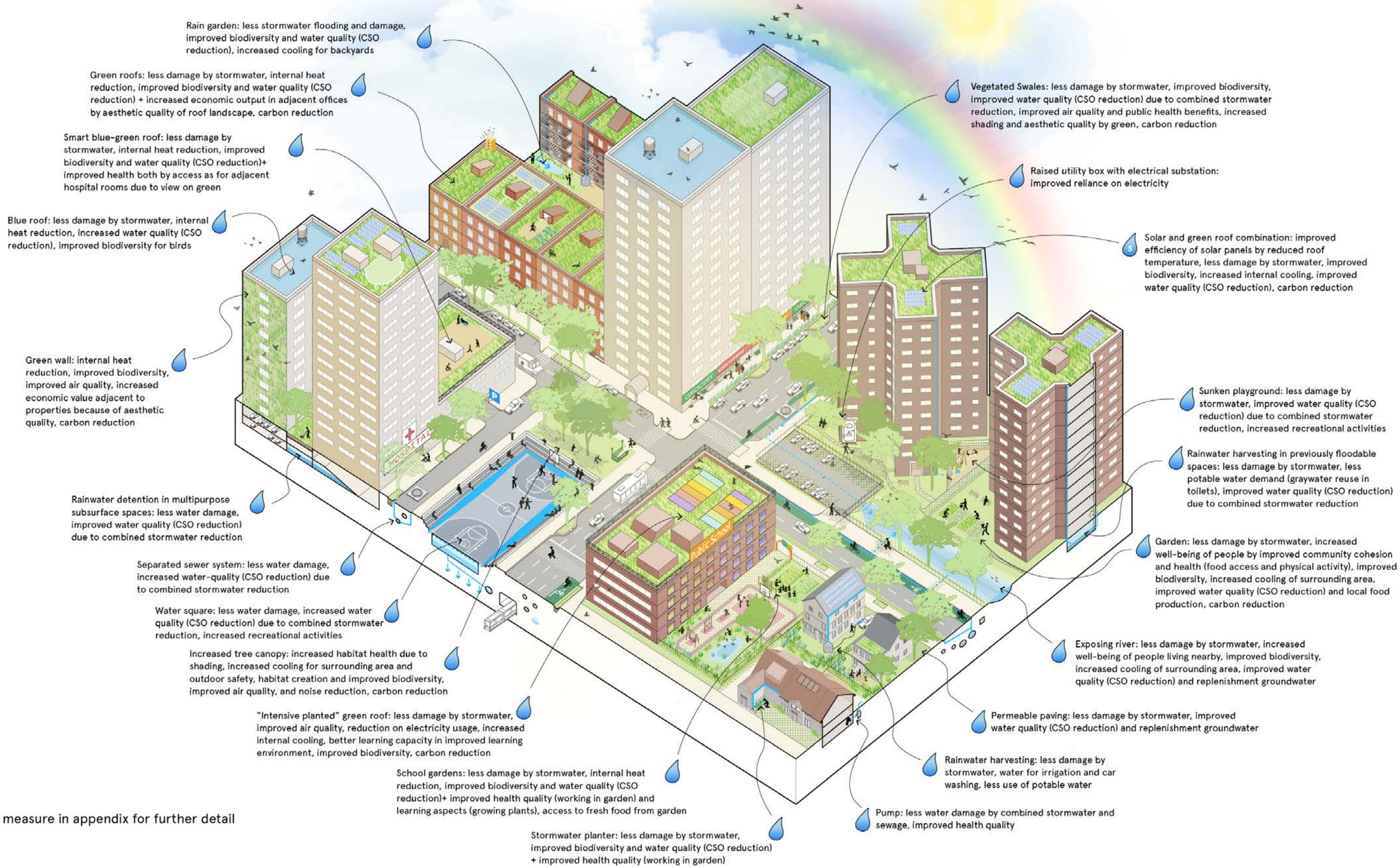
PHILADELPHIA GREEN CITY, CLEAN WATERS

Beginning in 2011, this 25-year citywide program plans to use green infrastructure to capture, store, and slowly release the first inch of rainfall across 10,000 acres, which currently keeps approximately three billion gallons of stormwater runoff and sewer overflow out of the local waterways.

Takeaway: From the outset, the program has been intended to create environmental and social co-benefits, so the challenge of stormwater could be turned into an amenity for communities. Read more here.



THE BENEFITS



Refer to measure in appendix for further detail

THE CO-BENEFITS OF GREEN INFRASTRUCTURE

Prioritizing nature-based solutions will lead to environmental, social, economic, and health benefits in New Yorkers' everyday lives. There is a robust and growing body of literature about the co-benefits of green infrastructure. For years, the World Health Organization[13] has been reviewing the evidence from cities throughout Europe; in the US, the Environmental Protection Agency (EPA)[14] has been tracking, reporting, and recommending the benefits of green infrastructure for communities to use in local planning; in NYC, the DEP's Cloudburst Resilience Study of select neighborhoods demonstrated the types of benefits New Yorkers could experience with even just a few interventions.

ENVIRONMENTAL BENEFITS

Known as "The Concrete Jungle," New York City has paved and paved over what once were marshes, meadows, rivers, and streams. In order to solve the problems of today and the increasing challenges of tomorrow, we have to take a look back and learn to live with nature once again. Reintroducing natural landscapes into the city's fabric can create natural buffers from storm surge[15] and restore habitats for native species,[16] such as bees and other natural pollinators that enable local farmers to grow fresh fruits and vegetables. Simultaneously, natural solutions have the benefit of capturing carbon, which further mitigates global warming, cleans the air, reduces city temperatures, and filters water of pollutants before they reach the waterways and aquatic habitats.[17]

HEALTH BENEFITS

Due to the history of redlining in urban planning practices, many predominantly low-income communities and communities of color in NYC are living in unhealthy environments that make them particularly vulnerable to climate change.[18] Polluting infrastructure, with noxious emissions that cause adverse health effects, are often built in or directly through low-income neighborhoods. This includes highways (such as the Cross Bronx Expressway, the Brooklyn-Queens Expressway, and the FDR Drive), factories, wastewater treatment sites, and landfills. As a result, these neighborhoods, known as Environmental Justice communities, see higher rates of asthma, respiratory infections, and cardiovascular diseases.

Green infrastructure can provide health benefits to all neighborhoods, and should particularly be used to combat the disproportionate health burden of Environmental Justice communities. Cleaner air leads to better respiratory health; green spaces can be used for exercise and recreation, improving physical health; tree canopies reduce the urban heat island effect and provide shade protection during heat waves; converted lots can be used for urban gardens that grow healthful foods; and access to natural areas improves mental health. Collectively, these interventions help communities by reducing hospital visits, lost work days, and mortality rates.[19]

SOCIAL BENEFITS

The COVID-19 pandemic highlighted the importance of social cohesion during times of crisis, and the critical role it plays in a community's ability to recover from a disaster. Utilizing stormwater management measures that can also be designed for recreation and leisure creates spaces for community gatherings and builds social infrastructure among neighbors. Studies also show that well maintained green spaces in a community can lead to a reduction in crime.[20]

ECONOMIC BENEFITS

Natural solutions have short- and long-term financial payoffs that would benefit every New Yorker. At the household level, reducing the urban heat island effect means less reliance on air conditioning and therefore lower energy bills.[21] At the city scale, lowering the city's reliance on air conditioning also reduces the risk of blackouts.[22]

Additionally, most green infrastructure interventions are less expensive to implement than traditional gray infrastructure and reduce the cost of future storms. Investments in green infrastructure can reduce the risk to communities during major flood events and their long-term economic toll, particularly for low-income communitities and communities of color, and should therefore be used to systemic underlying inequities that make these communities more vulnerable to the impacts of a rainstorm.

MITIGATING THE INEQUITABLE IMPACTS OF SEVERE FLOODING

DURING A FLOOD

Low-income communities experience greater challenges evacuating due to the cost of transportation and relocation, placing them at a greater risk of injury, disease, or death.

Residents who do not leave during a storm have increased health risks, such as exposure to contaminated water, interrupted acces to medical care, and difficulty acquiring food.

Low-income and minority populations, as well as elderly nursing home residents are more likely to have chronic health problems, increasing their vulnerabiity to other storm hazards.[23]

AFTER A FLOOD

Ninety percent of smaller companies fail within a year following a disaster, unless they can resume operations within fice days.[24]

A medium-sized natural disaster leads to a 5% increase in the share of people with debt collections after one year, which doubles to 10% after four years.[25]

People in poverty are less likely to have flood insurance or to maintain flood insurance payments.

The Urban Institute has found that after 4 years, a medium-sized disaster has caused an average 31-point decline in credit scores for people living in communities of color, whereas people living in majority white communities experienced a 4-point decline.[26]

FEMA funding largely focuses on homeowners, meanwhile renters typically face rent hikes and mass evictions.

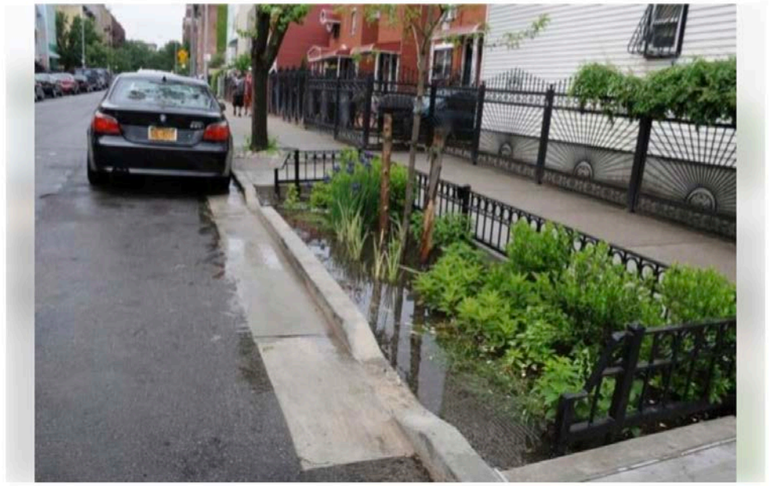
Lower income households may not have the financial and educational resources to advocate for fair buyouts, repair damages, and afford temporary housing.

After federal aid has been distributed to communities that have experienced a disaster, predominantly white, well-educated home-owners experience a significant increase in wealth. Conversely, communities of color, particularly those who are less educated renters, experience a decline in wealth.[27]

QNS

Avella demands opt-out to citywide bioswales program

By Gina Martinez 0 comments Posted on May 7, 2018



State Sen. Tony Avella is calling on the city to grant a full opt-out from the Bioswales program.

A CAUTIONARY TALE: The above headline[28] from in 2018 occurred in response to the City's initiative to install bioswales in a Queens neighborhood. Homeowners were upset to learn that they would be responsible for the maintenance of this infrastructure. In order for any greening to be accepted, at scale, the city needs to 1) meaningully collaborate with the community from the start, 2) educate community members and local businesses on how the infrastructure will directly benefit the community such as as experiencing less flooding, 3) create and fund a robust maintenance program that does not put an unfair burden on homeowners and community organizations, and 4) deploy these strategies in neighborhoods that already flood first to demonstrate their effectiveness citywide.

EVERY ACTION ADDS UP

The New York City stormwater management system is already enormous, and the City has been working hard to expand it; however, with climate change, the current plans will not yet address the expected increases in heavy rain.

In addition to prioritizing green infrastructure and expanding existing programs, creating smart changes to existing infrastructure will enable us – the City, residents, and business owners – to manage a future with more frequent extreme rainstorms. These changes will reduce the need to expand sewer capacity, save money, and create fewer disruptions for New Yorkers. Capturing water on retrofitted infrastructure may mean that the infrastructure's primary purpose is temporarily interrupted from time to time, while it plays its role in storing water and protecting surrounding infrastructure during major storms. For example, during a rainstorm a parking lot would store a few inches of water to reduce the amount of water going into the sewer. As the storm clears, the water is conveyed to the sewers to drain, returning the infrastructure to its primary function. Over time, New Yorkers will learn to live with water, and develop new practices to continue with their daily lives, even during high-intensity storms.

Rebuild by Design and One Architecture consulted with experts from New York and around the world to develop a rough calculation as to how New York City could leverage green, multi-benefit, and multi-purpose infrastructure to supplement the existing stormwater management system to address a substantial portion, if not all, of the city's needs. Though every neighborhood will require a unique approach informed by its existing infrastructure, typology, and built environment, this illustrative "back-of-the-envelope" approach shows that capturing 8.9 billion gallons or ~32 Empire State Buildings of water is not as daunting as it sounds – it is within reach.

A combination of various programs and projects, such as the list below, demonstrates how every measure has a role to play in bringing the City closer to its goal. This list is only a selection of possibilities for green and multi-benefit infrastructure, as there are many more (see p. 30). The calculation does not include all of the programs and measures that DEP has already put in place, such as 10,000 designed green infrastructure assets that are already on streets, NYCHA campuses, parks, or the incentives for private action, detention rules for new development, and the expanding of the blue belts in Staten Island.

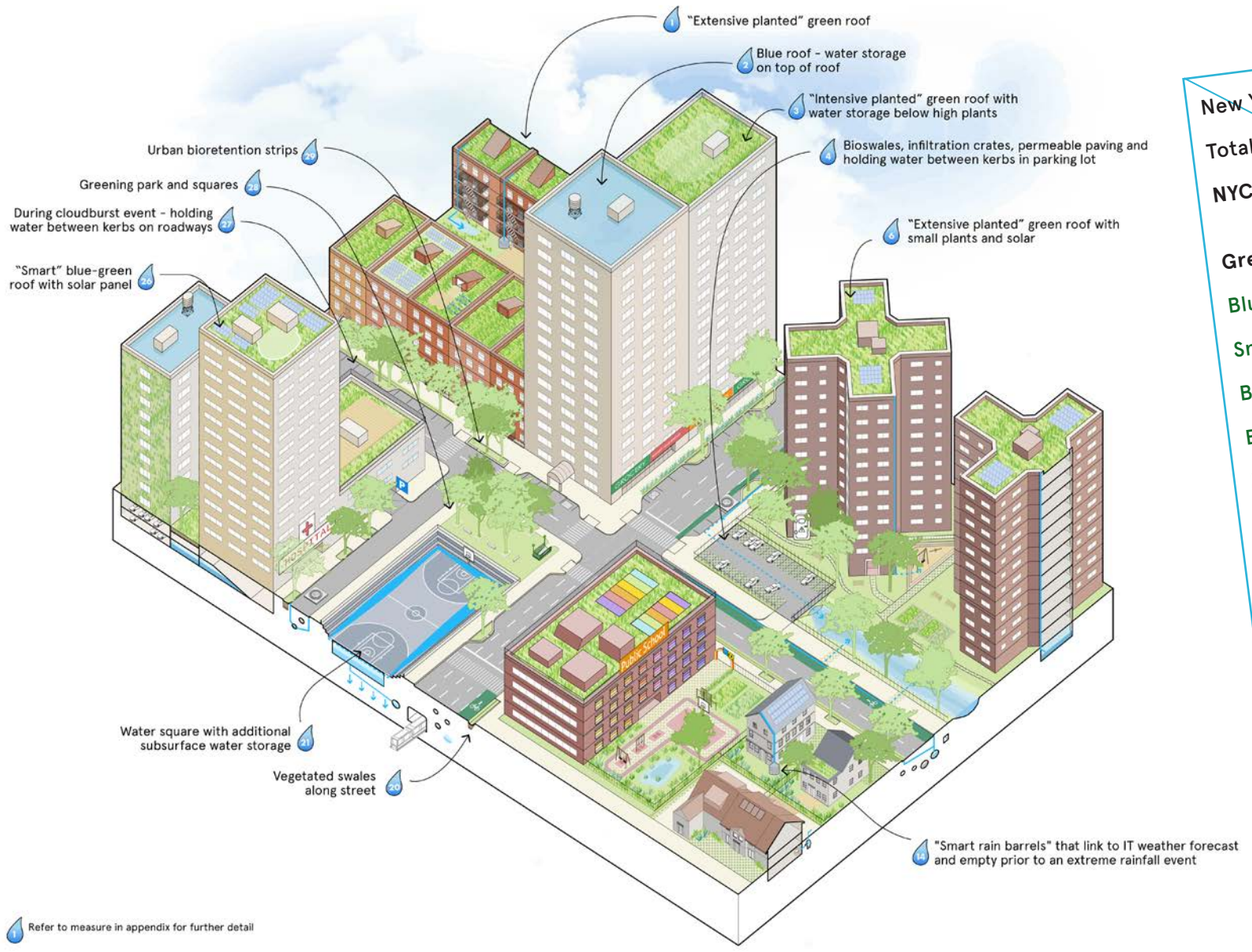
There are many more measures that could add to this approach, such as daylighting rivers and investing in our natural areas like wetlands, depaving school yards, and using the medians on streets to detain water. If stormwater flood infrastructure is prioritized across agencies, it is quite possible that the City could hold 100 percent of a predicted heavy rainfall, without expanding the sewer system in most neighborhoods.

"GOING FORWARD, EQUITY AND HEALTH WILL NOT JUST BE CO-BENEFITS OF OUR INVESTMENTS, THEY WILL BE THE NORTH STAR THAT GUIDES THIS ADMINISTRATION'S CLIMATE PORTFOLIO."

– KIZZY CHARLES-GUZMAN, DIRECTOR OF THE MAYOR'S OFFICE OF CLIMATE AND ENVIRONMENTAL JUSTICE, CITY OF NEW YORK

JANUARY 31, 2022 REMARKS AT NYC MAYOR'S PRESS CONFERENCE

LEVERAGING A SYSTEMS APPROACH TO MEET THE CHALLENGE



New York City design storm (DEP) - total rain	3.5 inches/hour
Total sewer capacity = 1.75 inches/hour; so, the design storm target for multi-benefit infrastructure	1.75 inches/hour
NYC target for multi-benefit infrastructure capcity (land area - wetlands - lakes = 188,647.45 acres)	8.9 billion gallons
Green Infrastructure potential contributions (not all options for GI are included):	
Blue-Green Roofs on existing large buildings	2.5% of total
Smart rain barrels for all single-family houses	0.5%
Bioswales on roads	7-9%
Bioswales on all parking lots	3-4%
Playing fields with granular layers	7%
Playing fields with water storage tanks	0.5-12%
Parks with double the storage capacity	22%
Plus, learning to live with water during a storm:	28%
All ramaining roads - 4 inches of rain detained between curbs	7%
All parking lots - 4 inches of rain detained onsite	77-95%
TOTAL RAIN IN MULTI-BENEFIT INFRASTRUCTURE IN NEW YORK CITY	

The back of the envelope calculations (p. 43) represent one way that New York City can use green infrastructure to address increasing rainfall while leveraging the other benefits. However, the typology of each neighborhood, among many other factors, would determine the unique approach needed to meet the demand for increased capacity to handle heavy rain in the area. By implementing many of the same approaches that DEP already uses on a systems scale, we can reach a citywide goal of managing the majority - if not all - of predicted rainfall with green or multi-benefit measures. An example of this approach would include:

- Utilizing half of the roof footprint of existing large buildings to install blue or green roofs that hold rain where it falls.
- Distributing 55 gallon rain barrels to every single-family homeowner and create an alert system for homeowners to empty their rain barrels ahead of a storm. Homeowners can reuse the water to water their plants or wash their car.
- Return 25 percent of reclaimed roadways under the Livable Roads program to pedestrian, cycling, and stormwater uses. Expanding DEP's bioswale program to dedicate 25 percent of the City's roadways for nature-based solutions, which would also enhance livability across communities. Fund local neighborhood organizations to ensure the investment will work as designed.
- Reimagine 10 percent of parking lots (including public lots and big box stores) for bioswales, use the other 90 percent to hold water between the curbs, allowing the parking lot to flood a few inches during a storm.
- Retrofitting all sports fields with gravel beds that can store 8 inches of water and reimagine one third with water squares, detaining 1-3 feet of rain storage in newly designed basketball courts such as in the Netherlands, a soccer field in Denmark (see page 29), and other active recreation spaces like those in Hoboken.
- Doubling the storage capacity of every City park to ensure they are able to hold every drop of stormwater that falls on the park itself, plus an equal amount of water from the neighborhoods adjacent to the park.
- Learn to live with water by using our roadways to hold 4 inches of stormwater between curbs during an extreme rain event, still enabling emergency vehicles to travel safely, and by conveying stormwater away from buildings and homes.

RISING TO THE CHALLENGE

With the destruction and needless death it left in its wake, Hurricane Ida gave New York City a clear warning of what we should expect with climate change. We now have the experience to know that unless we massively change course, more lives will be lost to extreme stormwater flooding. It is time to put New York City on a path toward equitable adaptation and to not let one single more death occur from lack of planning for a challenge we know is coming.

Further, our process for adapting is just as important as the kinds of infrastructure choices we make. New York City must invite communities to co-lead the planning process from the start, and work with homeowners and renters, property owners and managers, to take into consideration their budgets and needs, because New York City will not become rainproof without everyone doing their part. Additionally, the City must transform the way it plans and budgets to ensure that every single investment made is one that will also address extreme flooding events. The following specific measures will put New York City on a path toward becoming a sponge.

LEADERSHIP

1 Make rainproof the new standard. Climate change is here and New York can lead the way. Starting today, New York must take flood reduction measures into account in all public and private investments to manage 100 percent of current and projected future rainfall to transform NYC into a sponge.

2 Choose green and multi-benefit infrastructure over gray every time. Create better decision-making frameworks to prioritize projects that maximize co-benefits, such as using nature-based infrastructure to leverage opportunities for cleaner air, better mental and physical health, enhanced ecology, carbon capture, and good jobs.

3 Educate the public on multi-hazard risk by publishing maps of the compounded effects of storm surge, cloud burst events, and sea level rise that are also used to guide all City investments. Use the language "live with water" so the public understands that NY will flood, and that the overarching goal is to manage the flooding.

CENTERING COMMUNITIES

A citywide comprehensive plan must be centered on equity. The City has released maps of all environmental justice areas in New York, meaning areas that are "low-income or minority communities."[29] Environmental justice areas should be prioritized for the implementation of multi-benefit approaches. These investments should be accompanied by deep collaboration with the community to better understand how the infrastructure could serve multiple needs in the neighborhood, to ensure that infrastructure improvements do not lead to displacement of communities, and to guarantee that local community members are trained and prioritized for jobs that are created by the installation and maintenance of these investments. Community engagement must go beyond listening; community groups need to be given decision making power when it comes to how money is used.[30]

4 Help the people who need help the most first. Develop a systematic approach to rainproofing the city that prioritizes the most physically and socially vulnerable New Yorkers first. Communicate that plan with the public so it is understood.

5 Collaborate with intermediaries to maximize impact. Learn from Amsterdam Rainproof by working with all private stakeholders--gardeners, roof layers, landscapers, big box retail stores, architects, engineers, contractors, developers, and insurance companies- to educate private owners on their role in executing on the City's new goals and mandates.

6 Articulate achievable targets for detaining and retaining floodwaters. Annually report on the City's progress toward managing 100 percent of rainfall, using up-to-date climate predictions.

BETTER PLANNING

7 Put communities at the center of the design process. Work with community leaders to identify the location of flood prevention measures and creatively tackle maintenance challenges.

8 Use every piece of New York City property to delay and store rainwater. NYC owns over 362 million square feet and nearly 5,000 parcels of land and buildings. All streets, public spaces, and buildings need to be part of a system of green and multi-benefit infrastructure measures for detention, reuse, and conveyance systems to safely drain to the sewers. Update design guidelines for each capital agency to be inclusive of the City's new stormwater goals.

9 Learn to live with water we cannot absorb. Existing infrastructure with modifications, such as roadways or parking lots, can hold a few inches of rain safely. By planning comprehensively, we can detain water in our parks, streets and other infrastructure during extreme events and steer floodwaters away from homes and critical infrastructure.

10 Embrace large-scale measures such as blue-belts, daylighting rivers, detention ponds, and wetlands restoration. In addition to daylighting Tibbetts Brook, the City should do an analysis of all former locations that held water and determine which locations would contribute the largest impact of flood reduction if returned to their natural state.

11 Move homeowners to safer places. We will not be able to protect everyone. NYC needs to institutionalize buying out properties to help homeowners and renters move to areas that will flood less. Ensure that the influx of new residents will not further strain the housing market or push up rents for the existing community.

12 Leverage incentives to help private property owners implement rainproofing measures. To complement the green roof tax credit, create funding opportunities for those who have financial barriers to implementation. When homeowners change their garden, roof, or yard, provide education and incentives for them to retrofit those spaces to detain rainwater and reuse or infiltrate to the ground.

13 Create a central depository of as-built plans and working models of City infrastructure across City Agencies so future plans will be informed by that knowledge.

14 Create a robust education program. Use the City's deep reach to educate homeowners, large property owners, building trades, contractors, and big box retailers about the opportunities of rainproofing, so that every private investment contributes to a rainproof NYC.

GOVERNANCE

15 Plan collaboratively with every City agency. Break down the silos of budgeting and planning among agencies and create a unified method for investing in cross-cutting solutions that help New Yorkers. Hold every agency accountable in doing their part.

16 Appoint an entity within the City government to be responsible for meeting the City's overall flood risk, rain, and storm surge reduction targets. Appoint a single person or agency, a department, or person that has the policy and budgetary oversight to be accountable to work with each agency, create the overall plan, and lead the City in its flood management goals. Without a designated entity and budget, this problem will not be fixed.

BUDGET

17 Accept and plan for the new reality. Substantially increase the budget for green infrastructure maintenance in this year's capital plan, and plan to support escalating costs in future years.

18 Modify the stormwater fee model, placing accountability on properties with the most runoff. Use a carrot and stick method that encourages building owners to reuse captured stormwater for greywater purposes and implement a stormwater charge for what they cannot detain.

19 Regulate and incentivize the private market and developers to implement green infrastructure. Look to examples such as Washington D.C. to establish a stormwater credit trading program that incentivizes private developers and homeowners to either implement or pay for green infrastructure, while enabling the city to prioritize the most vulnerable areas. Use incentives such as accelerated permitting to expedite the implementation of green infrastructure.

20 Place a "price" on water kept out of the NYC stormwater sewer. Every inch of rainwater kept out of the system saves the City money by not having to expand the system. Let's follow the City of Rotterdam's success by paying other entities with large footprints, such as universities and hospitals, to go above and beyond their own stormwater responsibilities by detaining water from adjacent properties.

21 Create a workforce that is ready to support a full rainproof of NYC. Invest in job training programs by supporting organizations such as Green City Force, the Bronx River Alliance, Gowanus Canal Conservancy, the HOPE Program, and the Newtown Creek Alliance. Work with union-adjacent programs to support a pipeline of trained workers through the Apprenticeship Readiness Collective that places women, veterans, formerly homeless, and those living in low income communities into career pathways.

22 Dedicate resources to fund neighborhood organizations and schools to maintain nature-based infrastructure so it can be utilized at its fullest capacity.

WE CAN GET TO A RAINPROOF NEW YORK CITY, BUT WE CANNOT REACH A GOAL WE HAVE NOT SET.

LET'S LEAD THE WAY, NEW YORK CITY.

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