Climate Change Planning for NYC Stormwater Management

Alan Cohn, NYC DEP

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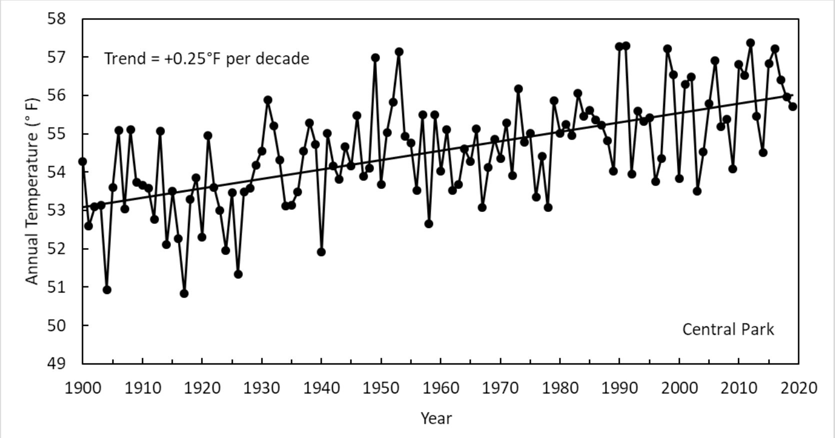
Overview

- Observations and Projections
- Impacts of Climate Change on Stormwater Systems
- Historical and Projected IDFs
- Applying Precipitation Projections in Practice

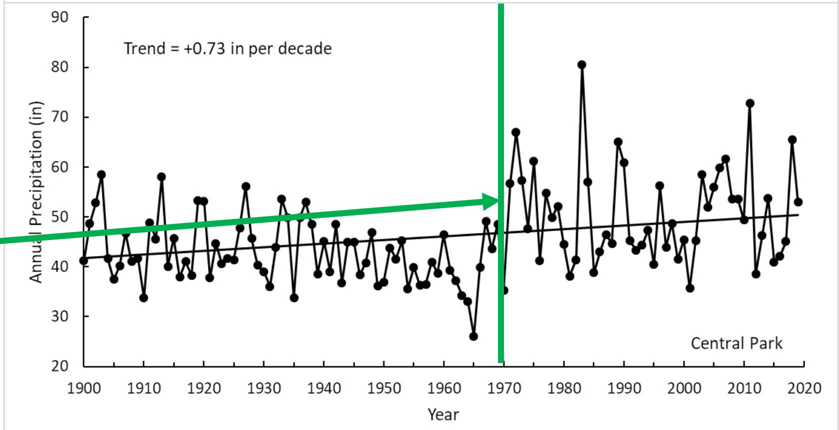
NYC Observed Climate Trends

Mean annual **temperature** has increased at a rate of 0.25°F per decade.

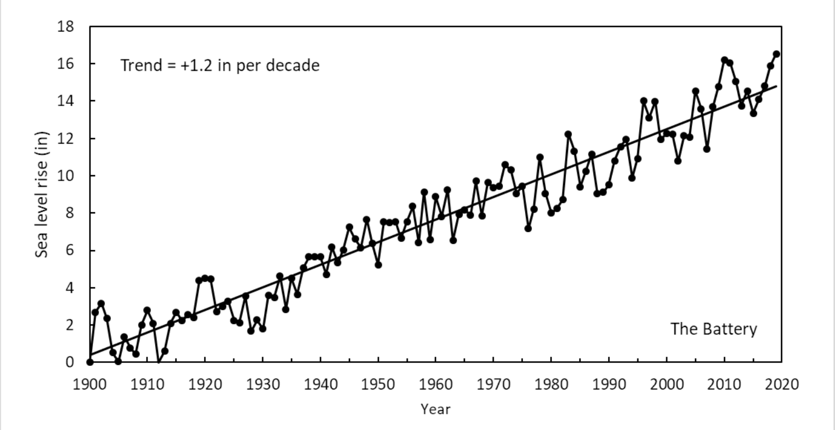


Mean annual **precipitation** has increased 0.73 inches per decade.

Year-to-year variability has become more pronounced, especially since the 1970s.



Sea level rise has averaged 1.2 inches per decade, nearly twice the observed global rate.



Heat:

Average temperatures are expected to increase by 4.1 to 5.7 degrees by 2050

Number of days in NYC above 90° could triple by 2050

Precipitation:

Average precipitation is expected to increase by 4 to 11 percent by 2050

Sea Level Rise:

Seas are expected to rise between 11 to 24 inches by 2050

High end projection: 72 inches by 2100

NEW YORK CITY COLLEGE OF TECHNOLOGY
the senior-level college of technology of The City University of New York

Stony Brook University

Penn
University of Pennsylvania

The Institute for Sustainable Cities
City University of New York

The Earth Institute
Columbia University

Rutgers University

Princeton University

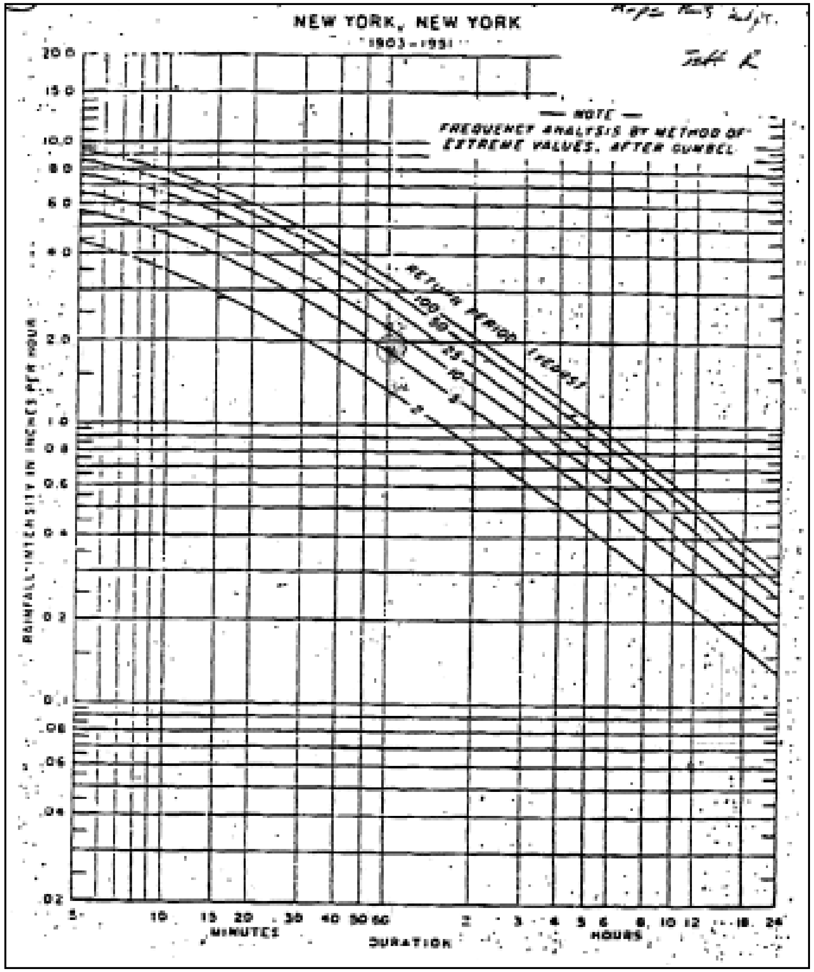
Impacts on Stormwater Systems

- Flooding is most effected by rainfall intensity and receiving water level
- CSO volume and frequency changes with increases in rainfall volume and intensity
- Sea level rise can decrease CSOs, but increases flooding

September 2004: Flooding after a downpour on 9th Street, Brooklyn, NY (Credit: Seth Wenig/The New York Times)

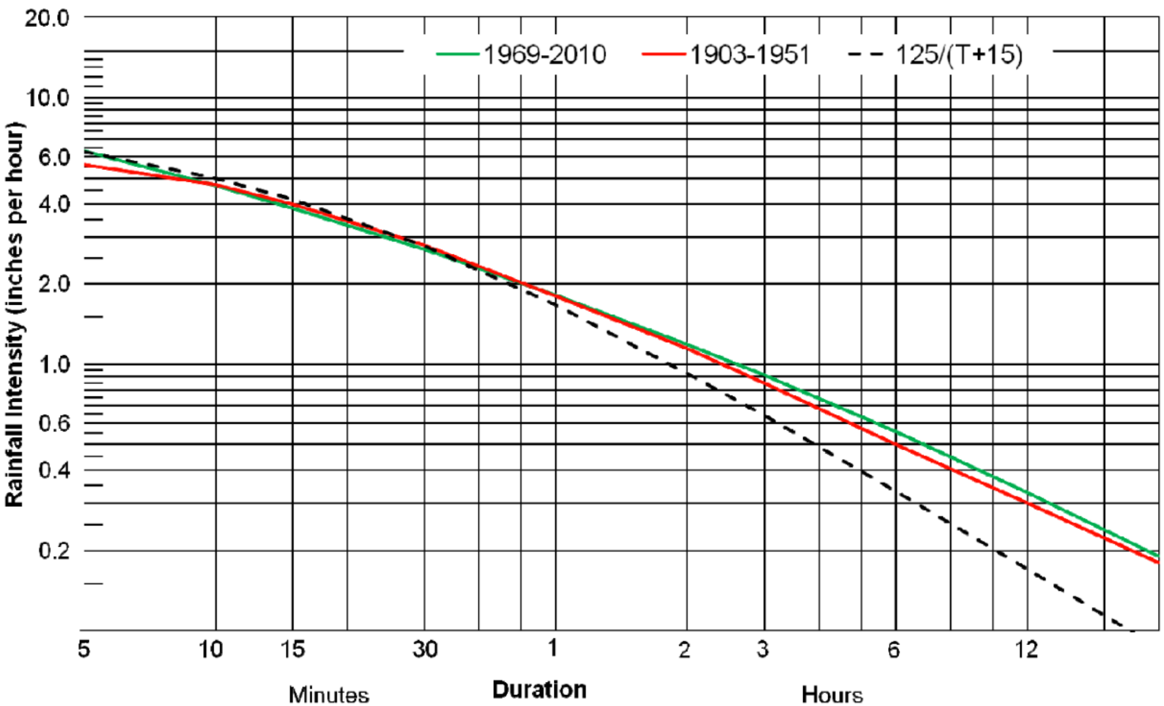
Precipitation IDF

- Precipitation Intensity-Duration-Frequency (IDF) curves used in engineering and planning applications:
    - Sewer design/construction
    - Sizing of onsite detention systems
- A single curve is applied citywide; historically based on observed rainfall data from 1903 to 1951.
- Application focused on short duration, high frequency events (5-10 year return periods).



Precipitation IDF

- A 2011 DEP study analyzed hourly data for 10 stations, including 4 stations with 15-minute data, from as early as 1876 (Central Park) to the present:
  - Found no statistically significant trend in daily or hourly annual maximum rainfall and no statistically significant trend in the recurrence of large rainfall events.
  - Found results to be similar to existing IDF curves based on data from 1903 to 1951.
  - Approximation used for estimating intensity (125/(T+15)) remained the same.

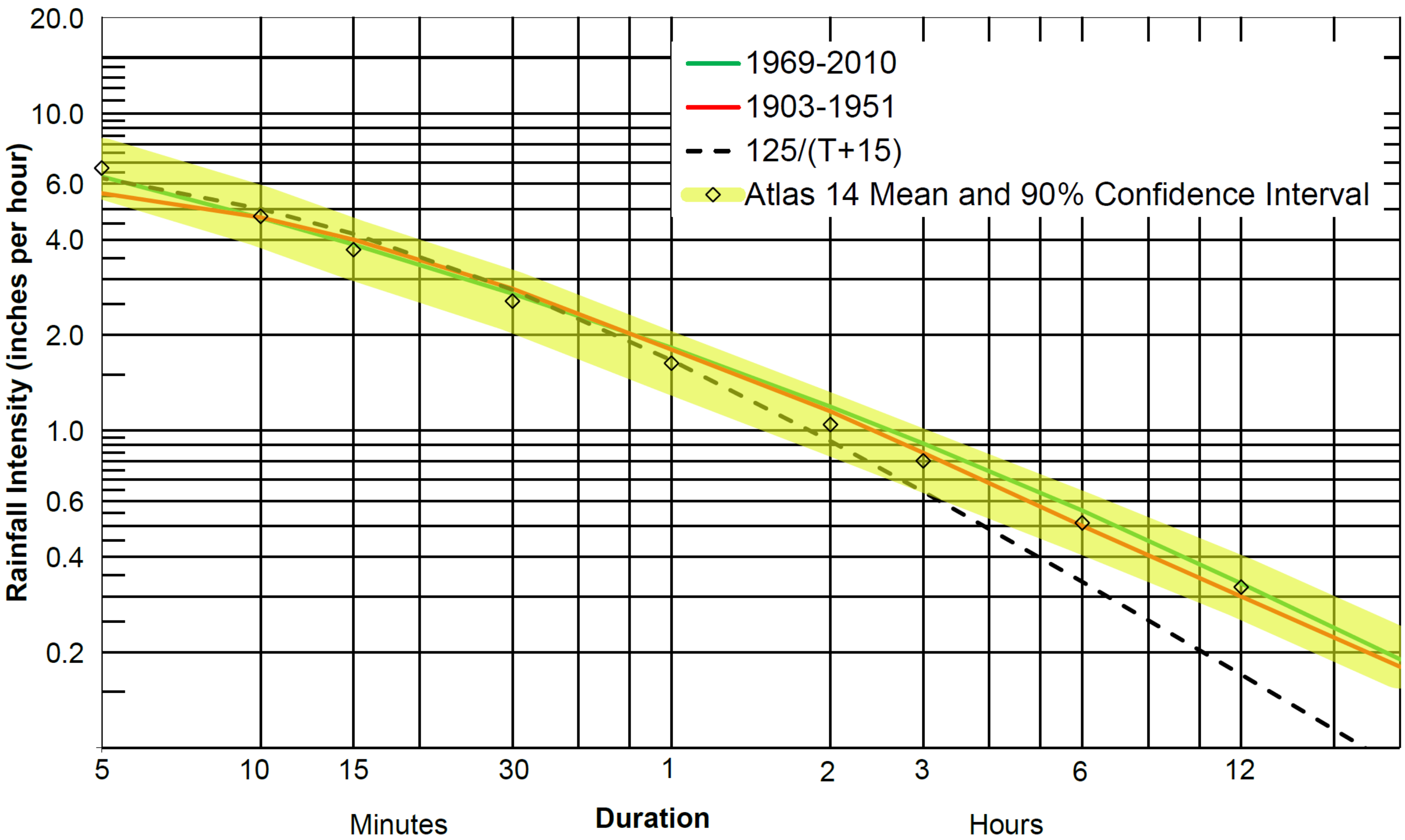


Precipitation IDF

Additional Developments Since the 2011 Analysis

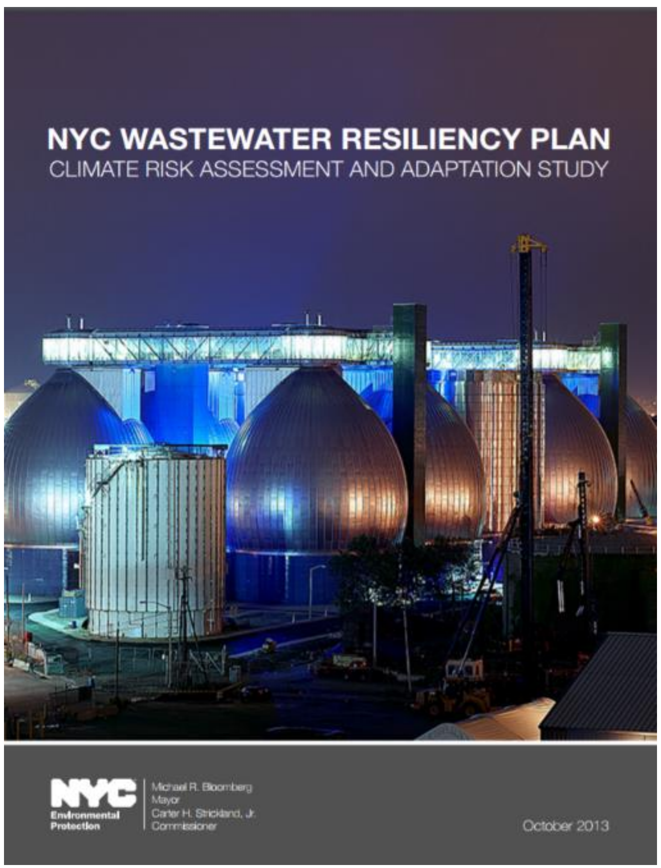
- NOAA Atlas 14 (2015)
  - ✓ Updated precipitation frequency estimates
- Cornell/NYSERDA IDF Curves (2015)
  - ✓ IDF curves for three future time periods based on climate change data throughout New York State
- Columbia University/NPCC (2015)
  - ✓ Updated NPCC daily rainfall (24 hour) projections

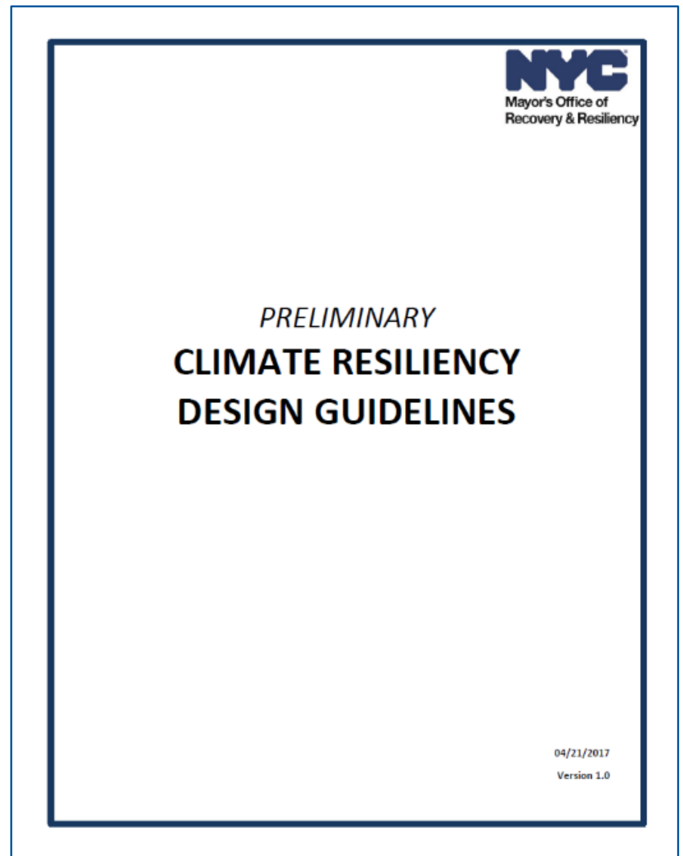
Historical IDF Analysis



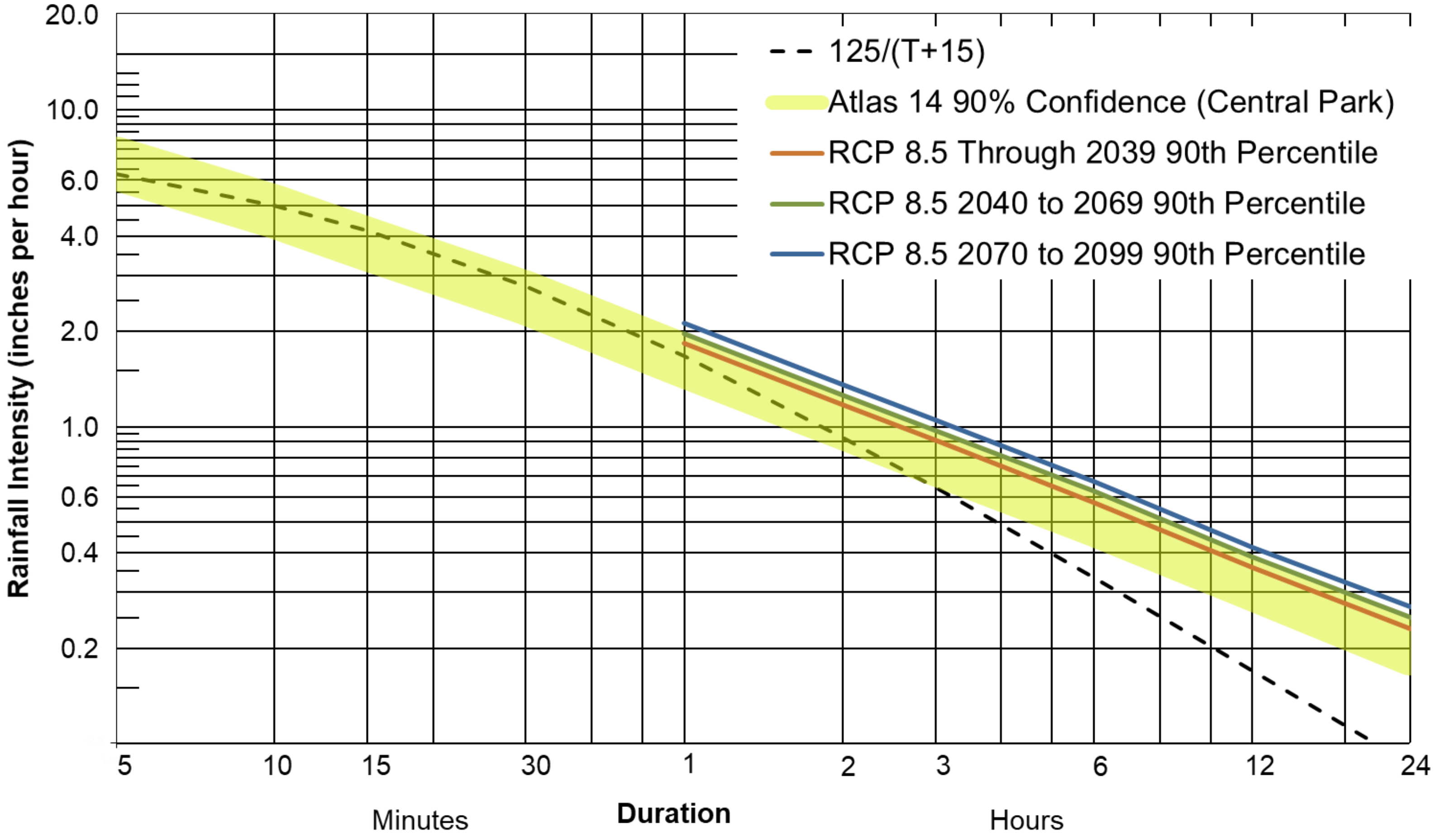
- Numerous projects around NYC factor future resiliency into designs, namely incorporating sea level rise and storm surge.

- How to incorporate extreme precipitation?





IDF Analysis Future Climate Change



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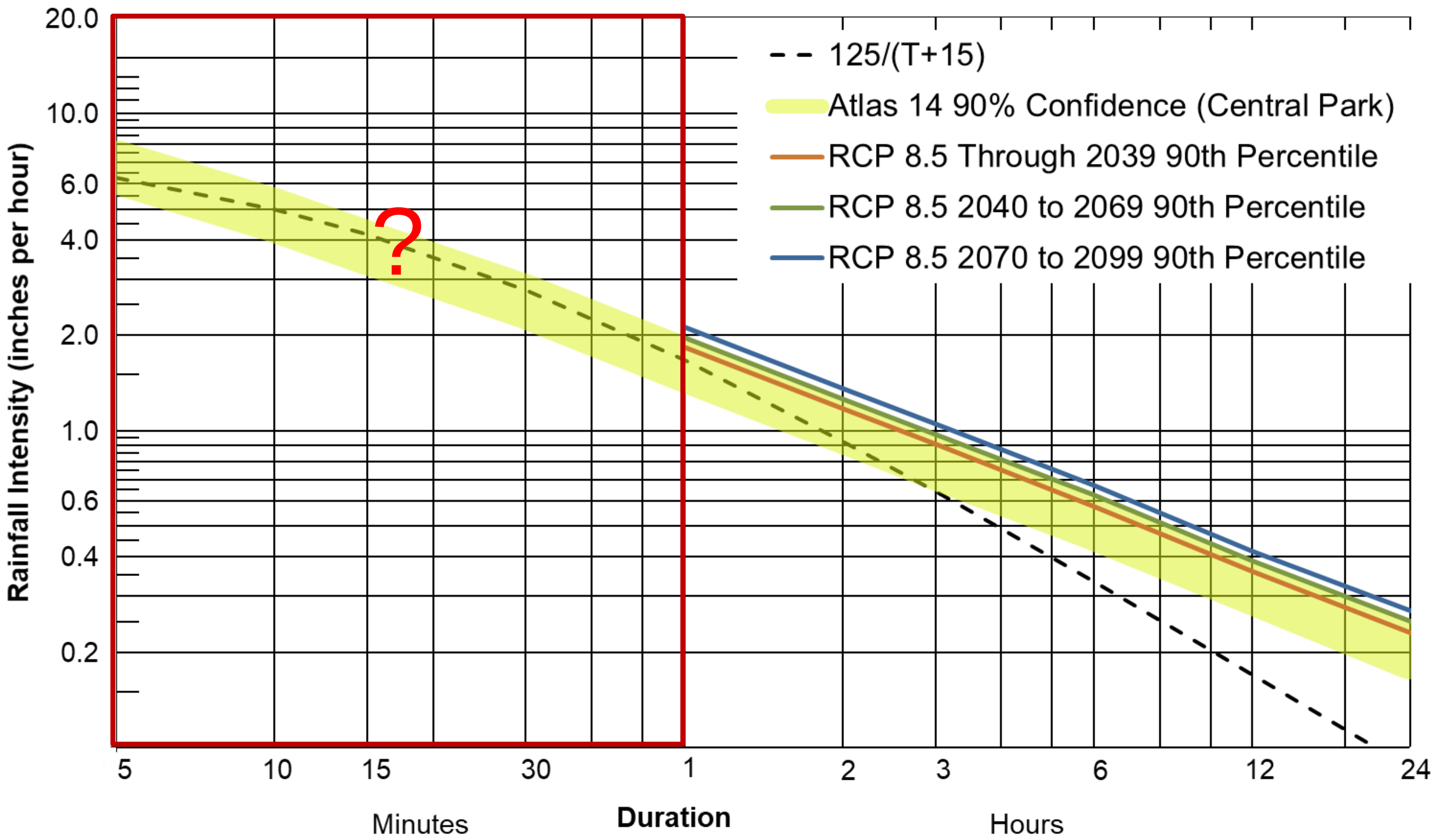
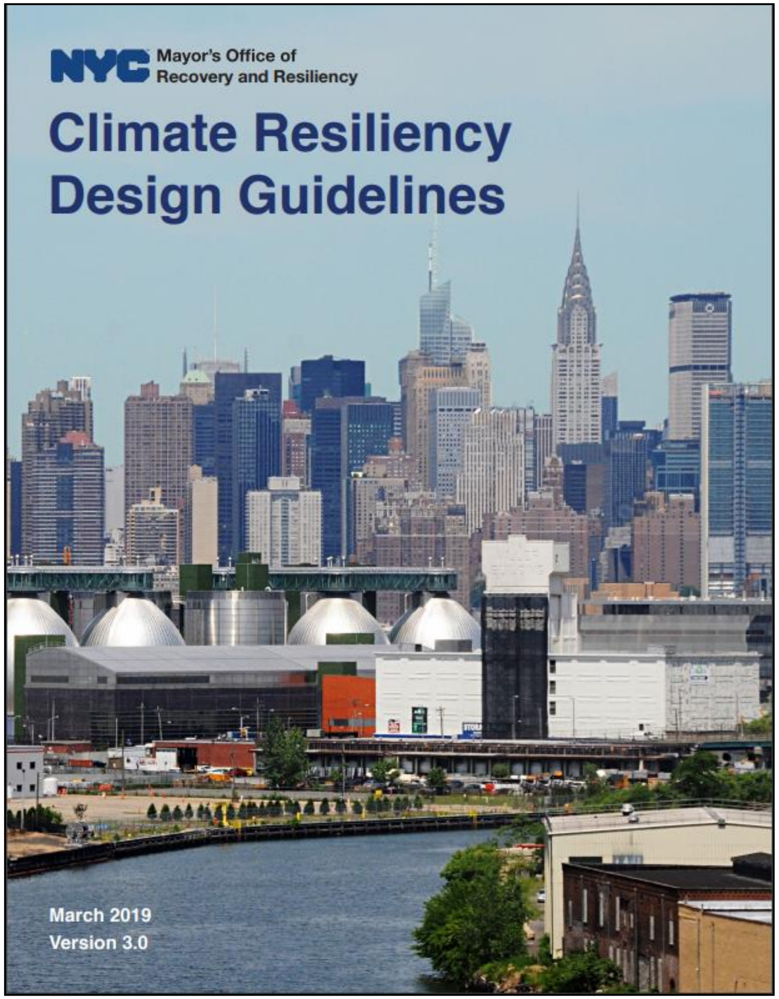
IDF Analysis Future Climate Change



Incorporating Climate Science



Who will use the guidelines?

- City agencies
- Engineers, architects, and planners

What kinds of projects?

- Buildings and infrastructure
- New capital construction and major rehabilitation

What kinds of assets are not included?

- Coastal protection projects
- Private developments

Precipitation design adjustment for on-site stormwater systems

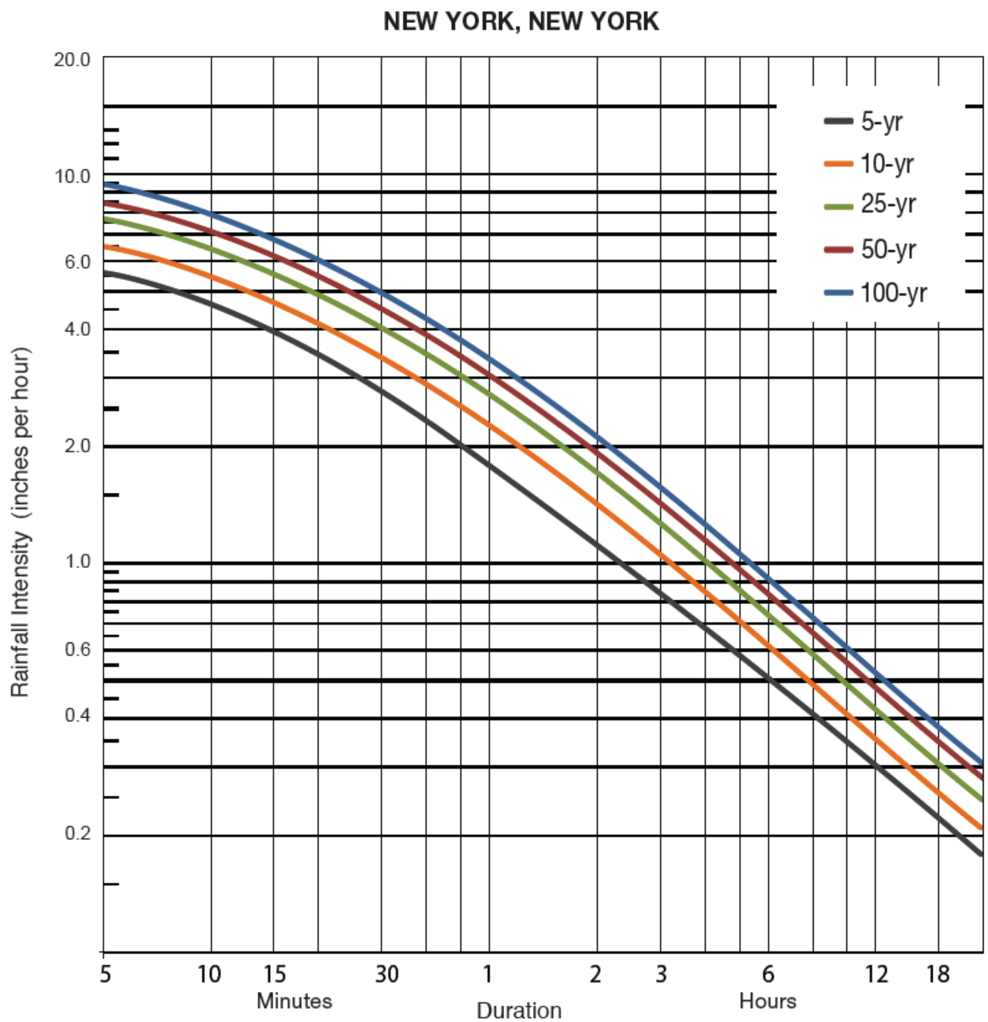
"The current 50-year intensity-duration-frequency (IDF) curve can be used as a proxy for the future 5-year storm (projected for the 2080s)"

Equation 1. Equation for sizing on-site retention

i = (350/(t+38))

Where: i = intensity

t = time of concentration

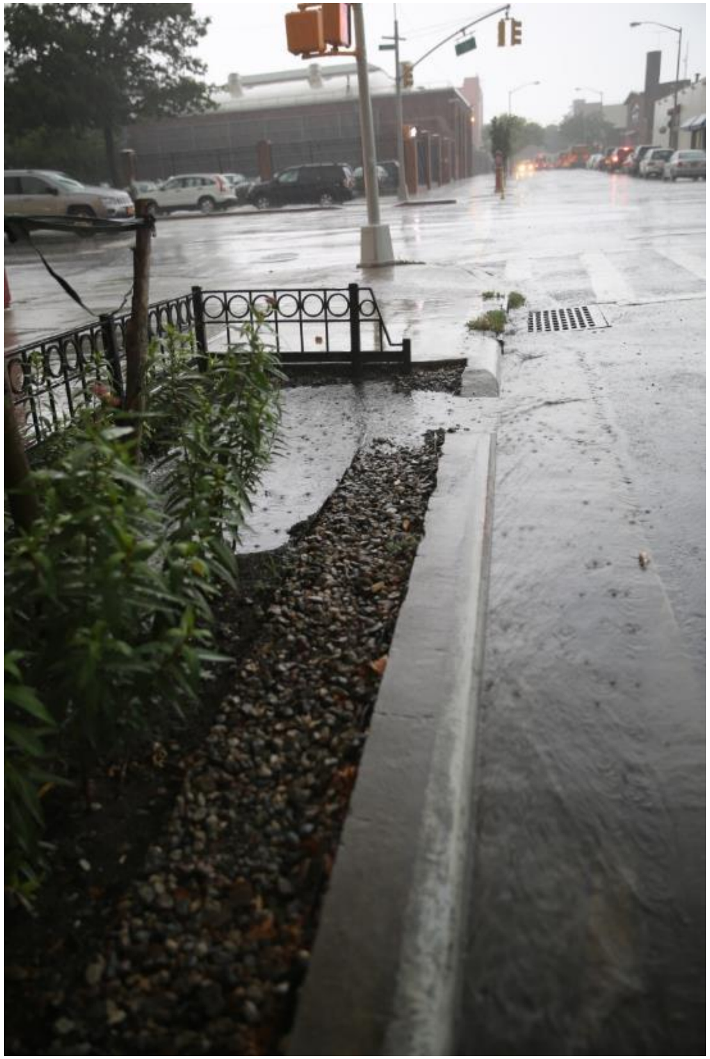


Precipitation design adjustment for on-site stormwater systems

Conduct sensitivity analysis.

- *Compare the retention/detention required for the current 5-year IDF versus the current 50-year IDF to determine the additional volume and costs associated with complying with these Guidelines.*
- *The goal is to maximize retention/detention capacity given site and cost constraints, as well as through an evaluation of the benefit of adding capacity to detain/retain water for larger storm events.*
- *Given the results of the benefit-cost analyses, review the added benefit of designing retention/detention using greater magnitude storms (e.g. 100-year) or, as needed, lower magnitude storms (e.g. 25-year).*

Precipitation design adjustment for on-site stormwater systems



"Choose the right combination of interventions after considering the project type, site location, operational requirements, cost, benefits, and useful life of the intervention."

- Utilize strategies that infiltrate, evaporate, or reuse rainwater
- Install stormwater infiltration, detention, and storage
- Protect areas below grade from flooding
- Develop plan to keep catch basin grates clear

NYC Water Quality & Urban Flooding Efforts

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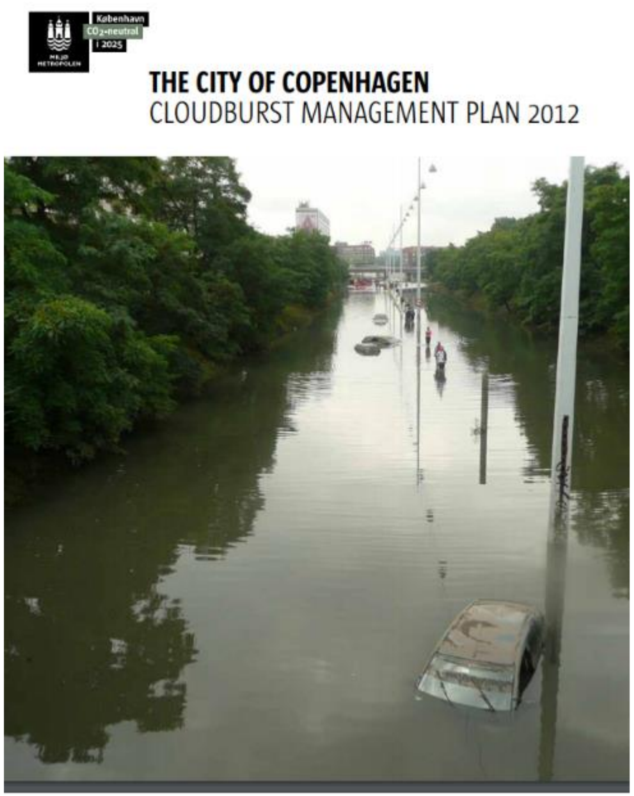
City Sidewalks

City Streets

Grant Program for Private Property Owners

Public Property Retrofits

Preparing for Extremes: Blue-Green Infrastructure



September 2015: Cloudburst event in Copenhagen, Denmark

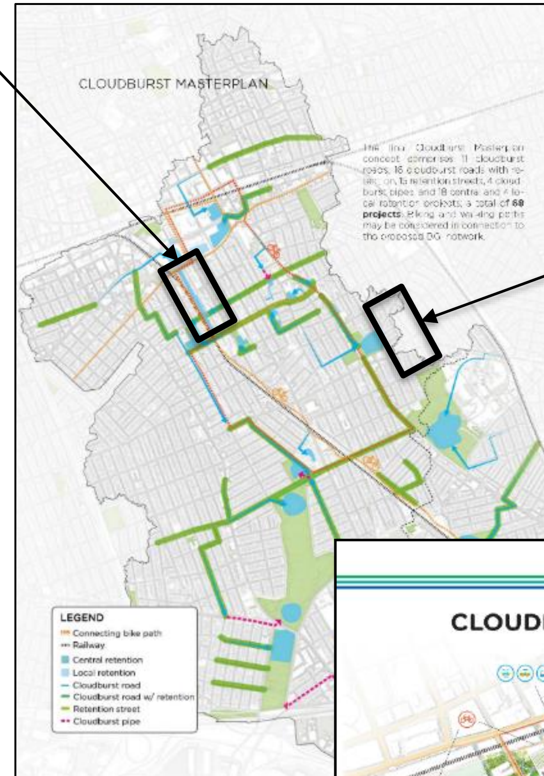
Preparing for Extremes: Blue-Green Infrastructure

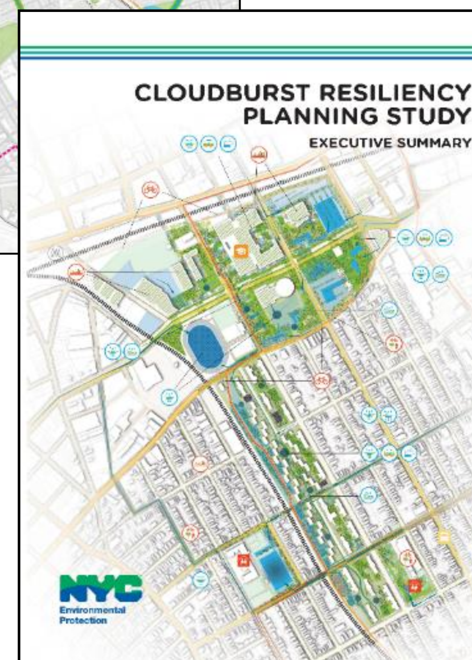
NYC Cloudburst Pilot Projects

- Reduce risk associated with flooding
- Plan for future climate scenarios and high intensity storm events
- Enhance capacity of current stormwater sewer system
- Provide co-benefits where feasible

South Jamaica Houses

St. Albans





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NYC Cloudburst Pilot Projects: Adjusted Design Storm

1-hour duration rainfall depths			
End of useful life	5-year design storm (in)	50-year design storm (in)	100-year design storm (in)
Baseline[1, 2]	1.61	2.57	2.87
Through to 2039	1.83	3.02	3.41
2040-2069	1.97	3.33	3.93
2070-2099	2.12	3.74	4.34
24-hour duration rainfall depths			
End of useful life	5-year design storm (in)	50-year design storm (in)	100-year design storm (in)
Baseline[1, 2]	4.70	7.83	8.79
Through to 2039	5.41	9.21	10.55
2040-2069	5.88	10.13	12.31
2070-2099	6.35	11.28	13.40

Preparing for Extremes: Blue-Green Infrastructure

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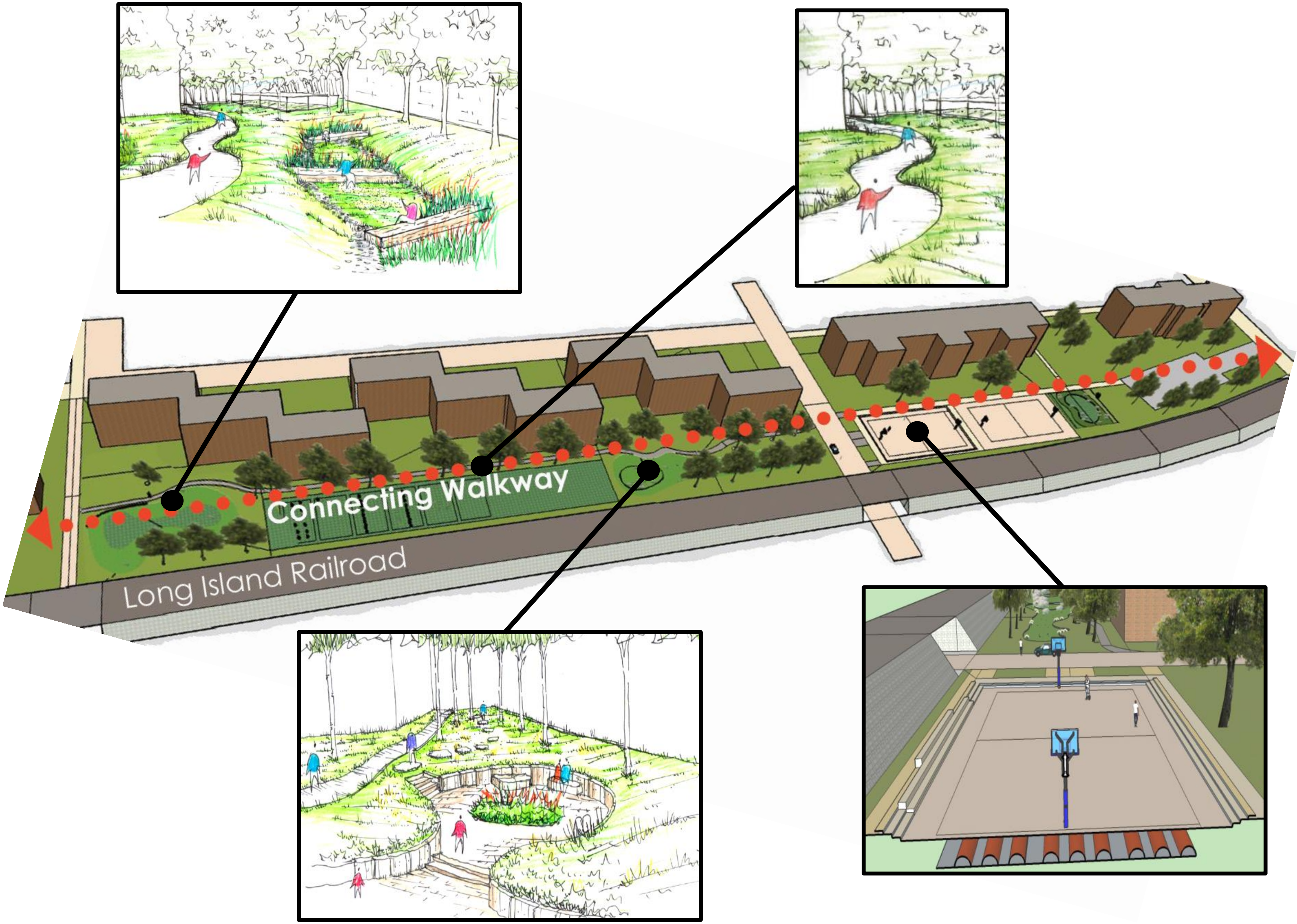
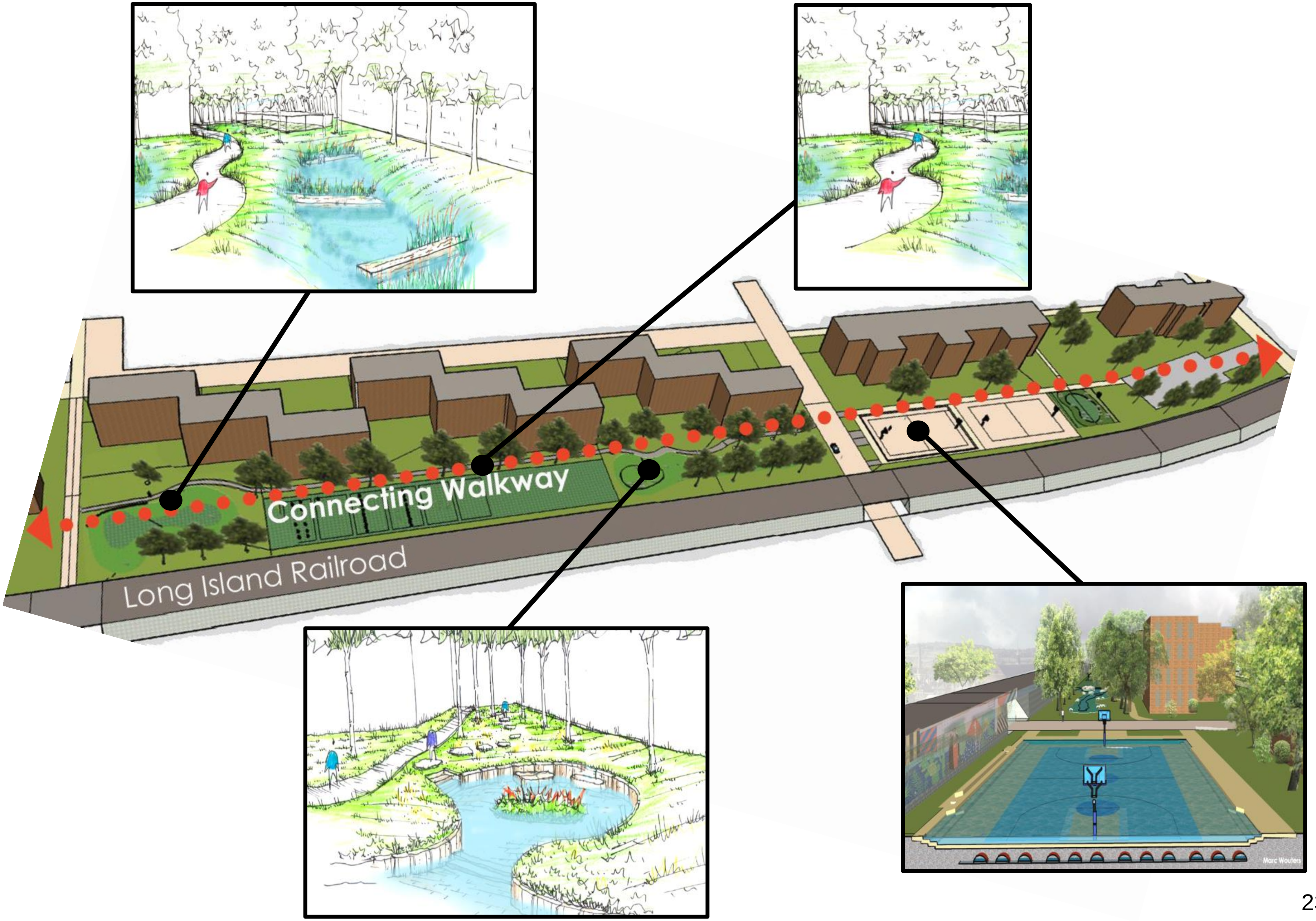
10-year 2.30

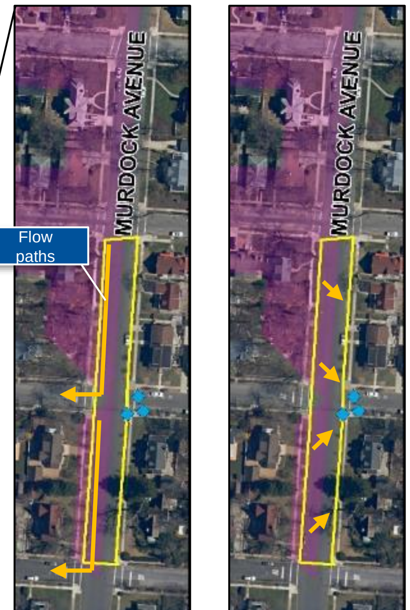
South Jamaica Houses Pilot Project



South Jamaica Houses Pilot Project

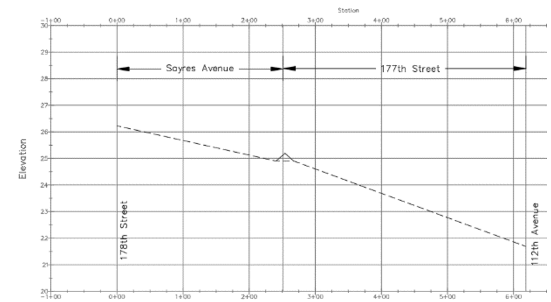


NYC Cloudburst Pilot Projects: St. Albans Right-of-Way



Before

After



Citywide Stormwater Resiliency Study

Objective

- Characterize potential flood risks citywide and identify range of available interventions for managing extreme precipitation events, considering the compound impacts due to sea level rise and storm surge

Tasks

- Create hydraulic and hydrologic model of 14 drainage areas to identify priority at-risk areas
- Build and test comprehensive model under 20 rainfall and receiving water conditions
- Conduct sensitivity analysis of response to interventions including construction of grey, green, and blue-green infrastructure

Next Steps

- Continue to refine Climate Resilience Design Guidelines (coordination with Mayor's Office)

- Advance Pilot Projects
  - Design and construct cloudburst projects at St. Albans and South Jamaica Houses
  - Identify additional pilot project opportunities

- Fill in the Gaps
  - Seek additional studies on rainfall intensity projections
  - Reconcile design guidelines with practical applications

Sources for Additional Information

- NYC Panel on Climate Change:
  https://www1.nyc.gov/site/orr/challenges/nyc-panel-on-climate-change.page

- NYC Climate Resiliency Design Guidelines:
  https://www1.nyc.gov/assets/orr/pdf/NYC_Climate_Resiliency_Design_Guidelines_v3-0.pdf

- NYC DEP Climate Resiliency Programs:
  https://www1.nyc.gov/site/dep/environment/climate-resiliency.page

Alan Cohn
NYC DEP
alanc@dep.nyc.gov
(718) 595-4536

Eric Rosenberg
Hazen and Sawyer
erosenberg@hazenandsawyer.com
(212) 539-7192