YONKERS, NEW YORK

THE NEW SCHOOL URBAN SYSTEMS LAB

THE KRESGE FOUNDATION

GROUNDWORK Hudson Valley

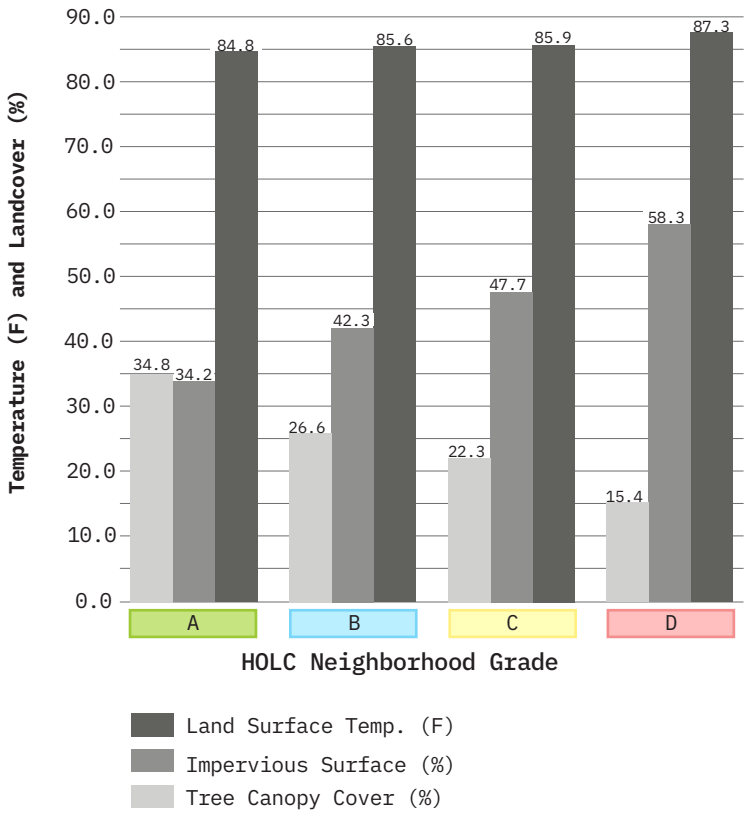
THE ENVIRONMENTAL JUSTICE OF URBAN FLOOD RISK AND GREEN INFRASTRUCTURE SOLUTIONS

This project aims to better understand the environmental justice considerations of climate change related to urban flooding in vulnerable communities across 4 U.S. cities. This factsheet summarizes key takeaways for the city of Yonkers, NY. Click here to access the project's website, and the results obtained in other cities. This project is co-led by the Urban Systems Lab Research Fellow Pablo Herreros Cantis and Director Timon McPhearson with support from the Kresge Crews Program and in collaboration with Groundworks Hudson Valley.

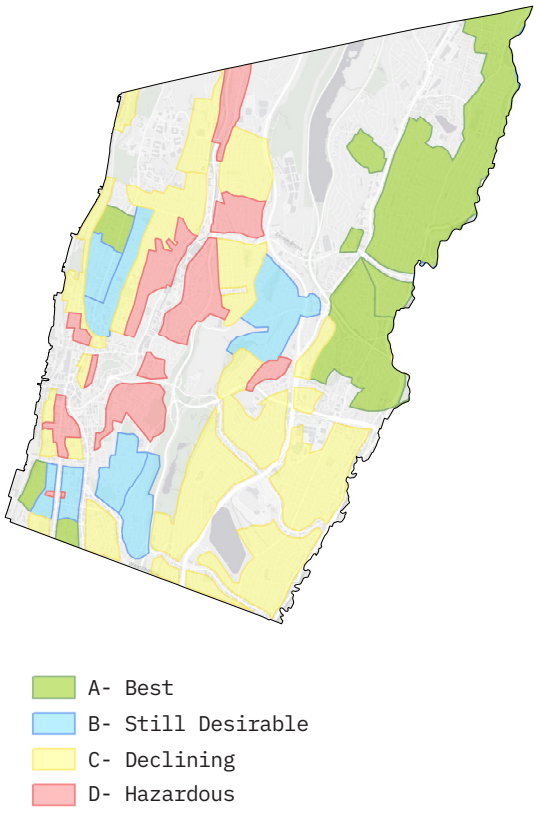
THE CLIMATE SAFE NEIGHBORHOODS PARTNERSHIP

In Yonkers, the Urban Systems Lab partnered with Groundwork Hudson Valley to support the Climate Safe Neighborhoods (CSN) partnership, which focuses on linking the legacy of segregation in American cities with the disproportionate impacts that climate change and extreme weather events have on low-income and minority populations. To do this, the CSN partnership relies on spatial data to analyze the environmental injustices linked to the unequal exposure to heat and flooding suffered by vulnerable communities. As part of the initiative, this story map was published to illustrate and communicate the overlap between heat, impervious surfaces, and green spaces with the Yonkers' former redlined neighborhoods. In addition, this interactive dashboard allows users to explore the data presented in the story map more closely.

Environmental Risk Factors by HOLC Neighborhood Grade in Yonkers, NY



HOLC Neighborhood Grade in Yonkers, NY



Land Surface Temperature and Impervious Surface increase as HOLC neighborhood grade decreases, while Tree Canopy Cover increases with neighborhood grade.
(Source: Groundwork Hudson Valley Climate Safe Neighborhoods Storymap)

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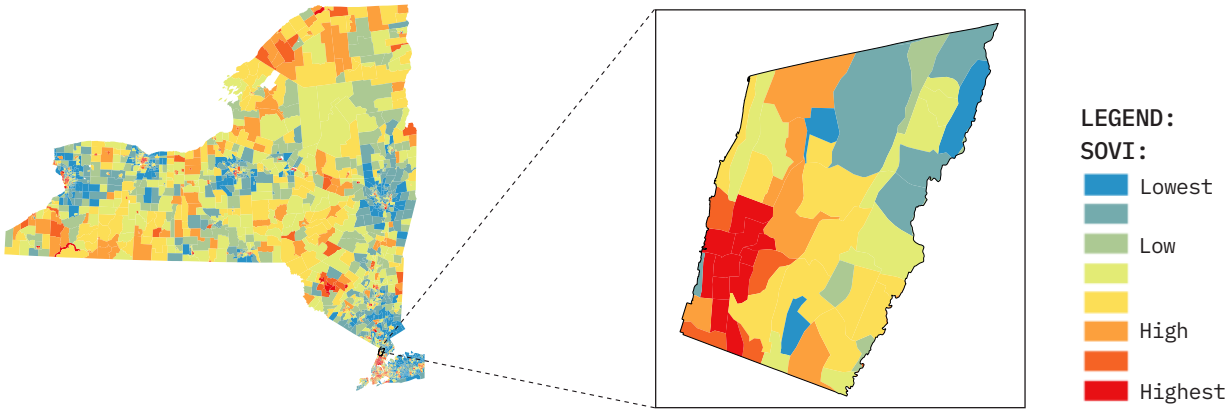
Regarding flood risk, the City of Yonkers, known to be the second hilliest city in the US after San Francisco, suffers from recurrent fluvial and pluvial flooding due to extreme precipitation along the four streams which traverse the city and low-lying areas. Such flood events cause damage to residential properties and public utilities. In addition, unmanaged slopeside runoff creates a risk of mudslides. In 2015, a mudslide caused by heavy rainfall forced more than a 100 senior citizens living in municipal housing to permanently relocate, after the property they lived in was severely damaged. Throughout the years the City of Yonkers, together with the Army Corps of Engineers, implemented several flood mitigation projects along the Saw Mill River and the Bronx River, but similar efforts to mitigate pluvial flooding were never made. Only recently, the Municipal Housing Authority for the City of Yonkers, together with Groundwork Hudson Valley, has developed a Green Infrastructure Feasibility Study to reduce flood risk at some of its most vulnerable properties.

DEMOGRAPHICS

NY Social Vulnerability Index

Yonkers Social Vulnerability Index



Total Area: 12.3 mi²
Total Population: 594,833
18.5% Black
59.5% Latinx
2.0% Asian
0.006% Indigenous
0.02% Islander
18.1% White
Median Household Income: $47130
18.2% Below Poverty
6.9% w/ a Disability
21.9% W/o Health Insurance
33984 Buildings
478.6 Miles of Road (3.2 mi²)*

* Road lengths were calculated using the TIGER/LINE data for roads in USA. Road areas were calculated using Yonkers' parcel land use data, which excludes large expressways and highways.

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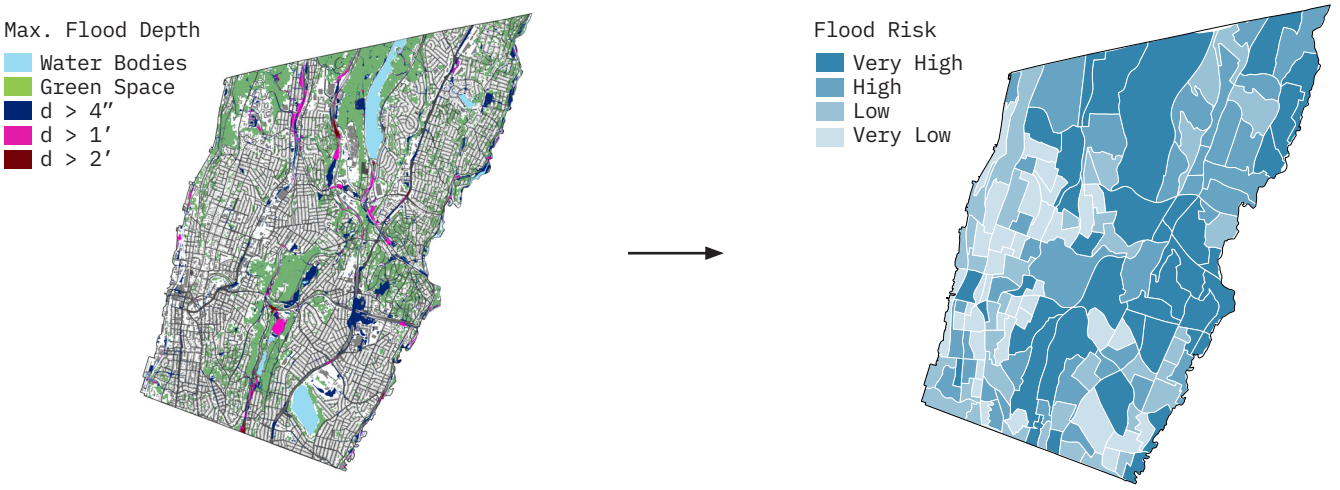
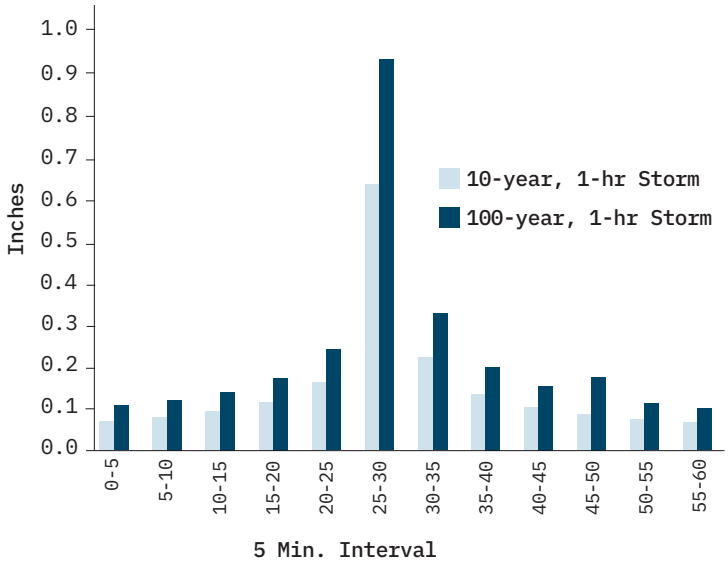
BASELINE FLOODING RESULTS

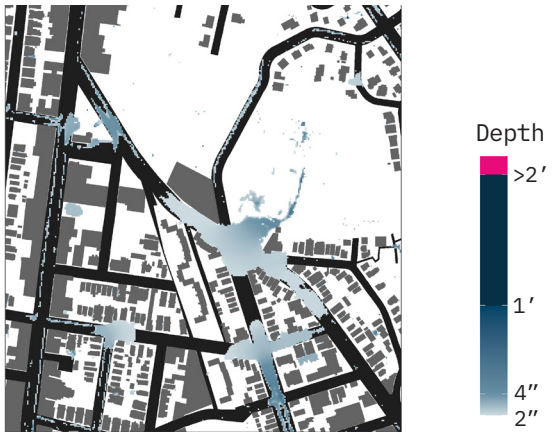
Aggregating Results to the Census Block Group Level





10 yr. storm - McLean Ave, Yonkers

100 yr. storm - McLean Ave, Yonkers



	10 yr. storm	100 yr. storm
Total Area Flooded > 4″	0.99mi²	1.29mi²
Road Area Flooded > 4″ *	0.19mi²	0.4mi²
Total Area Flooded > 1′	0.15mi²	0.27mi²
Buildings Flooded > 4″	2181	2965
Residential Prop. Flooded > 4″	2654	3530

* this area corresponds to roads owned and managed by the municipality, excluding state-owned highways

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RESEARCH QUESTION AND METHODOLOGY

In the city of Yonkers, we focused on identifying locations within or close to the CSN neighborhoods of interest (Getty Square, Old 7th Ward and Radford) that experience flooding according to the 10 and 100 year, 1-hour baseline simulations. We then proceeded to incorporate changes in the model that represent interventions that could be used to mitigate flood risk. We then assessed the impact of intervening in these specific locations by re-running the 10 and 100 year storms in the model after adding the interventions to the input data. In the takeaways below, we present the results obtained in the four intervention sites identified.

The results presented in this brief report aim to identify locations that may be prone to flooding due to the accumulation of water in sinks and low-lying areas. The water accumulations identified may also represent locations in which the drainage infrastructure receives a higher load of runoff, posing higher risk of sewer backup. However, it is important to highlight that, due to data and computational limitations, the drainage infrastructure was not considered in the modeling. Hence, while the results obtained in this study are useful to identify potential areas at risk and intervention locations, they should not be considered a final, comprehensive mapping of the distribution of flood risk and the viability of specific interventions. Further modeling, validation and collaboration with the local planning and engineering offices is needed to improve the validity of the results obtained. Therefore, these results should not replace future design and engineering work. For more details about our methodology and the results of other cities, visit the project's website or contact us at urbansystemslab@newschool.edu.

WHY URBAN FLOODING AND SEWERS MATTER IN YONKERS

The city of Yonkers has two different kinds of sewer systems. In the majority of the city's area, a separate stormwater system discharges surface runoff into nearby water bodies. The Southwest area of Yonkers, however, presents a combined sewer system, through which both stormwater and domestic wastewater are transported to a wastewater treatment plant. In the event of moderate to high precipitation, combined sewer systems may receive more water than they are able to carry to the treatment plant. In these cases, a proportion of the mix of untreated wastewater and stormwater carried in the sewer system is redirected and discharged directly into water bodies, such as the Hudson River in the Yonkers case. This process is known as combined sewer overflow (CSO), and causes negative impacts in natural ecosystems and public health by deteriorating water quality and exposing people to diseases. In extreme cases, sewer backups may cause urban flooding with untreated wastewater.

As observed in these maps, the areas of Yonkers that have a combined sewer and are hence exposed to the negative public health conditions that CSOs may cause also include the most vulnerable neighborhoods of the city. These areas include some of the city's formerly redlined communities, such as the CSN neighborhoods of interest Getty Square, Old 7th Ward, and Radford.

In the results presented below, we focus on 4 locations of interest that were identified during the project.

```
Resolution of the simulation: 2m
Computed infiltration in Green Areas: Yes
Accounted for buildings: Yes
Accounted for soil textures: Yes
Accounted for the performance of the drainage
system: No
```

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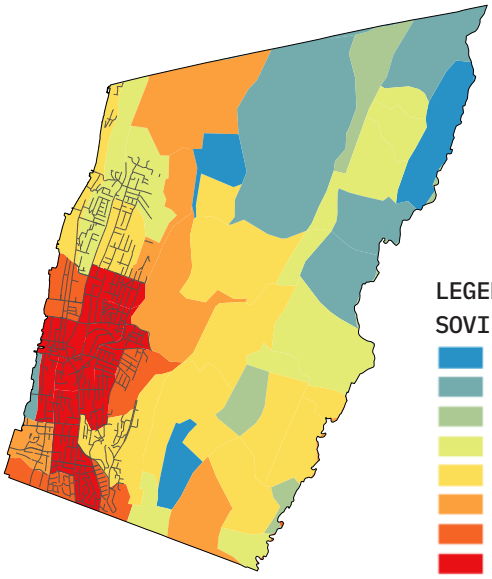
Yonkers Social Vulnerability Index (SOVI) w/ Combined Sewer System

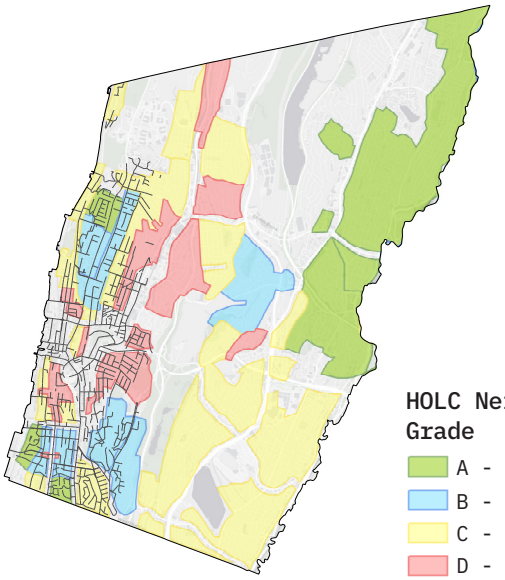


LEGEND:

SOVI:

- Lowest
- Low
- High
- Highest

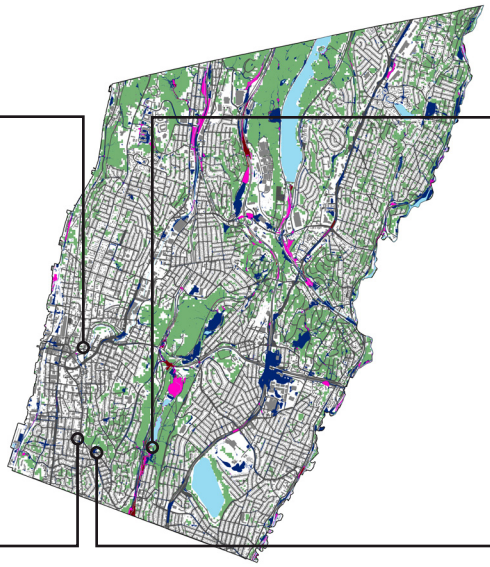
Yonkers HOLC Neighborhood Grade w/ Combined Sewer System



HOLC Neighborhood Grade

- A - Best
- B - Still Desirable
- C - Declining
- D - Hazardous

Yonkers Flood Depth and Intervention Sites



Chicken Island

Tibbets Brook

Lincoln Memorial Park

Pelton Oval Park

Max. Flood Depth

- Water Bodies
- Green Space
- d > 4″
- d > 1′
- d > 2′

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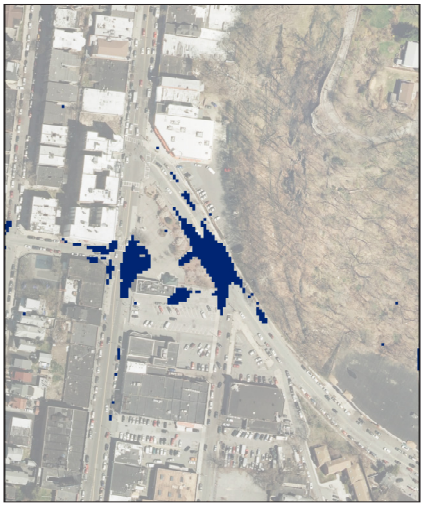
SITE 1: LINCOLN MEMORIAL PARK

The results show flooding in McLean Ave. According to the model, this is caused by a blockage due to the park's vegetation being raised and surrounded by a concrete border.

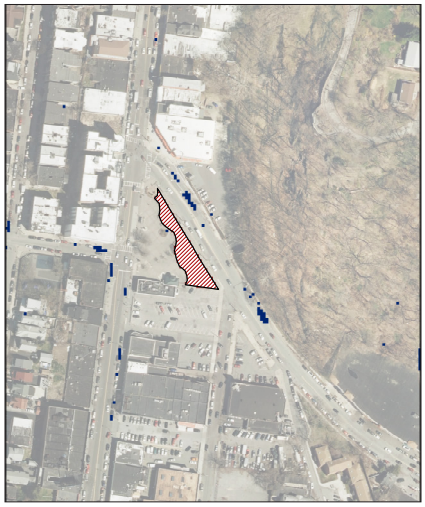
As an intervention, we explored the impact of replacing the raised vegetation by a structure capable of accumulating incoming runoff (e.g. a water tank under the park, or a rain garden). The structure's capacity was ~650,000 gallons. In both of the storms considered (10 and 100 years, 1-hour), the structure did not fill to capacity, but filled up to 83% in the 100-years storm.

For both storms, the intervention considered results in a remarkable reduction in the maximum depth reached at McLean Ave, illustrating the positive impact that developing green infrastructure in this location could have on the (combined) drainage system and potentially reducing flood risk.

Baseline 10 yr Flood:
No Intervention



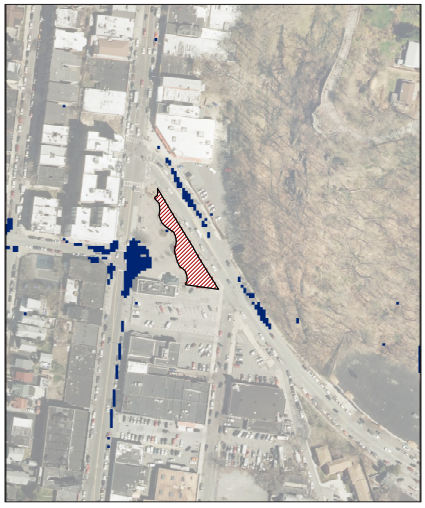
Baseline 10 yr Flood:
With Intervention



Baseline 10 yr Flood:
With Flood Depth Difference

Baseline 100 yr Flood:
No Intervention

Baseline 100 yr Flood:
With Intervention



Baseline 100 yr Flood:
With Flood Depth Difference

Flood Depth More Than 4″
Flood Depth More Than 1′
Flood Depth More Than 2′

Flood Depth Highly Reduced (more than 12″)
Flood Depth Moderately Reduced (between 4″ and 12″)
Intervention Boundary

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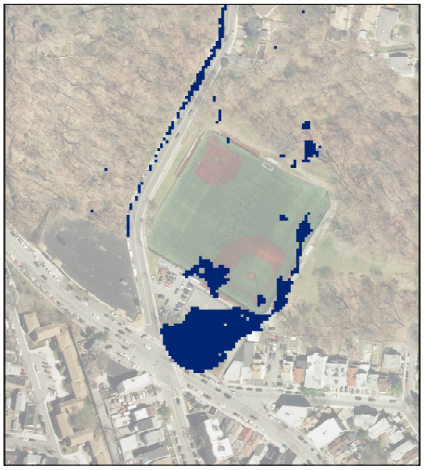
SITE 2: PELTON OVAL PARK

The results show flooding in McLean Ave and Van Cortlandt Park Ave. According to the model, this location receives water from several locations, including the extensive hill located behind Pelton Oval Park and the neighborhoods at its top.

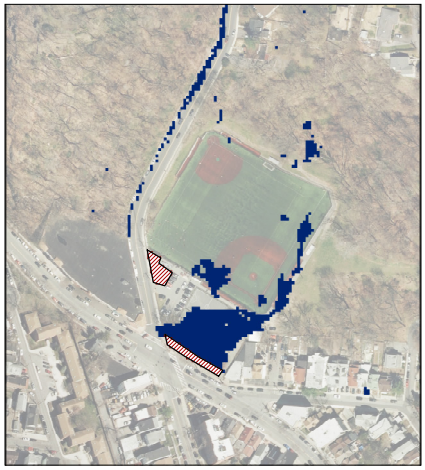
As an intervention, we explored the impact of replacing some of the green spaces in the location by a structure capable of accumulating incoming runoff (e.g. a water tank under the park, or a rain garden). The total capacity of both structures was ~365,000 gallons. In both of the storms considered (10 and 100 years, 1-hour), the structure located closer to McLean Ave filled to capacity, while the structure located closer to Van Cortlandt Ave filled to capacity in the 100 years storm.

For both storms, the impacts of the interventions considered are not clear. No remarkable reduction in the maximum depth is reached. Even though the updated flood risk map shows that the area flooded with a depth higher than 10" is reduced, the actual reduction in depth is quite low, and the new flood depths in the areas benefited is still high (~8-9.5"). These results highlight the need to continue working on the modeling, exploring new intervention configurations, and assessing the occurrence of flooding in real life events.

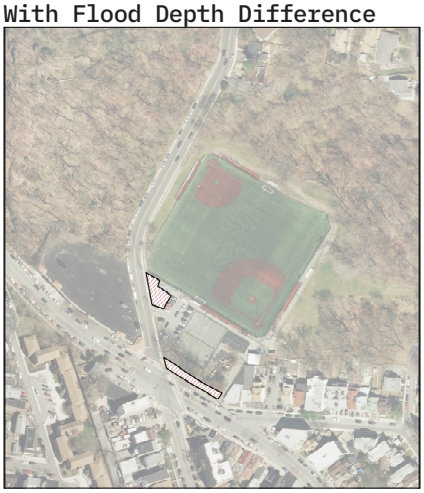
Baseline 10 yr Flood:
No Intervention



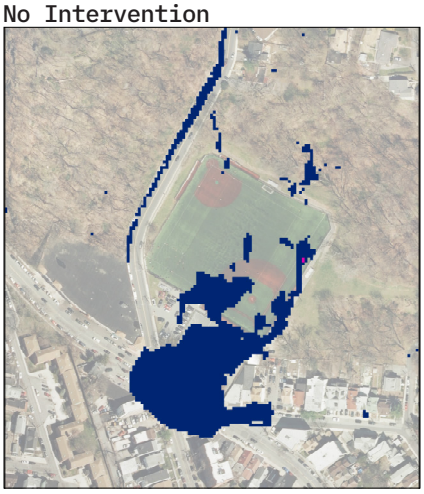
Baseline 10 yr Flood:
With Intervention



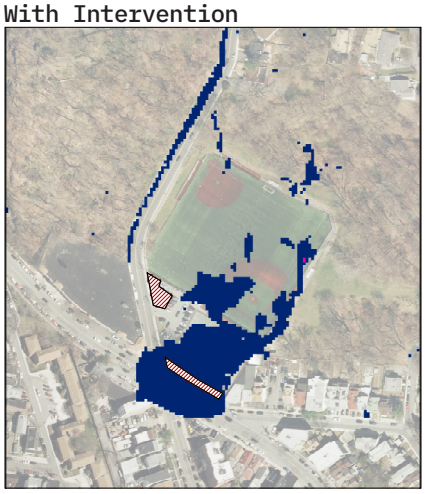
Baseline 10 yr Flood:
With Flood Depth Difference



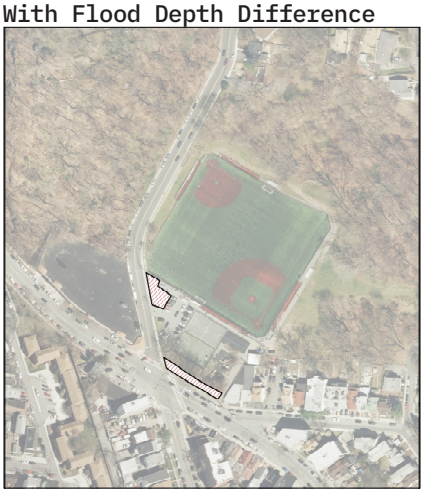
Baseline 100 yr Flood:
No Intervention



Baseline 100 yr Flood:
With Intervention



Baseline 100 yr Flood:
With Flood Depth Difference



Flood Depth More Than 4"
Flood Depth More Than 1'
Flood Depth More Than 2'

Flood Depth Highly Reduced (more than 12")
Flood Depth Moderately Reduced (between 4" and 12")
Intervention Boundary

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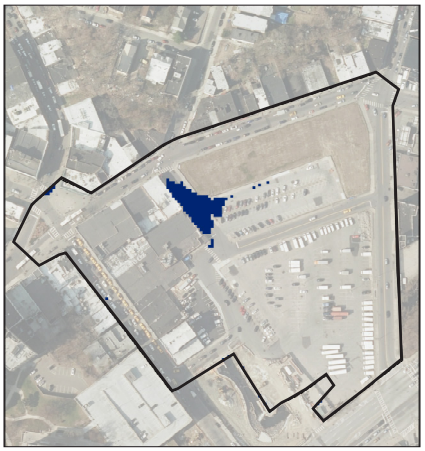
SITE 3: CHICKEN ISLAND

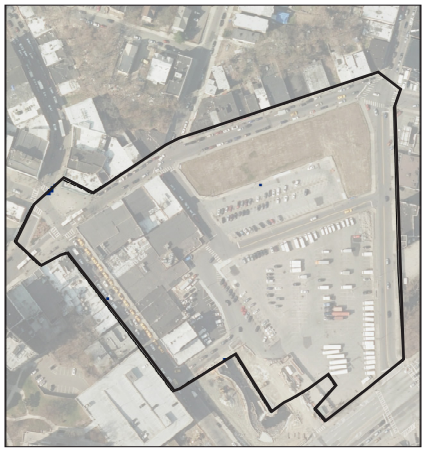
Chicken Island was selected as a location of interest due to the anticipated redevelopment that will be taking place in the coming years. By including this location in the model, the objective was to advocate for the inclusion of green infrastructure measures in the developed site in order to handle stormwater locally.

In this location, the model applied was influenced by the presence of the Saw Mill River, which goes intermittently underground. This situation is not accurately represented in the model, and produced faulty results. To overcome this, we limited this part of the study to only simulating precipitation within the area that will be redeveloped, ignoring external runoff. Hence, this part of the study focuses on assessing the impact of reducing flood risk due to on-site precipitation. To do this, we assessed the impact in reducing flood depths by removing the first 1.5 inches of precipitation in each storm, as a proxy for reducing the amount of runoff generated due to the presence of green infrastructure interventions. The results show that capturing the first 1.5 inches of precipitation through capturing techniques would indeed have a positive impact under the 10-years storm scenario, but its impacts might be negligible under the 100-years storm. It is important to keep in mind that this analysis only considers precipitation falling within the boundaries of the redevelopment area, ignoring incoming runoff from nearby areas and the flood risk posed by the nearby Saw Mill River.

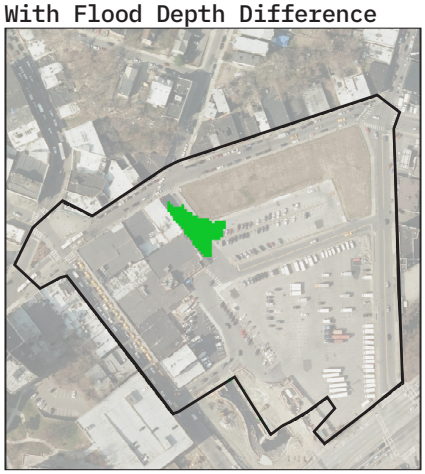
Baseline 10 yr Flood:
No Intervention



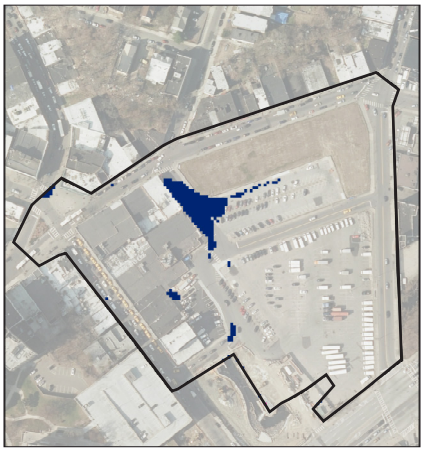
Baseline 10 yr Flood:
With Intervention



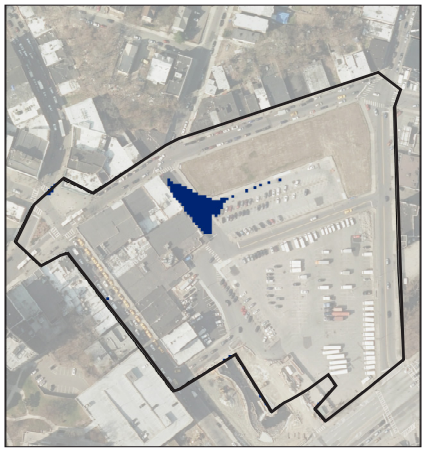
Baseline 10 yr Flood:
With Flood Depth Difference



Baseline 100 yr Flood:
No Intervention



Baseline 100 yr Flood:
With Intervention



Baseline 100 yr Flood:
With Flood Depth Difference

Flood Depth More Than 4″
Flood Depth More Than 1′
Flood Depth More Than 2′

Flood Depth Highly Reduced (more than 12″)
Flood Depth Moderately Reduced (between 4″ and 12″)
Intervention Boundary

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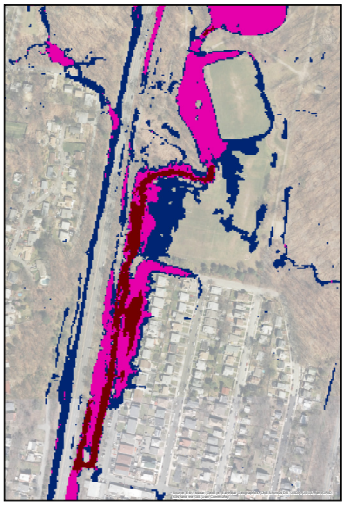
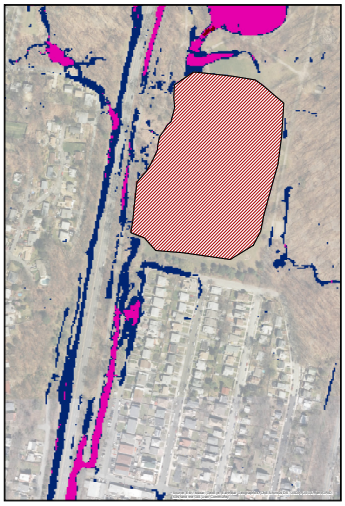
SITE 4: TIBBETTS BROOK

The streets located in the Southwest of the Lincoln Park neighborhood are highly exposed to flooding caused by the Tibbetts Brook. Some homes in this area are located in the special flood hazard area mapped by FEMA. In this location, we explored the impact of a much larger intervention by creating an extensive sink in the park located in the North of the residences exposed to flooding. This intervention implies providing additional space for the river to flood, reducing the amount of water that flows through the Brook. The intervention was represented in the model by reducing the altitude in the delimited area by 6 feet. The results illustrate how increasing the space and volume available for the river to flood in the green space near Tibbetts Brook reduces the flood depths in the residential area in the South. We understand that this intervention is a large-scale endeavour in terms of costs and impacts, and that further modeling work is necessary to better understand its benefits and potential risks. This case study, however, may be used to open up a conversation about the potential use of the larger green spaces in the city to mitigate the hazards that climate change is exacerbating.

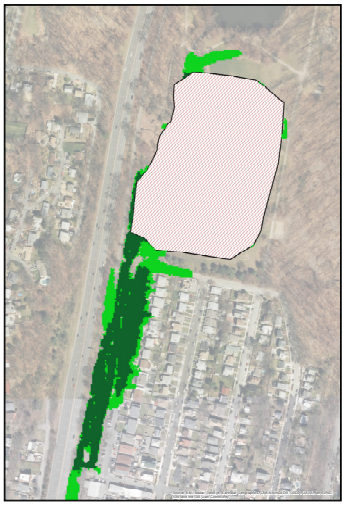
Baseline 10 yr Flood: No Intervention



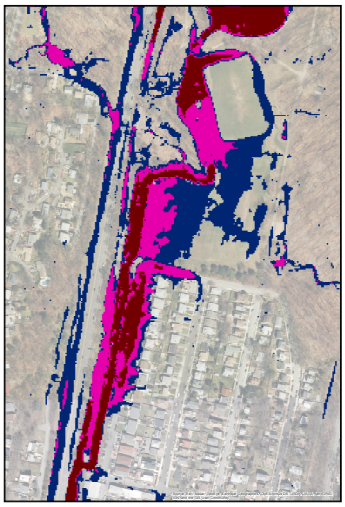
Baseline 10 yr Flood: With Intervention



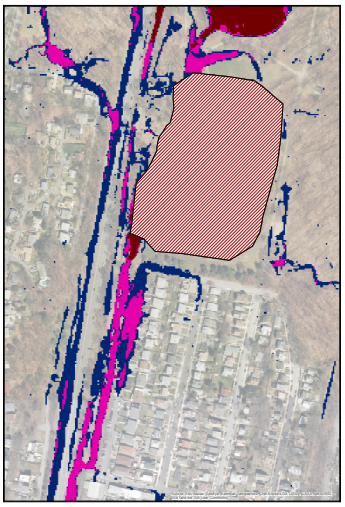
Baseline 10 yr Flood: With Flood Depth Difference



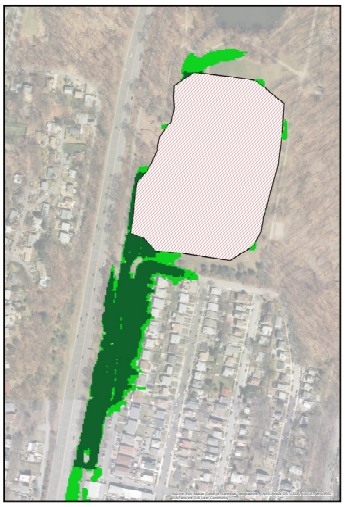
Baseline 100 yr Flood: No Intervention



Baseline 100 yr Flood: With Intervention



Baseline 100 yr Flood: With Flood Depth Difference



Flood Depth More Than 4″
Flood Depth More Than 1′
Flood Depth More Than 2′

Flood Depth Highly Reduced (more than 12″)
Flood Depth Moderately Reduced (between 4″ and 12″)
Intervention Boundary

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