



# CITY OF TRENTON

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# VULNERABILITY ASSESSMENT

*RESILIENT NJ*



# VULNERABILITY ASSESSMENT SCOPE

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- **Climate Categories**
  - Coastal Impacts
  - Precipitation
  - Temperature
- **Impact Analysis Subjects**
  - Critical infrastructure
  - Community assets
  - Land use and zoning
  - Vulnerable populations
  - Ecological resources



# PRECIPITATION

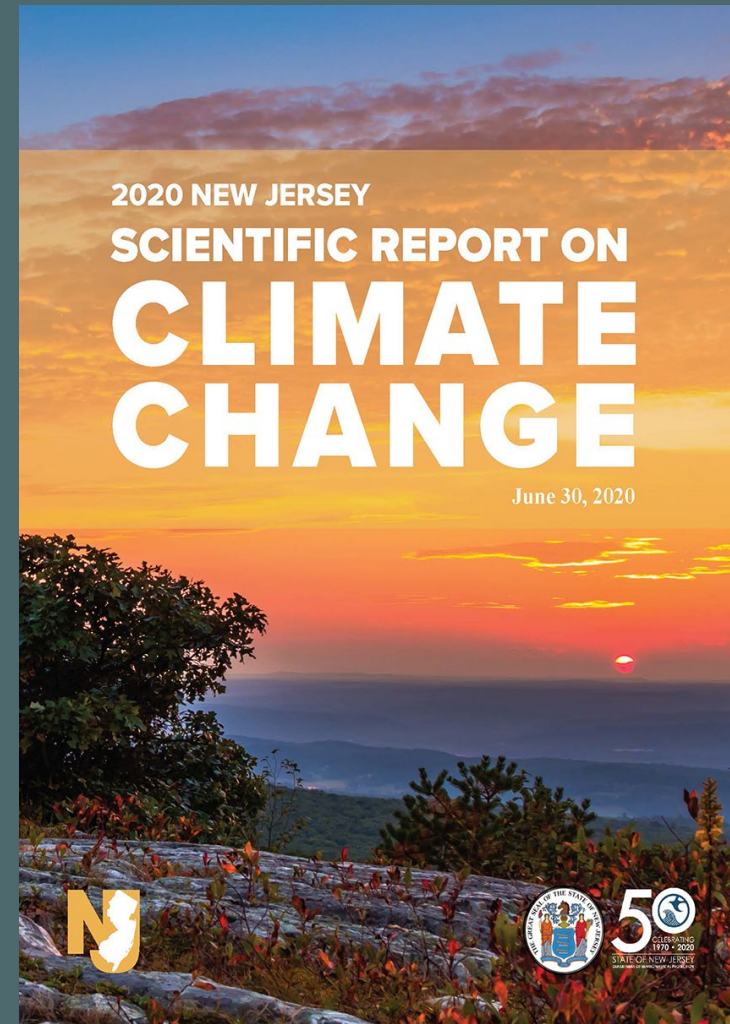
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# NEW JERSEY PRECIPITATION PREDICTIONS

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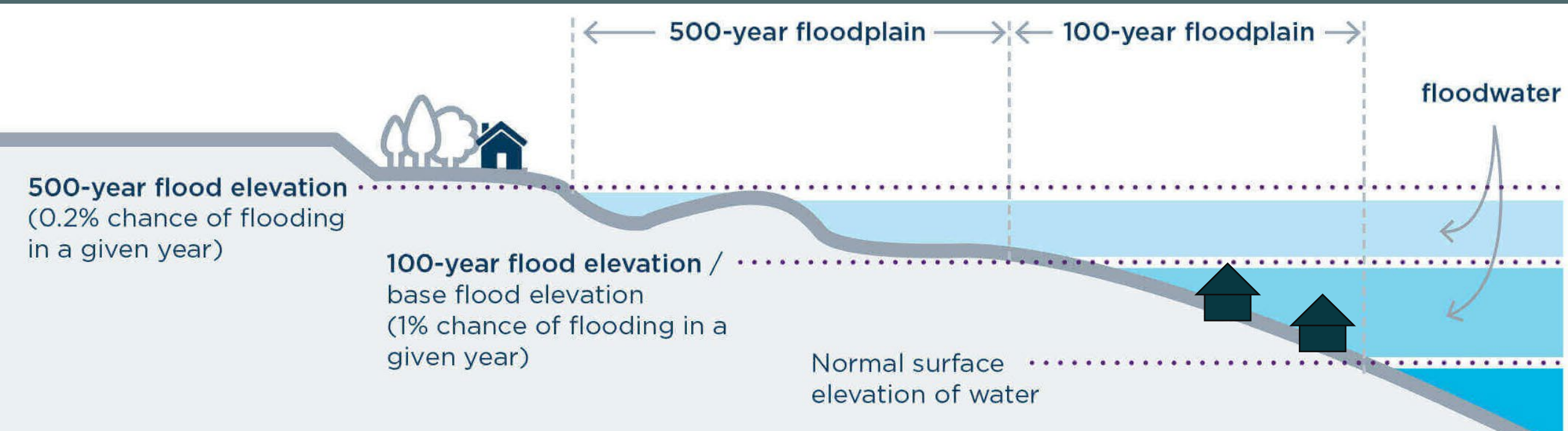
- Annual precipitation in New Jersey is expected to increase by 4% to 11% by 2050.
- The intensity and frequency of precipitation events is anticipated to increase due to climate change.
- The size and frequency of floods will increase as annual precipitation increases.
- Tropical storms have the potential to increase in intensity due to the warmer atmosphere and warmer oceans that will occur with climate change.
- Droughts may occur more frequently due to the expected changes in precipitation patterns.



-2020 New Jersey Scientific Report on Climate Change

# WHAT IS A FLOODPLAIN?

- A floodplain is an area next to a river or stream that is subject to flooding.
- FEMA (Federal Emergency Management Agency) models flood events and publishes floodplain mapping for use in regulation.
  - FEMA uses a 1% annual chance of flooding as their baseline.



# FLOODPLAINS CONSIDERED IN THIS ASSESSMENT

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- **FEMA Zone AE**
  - 1% annual chance flood.
  - Also known as the '100-year flood' or 'base flood'.
- **FEMA Risk MAP**
  - From the Risk Mapping, Assessment and Planning (Risk MAP) program.
  - FEMA, state and local leaders collect current and historic flood-related data and then meet to review this data, as part of the discovery process to get a complete picture of the area's flood risk.
- **Flood Vulnerability Planning Areas**
  - Based on proposed expansions to the New Jersey Flood Hazard Area
    - FEMA 1% Base Flood Elevation + 3 ft
    - NJ Flood Hazard Area Design Flood Elevation + 2 ft

# MAPPED FLOOD AREAS




**Flood Vulnerability Planning Areas** represent flood prone areas determined by one of the following methods: 1. Flood Hazard Area Design Flood Elevation (FHADFE) plus 2 feet; or 2. FEMA 1% base flood elevation plus 3 feet.

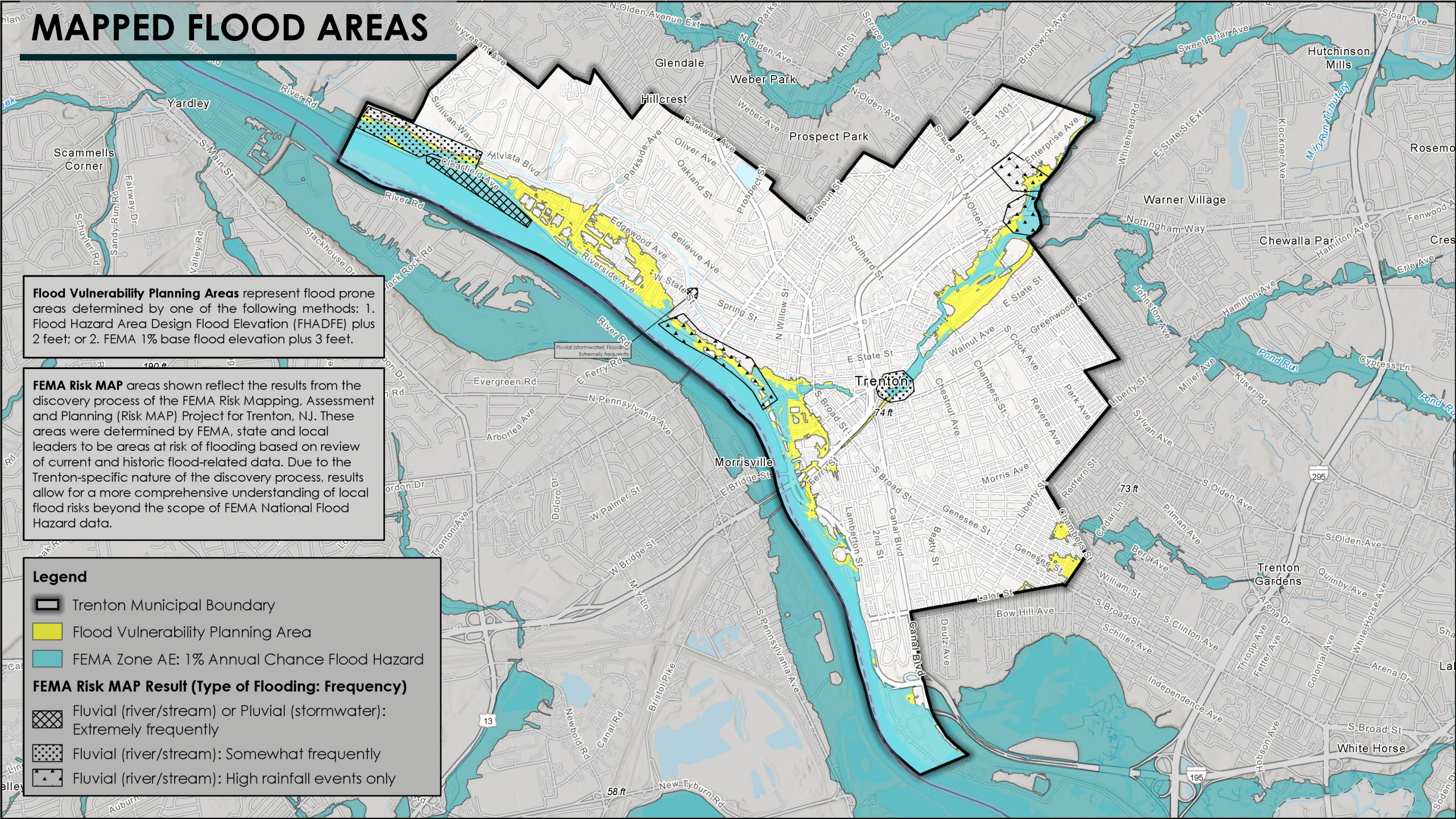
**FEMA Risk MAP** areas shown reflect the results from the discovery process of the FEMA Risk Mapping, Assessment and Planning (Risk MAP) Project for Trenton, NJ. These areas were determined by FEMA, state and local leaders to be areas at risk of flooding based on review of current and historic flood-related data. Due to the Trenton-specific nature of the discovery process, results allow for a more comprehensive understanding of local flood risks beyond the scope of FEMA National Flood Hazard data.

**Legend**

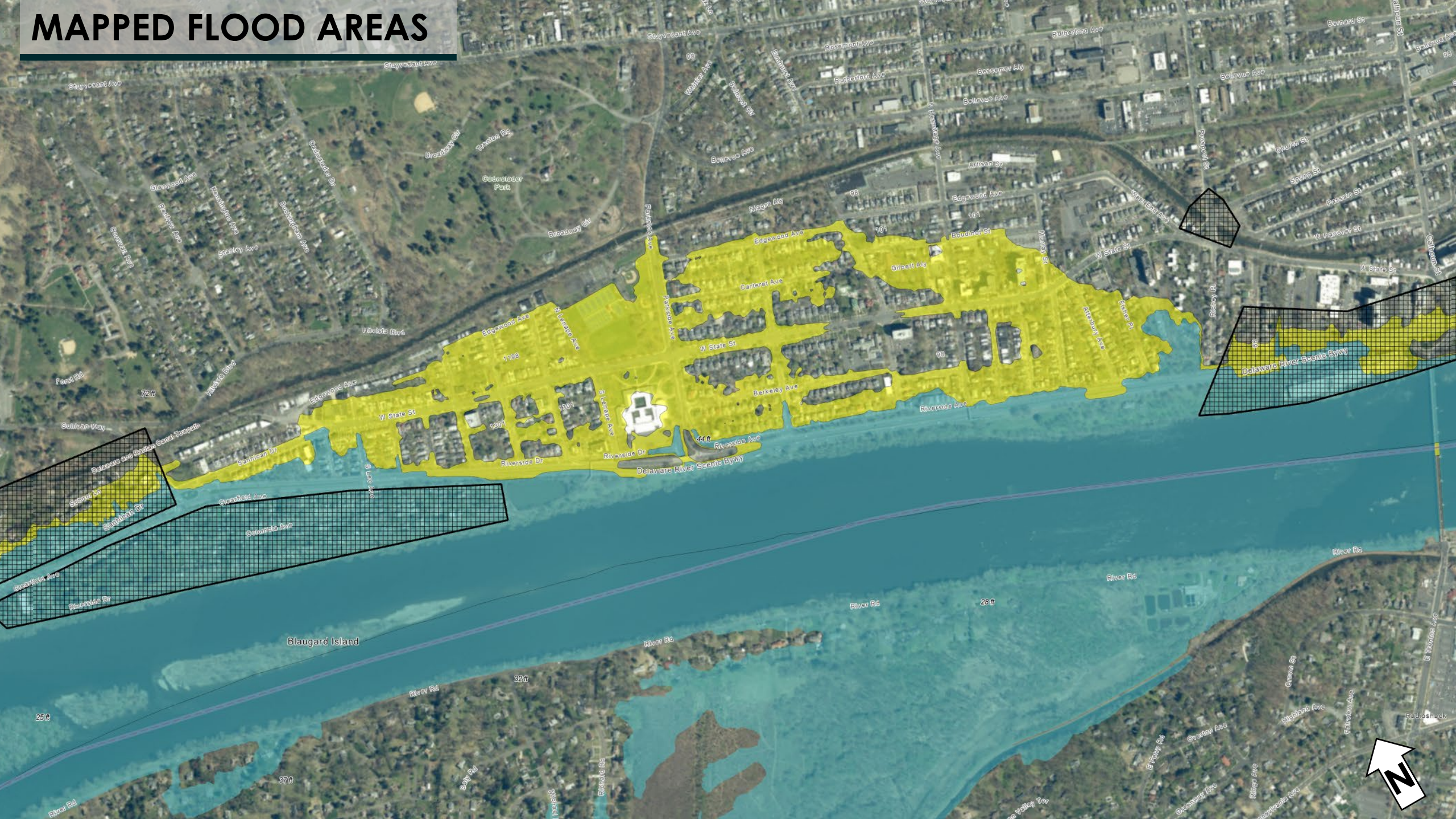
-  Trenton Municipal Boundary
-  Flood Vulnerability Planning Area
-  FEMA Zone AE: 1% Annual Chance Flood Hazard

**FEMA Risk MAP Result (Type of Flooding: Frequency)**

-  Fluvial (river/stream) or Pluvial (stormwater): Extremely frequently
-  Fluvial (river/stream): Somewhat frequently
-  Fluvial (river/stream): High rainfall events only

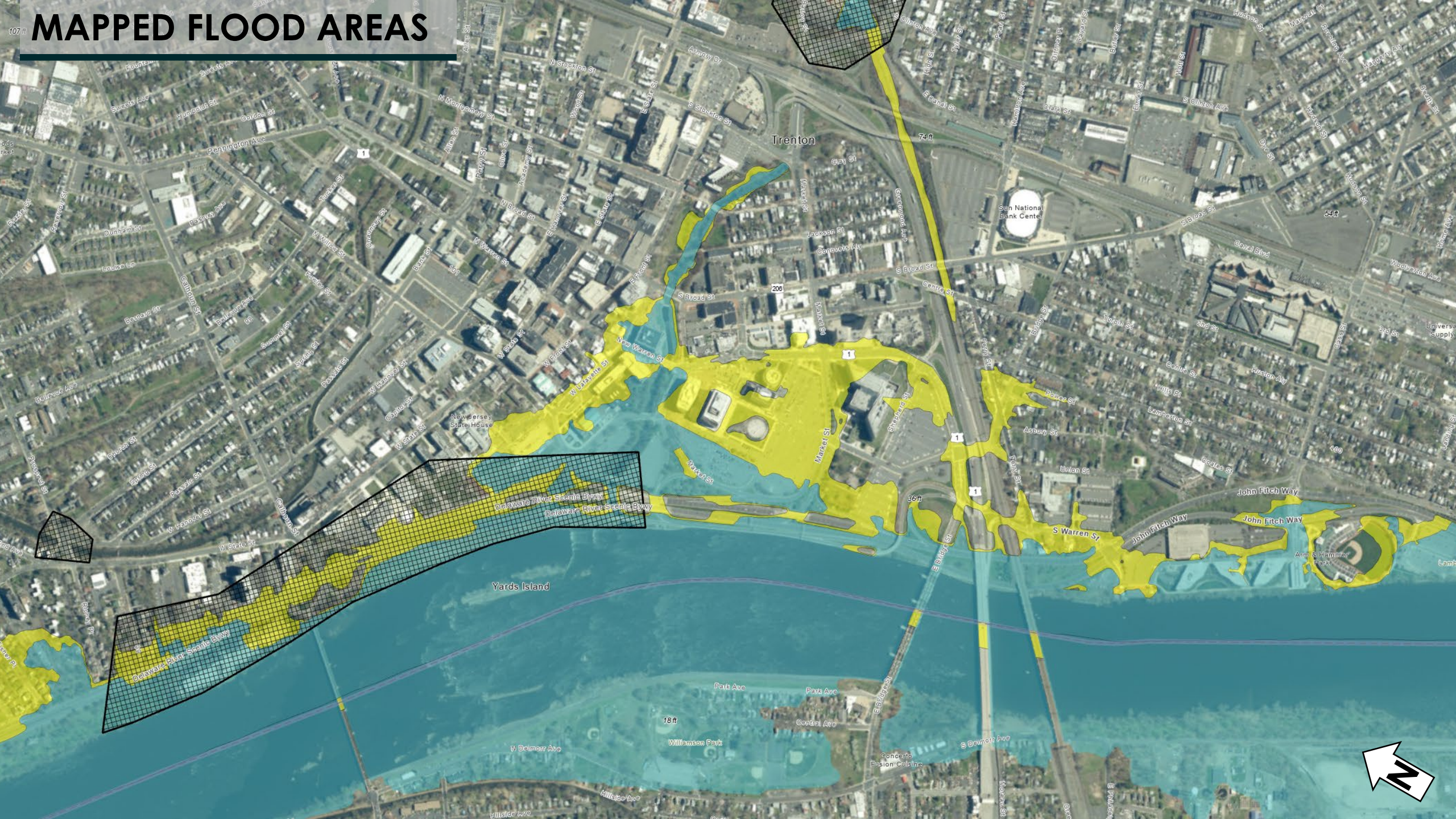


# MAPPED FLOOD AREAS

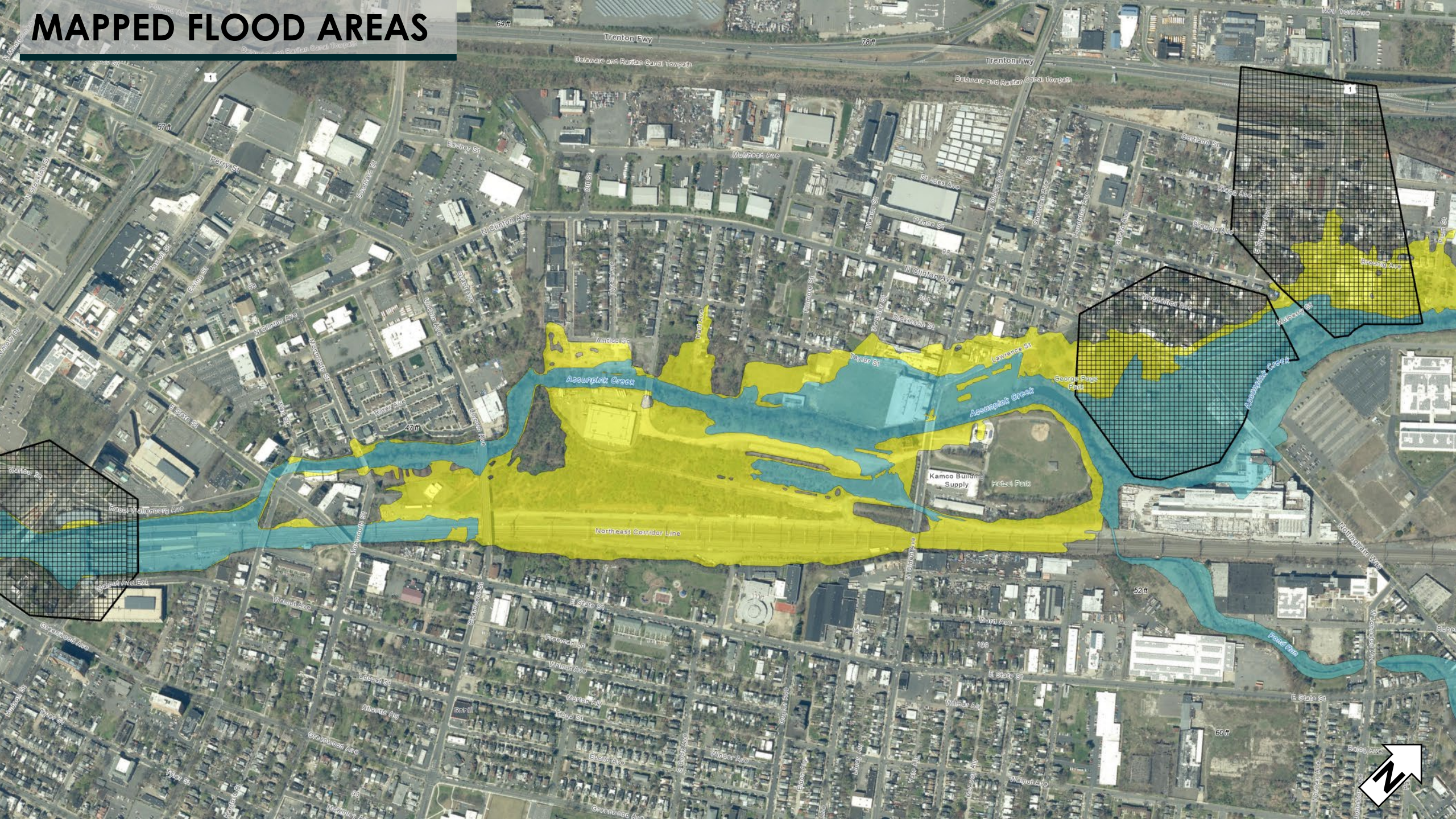




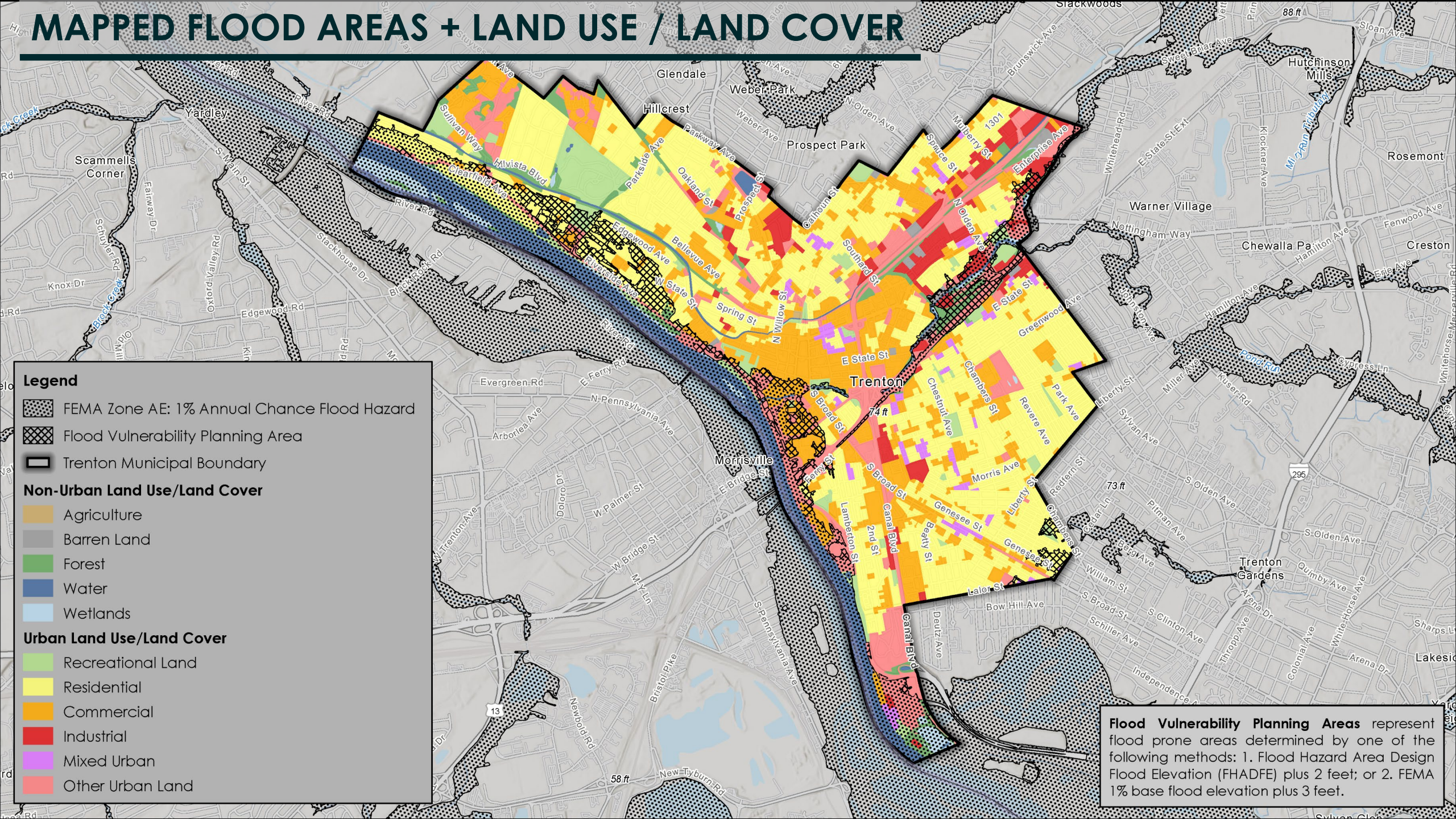
# MAPPED FLOOD AREAS



# MAPPED FLOOD AREAS



# MAPPED FLOOD AREAS + LAND USE / LAND COVER



**Legend**

- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- Trenton Municipal Boundary

**Non-Urban Land Use/Land Cover**

- Agriculture
- Barren Land
- Forest
- Water
- Wetlands

**Urban Land Use/Land Cover**

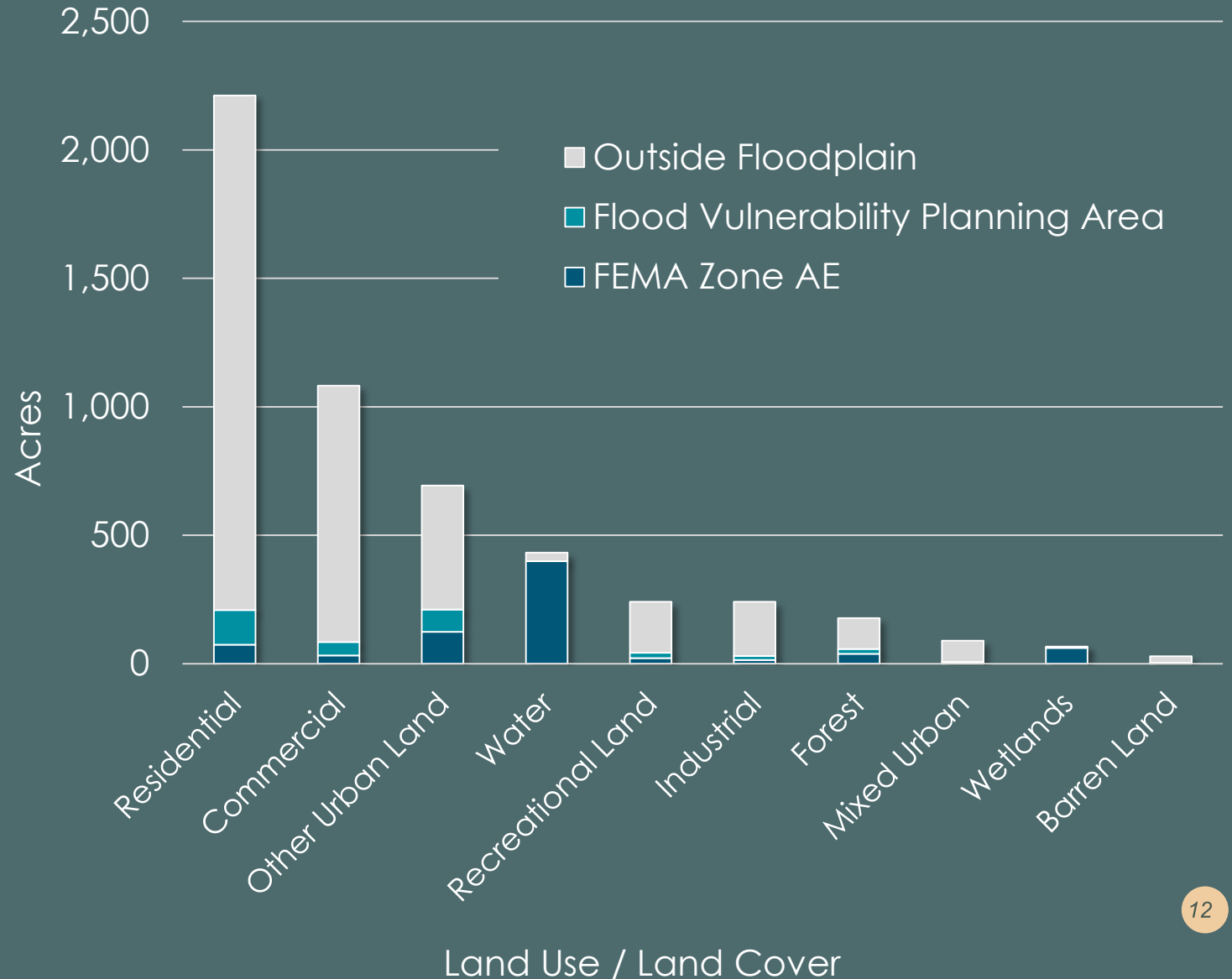
- Recreational Land
- Residential
- Commercial
- Industrial
- Mixed Urban
- Other Urban Land

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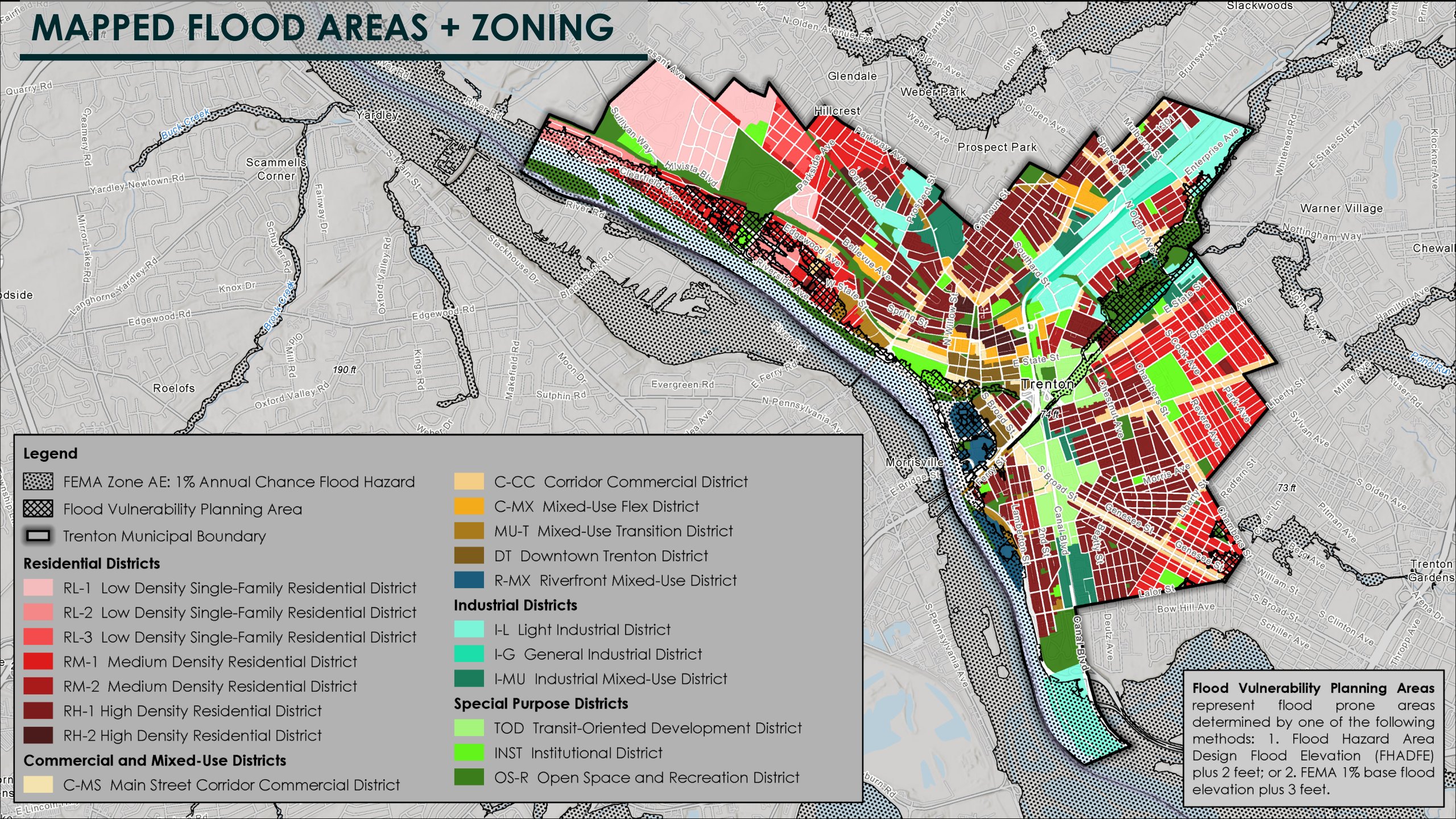
# MAPPED FLOOD AREAS + LAND USE / LAND COVER

## Flood Risk Area Expansion:

<b>Residential</b>	<b>+182%</b>
<b>Commercial and Mixed Use</b>	<b>+161%</b>
<b>Industrial</b>	<b>+118%</b>
<b>Recreational Land</b>	<b>+96%</b>
<b>Other Urban Land</b>	<b>+70%</b>
<b>Forest</b>	<b>+47%</b>
<b>Mixed Urban</b>	<b>+17%</b>



# MAPPED FLOOD AREAS + ZONING



**Legend**

- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- Trenton Municipal Boundary

**Residential Districts**

- RL-1 Low Density Single-Family Residential District
- RL-2 Low Density Single-Family Residential District
- RL-3 Low Density Single-Family Residential District
- RM-1 Medium Density Residential District
- RM-2 Medium Density Residential District
- RH-1 High Density Residential District
- RH-2 High Density Residential District

**Commercial and Mixed-Use Districts**

- C-MS Main Street Corridor Commercial District
- C-CC Corridor Commercial District
- C-MX Mixed-Use Flex District
- MU-T Mixed-Use Transition District
- DT Downtown Trenton District
- R-MX Riverfront Mixed-Use District

**Industrial Districts**

- I-L Light Industrial District
- I-G General Industrial District
- I-MU Industrial Mixed-Use District

**Special Purpose Districts**

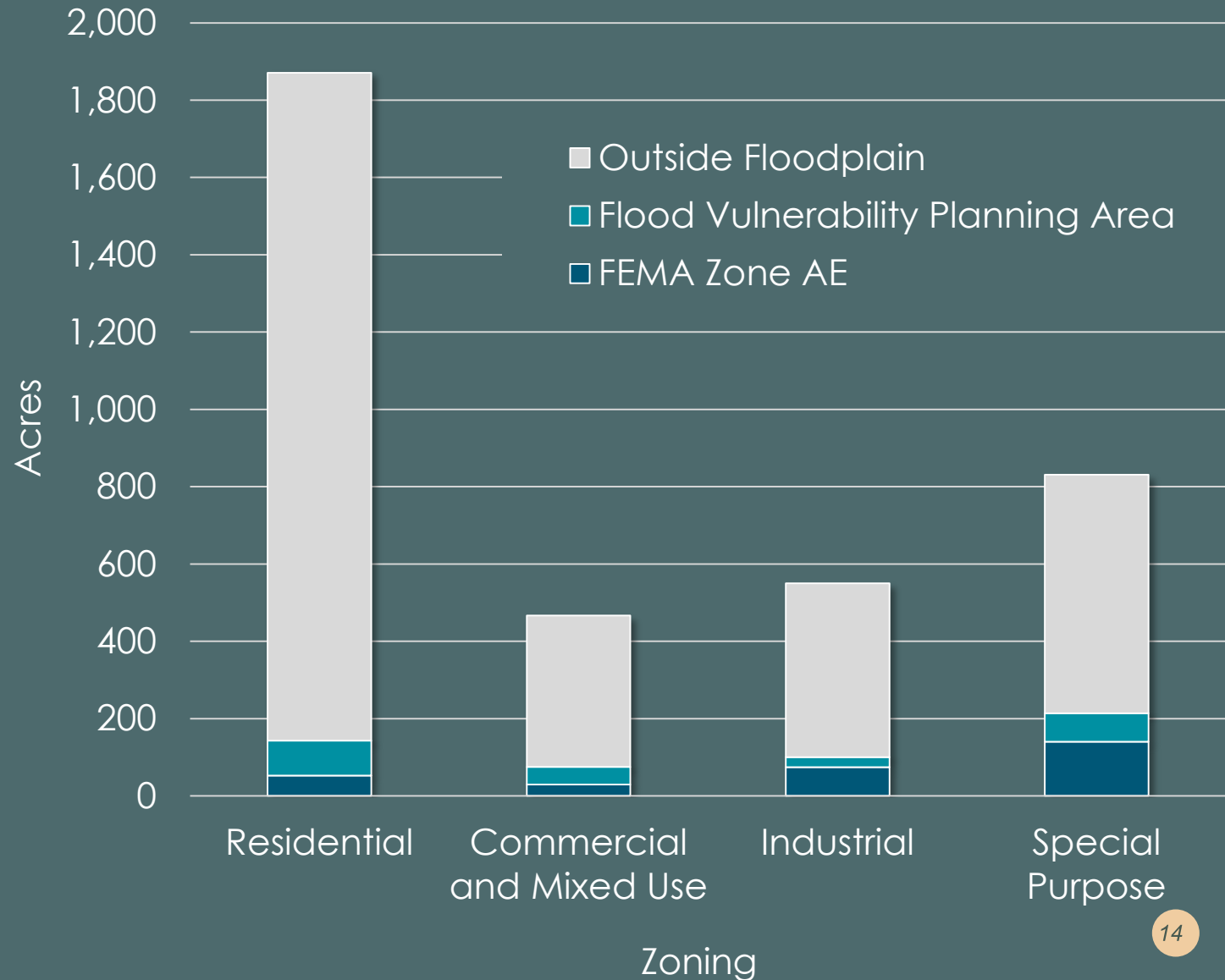
- TOD Transit-Oriented Development District
- INST Institutional District
- OS-R Open Space and Recreation District

**Flood Vulnerability Planning Areas** represent flood prone areas determined by one of the following methods: 1. Flood Hazard Area Design Flood Elevation (FHADFE) plus 2 feet; or 2. FEMA 1% base flood elevation plus 3 feet.

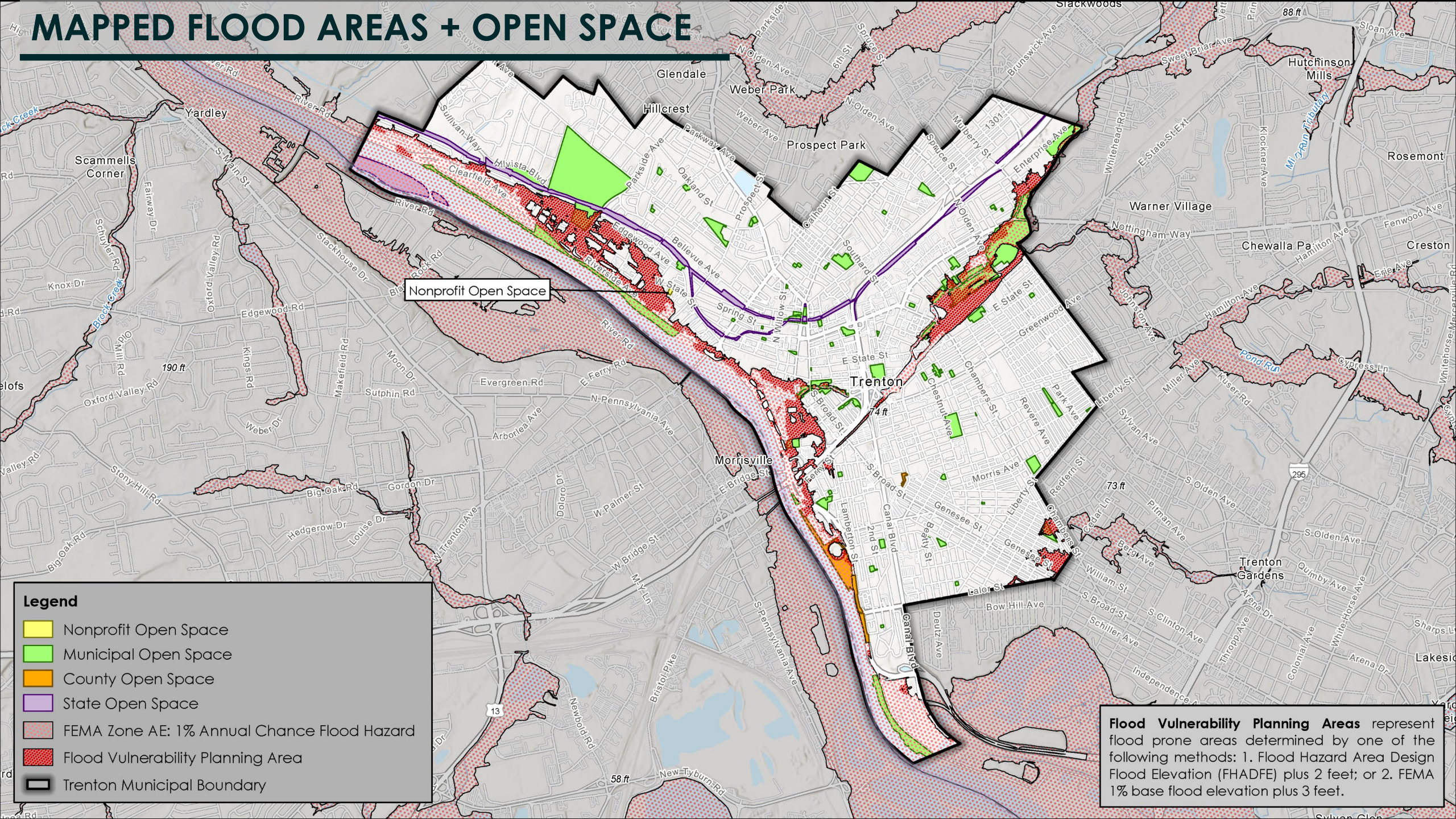
# MAPPED FLOOD AREAS + ZONING

## Flood Risk Area Expansion:

<b>Residential</b>	<b>+172%</b>
<b>Commercial and Mixed Use</b>	<b>+154%</b>
<b>Special purpose (Transit Oriented, institutional, Open Space)</b>	<b>+52%</b>
<b>Industrial</b>	<b>+35%</b>



# MAPPED FLOOD AREAS + OPEN SPACE



**Legend**

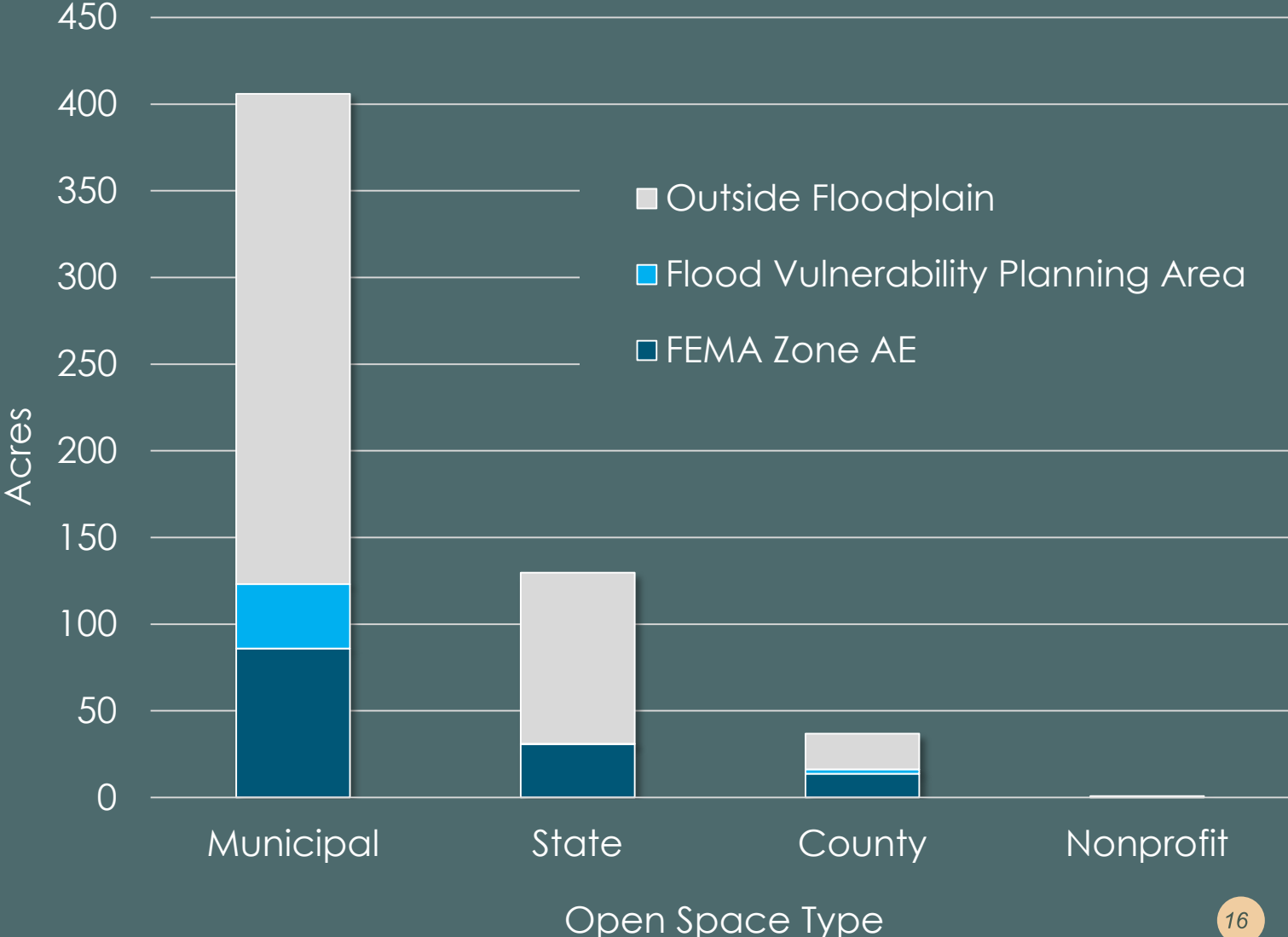
- Nonprofit Open Space
- Municipal Open Space
- County Open Space
- State Open Space
- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- Trenton Municipal Boundary

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# MAPPED FLOOD AREAS + OPEN SPACE

## Flood Risk Area Expansion:

<b>Municipal</b>	<b>+43%</b>
<b>State</b>	<b>+0.5%</b>
<b>County</b>	<b>+19%</b>
<b>Nonprofit</b>	<b>0%</b>
<b>Total</b>	<b>+30%</b>





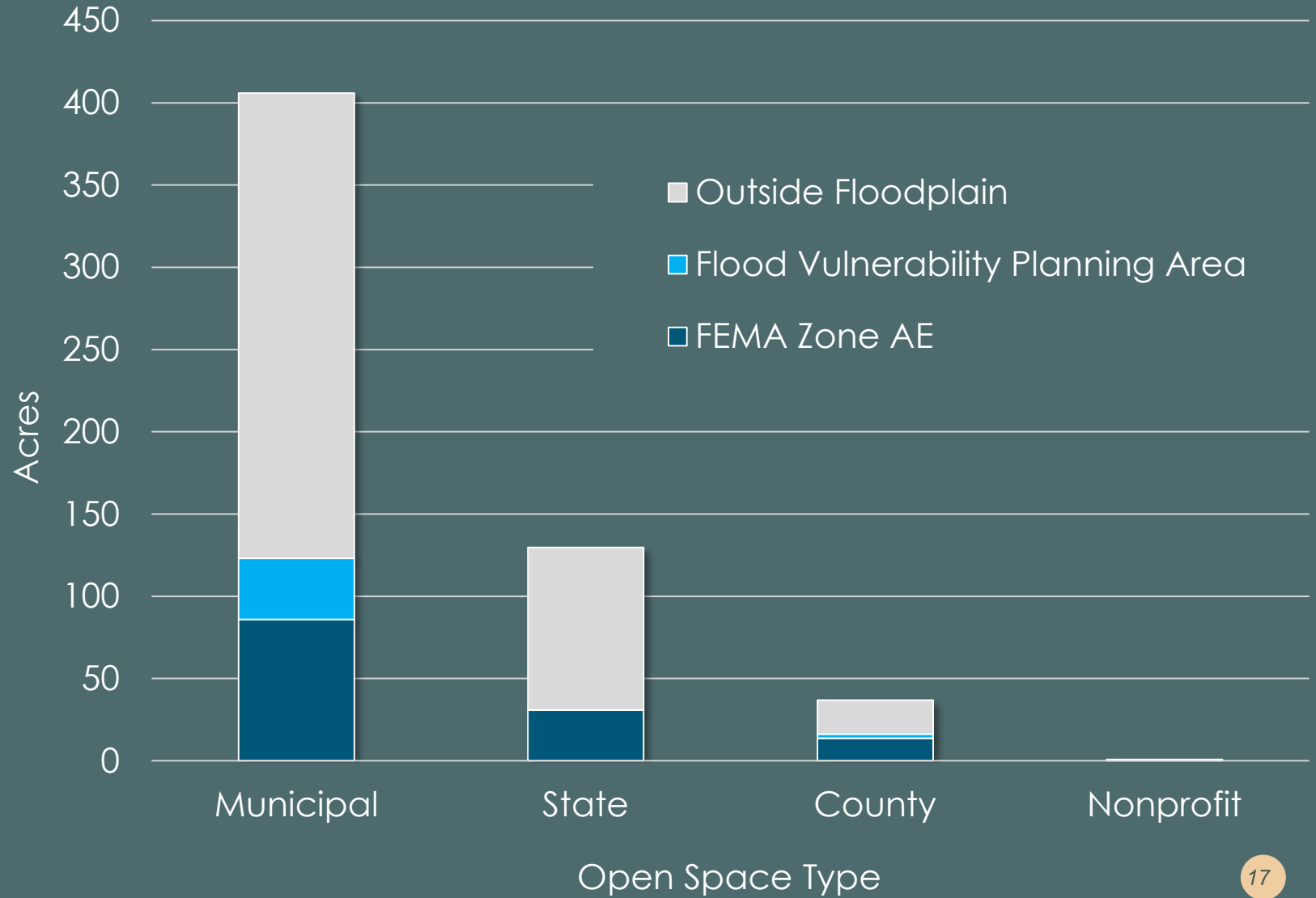
# MAPPED FLOOD AREAS + OPEN SPACE

- FEMA Zone AE:**

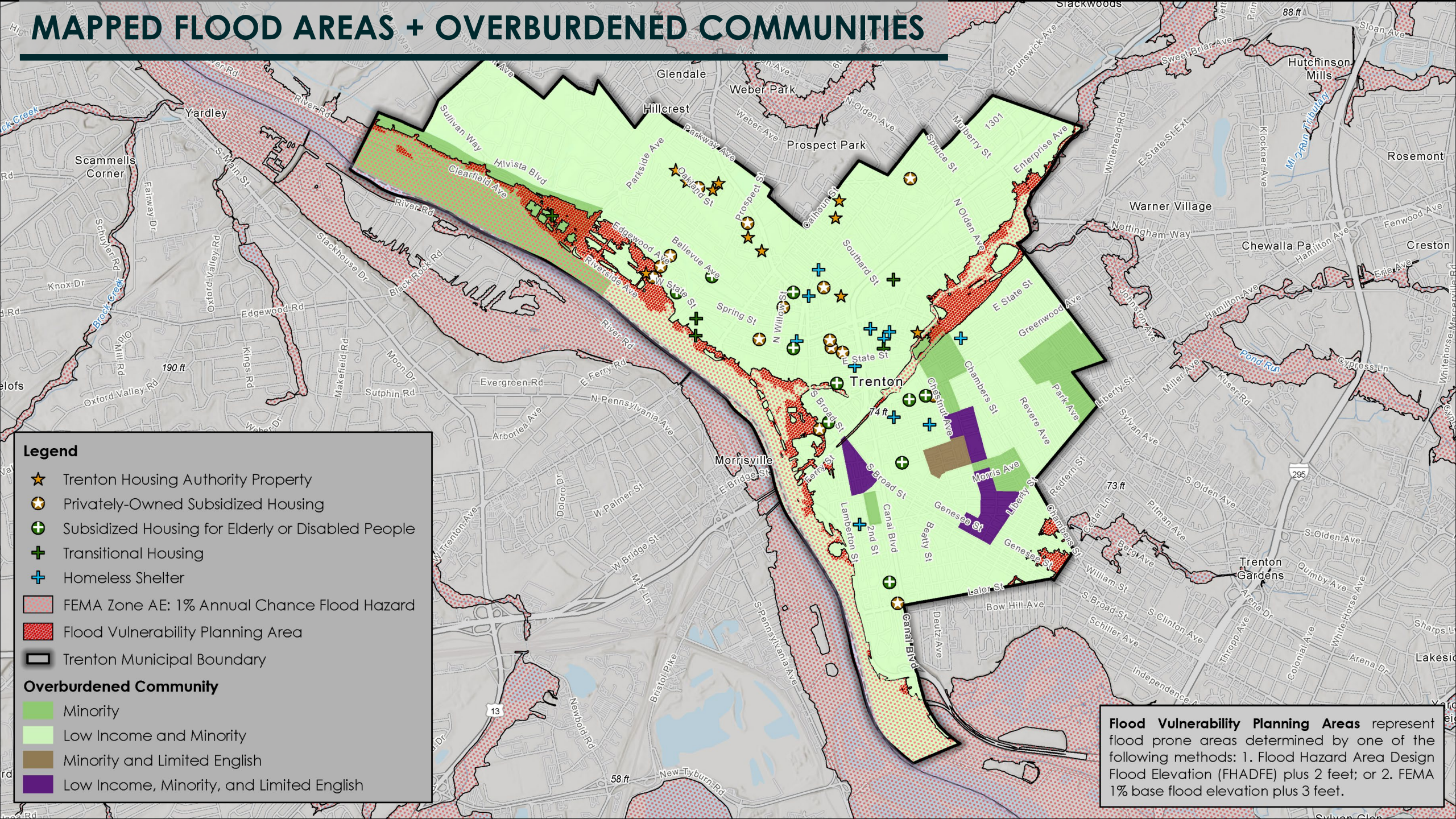
- Washington Crossing State Park (Rotary Island)
- Stacy Park
- Assunpink Center City Park
- Mill Hill Park
- Old Wharf
- Waterfront Park
- Marine Terminal Park
- Monmouth Field
- Amtico Square Park
- Assunpink Greenway
- Hetzel Field
- George Page Park

- Flood Vulnerability Planning Area:**

- Cadwalader Park
- Trent House
- Bridge Street Park
- Franklin Park



# MAPPED FLOOD AREAS + OVERBURDENED COMMUNITIES



## Legend

- ★ Trenton Housing Authority Property
- ★ (with star in circle) Privately-Owned Subsidized Housing
- ⊕ (with star in circle) Subsidized Housing for Elderly or Disabled People
- ⊕ (with plus in circle) Transitional Housing
- ⊕ (with plus in square) Homeless Shelter
- ▨ (red hatched) FEMA Zone AE: 1% Annual Chance Flood Hazard
- ▨ (red dotted) Flood Vulnerability Planning Area
- ▭ (thick black line) Trenton Municipal Boundary

## Overburdened Community

- (light green) Minority
- (yellow-green) Low Income and Minority
- (brown) Minority and Limited English
- (purple) Low Income, Minority, and Limited English

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# MAPPED FLOOD AREAS + OVERBURDENED COMMUNITIES

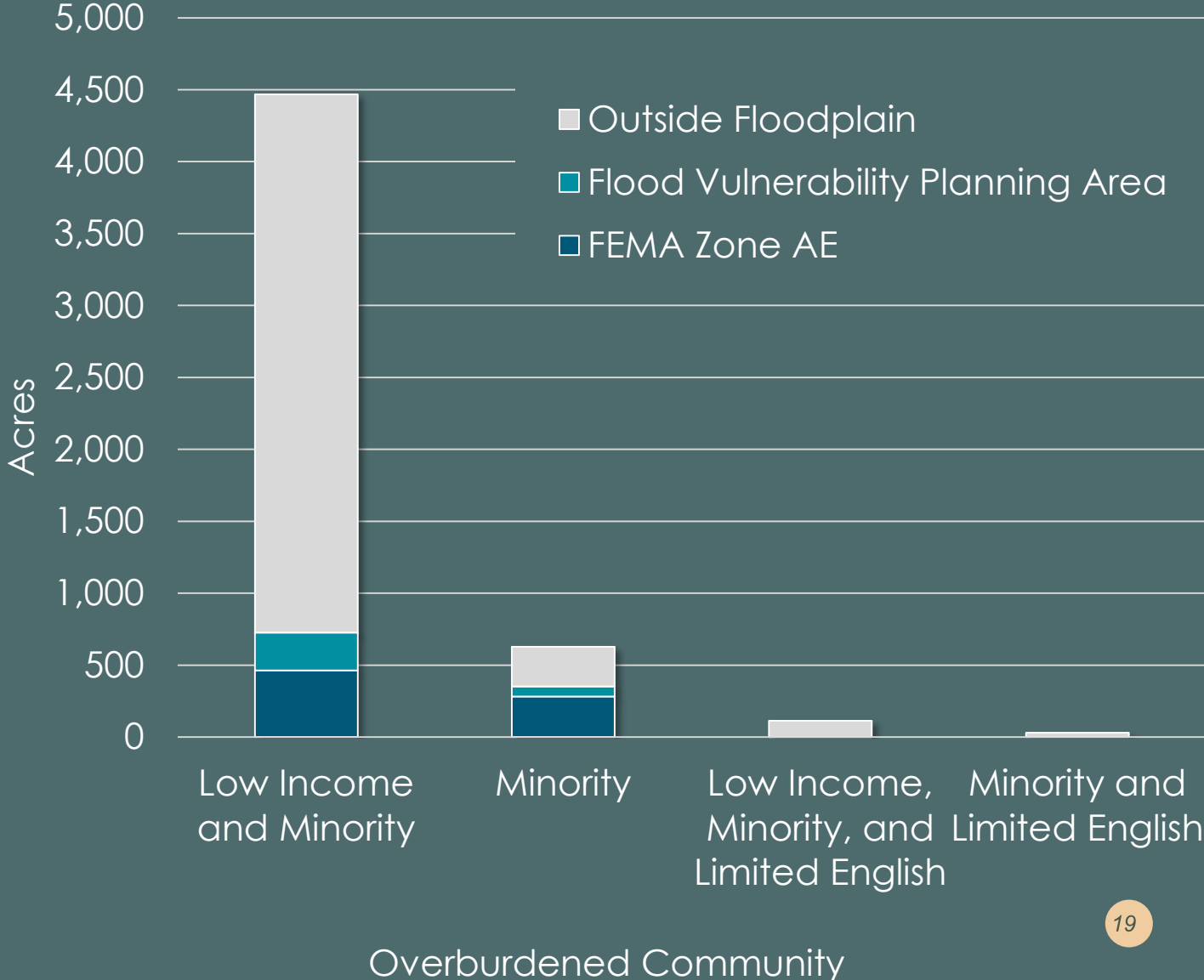
**Flood Risk Area Expansion:**

**Low Income and Minority**      **+57%**

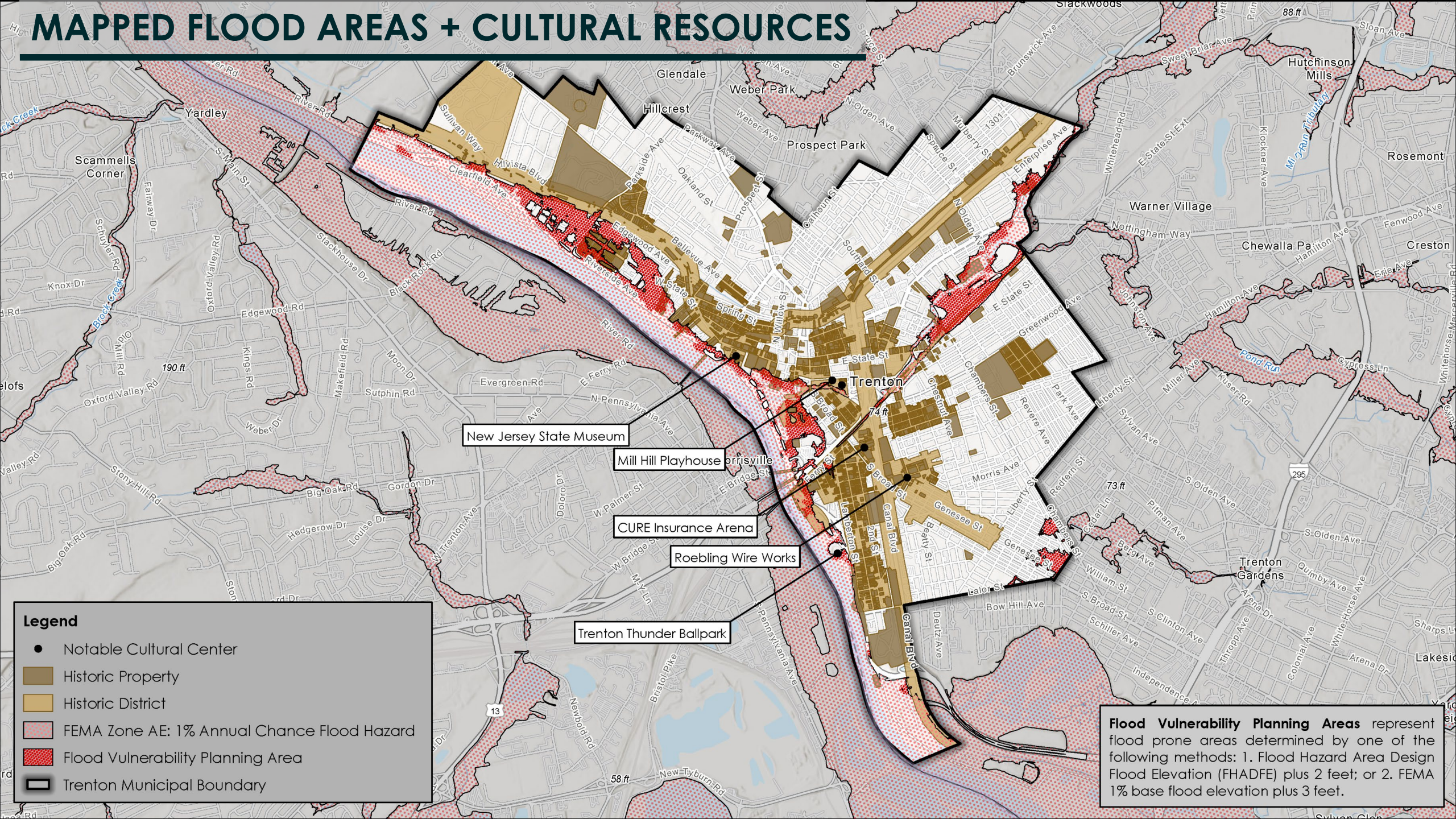
**Minority**      **+25%**

**Public, subsidized, and transitional housing complexes that would be added in the Flood Vulnerability Planning Area:**

- J. Conner French Towers
- Rowan Towers
- Oxford House West State
- Freedom House
- Kingsbury Corporation



# MAPPED FLOOD AREAS + CULTURAL RESOURCES



**Legend**

- Notable Cultural Center
- Historic Property
- Historic District
- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- ▭ Trenton Municipal Boundary

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# MAPPED FLOOD AREAS + CULTURAL RESOURCES

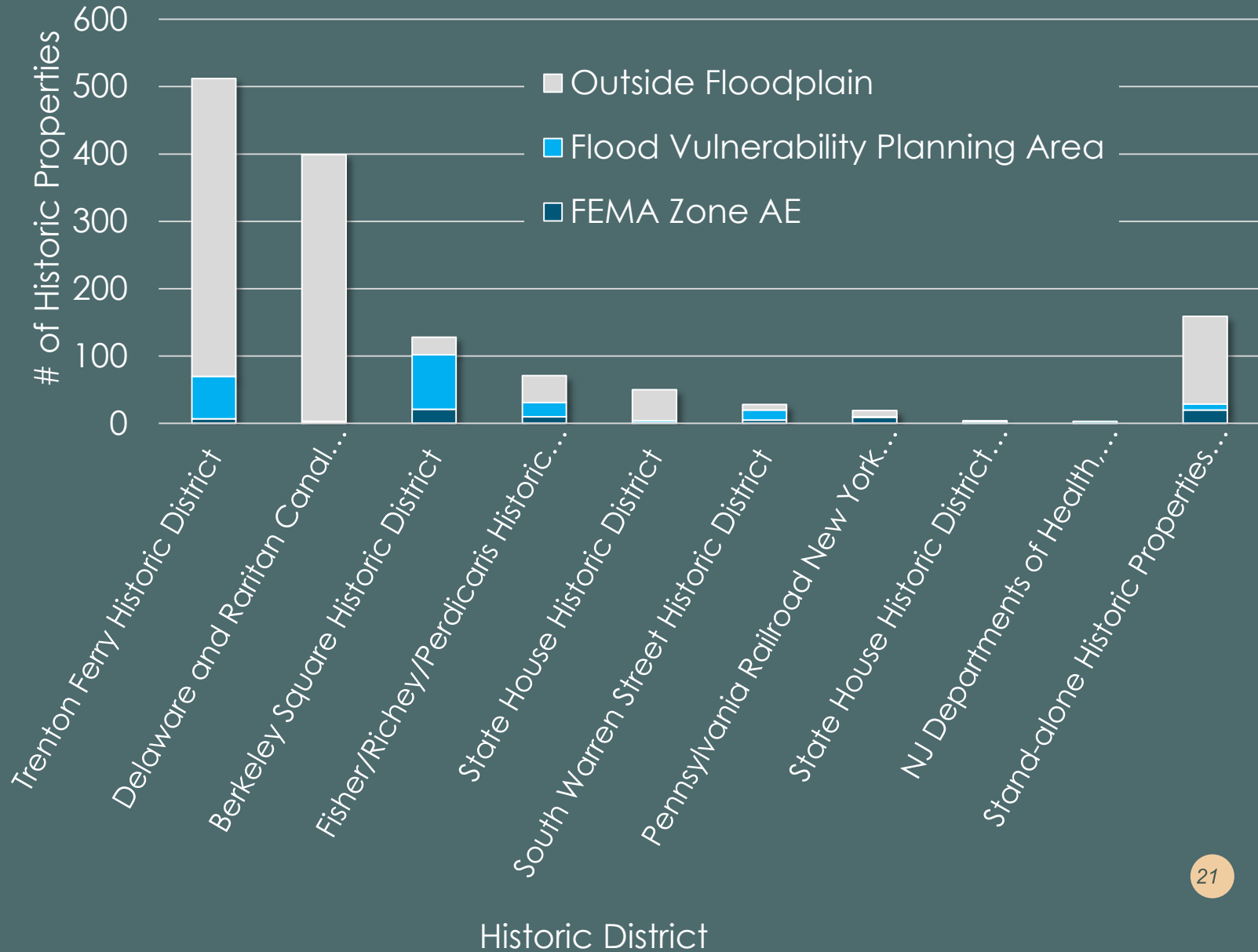
## Flood Risk Area Expansion:

Berkeley Square Historic District  
21 → 102 (+81)

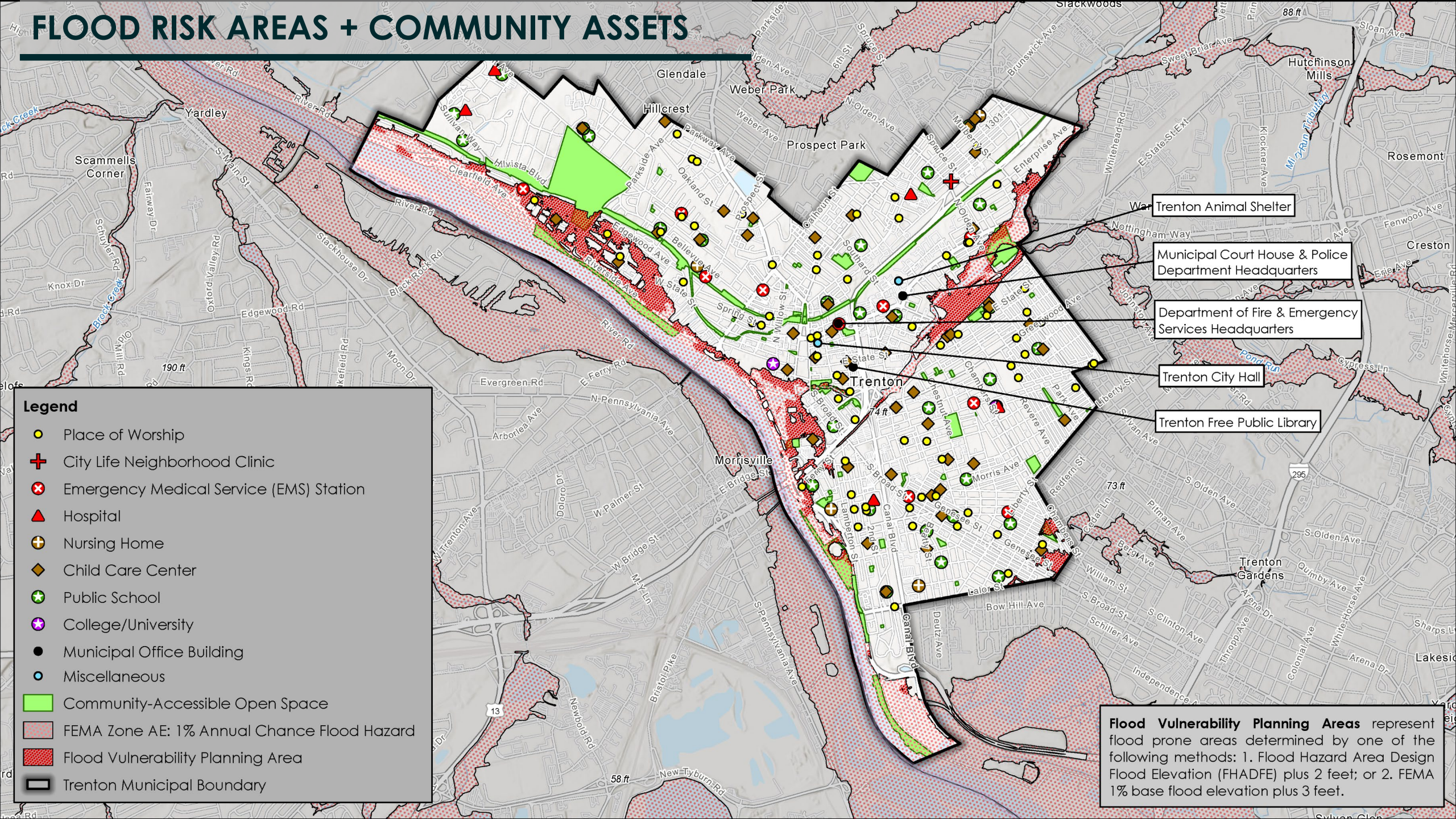
Trenton Ferry Historic District  
7 → 70 (+63)

Fisher/Richey/Perdicaris Historic District  
10 → 31 (+21)

South Warren Street Historic District  
5 → 20 (+15)



# FLOOD RISK AREAS + COMMUNITY ASSETS



## Legend

- Place of Worship
- City Life Neighborhood Clinic
- Emergency Medical Service (EMS) Station
- Hospital
- Nursing Home
- Child Care Center
- Public School
- College/University
- Municipal Office Building
- Miscellaneous
- Community-Accessible Open Space
- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- Trenton Municipal Boundary

- Trenton Animal Shelter
- Municipal Court House & Police Department Headquarters
- Department of Fire & Emergency Services Headquarters
- Trenton City Hall
- Trenton Free Public Library

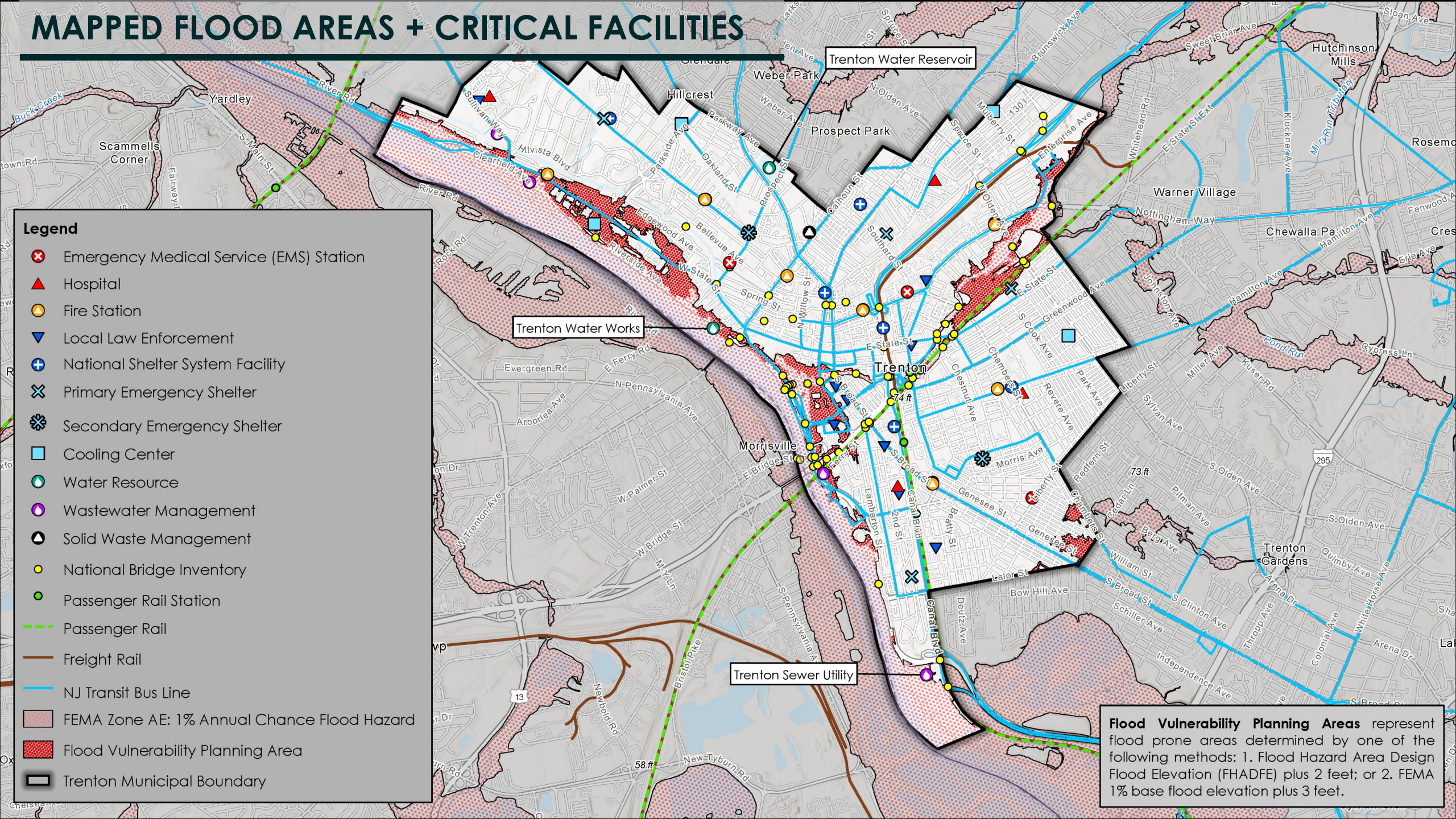
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# MAPPED FLOOD AREAS + COMMUNITY ASSETS

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- **FEMA Zone AE:**
  - Greater Emmanuel Pentecostal Church Of God
- **Flood Vulnerability Planning Area:**
  - Trenton Fire And Emergency Services Engine 9
  - Friends West State Child Development Center
  - Elect Saints Pentecostal Church
  - Spiritual Gates Of Prayer

# MAPPED FLOOD AREAS + CRITICAL FACILITIES



## Legend

- ⊕ Emergency Medical Service (EMS) Station
- ▲ Hospital
- Fire Station
- ▼ Local Law Enforcement
- + National Shelter System Facility
- ⊗ Primary Emergency Shelter
- ⊗ Secondary Emergency Shelter
- Cooling Center
- Water Resource
- Wastewater Management
- ▲ Solid Waste Management
- National Bridge Inventory
- Passenger Rail Station
- Passenger Rail
- Freight Rail
- NJ Transit Bus Line
- ▨ FEMA Zone AE: 1% Annual Chance Flood Hazard
- ▨ Flood Vulnerability Planning Area
- Trenton Municipal Boundary

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# MAPPED FLOOD AREAS + CRITICAL FACILITIES

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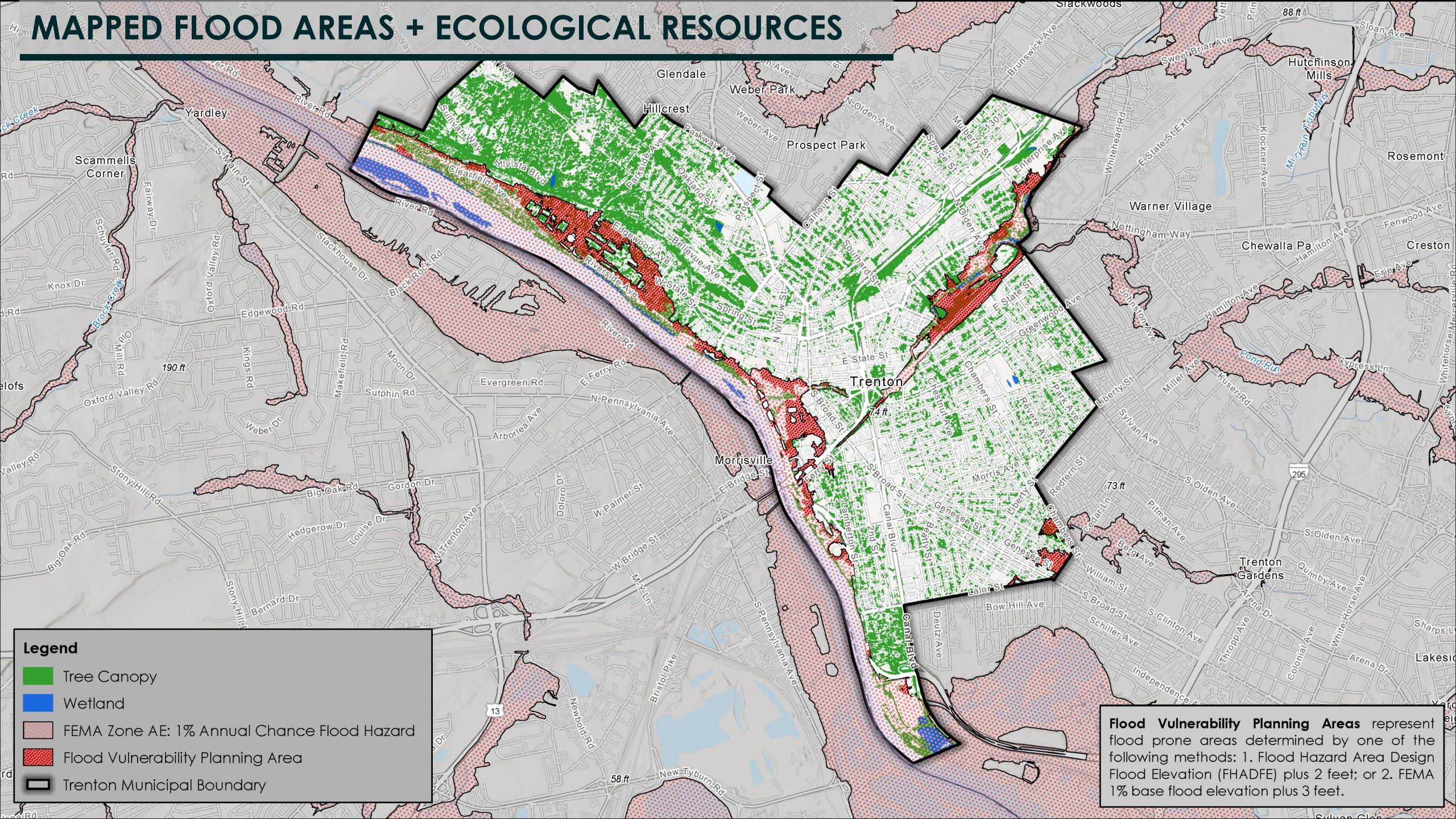
- **FEMA Zone AE:**

- Trenton Waterworks
- Ferry Street Pump Station
- Clearfield Ave. Lift Station
- Trenton Transit Center
- Portion of Bus Lines 418, 601, 606, 608, 609, 611, 619, 624

- **Flood Vulnerability Planning Area:**

- Trenton Fire and Emergency Services Engine 9
- Portions of Bus Lines 343, 603, 607

# MAPPED FLOOD AREAS + ECOLOGICAL RESOURCES



**Legend**

- Tree Canopy
- Wetland
- FEMA Zone AE: 1% Annual Chance Flood Hazard
- Flood Vulnerability Planning Area
- Trenton Municipal Boundary

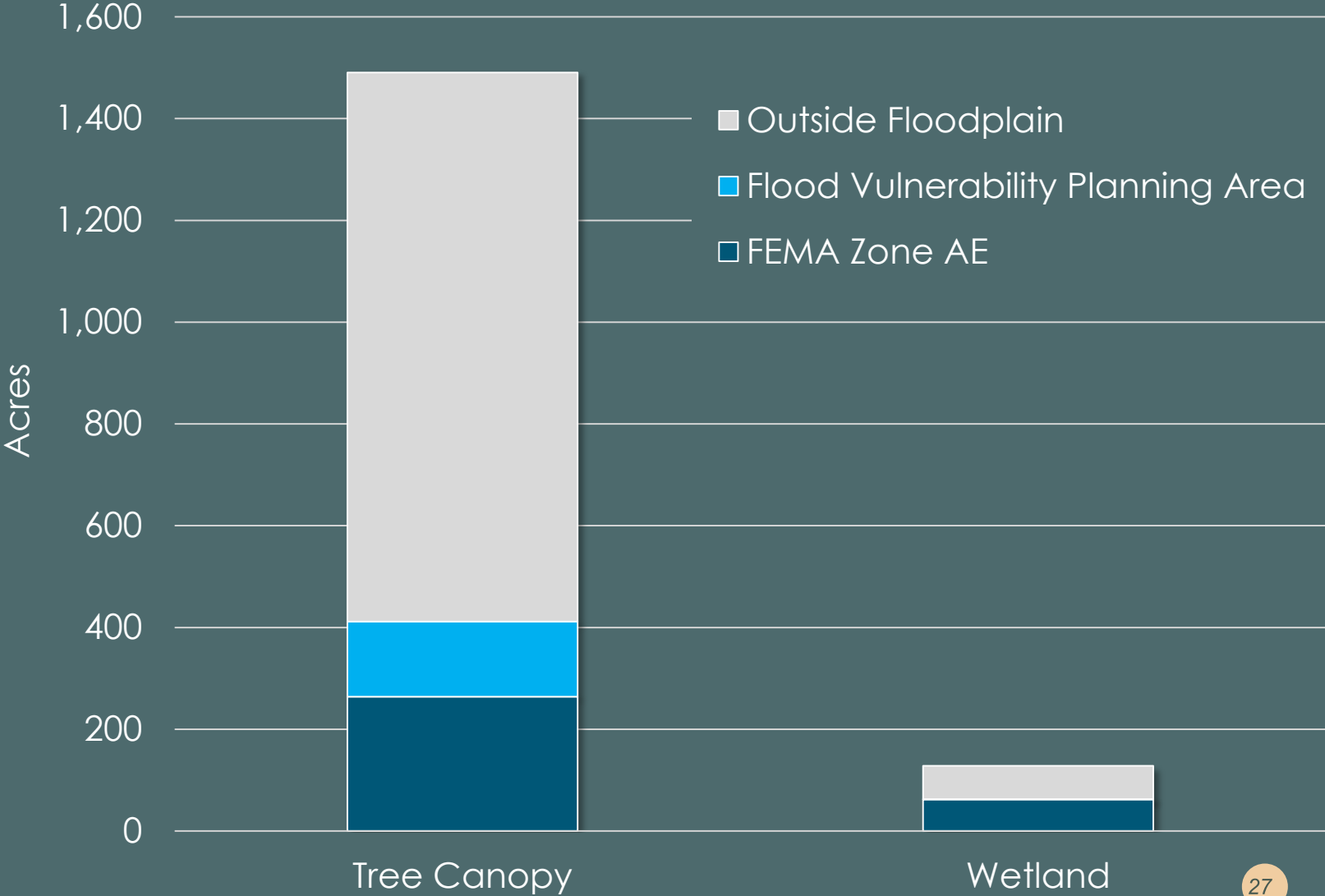
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# MAPPED FLOOD AREAS + ECOLOGICAL RESOURCES

## Flood Risk Area Expansion:

Tree Canopy +56%

Wetland +1%



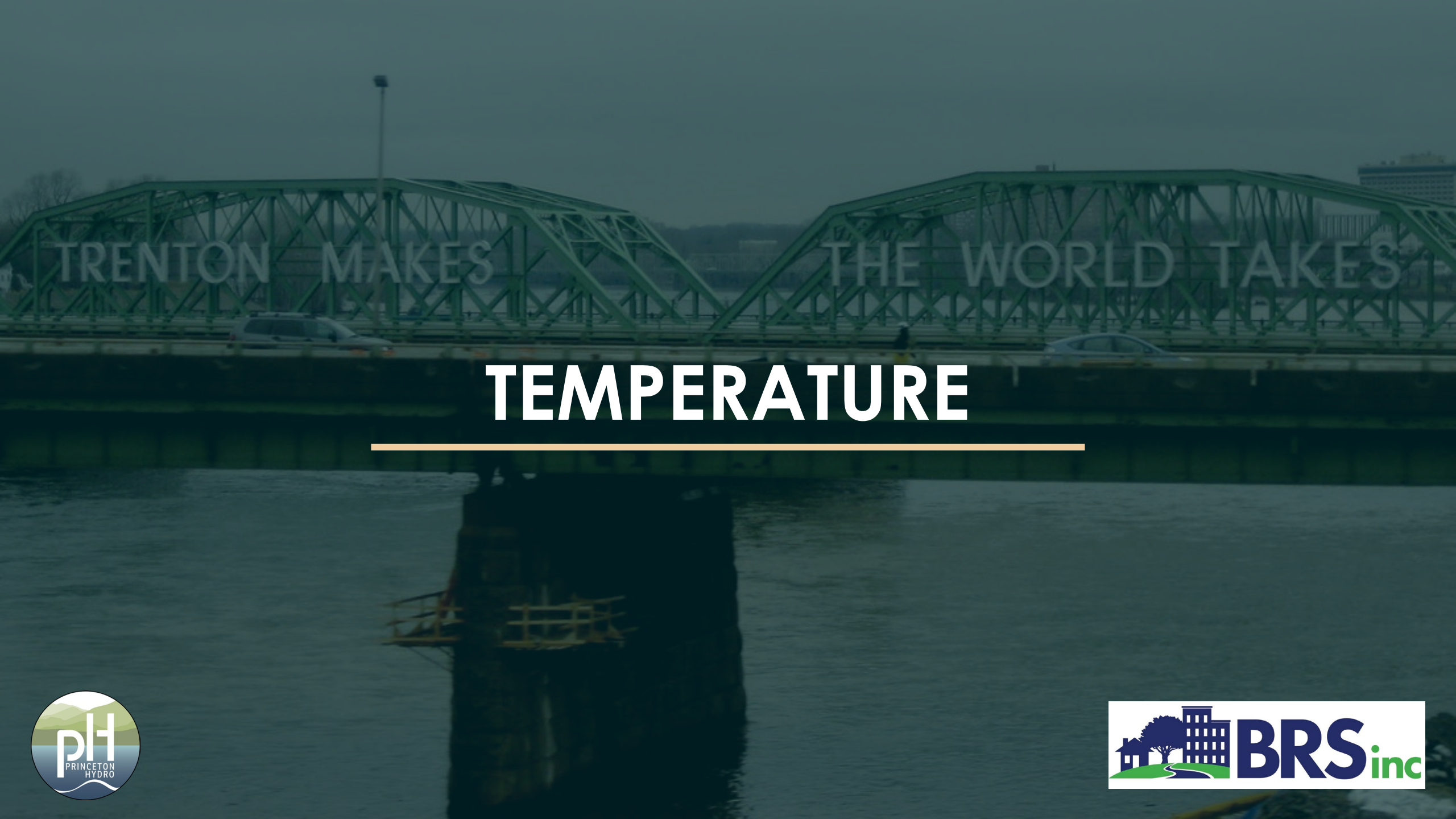
Ecological Resource



# QUESTIONS?

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# TEMPERATURE

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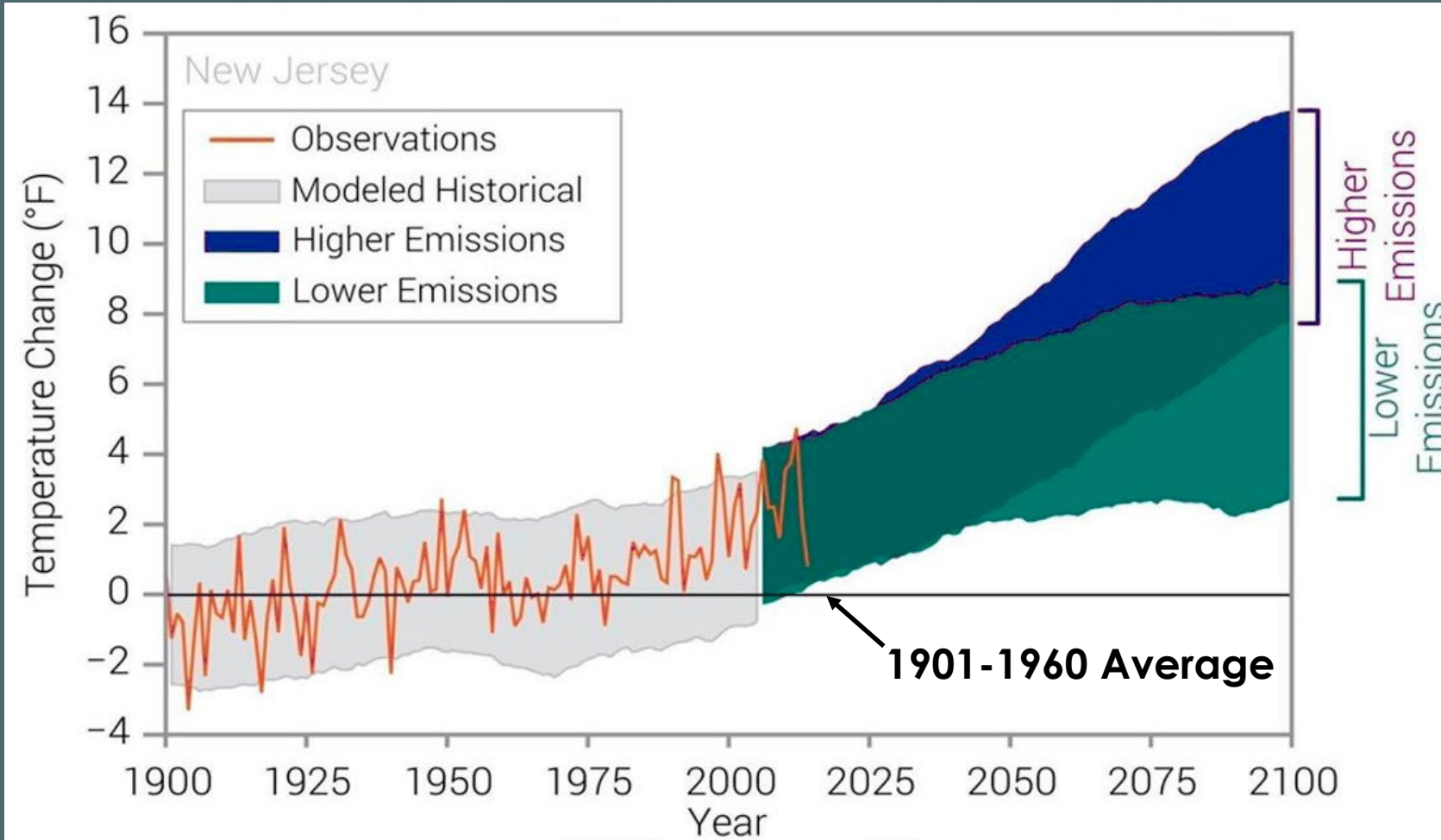
# NEW JERSEY TEMPERATURE PREDICTIONS

- New Jersey is warming faster than the rest of the Northeast region and the world.
- Since 1895, New Jersey's annual temperature has increased by 3.5°F.
- Historically unprecedented warming is projected for the 21st century with average annual temperatures in New Jersey increasing by 4.1°F to 5.7°F by 2050.
- Heatwaves are expected to impact larger areas, with more frequency and longer duration by 2050.
- Climate change could result in a 55% increase in summer heat-related mortalities.

Trenton's Regional Annual and Seasonal Increases in Air Temperatures, 1895 to 2019

Season	Temperature Increase (°F)
Winter	+4.6
Spring	+2.9
Summer	+3.1
Fall	+2.8
Annual	+3.4

# NEW JERSEY TEMPERATURE PREDICTIONS



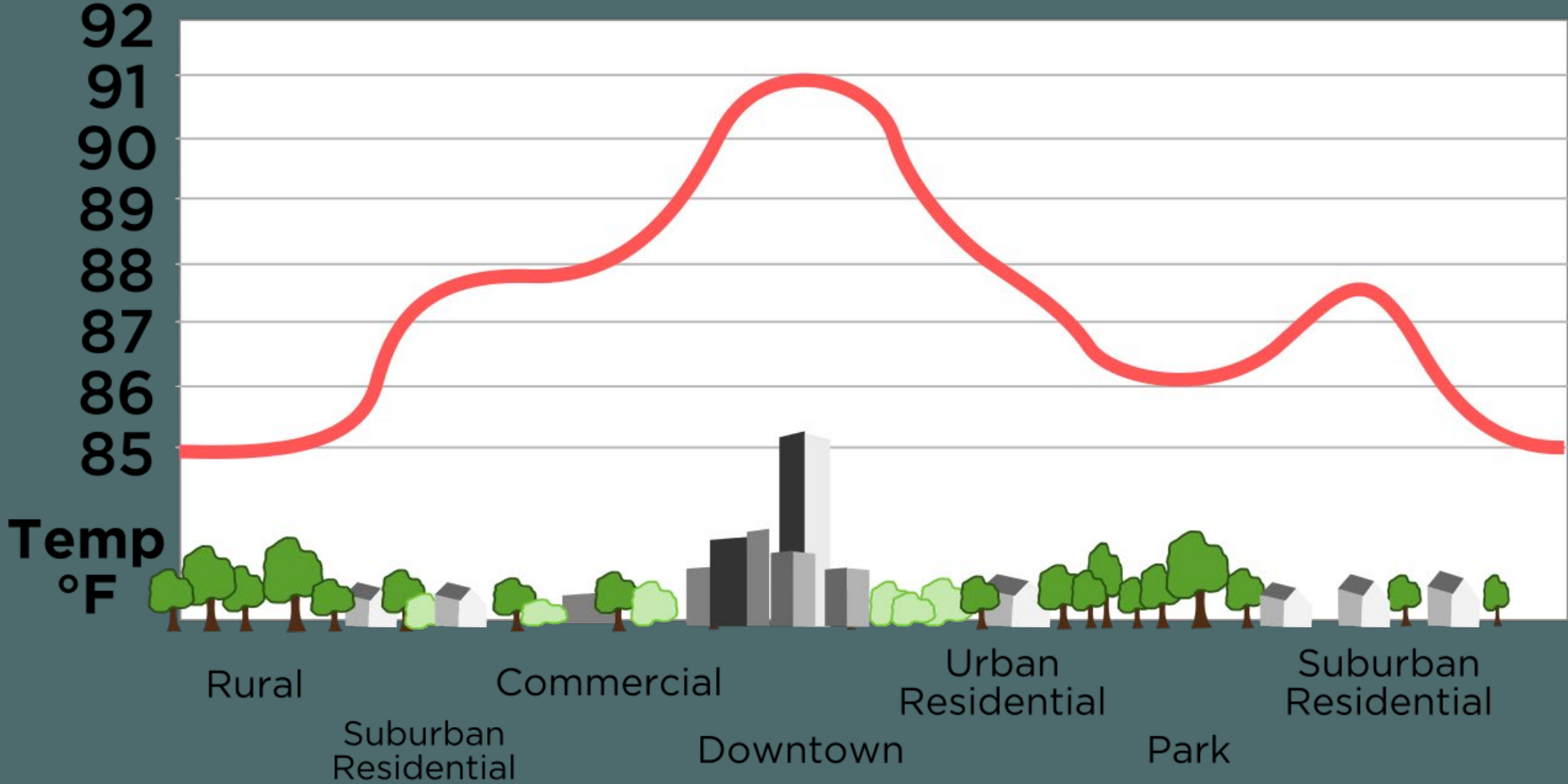
Year	Low Emissions	High Emissions
2050	+ 1°F - 6°F	
2100	+ 3°F - 9°F	+ 6°F - 13°F

-2020 New Jersey Scientific Report on Climate Change

**Observed and Projected Changes in Near-Surface Air Temperature for New Jersey.** Observed data are for 1900-2014. Projected changes are for 2006-2100 (Runkle et al. 2017).

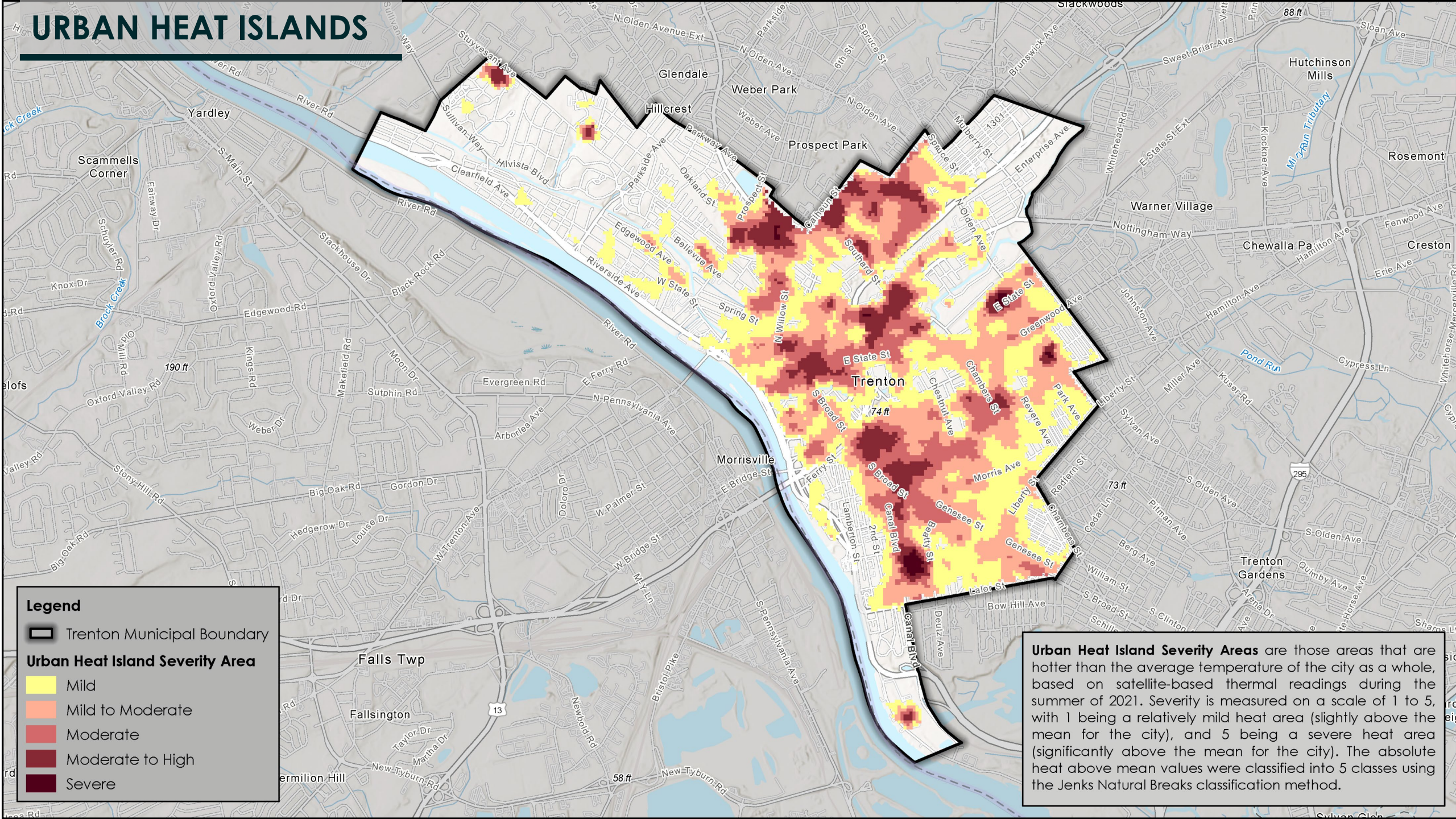
# THE URBAN HEAT ISLAND EFFECT

## URBAN HEAT ISLAND PROFILE





# URBAN HEAT ISLANDS



**Legend**

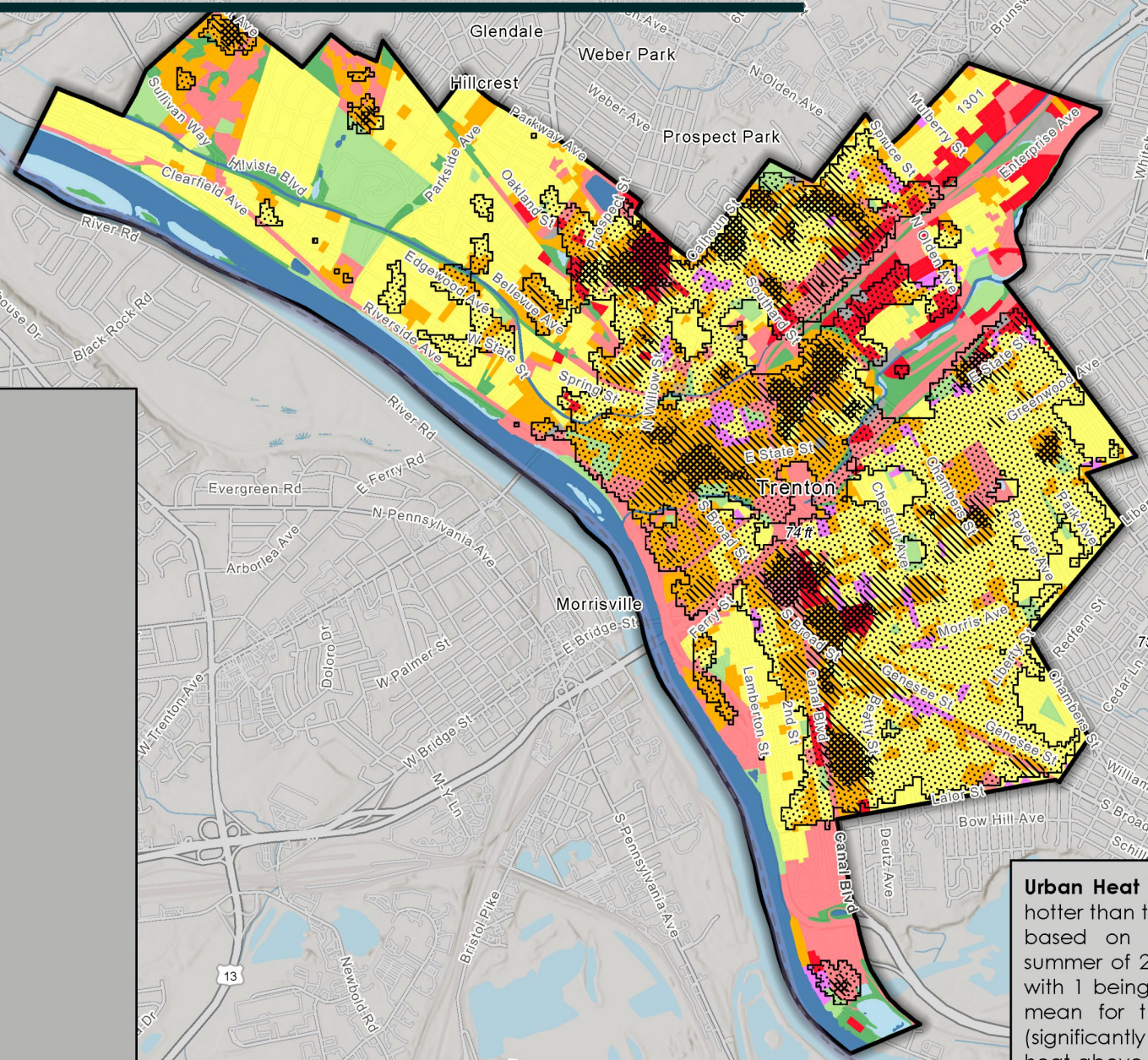
- Trenton Municipal Boundary
- Urban Heat Island Severity Area**
  - Mild
  - Mild to Moderate
  - Moderate
  - Moderate to High
  - Severe

**Urban Heat Island Severity Areas** are those areas that are hotter than the average temperature of the city as a whole, based on satellite-based thermal readings during the summer of 2021. Severity is measured on a scale of 1 to 5, with 1 being a relatively mild heat area (slightly above the mean for the city), and 5 being a severe heat area (significantly above the mean for the city). The absolute heat above mean values were classified into 5 classes using the Jenks Natural Breaks classification method.

# URBAN HEAT ISLANDS + LAND USE / LAND COVER

**Legend**

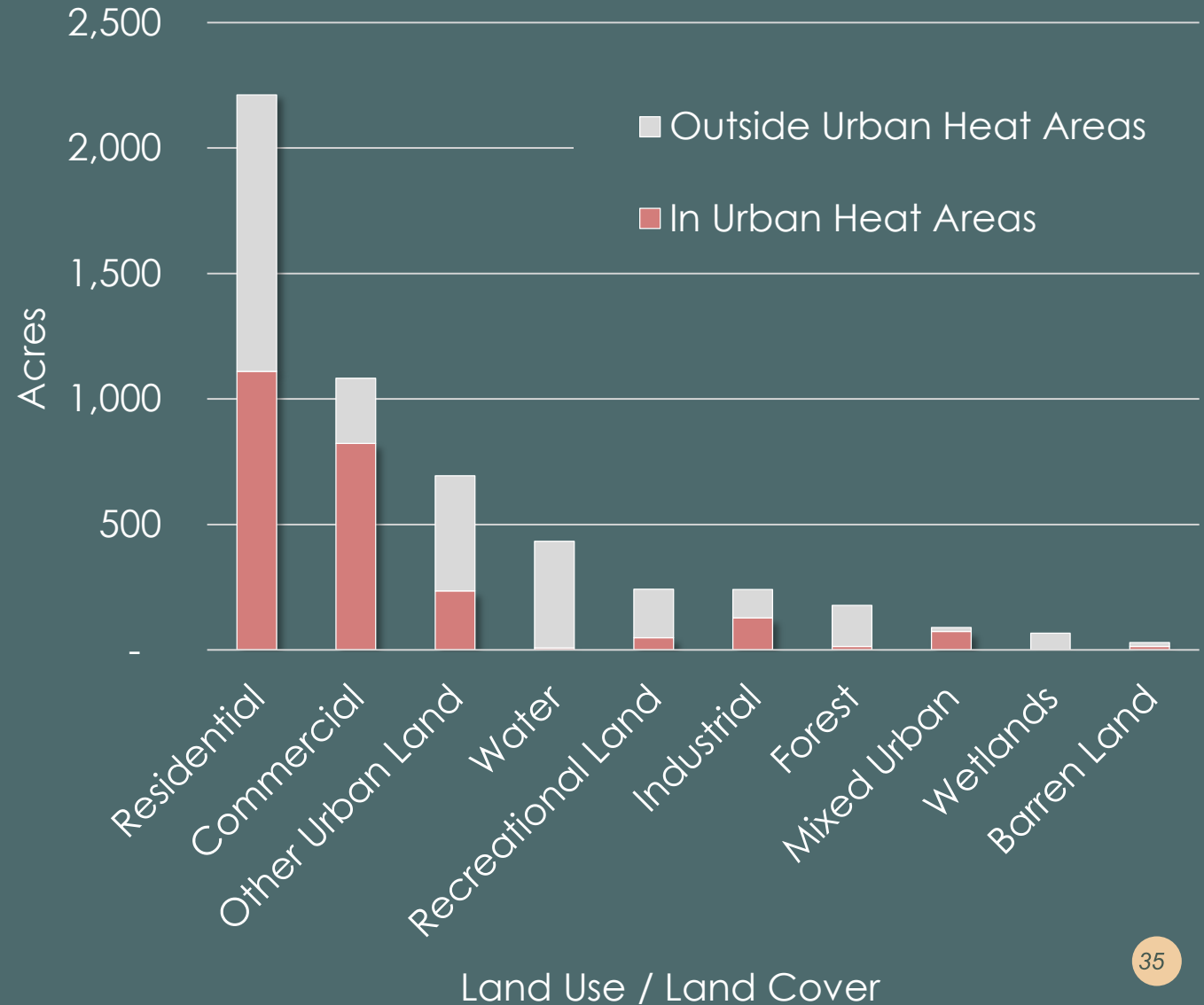
-  Trenton Municipal Boundary
- Urban Heat Island Severity Area**
-  Mild to Moderate
-  Moderate
-  Moderate to Severe
- Non-Urban Land Use/Land Cover**
-  Agriculture
-  Barren Land
-  Forest
-  Water
-  Wetlands
- Urban Land Use/Land Cover**
-  Recreational Land
-  Residential
-  Commercial
-  Industrial
-  Mixed Urban
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# TRENTON'S URBAN HEAT ISLANDS + LAND USE / LAND COVER

- **Forest, water, wetlands, and recreational land are less likely to be within urban heat areas.**
  - **< 2% of water and wetlands**
  - **8% of forest**
  - **20% of recreation land**
- **Residential and industrial land are about equally likely to be within or outside of urban heat areas.**
- **Commercial and mixed urban lands are more likely to be within urban heat areas**
  - **76% of commercial lands**
  - **82% of mixed urban lands**



# Commercial Urban Heat Area



# RESIDENTIAL URBAN HEAT AREA

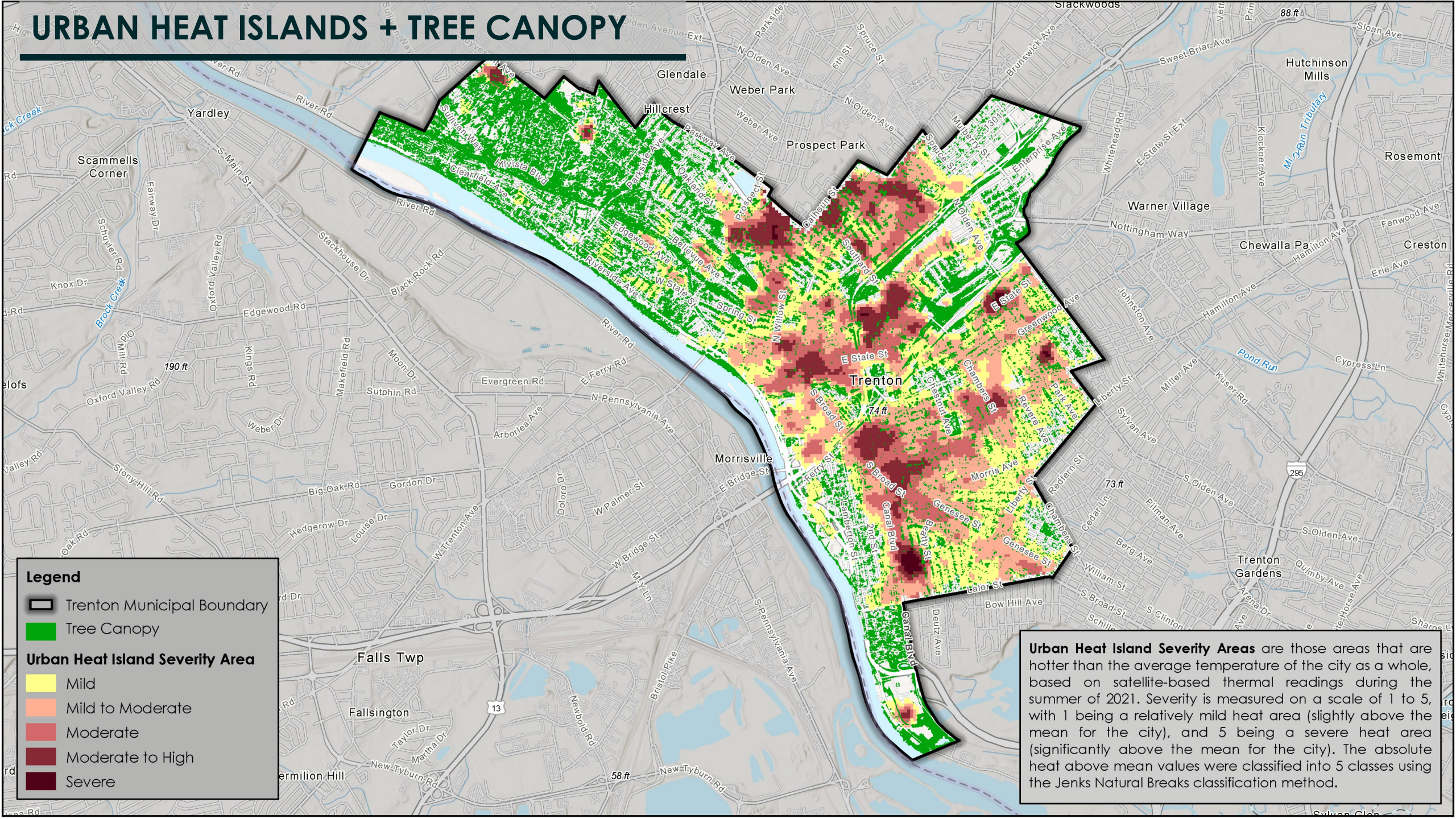
## Outside of an Urban Heat Area



## Inside of an Urban Heat Area



# URBAN HEAT ISLANDS + TREE CANOPY



**Legend**

- Trenton Municipal Boundary
- Tree Canopy

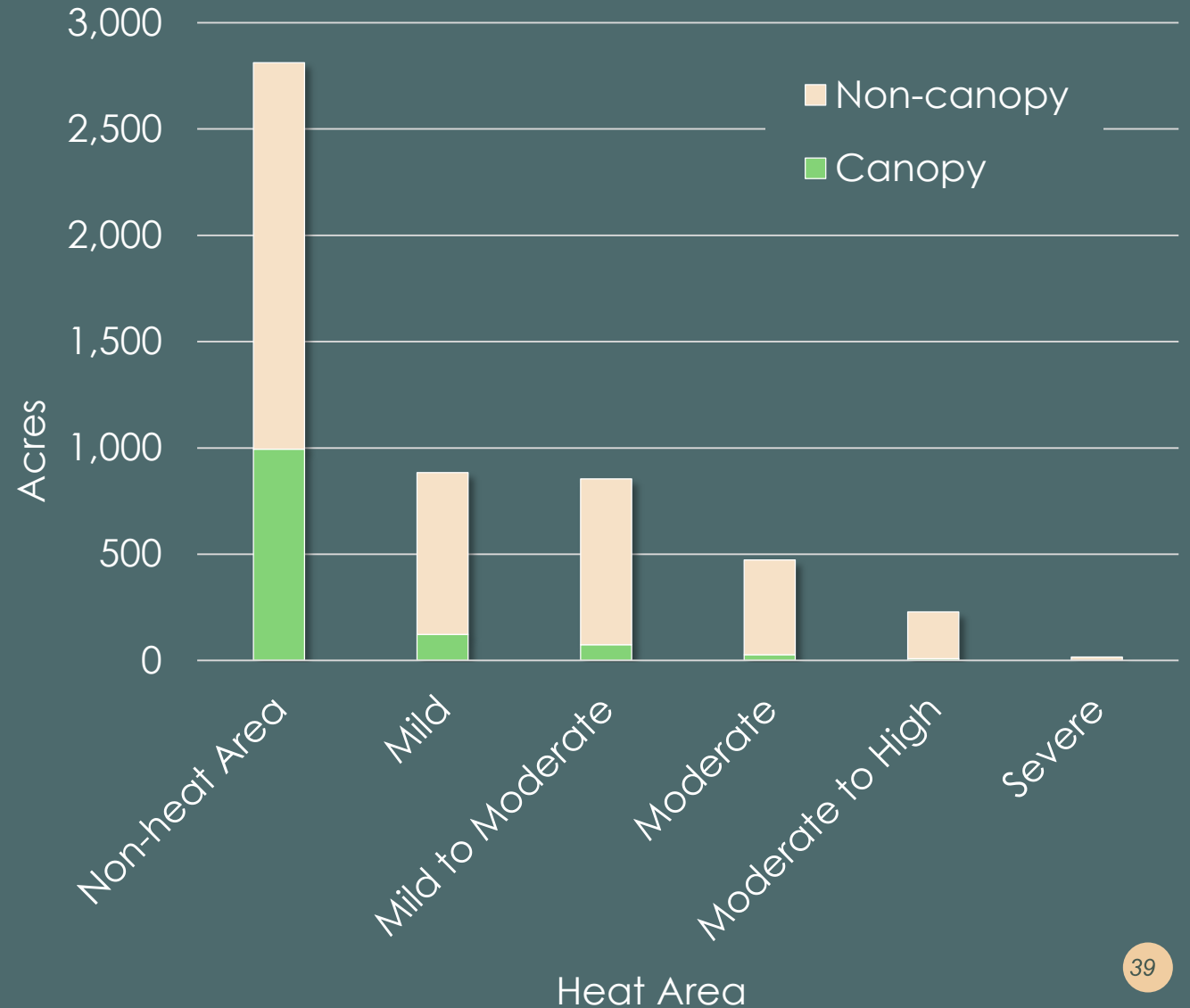
**Urban Heat Island Severity Area**

- Mild
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# TRENTON'S URBAN HEAT ISLANDS + TREE CANOPY

- About 23% of the city is covered by tree canopy.
- About 91% of urban heat areas are within non-canopy areas.
- About 81% of canopy covered areas are outside of urban heat areas.



# URBAN HEAT ISLANDS + VULNERABLE POPULATIONS

**Legend**

- Trenton Municipal Boundary
- U.S. Census Tract

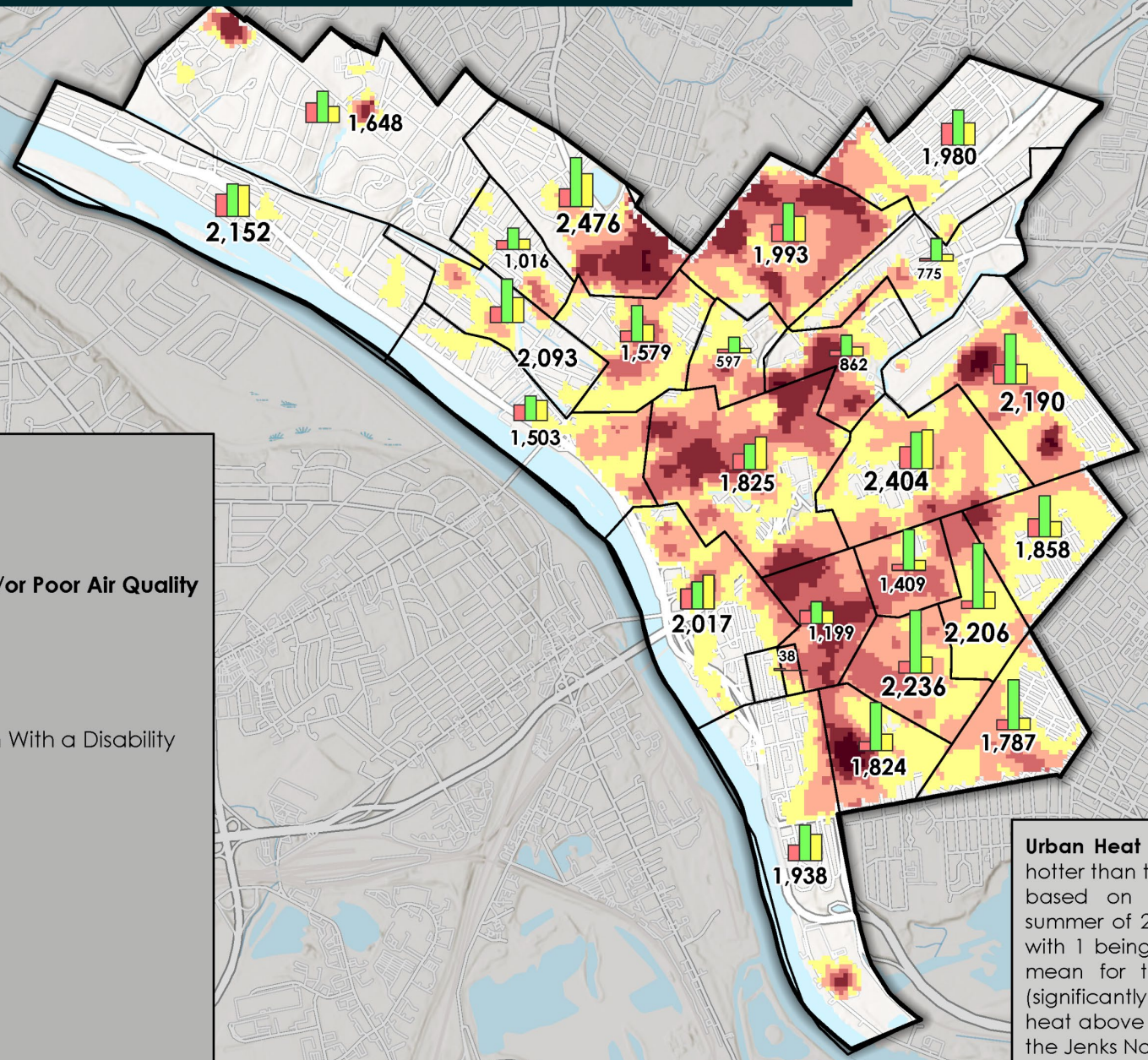
**Population Vulnerable to Extreme Heat and/or Poor Air Quality**

- Persons Aged 65 and Older
- Persons Aged 17 and Younger
- Civilian Noninstitutionalized Population With a Disability

2,000  
1,000  
0

**Urban Heat Island Severity Area**

- Mild
- Mild to Moderate
- Moderate
- Moderate to High
- Severe



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# QUESTIONS?

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