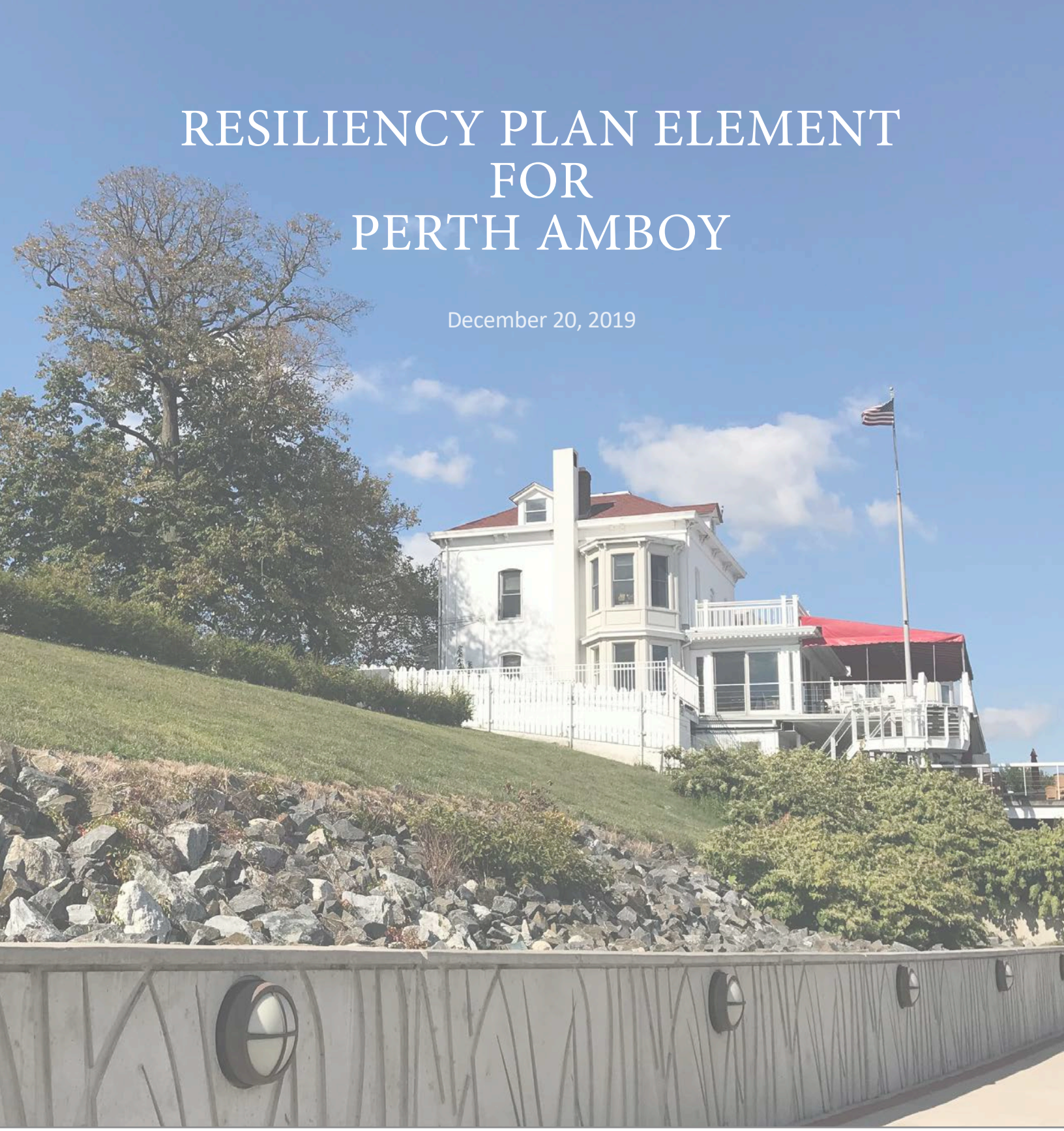
RESILIENCY PLAN ELEMENT FOR PERTH AMBOY

December 20, 2019



Resilient Perth Amboy Graduate Studio
Edward J. Bloustein School of Planning & Public Policy

RESILIENCY PLAN ELEMENT FOR PERTH AMBOY

Table of Contents

Acknowledgements

We'd like to thank the following Perth Amboy stakeholders for your guidance throughout the studio and hope that our research and recommendations can help to inform future City decision-making and policy:

Tashi L. Vazquez
Program Manager
City of Perth Amboy

Frederick C. Carr
Business Administrator
City of Perth Amboy

Larry Cattano
Deputy Chief
Perth Amboy Police Department

Geri Barcheski
Perth Amboy Green Team

Bill Schultz
Raritan Riverkeeper

Maximo Vazquez
Perth Amboy Expert

Frank Hoffman
Director of Public Works
City of Perth Amboy

Maritza Rodriguez
Office of Economic Development
City of Perth Amboy

Steve Jobin
Executive Director
Raritan Bay YMCA

Project Team

Instructor: Robert Freudenberg

Julie Blum
James Clavelli
Carolina Guzman
Carolyn Iwicki
Caroline Martin
Sarah Murphy
Nisan Novack
Sam Salvesen
John Sousa
Ellen O. White
Amanda Williams

Chapter 1.
Executive Summary

Executive Summary

Perth Amboy is a waterfront city, which brings unique economic, social, and aesthetic benefits. The Green Infrastructure and Water Quality section of this report seeks to take advantage of the benefits of the city's waterfront while combating the climate threats. Green infrastructure can help Perth Amboy accomplish this goal while improving the quality of the surrounding water bodies.

We strive to use green infrastructure to promote climate resilience and a healthy environment for the residents of Perth Amboy while also establishing natural habitat and enhancing public enjoyment of the city's waterfront. We can accomplish this through 1) improvement of the city's wastewater management systems, 2) landscape-based stormwater management planning, and 3) adding vegetated features to the city's streets and open spaces.

A rapidly changing climate poses significant threats to Perth Amboy's economy. Weather related loss to physical assets and hampered economic growth are of increasing concern. The effects of climate change are projected to cause damage to homes and businesses, decrease household disposable incomes, affect worker productivity, limit agricultural production and access, and contribute to overall loss in local Gross Domestic Product. [1]

While climate change poses multiple threats, it also provides an opportunity for economic improvement in Perth Amboy. It is critical that the city commits to exploring resilient economic strategies to position itself for major transformations in energy and industrial trends. Lower-income communities contribute the least to climate change but will be the most exposed to stressors. Therefore, resilient economic growth should follow the Just Transition movement in that, "workers and communities impacted first and worst must lead the transition first to ensure it is just." [2]

Perth Amboy faces many challenges that hinder economic growth. Limitations to transportation; a lack of industrial diversity in employment; and low economic mobility indicators are some of the issues facing residents. In addition, most potential sites in Perth Amboy require remediation due to pollution. However, Perth Amboy has many assets including a marina and waterfront; tax incentive overlay zones; and strong anchor institutions. Moreover, the city benefits from its prime location along the northeast corridor and within the New York City metropolitan area. The Green Jobs and Economic Development section seeks to address Perth Amboy's challenges and leverage its assets through the lens of forthcoming climate conditions so Perth Amboy can become resilient and experience sustained economic prosperity.

Green jobs provide a dual benefit of environmental gain and employment generation. Perth Amboy can encourage local green job creation by preparing its workforce for rising industries and focusing on jobs that do not require a bachelor's degree. Focusing on training for these types of jobs is necessary because 70% of residents lack a degree higher than high school level. It is projected that there will be significant growth in resilient related industries including construction, building operations and maintenance sectors, flood risk reduction, installation and repair, and energy-efficient building operations. [3] These industries will require a workforce that is trained in a new set of skills and Perth Amboy's construction workforce will prove beneficial

to these new industries. Climate change will force shifts in energy generation and food production that will create economic opportunities as new industries emerge. Recommendations in this report include preparing the City's workforce for the energy and urban agriculture industries as climate change will create a high employment demand in these sectors.

We seek to surface Perth Amboy's economic assets to attract green jobs and prepare existing industries for the effects of climate change, ensuring economic opportunity for legacy residents. Perth Amboy should encourage resilient economic growth through a focus on green jobs in the energy and urban agriculture sectors and leverage its existing strength in the healthcare industry. This can be achieved by establishing a green task force, developing workforce retraining, and improving transportation. Through these strategies, Perth Amboy will position itself as a regional example of effective urban coastal resilience.

Housing is part of the essential fabric of any community, and one of the most important aspects of an individual's life. Improving housing means it must be built with essential qualities in mind: improving public health and safety, combating inequality, dismantling systemic racism, and limiting pollution and greenhouse gases. Housing should be located near to jobs, open space, and other natural resources. Whether new or existing housing, steps need to be taken to make sure homes are safe, secure, resilient, efficient, and can provide for a good quality of life.

Climate Gentrification is displacement that results from green investment. Often with the best of intentions, investing in a community in a way that makes it greener, or sustainable, makes the location more desirable. This phenomenon can lead to higher prices for homes, and rentals. This can lead to the displacement of long-time citizens of a community.

Green investment in Perth Amboy will yield positive results for the city's residents and especially residents most vulnerable to negative climate effects. The Housing and Climate Gentrification section outlines steps that will lead to a more sustainable city, and recommends measures that will prevent displacement.

The following recommendations would help the City of Perth Amboy achieve climate resilience for its households and prevent displacement from climate gentrification by:

1) Increasing and preserving access to safe and affordable housing; 2) Building up the community's adaptive capacity to cope with environmental and climate hazards; and 3) Requiring new development and retrofitting existing development to be resilient and sustainable.

Chapter 2. Introduction

Introduction

The following Resilience Plan Element was drafted by graduate students from Rutgers University for the City of Perth Amboy, New Jersey. A multidisciplinary team of students from oceanography, biology, landscape architecture, urban planning, public policy and sustainable business collaborated to research the natural hazards and climate change effects threatening the city and recommend ways to create a more resilient Perth Amboy.

Resilience may have many meanings and interpretations. For the purposes of this document, resilience refers to the ability to easily and effectively recover or bounce back from and be better prepared for climate impacts that include increased coastal and inland flooding from precipitation, storm surge and sea level rise; more frequent and intense storms that inundate existing infrastructure; and extreme temperatures.

In order to be truly resilient, underlying stressors that hamper the ability to recover and be better prepared for natural hazards and climate change effects must be addressed. In the City of Perth Amboy, these underlying stressors include poverty, lack of access to transportation, aging infrastructure, the presence of multiple brownfield sites, and lack of access to green space. That said, physical assets like the Perth Amboy Train Station, waterfront marina, and social assets like the numerous active community organizations in the city, can be leveraged to increase resilience in the community.

Resilience requires improving infrastructure and redeveloping the built environment, reorienting the local economy around sustainable businesses, and improving residents' safety and quality of life. The following Resilience Plan Element seeks to achieve these overarching goals by exploring the City of Perth Amboy through three key themes:

1) Green Infrastructure and Water Quality

2) Energy Transition and the Green Economy

3) Housing and Climate Gentrification

With these key themes in mind, the Project Team crafted recommendations:

1) To promote resilience and a healthy environment for the residents of Perth Amboy through the creation of green infrastructure and improvement of the City's wastewater management system;

2) To surface Perth Amboy's economic assets to attract green jobs and prepare existing industries for the effects of climate change, ensuring economic opportunity for legacy residents; and

3) To build up the community's adaptive capacity to cope with natural hazards and climate change and to provide residents with safe, affordable, and resilient housing.

Chapter 3. Relevant Background Information

Relevant Background Information

Climate Threats

Flooding

The frequency of heavy rainfall events and the amount of precipitation falling during these events is expected to increase with climate change. When heavy rainfall occurs in urban areas with a significant amount of impervious surface cover, like the City of Perth Amboy, the rain hits the impervious surfaces and flows directly into the storm drains. When storm drains are over capacity, they inundate the city and create urban flooding. [4]

FEMA National Flooding Insurance Program (NFIP) and Community Rating System (CRS)

The City of Perth Amboy participates in the National Flood Insurance Program (NFIP), which provides insurance policies for residents in the floodplain and is administered by the Federal Emergency Management Agency (FEMA). NFIP sets flood insurance rates based on mapping areas flood inundation zones, called Flood Insurance Rate Maps (FIRMs). The current map used to set flood insurance rates for the City of Perth Amboy became effective on July 6, 2010. [5]

In addition to participating in NFIP, Perth Amboy also participates in the Community Rating System (CRS), and has done so since October 1, 2017. The CRS program incentivizes communities to mitigate flooding by offering discounted flood insurance rates to members of communities that exceed the minimum requirements of NFIP. [6] After FEMA has reviewed a community's application of flood mitigation initiatives, FEMA ranks the community based on their initiatives and assigns them a class from 10 to 1 which corresponds to a flood insurance discount rate for residents in the NFIP. Residents of Class 10 CRS communities receive no discount, while residents of Class 1 communities receive a 45% discount. Effective May 1, 2019, the City of Perth Amboy is a Class 9 communities whose members receive a 5% discount on their flood insurance. [7]

NFIP collects information on the number of insurance policies held by community members. As of July 31, 2019, there were 108 flood insurance policies in force in the City of Perth Amboy. As of that date, policyholders claimed 47 losses related to flooding, resulting in $3,442, 930 dollars in compensation. [8]

Precipitation

Due to New Jersey's location next to the jet stream between late fall and spring, precipitation events are frequent and intense storms occasionally manifest. At least one coastal storm strikes the state per year, though some years have seen as many as five or ten such storms. The state averages about 46 inches of precipitation annually, with variation between the north-central region (51 inches) and the coastal region (40 inches). Precipitation patterns can vary across the decades. For example, notably dry conditions occurred between 1962-1966, while particularly wet period occurred between 1971-1975. [9]

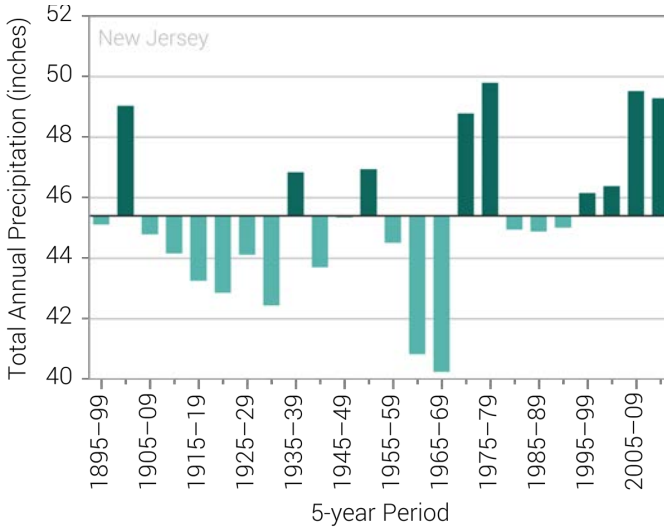


Fig.1. Observed annual precipitation amounts (in inches) in NJ for five year periods between 1895 and 2009.
Credit: Runke et al (2017 via CICS NC and NOAA NCEI)

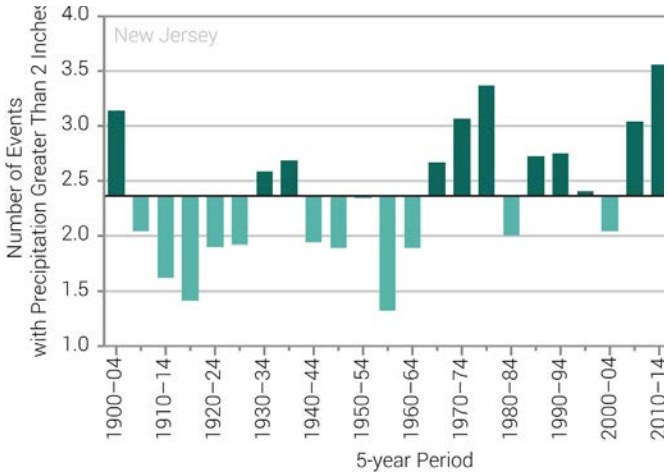


Fig.2. Observed number of extreme precipitation events between 1900 and 2014.
Credit: Runke et al (2017 via CICS NC and NOAA NCEI)

Over the past decade, New Jersey has seen precipitation levels 8% above average. Summer precipitation averages have been above the 1900-2014 mean since 2000, with the period between 2010-2014 seeing both the largest five-year average rainfall amount and the largest number of extreme precipitation events in the state since modern records began as of a 2017 study. This falls in line with projections of increased precipitation for northern middle latitudes in the Northern Hemisphere under climate change. Both winter and spring precipitation levels are projected to increase for New Jersey in the 21st century, along with the number of extreme precipitation events. In practice, this means a greater amount of precipitation may be deposited in storm events that increase the risk of serious coastal and inland flooding, which may overwhelm communities' floodwater management measures. [9]

Extreme Heat

New Jersey's geographic location has led to it developing a historical pattern of moderately cold, occasionally snowy winters followed by warm, humid summers (Runkle et al., 2017). There is a considerable temperature gradient across the state, with the mountainous northwest region seeing cooler temperatures and the eastern coastal region seeing warmer temperatures. The northwest sees average temperatures ranges of 15-20 degrees in January to 80-85 degrees in July, while coastal regions may see average ranges of 25-30 degrees and 85-90 degrees during these same time periods (Runkle et al., 2017). Temperatures in the state have increased over the 20th and 21st centuries due to climate change, with annual temperatures haven risen 3 degrees since the start of the 20th century. At least nine out of ten of New Jersey's hottest years recorded have occurred since 1990, with temperatures continuing to rise as the effects of climate change worsen. [9]

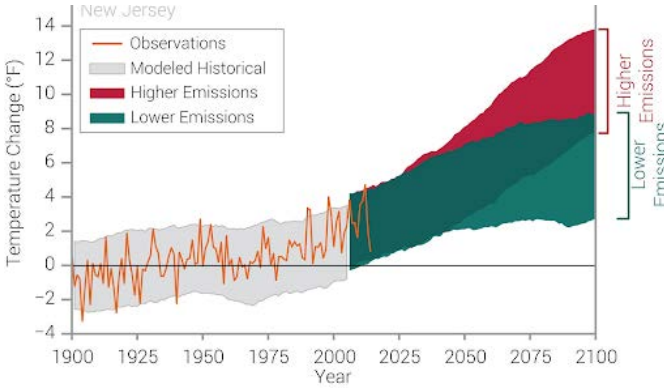


Fig.3. Observed and projected temperatures for NJ from 1900-2014, relative to the 1901-1960 baseline.
Credit: Runke et al (2017 via CICS NC and NOAA NCEI)

Historically, the state has seen an average of three to four extreme heat days above 95 degrees per year. The average number of annual extreme heat days has since risen to four to six since 1990. Under the effects of climate change, the number of extreme heat days is projected to spike much higher (see Figure 4), particularly for interior portions of the state and urban corridors. Some regions of the state are projected to see at least 50 extreme heat days occur annually by 2100.

Additionally, the number of very warm nights above 70 degrees has risen as well, from a historical average of eight nights per year to an average of ten to fourteen nights per year between 2005-2014. When these events coincide in heat waves, it can become difficult for New Jerseyans to escape the extreme heat, particularly those who are socially vulnerable. [9]

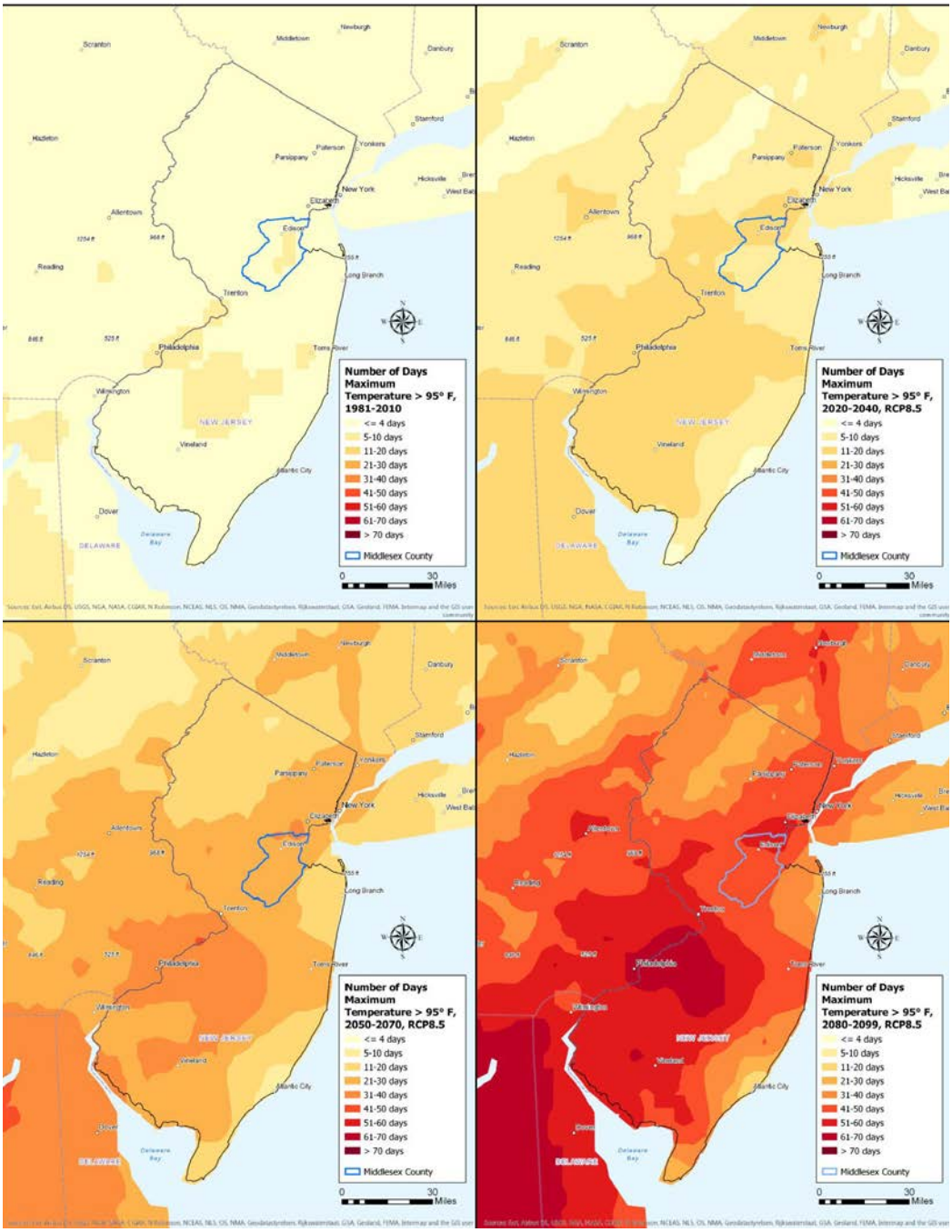


Fig.4. Number of days per year with a maximum temperature above 95 degrees F, projected to 2100.
Credit: Rutgers NJ Adapt)

Sea Level Rise

New Jersey is expected to sustain significant impacts from sea level rise in the coming century. The state as a whole has already experienced a steady and significant rate of sea level rise since the beginning of the industrial age. Mean sea level rose 17.6 inches (1.5 feet) along the New Jersey coast since 1911, more than twice that of global mean sea level in the concurrent period (7.6 inches/0.6 feet). In the past forty years alone, the mean sea level in New Jersey has risen 8.2 inches (0.7 feet) compared to the global mean of 4.3 inches (0.4 feet). This breaks down to an average rate of sea level rise of 0.2 inches/year in New Jersey and 0.1 inches/year globally since 1979. [10]

Relative to the 2000 mean sea level, New Jersey will likely see mean sea level rise on the magnitude of 0.5-1.1 feet by 2030 and 0.9-2.1 feet by 2050. [10] Prior to 2050, these sea level rise projects are not particularly sensitive to different greenhouse gas emissions scenarios. Following 2050, however, sea level rise projections become highly dependent upon these scenarios. Even under a low emissions scenario in which global warming is limited to 2 degrees above pre-industrial (1850-1900) levels, New Jersey could still experience between 1.7-3.9 feel of sea level rise by the end of the century. A status quo moderate emissions scenario projects between 2.0-5.1 feet of sea level rise across the state, while a high emissions scenario characterized by increased consumption of fossil fuels projects between 2.3-6.3 feet of sea level rise.

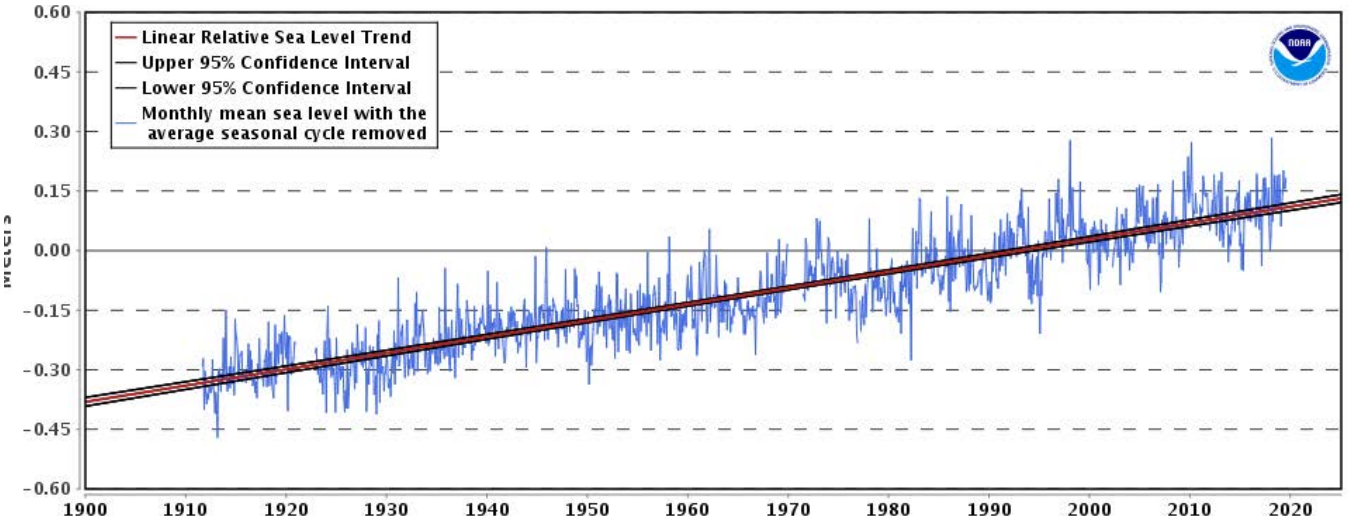


Fig.5. Trends in sea level rise at Atlantic City, NJ between 1900 and 2020.
Credit: NOAA

Fig.6. Sea level rise projections (in feet) for NJ relative to the 2000 mean sea level.
Credit: NJDEP

Chapter 4.
Demographic Analysis

Demographic Analysis

General Demographics

This report conducted a demographic analysis to better understand the context of Perth Amboy and the climate risks facing the community. The demographic composition in Perth Amboy is generally diverse and skewed toward a younger population (Figure 7). Hispanic/Latino residents comprise 82% of the population, while the median age is 32.8, nearly seven years younger than the median age for New Jersey (Figure 8). Data from the American Community Survey (ACS) indicate that the population in Perth Amboy increased by 3.4% between 2010 and 2017, compared to 1.9% for New Jersey in the same time period.

The adaptive capacity of residents of the City of Perth Amboy is also hindered by poverty and mobility challenges. The median household income in Perth Amboy is $50,883 as compared to $83,133 in Middlesex County (2017). Moreover, at an estimated percent of

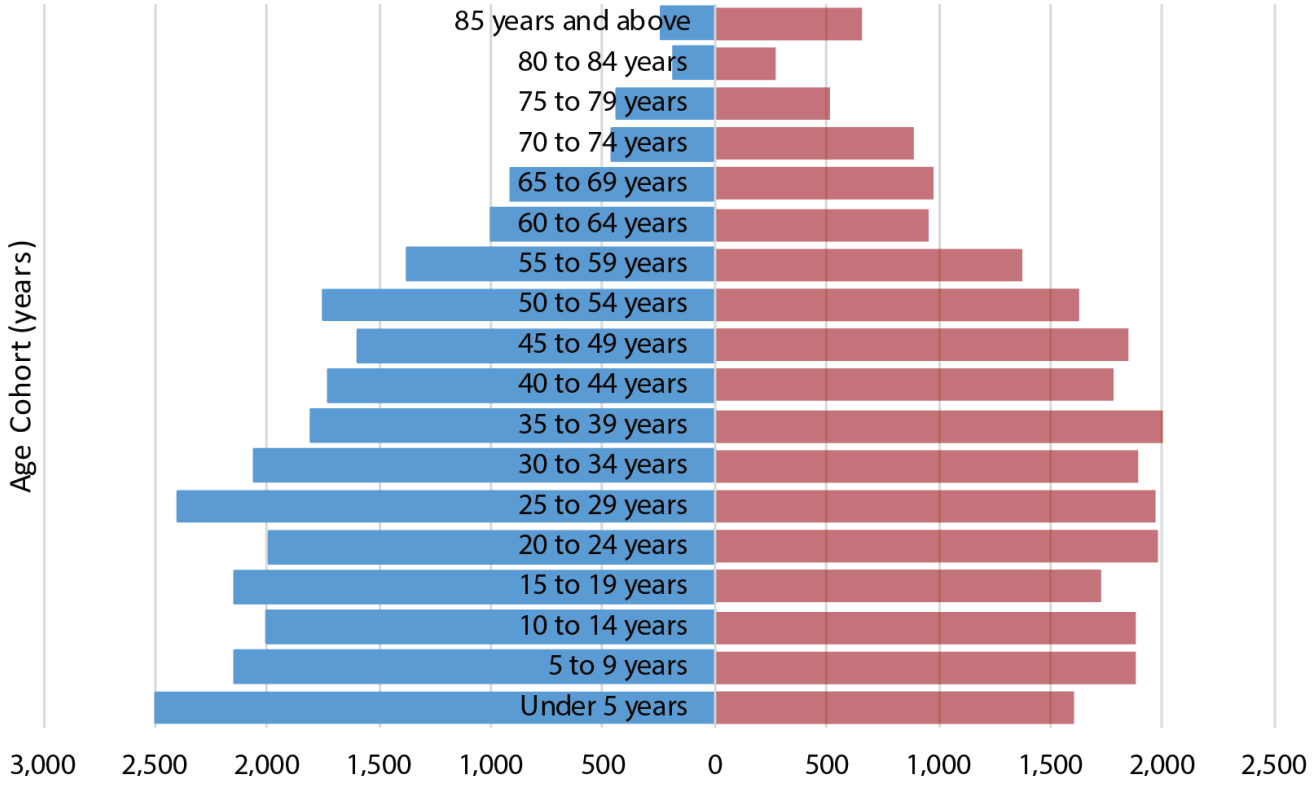


Fig.7. Perth Amboy Population

persons in poverty of 21% despite a 6% unemployment rate, Perth Amboy lacks an appropriate share of living-wage occupations.

Residents of Perth Amboy have an average educational attainment that is considerably lower than the county and state in all categories except for an Associate's degree, which doubtless reflects the strong educational infrastructure available in the City's high schools and the existing network of community colleges available in the region (Figure 9).

Characteristic	Perth Amboy	Middlesex Co.	New Jersey
Population	51,765	828,120	8,863,801
Hispanic/Latino	82%	22%	21%
Black/African-American	6%	9%	13%
White	9%	42%	55%
Asian	1%	24%	10%
Foreign-born population	42%	33%	22%
Median household income	$50,883	$83,133	$76,475
Median age	32.8	38.1	39.6
Poverty rate	21%	8%	10%
Unemployment rate	6.40%	3.60%	4.10%

Fig.8. General Demographics

Characteristic	Perth Amboy	Middlesex Co.	New Jersey
Population over 25	63%	69%	70%
High school graduate	70%	90%	90%
Associate's degree	6%	7%	7%
Bachelor's degree or higher	15%	44%	41%
Moved since previous year	7%	10%	10%
Speak Spanish at home	76%	16%	16%

Fig.9. Economic Mobility

Social vulnerability

The Center for Disease Control (CDC) highlights four social vulnerability themes. Theme 1 is Socioeconomic Status, which refers to individuals who are unemployed, have low income, or never received a high school diploma. Theme 2 is Household Composition & Disability, which refers to elderly, disabled, and single-parent households. Theme 3 is Minority Status & Language, which refers to minority populations and those who speak English “less than well”. Theme 4 is Housing & Transportation, which refers to overcrowded households, mobile homes, or households with no access to a vehicle.

Climate stressors such as severe storms and high temperatures can have a disproportionate impact on these socially vulnerable populations. In Perth Amboy, every census tract is within the 75th percentile for vulnerability in one or more of the four themes (Figure 10). When addressing issues of climate resilience, these vulnerabilities must be taken into account. Socially vulnerable populations are not only at increased risk from climate threats themselves, but also from the socioeconomic and cultural changes that can occur as a result of new resilience endeavors.

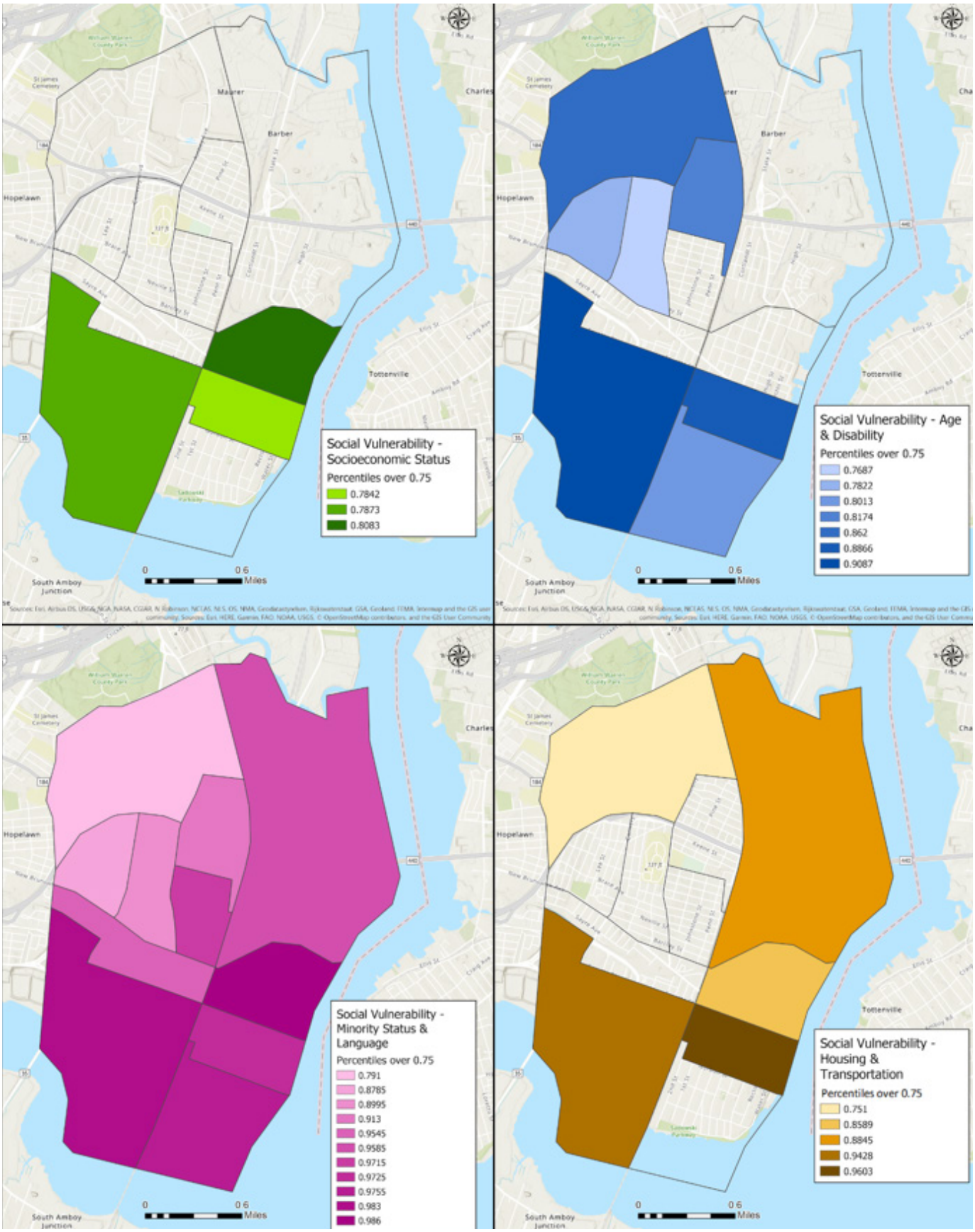


Fig.10. Social vulnerability in Perth Amboy based on the four themes of the CDC Social Vulnerability Index.
Credit: U.S. Center for Disease Control

Chapter 5. Current & Future Risks: Vulnerability to Natural Hazards

Current & Future Risks: Vulnerability to Natural Hazards

Sea Level Rise & Infrastructure

Perth Amboy's critical infrastructure is extremely vulnerable to flood events caused by precipitation. Utilities such as wastewater treatment plants, surface water discharges, and Combined Sewer Overflows (CSOs) are at highest risk (Figure 12). Stormwater management strategies such as green infrastructure can help to redirect floodwaters from these essential facilities while simultaneously improving water quality.

Other than the potential impacts on these critical utilities, sea level rise is not a primary threat to Perth Amboy when compared to other coastal NJ municipalities (Figure 11). Critical facilities such as police stations, hospitals, and childcare centers are not impacted, even by water levels 12ft above mean higher high water (Figure 13).

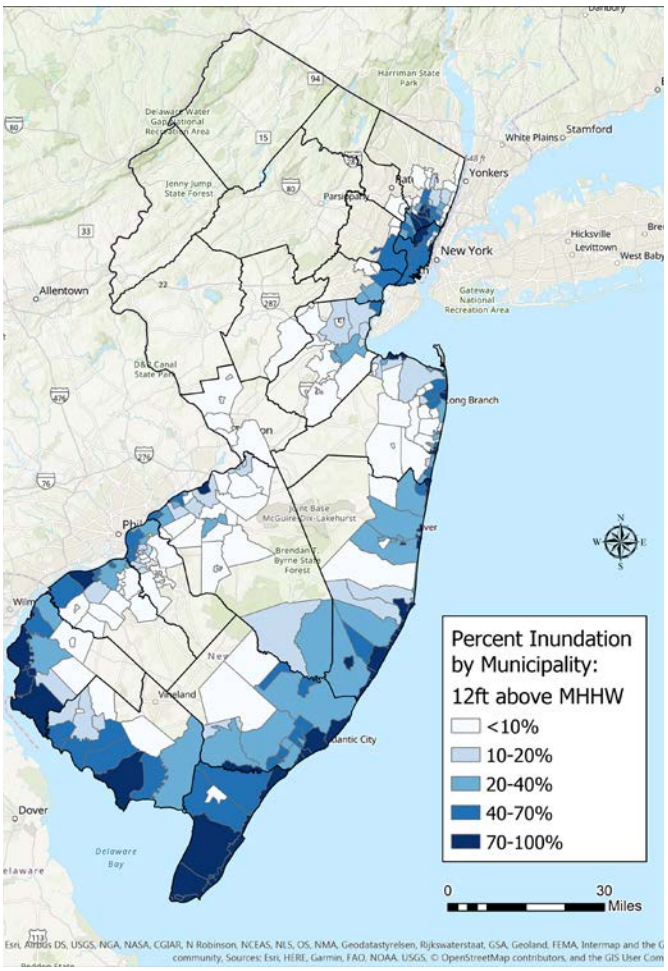


Fig.11. Percent inundation of coastal NJ municipalities at a 12ft water level.
Credit: Rutgers NJAdapt

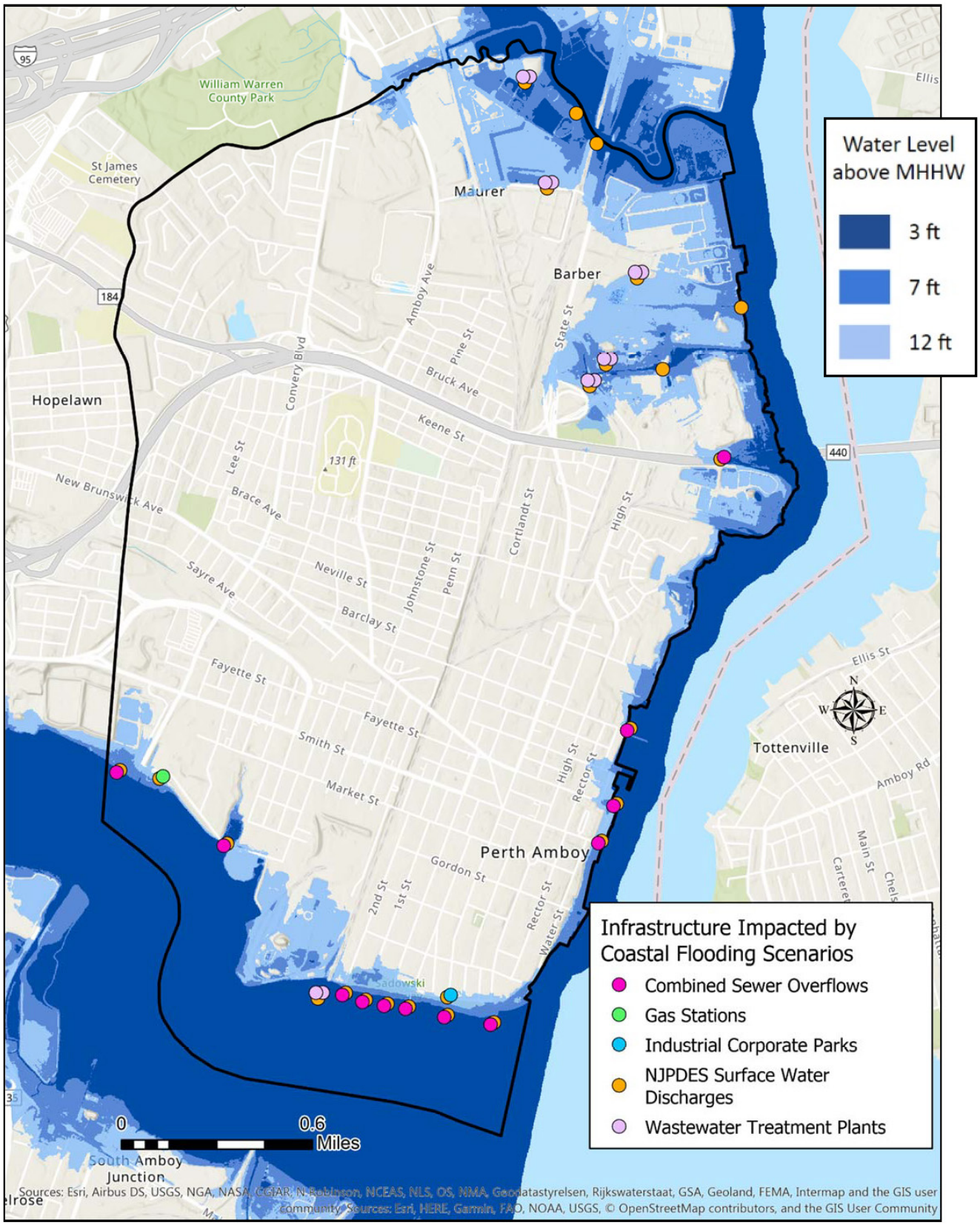


Fig.12. Impacts of 3ft, 7ft, and 12ft water levels on Perth Amboy infrastructure
Credit: Rutgers NJAdapt, NJDEP

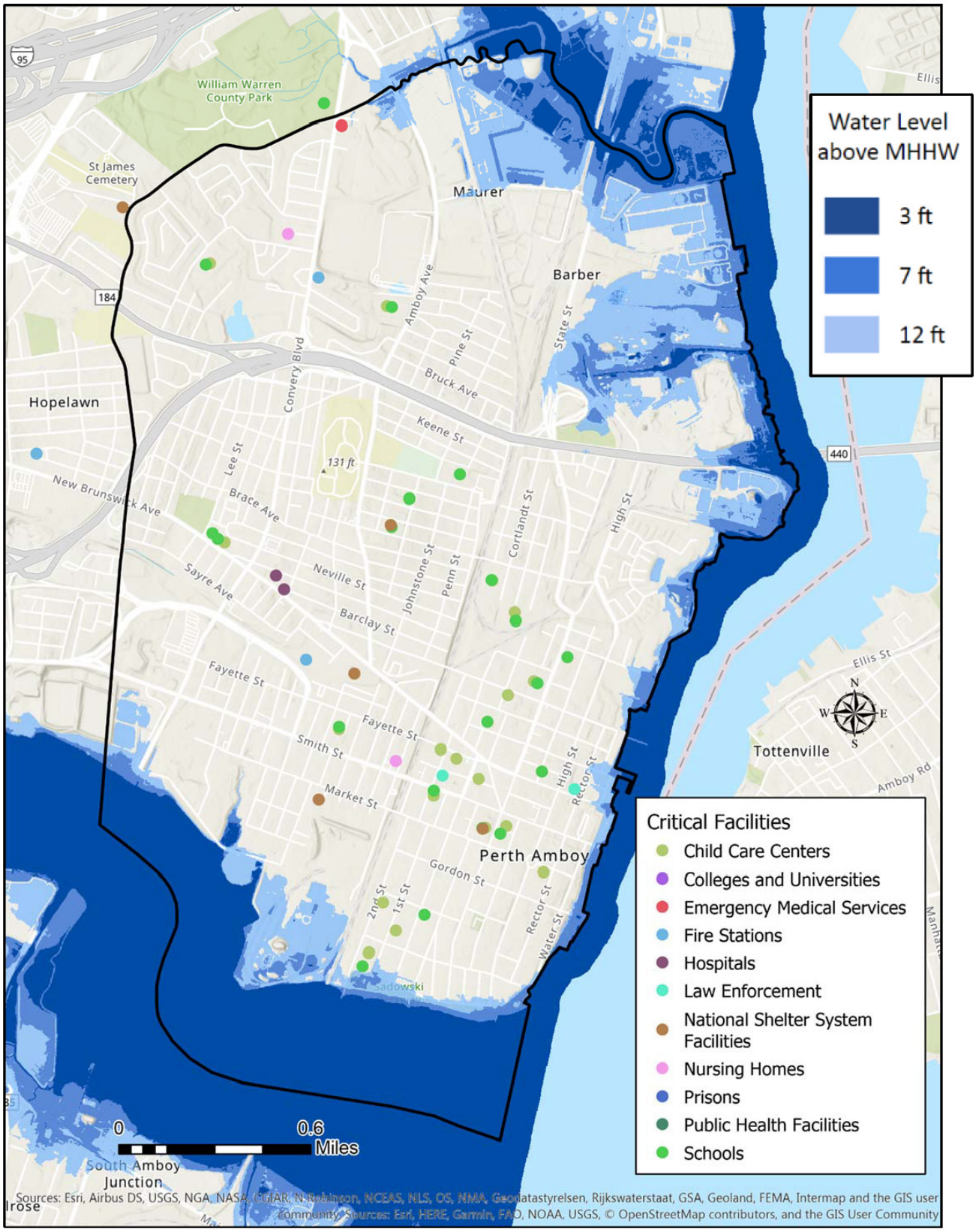


Fig.13. Impacts of 3ft, 7ft, and 12ft water levels on Perth Amboy critical facilities
Credit: Rutgers NJAdapt

Precipitation & Infrastructure

Flooding

The frequency of heavy rainfall events and the amount of precipitation falling during these events is expected to increase with climate change. When heavy rainfall occurs in urban areas with a significant amount of impervious surface cover, like the City of Perth Amboy, the rain hits the impervious surfaces and flows directly into the storm drains. When storm drains are over capacity, they inundate the city and create urban flooding.

Perth Amboy's aging infrastructure exacerbates the problems caused by impervious cover and heavy rainfall. In July 2019, a heavy rain event caused a sinkhole to open up near Gordon and Front Streets. Rainfall eroded the soil under the asphalt, causing the brick sewer to collapse. As extreme precipitation events become more frequent, an extra load is exerted on the city's Combined Sewer Systems (CSS).

FEMA National Flooding Insurance Program (NFIP) and Community Rating System (CRS)

The City of Perth Amboy participates in the National Flood Insurance Program (NFIP), which provides insurance policies for residents in the floodplain and is administered by the Federal Emergency Management Agency (FEMA). NFIP sets flood insurance rates based on mapping areas flood inundation zones, called Flood Insurance Rate Maps (FIRMs). The current map used to set flood insurance rates for the City of Perth Amboy became effective on July 6, 2010.

In addition to participating in NFIP, Perth Amboy also participates in the Community Rating System (CRS), and has done so since October 1, 2017. The CRS program incentivizes communities to mitigate flooding by offering discounted flood insurance rates to members of communities that exceed the minimum requirements of NFIP. After FEMA has reviewed a community's application of flood mitigation initiatives, FEMA ranks the community based on their initiatives and assigns them a class from 10 to 1 which corresponds to a flood insurance discount rate for residents in the NFIP. Residents of Class 10 CRS communities receive no discount, while residents of Class 1 communities receive a 45% discount. Effective May 1, 2019, the City of Perth Amboy is a Class 9 communities whose members receive a 5% discount on their flood insurance .

NFIP collects information on the number of insurance policies held by community members. As of July 31, 2019, there were 108 flood insurance policies in force in the City of Perth Amboy. As of that date, policyholders claimed 47 losses related to flooding, resulting in $3,442,930 dollars in compensation.

Combined Sewer Overflows (CSOs)

The United States Environmental Protection Agency (EPA) is responsible for enforcing the Clean Water Act to address combined sewer overflow (CSO) issues throughout the country. Although NJ has implemented a state-wide CSO control program to bring CSSs into compliance with the Clean Water Act, communities with CSO systems continue to struggle to manage the systems and reduce overflows. This has proven to be the case for Perth Amboy, many times over.

CSO infrastructure was originally designed based on historical climate data. Unfortunately, these designs will not hold up in the face of anthropogenic climate change. Variability in rainfall intensities and patterns, caused by climate change, have already exhibited a significant impact on the performance of urban drainage systems. CSOs taint waterways with untreated wastewater coming from residential, commercial, and industrial units (U.S. EPA, 1999), in the form of highly concentrated pathogens, toxic pollutants, debris, and solids in waterways. This results in significant water quality and public health concerns. Estimates have placed the amount of untreated/partially untreated sewage overflowing into waterways to be more than 3000 million cubic meters, annually (U.S. EPA, 2004).

Impervious Cover & Climate Change

As previously mentioned in this report, Perth Amboy is a highly developed city (Figure 14). The high amount of impervious cover can exacerbate the negative impacts of heavy precipitation and extreme heat, both of which are likely to occur more and more often.

Impervious cover prevents stormwater from infiltrating the ground; this leads to higher-velocity, higher-volume flood events that put the city's residents and infrastructure at greater risk. The lack of vegetated areas also negatively impacts water quality; Perth Amboy's

stormwater flows straight into Raritan Bay and the Arthur Kill without experiencing the filtration properties of vegetation.

Another negative impact of impervious cover is the Urban Heat Island Effect. Naturally-occurring vegetation removes carbon from the air and provides increased shade, both of which can generate a local cooling effect. When vegetation is replaced with concrete and dark asphalt, the opposite phenomenon occurs; the sun's heat is trapped within these surfaces, thus raising temperatures in localized developed areas.

Implementing green infrastructure projects can mitigate the negative effects of impervious cover in Perth Amboy; the many co-benefits of green infrastructure will be discussed in detail later in the report.

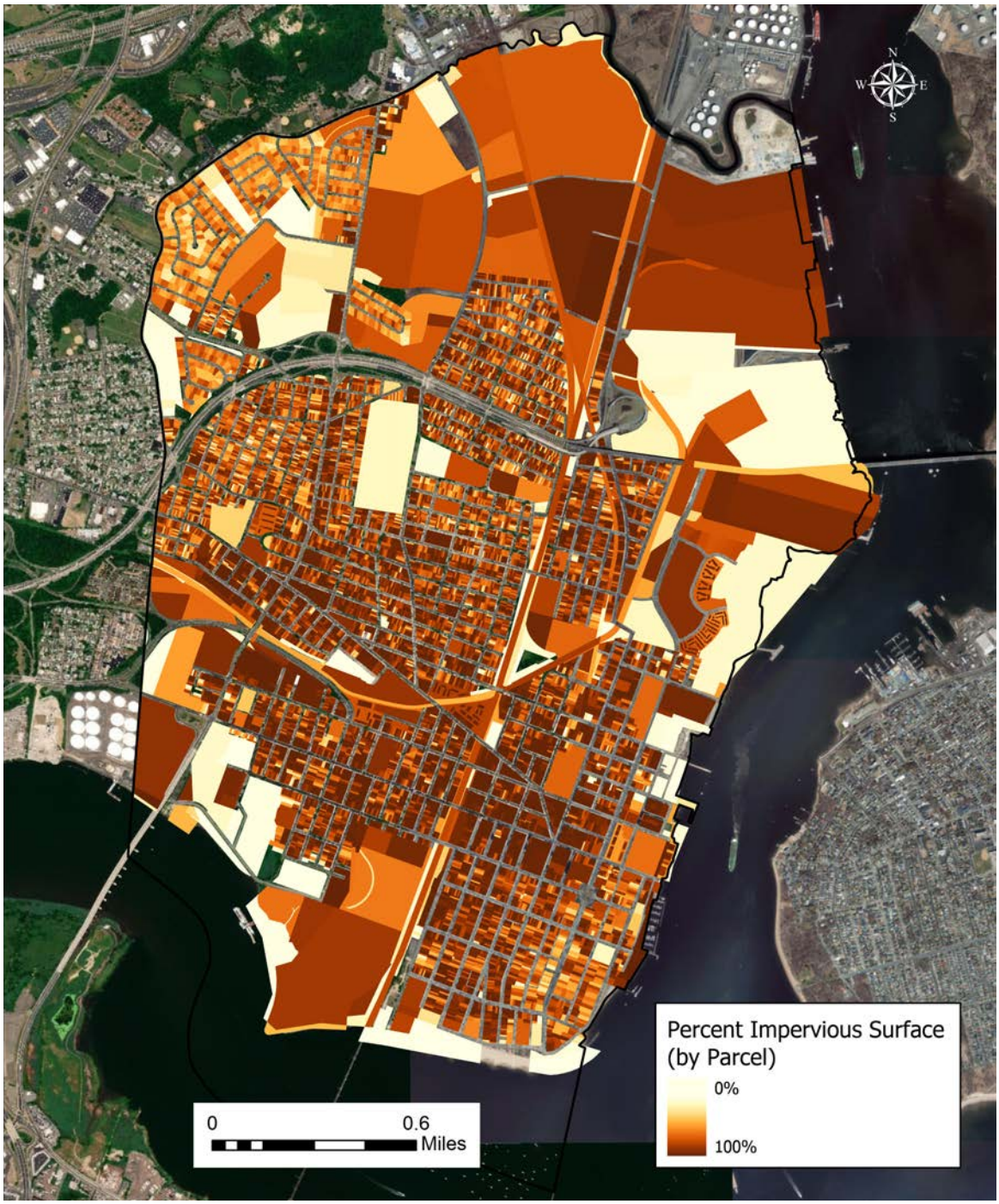


Fig.14. Percent impervious surface (impervious cover) by parcel in Perth Amboy.
Credit: NJDEP

Chapter 6.
Master Plan Elements

Community Risks and Vulnerability & The Master Plan

Natural Hazards, Climate Risks, and Circulation

The road network in Perth Amboy is highly connected with relatively safe local streets and several state highways and county roads that give residents a high level of access. As the city looks toward a future through the lens of climate change, the assets of the train station, bus services, and relative walkability mean that the city has a somewhat resilient transportation network. The recommended ferry service would enhance connectivity. The master plan's focus on bicycle and pedestrian networks will become ever more important in the face of a newly resilient future.

Natural Hazards, Climate Risks, and Open Space

Perth Amboy offers a wide range of recreational opportunities for its residents, including walking, jogging, cycling, sailing, fishing, and sports activities, to name a few. At the time of the 2013 Master Plan's Recreation Element's writing, the City owned 21 public parks totaling 110 acres, though these parks were not evenly distributed throughout the city. Moving forward, Perth Amboy should strive to more even distribution of parks and open spaces throughout the city while designing said spaces in a way to maximize stormwater management and heat-reduction co-benefits. City-owned parks and open spaces are prime locations to implement green infrastructure projects that can retain and redirect stormwater runoff to mitigate street flooding and CSO overload. In line with the City's desire to improve park maintenance, more low-maintenance projects such as rain gardens and native vegetation planting could be pursued. An increase in the amount of parks, open space, and green cover -- however small -- also serves to break up and reduce the amount of impervious cover within the city, reducing the urban heat island effect. Perhaps most importantly, a more even distribution of parks throughout the city provides easier access to and a more equitable distribution of recreational opportunities for city residents.

Natural Hazards, Climate Risks, and Conservation

Perth Amboy is home to several estuarine wetlands along both the Arthur Kill and the Raritan Bay, as well as a few freshwater wetlands in the northern portion of the city. The conservation of these wetlands should be a priority for Perth Amboy; in addition to storm buffering and water filtration, these areas provide habitat for many plants and animals while bringing aesthetic enjoyment to the city's residents. Due to hydrologic patterns and poorly drained soil conditions, Perth Amboy's wetlands correspond well with the FEMA flood hazard regions; this suggests that further development around these areas should be avoided, and resources should instead be allocated to enhancing public access, recreation, and educational outreach programs. Conserving Perth Amboy's natural assets will improve water quality and preserve the value of the city's waterfront.

Natural Hazards, Climate Risks, and Housing

The twenty first century challenges of climate change and increasing costs of housing mean that Perth Amboy must take preventative action to protect, and provide for its residents. More frequent and severe rain events, increased instances of extreme heat, and increasing flood events present challenges to Perth Amboy's existing housing stock. The city should be proactive in updating building codes to help mitigate these threats, and create a resilient community that can thrive in an era of more extreme weather. Increasing costs in the New York metropolitan area can be mitigated by affordable and subsidized housing, increasing

availability of market rate housing, and changing zoning regulations to allow for accessory dwelling units within existing housing stock. By increasing protections for tenants, providing more affordable housing, and focusing on more dense development, Perth Amboy can proactively prevent the displacement of its residents. By concentrating dense development in areas that are located near mass transit, Perth Amboy can utilize its existing assets to improve the quality of life of its residents while working to combat climate threats.

Natural Hazards, Climate Risks, and Community Facilities

Community facilities are important to the fabric of all communities, and Perth Amboy is no exception. Its schools, libraries, community centers, transportation hubs, and public buildings are necessary for the function of the city and the well being of its citizens. These facilities will become more important in the decades to come, as threats from climate change and increasing cost of living become more and more of a reality. In order to prevent the loss of these facilities, a resiliency plan must be in place to protect these assets, and to help them rebound in the event that they are damaged in any instances of severe weather or other threats. In addition to protecting existing assets, investments should be made to improve the availability and quality of public facilities. The stronger, and more available the facilities are, the more they can be relied on by the city in times of difficulty and struggle. In addition, increased investments in public facilities will benefit students, local businesses, and all other residents, and lead to a stronger and more vibrant city.

Natural Hazards, Climate Risks, and Utilities

Climate change will place additional stress on Perth Amboy's already vulnerable and aging infrastructure, particularly the wastewater and storm water system. For example, more frequent severe rain events will cause an increase in duration and frequency of combined sewer outflow discharge. Sea level rise will inundate sewer outfalls, and extreme storm events will cause flooding along the waterfront. The Utility plan element must consider these climate stressors and be proactive in upgrading infrastructure in order to preserve and protect public water supply and reduce pollution to the surrounding environment. This element should review the recommended green infrastructure solutions and consider renewable energy integration into the city's electrical grid to mitigate climate change impacts.

Natural Hazards, Climate Risks, and Recycling

Ensure that a standard operating procedure is in place to protect critical assets, especially recycling vehicles, in the event of a flood or storm event. Following a major climate event, a comprehensive plan should be in place to execute a city-wide cleanup to prevent excessive pollution of litter and debris in waterways.

Natural Hazards, Climate Risks, and Economics

In order to achieve favorable economic resilience in Perth Amboy, risks to key economic assets should be evaluated along with the development of robust response capabilities. It is critical for the city's economic development organization to consider both steady-state and responsive initiatives. Continued and future brownfield redevelopment has the potential to impact community health associated with toxic run-off during storm events; therefore, incorporating engineering controls and stormwater management around these sites will lessen negative public health impacts. Likewise, integrating sea-level rise projections and mitigation measures into waterfront redevelopment plans will ensure that Perth Amboy's coastal economic assets are protected. The potential shock to energy infrastructure would manifest in significant disruption to the city's economic base and continued development. A collective resiliency vision must integrate planning efforts and consider diversified funding sources in order to prepare for natural hazards.

Chapter 7. Recommendations: Green Infrastructure & Water Quality

Recommendations: Green Infrastructure & Water Quality

Introduction

Perth Amboy is a waterfront city, which brings unique economic, social, and aesthetic benefits. The Green Infrastructure and Water Quality section of this report seeks to take advantage of the benefits of the city's waterfront while combating the climate threats. Green infrastructure can help Perth Amboy accomplish this goal while improving the quality of the surrounding water bodies.

Vision Statement

We strive to use green infrastructure to promote climate resilience and a healthy environment for the residents of Perth Amboy while also establishing natural habitat and enhancing public enjoyment of the city's waterfront. We can accomplish this through 1) improvement of the city's wastewater management systems, 2) landscape-based stormwater management planning, and 3) adding vegetated features to the city's streets and open spaces.

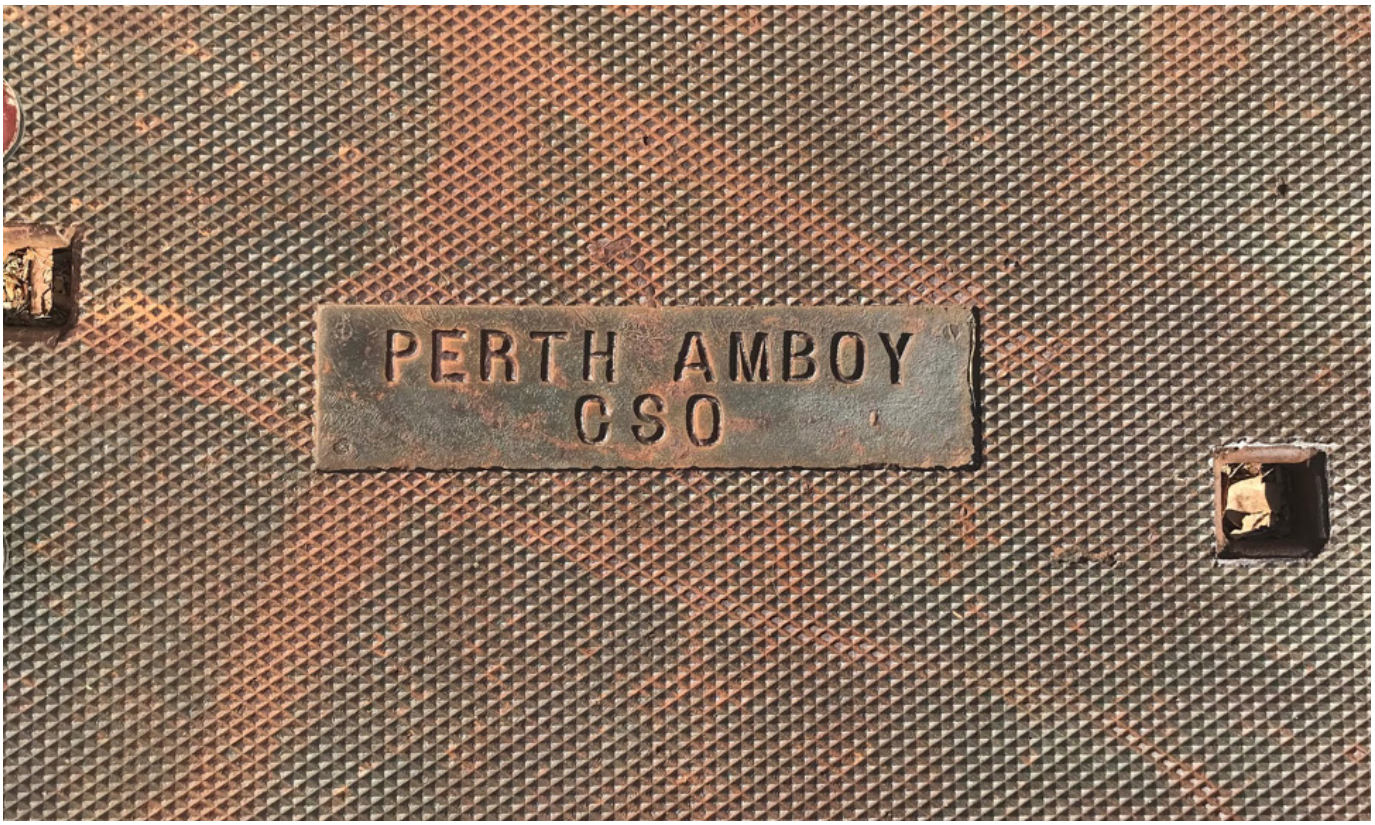


Fig.15. A CSO cover on a Perth Amboy Street
Credit: Ellen O. White

Background

Water Quality and Wastewater Management

Perth Amboy retains ownership of existing sewer infrastructure, but the operations of the City's CSO system is performed by Middlesex Water Company, as of January 2019. While the city cannot control the sewage treatment processes, Perth Amboy can modify its sewage infrastructure. To continue to comply with the Clean Water Act, an updated, separate sewer system will be indispensable.

Perth Amboy owns and operates 16 combined sewer overflows (CSOs), discharging into the Raritan River and Arthur Kill. Approximately 84% of Perth Amboy's residents are served directly by a CSS, while the other 16% of the residents are served directly by a separated sewer system, conveyed to the CSS (U.S. EPA, 2004). With an increase in extreme precipitation events, sea level rise, and elevated terrestrial temperatures, the number of overload events for the Perth Amboy water system will surge.

Not only will Perth Amboy's problems with water pollution, pathogens (specifically in the Raritan River), and flooding get worse, but the CSS and CSO systems will become more expensive and difficult to manage. Ultimately, without adopting more sustainable water management practices, residents of Perth Amboy could lose potable water and incur repeated flooding damage. This is why organizations, such as New Jersey Clean Water Council (NJCWC), have recommended that utilities that do not engage in proper infrastructure management should be declined subsidies, like federal stimulus funds.

Widespread and local sustainable practices, modeled by cities all over the world, will be required to combat effects of climate change in the coming century. Permitting the forecasted escalations in precipitation events, CSO control plans must be adapted to concord future changes. There are two major categories when considering CSO control: centralized and decentralized.[11] Centralized techniques are concerned with enhancing the conveyance capacity of the sewer system. Eventually, updated separate sewer systems will be necessary, but these plans are very costly with limited financial support from the state and federal governments.

Positive impacts resulting from sewer separation include reduction or elimination of basement and street flooding, reduction or elimination of sanitary discharges to receiving waters, decreased impacts to aquatic species and habitat, decreased contact risk with pathogens and bacteria from domestic sewage in the receiving water, and relief from CSO regulations (EPA 1999). Ultimately, in every case, CSS separation has eventually paid for itself due to a reduction in water quantity pumped, water quantity treated, and general system maintenance. It is estimated that for every $1 invested in water infrastructure, $2.62 is generated in all industries in the same year. [12]

There are potential issues associated with CSS separation, primarily no stormwater treatment. Runoff collects pollutants, such as oil, antifreeze, paints, solvents, cleaners, etc., emptying them into the water bodies, but decentralized techniques can help filter runoff, reducing these pollutants. Decentralized techniques reduce stormwater runoff by infiltrating or detaining the rainwater in a distributed and localized way. Green infrastructure, protection of natural landscapes, and universally reducing impervious surfaces represent more immediate solutions to help alleviate stress on water management.

Green Infrastructure

Green infrastructure practices can take many forms, but all are designed to capture and detain or infiltrate stormwater. These practices filter water using soil, stone, and other organic materials in a planted area, then either allow infiltration or return the water to the stormwater sewer system through perforated pipes. Green infrastructure practices are typically sited, designed, and implemented to retrofit areas that were developed without sufficient stormwater management.

For Perth Amboy to reduce localized flooding, increase climate resilience, reduce the occurrence of CSOs, and/or improve the overall health of local waterways, green infrastructure needs to be installed wherever possible. In a built-out urban area like Perth Amboy, this means taking advantage of even the smallest unused or overlooked areas--parking lot medians, vegetated areas on the sites of public buildings, or in street spaces such as medians, pedestrian bump-outs, and other planted areas.

The process of greening tiny spaces is sometimes referred to as "green acupuncture," referencing the small green infrastructure interventions--many green infrastructure designs fit into tiny spaces along streets or yards--that compound to create a systemic effect across a network. Though each individual bioswale or rain garden may only capture a few extra gallons of stormwater during a rain event, a network of swales, gardens, and other green infrastructure can provide flood protection at a larger scale.

The general implementation process entails:

1. Assessment of existing stormwater issues
2. Identification of site opportunities
3. Evaluate GI feasibility
4. Designing of GI for each location

Natural vegetated landscapes can function as stormwater management systems very similarly to green infrastructure. The protection of natural landscapes provides important hydrologic functions of retention, detention, infiltration, and filtering of stormwater by:

» Avoiding development on permeable soils
» Restoring/preserving wetlands
» Preserving areas of undisturbed soil and vegetation cover
» Preserving existing trees and, where possible, tree clusters.
» Fitting designs to existing terrain

Retain, Redirect, Reuse

The goal of green infrastructure is to retain, redirect, and reuse water in order to reduce flooding and pressure on the stormwater system. The interventions outlined in this report, like bioretention swales and planters, most typically retain water. Many also redirect water to infiltrate into the ground instead of flowing directly into the stormwater sewers. A few, like cisterns and rain barrels, simply reuse water on site and avoid the ground altogether.

Perth Amboy is a city built on clay soils, which were a boon to its past economic base as a brick and terracotta manufacturing center. For stormwater management, however, these same clay soils allow less infiltration than sand or silt soils; infiltration is less of a possibility for green infrastructure designs. Therefore, detention--detaining stormwater as long as possible before entering the sewer system--should be the focus of green infrastructure designs. Typically, this involves a perforated pipe at the bottom of the designed green infrastructure that collects the water and redirects it to the sewer.

Recommendations

Water Quality & Wastewater Management

Suggestions for Middlesex Water Company

» One way to decrease trihalomethanes (THM) is to eliminate or reduce chlorination before the filters and to reduce precursors. An alternative disinfectant like potassium permanganate or peroxide should be utilized.
» THM levels increase with pH, temperature, time, and the level of organic material present. The EPA has indicated that the best available technology for THM control at treatment plants is the removal of precursors through "enhanced coagulation". Enhanced coagulation refers to the process of optimizing the filtration process to maximize removal of precursors. Removal is improved by decreasing pH (to levels as low as 4 or 5), increasing the feed rate of coagulants, and possibly using ferric coagulants instead of aluminum.

Improvements to Infrastructure

» Sewer separation has been used effectively in many communities, such as, Minneapolis, St. Paul, and South St. Paul, MN; the metro Detroit, MI, area; the metro Boston, MA, area; Salem and Portland, OR; the metro Seattle, WA, area; Lynchburg, VA; Bangor, ME; Hartford and Norwich, CT; and Remington, IN (EPA, 1999). Sewer separation can be accomplished through installing either new storm or sanitary sewers to be used in concurrence with the existing sewer, but converting the combined sewer to a sanitary sewer confers added costs benefits, since all sanitary flows are already connected to the converted sanitary sewer. Additional cost benefits can be obtained by coinciding incidental infrastructure work (i.e., road repaving and the repair or replacement of miscellaneous utilities) with sewer separation. For example, in St. Paul, MN, streets were paved, handicap ramps were added to sidewalks, gas

and water mains were installed, gas services were renewed or replaced, lead water service connections were replaced, and streetlights were installed. [13] Sewer separation may also result in other related improvements to water quality. In stretches of the Mississippi, water quality improvements attributed to sewer separation projects have resulted in the return of the pollution-sensitive Hexagenia mayfly after a 30-year absence; the return of Bald Eagles to the area; and the recovery of fish populations and diversity from 3 species to over 25 species. [13]

» The Perth Amboy wastewater collection system is comprised of approximately 366,000 load force (LF) of gravity. These mains are constructed of vitrified clay, brick, and concrete. Contemporary practice is to use PVC, ductile iron, and concrete for new sewer pipelines and system repairs.
» Install more regulator structures. Currently, Perth Amboy has plans for three regulator structures, but one should be implemented with each CSO.

Strategic Management

» Conduct risk management scenario planning exercises for managers to consider the joint effects of simultaneous flooding and power outages, and drought and power outages, as a watershed climate impact analysis.
» Conduct a study to determine the diameter of all CSS pipes.

Regulatory/Administrative Management

» Review the regulatory context for decentralized water supply and wastewater treatment facilities (cisterns, grey water recycling, and decentralized water and wastewater treatment). Identify regulatory obstacles to innovative applications of decentralized water technologies and develop a municipal strategy for creating water technology innovation testbeds.
» Analyze water-use efficiency among industrial and residential consumers. Review the international standard for industrial water-use efficiency and consider incentives for water conservation and for encouraging water recycling.
» Conduct a feasibility analysis of water trading systems for industrial consumers in order to drive down demand. Include a review of international precedents for water supply trading. This has been done by California, Colorado, Arizona, New Mexico, and Texas to ensure residents always have access to clean drinking water. [14]

Pollution Reduction

» Restriction on the flushing of solids (i.e. baby wipes). Moreover, instituting government approval of certain brands/types of toilet paper in order to reduce the number of suspended solids in the sewage system.
» Reduce/eliminate fertilizers, pesticides, and herbicides city-wide. New Jersey has already passed a law stating fertilizer must contain 0% phosphorus, but other cities have taken it further (Sanibel Island, FL), also restricting nitrogen use.[15] Like many towns in Florida, Perth Amboy can set limits on the overall amount of fertilizers, pesticides, and herbicides used.
» Institute a Beyond Waste Management Program to incentivize businesses and residents to dispose of their hazardous waste (paints, solvents, oil, antifreeze, etc) properly. The Washington Department of Ecology (2005) implemented this type of plan, wherein they educated residents about how to properly dispose of their hazardous materials.[16] They offered tax credits to businesses, removed fees for Hazardous Waste Education, changed their Hazardous Waste Planning Fee structure to reward good waste management practices, and changed the Hazardous Substance Tax from a percentage of value basis to a per-pound basis.

Bioremediation

» Recently shown that some microbes can respire upon dioxane, breaking it down in the process. Dioxane can weakly bind to soil before migrating down water column. This would allow an opportunity for microbes to naturally breakdown 1,4-dioxane by combining bioremediation with certain green infrastructure practices. Dr. Gerben Zylstra at Rutgers University (New Brunswick) is a leading role in this research.
» Commercially available advanced oxidation processes using hydrogen peroxide with ultraviolet light or ozone can be used to treat 1,4-dioxane in wastewater (Asano and others 2012; EPA 2006).

Economic Instruments

» Review tariff structures for residential and industrial water supply and consider alternative tariff structures for consistency with social justice, equity

and conservation objectives.[17]

Water Quality & Implementation

Board of Public Utilities (BPU) and NJDEP should be consulted for all recommendations listed above. The cost of updating/separating all of Perth Amboy's CSS's can only be determined with a proper plan. While this is an expensive undertaking for any city, there are ways to minimize the cost. These options include combining separation with road maintenance and adding storm sewer lines rather than sewage lines. It is also important to remember that the entirety of the CSS separation can be done in increments. The city does not have to commit to the entire separation all at once.

Currently, financial assistance for these projects is made available by the state of New Jersey, as $1.5 billion has been made available to manage/update CSOs. The main options for funding have been through raising taxes or applying for a federal loan. There are groups that can provide grants. These groups can generally be useful with facilitating the process and identify potential regulatory or financial incentives for all recommendations listed above.

» Jersey Water Works is a "cross-sector initiative focused on transforming New Jersey's inadequate urban water infrastructure by investing in sustainable, cost-effective solutions that provide communities with clean water and waterways; healthier, safer neighborhoods; local jobs; flood and climate resilience; and economic growth."
» New Jersey Future is a nonprofit, nonpartisan organization that promotes sensible growth, redevelopment, and infrastructure investments. NJ Future has a group dedicated to improving water quality and infrastructure. Particularly, Chris Sturm, who also facilitates the Jersey Water Works collaborative, has agreed to be a point of contact for Perth Amboy.
» New Jersey Water Bank (formally NJEIFP) is a partnership between the NJDEP and the New Jersey Environmental Infrastructure Trust to provide low cost financing for the design, construction, and implementation of projects that help protect and improve water quality and help ensure safe and adequate drinking water. They have allocated money for CSO elimination projects, through 30 year no-interest loans for cities, called H2LOANS (https://www.njib.gov/nj/Setup+H2LOans+Account.19).

While CSS separation is ultimately the best course of action in the long-term, the high cost can be a major limiting factor. As a result, Perth Amboy can most benefit by also implementing a series of smaller-scale green infrastructure projects in the short term. These projects will reduce the amount of stormwater the CSS must take on while simultaneously reducing the impacts of water pollution.

Green Infrastructure Framework

Site Selection

Site selection for green infrastructure projects is complex, with competing social and technical priorities. This section offers a framework for guiding investment that can maximize flooding mitigation while also fast tracking implementation.

Site Selection: Historic Wetlands/Streambeds

Green infrastructure investment is maximized in low-lying areas that collect stormwater. Historic stream beds and wetlands can serve as a guide for selecting sites and targeting resources for green infrastructure. Figure 16 illustrates the areas of the historic streambeds in Perth Amboy. Despite the filling of the streams, the land "remembers" where these streams were. The elevation is still lower, so the water still flows toward these stream beds. The cross section in Figure 17 reveals that even where the stream bed was filled, the elevation of the former stream bed is still slightly lower than the surrounding areas. Thus, while the stream itself is no longer visible, water still flows to the historic stream location. The fill shown in the cross section also drains water differently from the surrounding area, creating additional runoff issues.

These maps should guide green infrastructure investment. The historic stream beds show the target areas where green infrastructure funding should be prioritized over places not in these regions. Small green infrastructure projects like infiltration planters and bioswales in the street right of way, rain gardens, and private property incentives should target these historic stream beds.

Fig.16. Historic 1777 streams and wetlands overlaid with current aerial imagery
Credit: Library of Congress

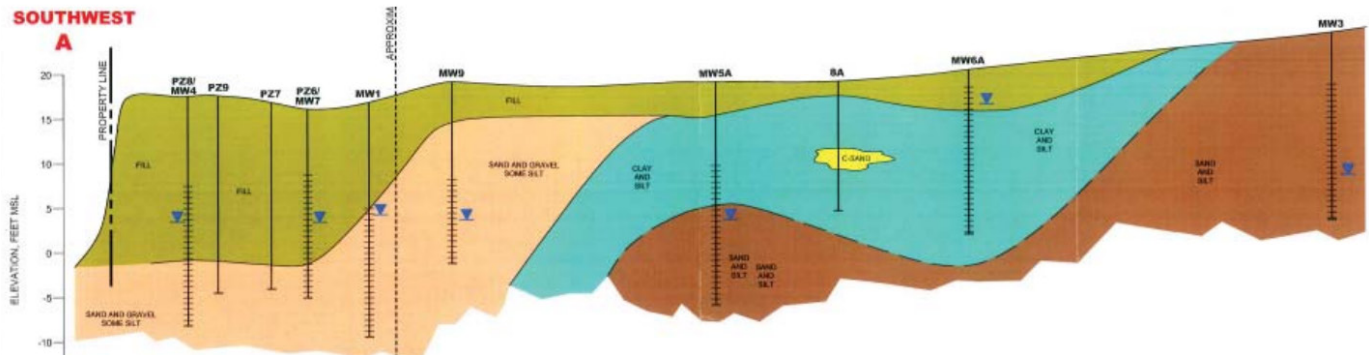


Fig.17. Hydrologic cross section of former stream bed along Proposed 2nd Street Park
Credit: TRV Raviv Associates (2004) via Rutgers' "City of Perth Amboy 2nd Street Park Concept Design" (2015)

Site Selection: Impervious Cover

When choosing sites for green infrastructure, the density of impervious cover in the area is an important consideration. As mentioned earlier in the report and shown in Figure 14, Perth Amboy has many areas of high impervious cover; these areas are more susceptible to flooding and are largely responsible for the urban heat island effect within the city. Implementing green infrastructure in such areas can slow the movement of floodwaters and better allow for rainwater recharge into the soils. Rainwater can also be collected for reuse or redirected in more favorable directions, i.e. toward storm drains and waterbodies. In addition to stormwater management, green infrastructure can also mitigate urban heat island effect in these high impervious cover areas.

Site Selection: Schools and other public property

Schools and property owned by public agencies can be targeted for green infrastructure projects since site control is already established, streamlining the implementation process. Schools, especially, are ideal green infrastructure sites since they provide learning tools for teaching students about stormwater, plants, and construction (if building the site is part of a school project). Further, schools are a specialty of the Rutgers Cooperative Extension Water Resources program, which offers workshops specifically for creating rain gardens and other green infrastructure on school grounds. Figure 18 depicts the public K-12 schools throughout Perth Amboy, as well as any other public schools in the city.

Social Considerations for Green Infrastructure

Avoiding Environmental Gentrification

Environmental gentrification -- also known as green gentrification and ecological gentrification -- has become a cause for concern for some in cities undergoing the

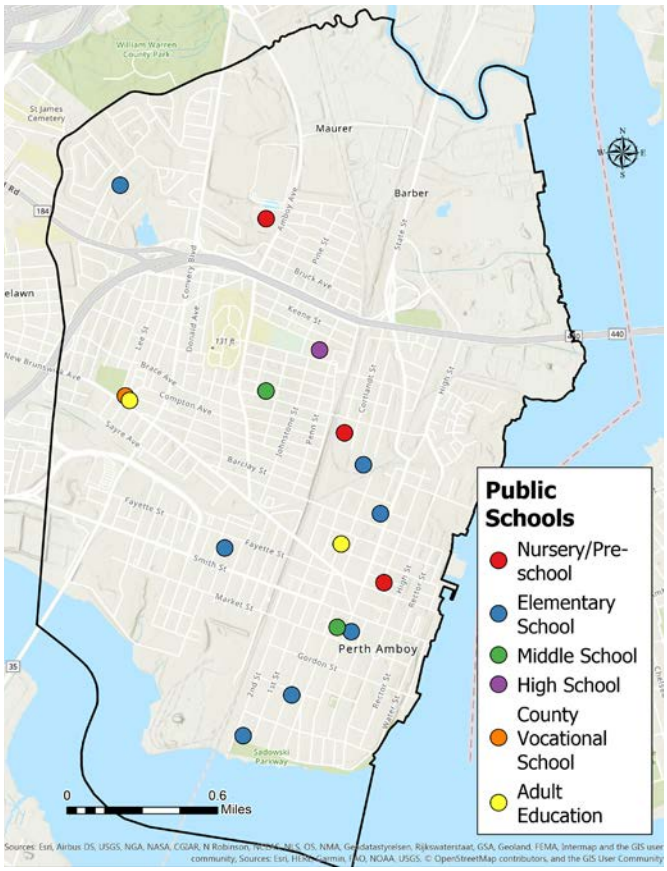


Fig.18. Food Insecurity Problem

"greening" process.[18] While several different definitions for green, environmental, and ecological gentrification exist, they share a core concept of green initiatives and ecological and environmental improvement leading to increased gentrification, which can be defined in turn as an increase in high-end development and the displacement of low-income residents (ibid). More specifically, Gould and Lewis noted green gentrification to be "the appropriation of the economic values of an environmental resource by one class from another," while Checker noted environmental gentrification "builds on the material and discursive successes of the urban environmental justice movement and appropriates them to serve high-end redevelopment that displaces low income residents." Many discussions regarding environmental gentrification focus on the "equity deficit" that emerges between socio-economic classes through displacement. [19, 20] Displacement may be intentional -- such as through rezoning -- or unintentional -- such as re-valuation of properties after green infrastructure has been put in place (ibid). It is important to note that displacement may not just be physical, but cultural as well (ibid).

When selecting where to implement green infrastructure projects, it is important to select a suite of sites that both insures the equitable distribution of green infrastructure benefits and minimizes displacement. This would mean not just concentrating green infrastructure projects along the waterfront and downtown shopping district, but across several of Perth Amboy's neighborhoods as well. Particularly socially vulnerable areas within Perth Amboy should be given careful consideration when sites for green infrastructure projects are chosen. For example, neighborhoods with transportation vulnerability may benefit from additional pedestrian-friendly projects, such as planted bump-outs with benches and shade trees, while neighborhoods with a more elderly population will benefit from projects that reduce the urban heat island effect.

Addressing Resident Interests

When selecting green infrastructure projects to pursue, it is also important to maintain consistent and transparent engagement with residents and determine which types of green infrastructure projects are most appealing. Within Perth Amboy, residents have expressed an interest in projects that provide more resting places in the downtown shopping district, reduce the amount of urban heat, and increase overall greenery downtown (Maximo Vazquez, personal communication). Taken together, these resident interests imply that a suite of pedestrian-friendly, heat-reducing green infrastructure projects may be in order for the downtown shopping district.

Example Strategies for Green Infrastructure: Retain, Redirect, Reuse

This section reviews some examples of green infrastructure that may be suitable for Perth Amboy to construct. Several excellent reports have been published in the past four years that dive into more technical detail of how to site and construct each of these interventions.

» The New Jersey Department of Environmental Protection Division of Water Quality published a report in January 2018 titled "Evaluating Green Infrastructure: A Combined Sewer Overflow Control Alternative for Long Term Control Plans."
» New Jersey Department of Environmental Protection also published "Planning and Technical Support for Incorporating Green Infrastructure in Long Term Control Plans" for Perth Amboy in 2018. This study focused on two areas in Perth Amboy and included soil samples and also includes excellent details of types of green infrastructure, their costs and benefits, and other considerations for implementation.
» Rutgers Water Resources published "Green Infrastructure Feasibility Study for Perth Amboy" in 2015. This study provides design details for constructing green infrastructure and recommends specific sites in Perth Amboy for each type. It is the most detailed of the three recent publications.

These previous studies are helpful toolkits for implementing the recommended green infrastructure elements. In addition to taking historic wetlands, impervious cover, and school property into consideration, reviewing the sites in the previous plans can help the city identify sites to prioritize for green infrastructure and decide which type of green infrastructure to construct on the sites.

All of the example strategies for green infrastructure mentioned below can "retain, redirect, or reuse" Perth Amboy's stormwater while providing a multitude of co-benefits to the city.

Implementation Framework

Green infrastructure can be built in Perth Amboy on both public and private property. Implementation can take two forms: a city-driven, in-house design and construction team or a set of incentives that encourages or requires green infrastructure in new construction. These two models are not exclusive.

The in-house model has been successful in larger cities such as Philadelphia, New York, and Portland, OR. Typically, some combination of city agencies, often the Department of Environmental Protection, Department of Transportation, Department of Public Works, and/or the Parks Department, collaborate to create a set of guidelines or designs for green infrastructure. The agencies then work together to review sites and construct in the public right-of-way or on other city properties. Green infrastructure efforts are funded through the city, usually with grants, and staffed by city employees.

Perth Amboy can also create incentives or requirements for new development to incorporate green infrastructure. For instance, Seattle created a program called the "Green Factor," to require green infrastructure in new construction. The program is similar to LEED, allowing the property owner to acquire points for meeting certain requirements. The city still must dedicate staff time to site plan review and work with developers, but the city itself is not paying for the design and installation of green infrastructure. Building incentives into the zoning code or into the site plan review process can strengthen the green infrastructure network in Perth Amboy.

Green Roofs and Blue Roofs (Retain & Redirect)

Green roofs and blue roofs are two measures that may be taken to reduce stormwater runoff for the structures on which they are located.

Green roofs are planted roofs that can reduce stormwater runoff, reduce heating and cooling costs, provide habitat to urban species, improve air quality, and increase roof longevity.[21] There are three different types of green roofs -- extensive, intensive, and semi-intensive -- that differ by the amount planting medium they contain and the varieties of plants they can support. Extensive green roofs have a shallow planting medium that supports low vegetation, intensive green roofs have deep planting mediums that support plants as large as small trees and shrubs, and semi-intensive green roofs fall somewhere in the middle. Depending on the type of green roof chosen, costly structural retrofits may be necessary for the structure to support the weight of the roof. Not only do green roofs stem runoff over the roof's surface area, they are among the least cost-efficient methods of stormwater runoff. However, the many co-benefits of green roofs -- namely their reduction of the urban heat island effect via an increase in green cover and reductions in heating and cooling bills for associated structures -- justify their high initial costs over time. Once installed, green roofs require periodic maintenance to maintain plants, unclog roof drains, and insure roof membrane health. The 2018 report conducted by eDesign Dynamics for the City of Perth Amboy -- titled Planning and Technical Support for Incorporating Green Infrastructure in Long Term Control Plans -- contains a more detailed layout of green roofs and possible implementation plans for the City.

Blue roofs -- also known as controlled flow roof drain systems -- are designed purely for stormwater-management practices.[22] Stormwater is detained on these roofs through a series of dams and/or drain restrictors before being discharged at a managed rate into a building's storm drains, scuppers, or downspouts (ibid). They are most efficient for buildings with flat-to-mildly sloped roofs. Compared to green roofs, blue roofs can be more cost-effective and easier to install. However, blue roofs require strictly adhered-to regular maintenance and inspection, as waterproofing roof membrane health must be assured and roof drains can become easily clogged by debris such as fallen leaves. Depending on the pre-existing roof structure, structural

Fig.19. Example of green roof on commercial building in Brooklyn, NY
Credit: Pacific Park Brooklyn

load retrofits may still be required. The Philadelphia Water Department has an excellent primer available online regarding blue roofs and their requisite codes and regulations the City may wish to consult.

Implementation & Funding

For public property, funding for green roofs and blue roofs, and indeed most green infrastructure projects, primarily flows through the NJ Department of Environmental Protection (NJDEP). The Green Acres program can be used if a recreational component is included, which is a possibility for green roofs, but typically not on blue roofs. The Clean Water State Revolving Fund can also be used. The federal Environmental Protection Agency has some direct grants that can be used for green infrastructure, including the Greening America's Communities program and the Environmental Justice Small Grants program.

Permeable Pavements (Retain & Redirect)

Impervious surface creates polluted runoff that increases flooding; it also contributes to the urban heat island effect. Permeable, or pervious, pavements can mitigate these effects by allowing more water to infiltrate, either into the soil or into a gravel-filled detention chamber before returning to the stormwater sewer.

Permeable pavements come in a wide range of materials and designs for different applications and settings. Permeable asphalt (Figure 21) is used in paving applications instead of standard asphalt, often in parking lots or very low-volume roads. Permeable asphalt must be maintained to keep the voids free of debris, typically by vacuuming with a vacuum sweeper twice each year.

A second primary type of permeable pavement is pavers with open cells or pavers designed to interlock while leaving a larger space between them than is typical (Figure 20). Permeable pavers are set on a bed of gravel or sand to maximize infiltration.

Unlike other types of green infrastructure composed of vegetation and soil, permeable pavements do not typically affect water quality; they simply allow for water to infiltrate on site instead of running off into the stormwater sewage system.

Implementation & Funding

Like green roofs and blue roofs, permeable paving is an eligible project under NJDEP's Green Acres, Clean Water State Revolving Fund, and the Nonpoint Source Program (319(h)). Additionally, the New Jersey Department of Transportation funding for resurfacing or construction projects can be used for permeable paving as part of the design process.

Bioretention: Planters, Swales, Gardens, and More (Retain & Redirect)

Bioretention designs are what first come to mind when many people hear the term "green infrastructure." Interventions such as infiltration planters, bioswales, and rain gardens are popular forms of retaining stormwater before allowing it to infiltration into the ground water

Fig.21. Permeable Asphalt
Credit: Sustainable Buildings Initiative

Fig.20. Open Cell Permeable Paver
Credit: Braen Supply

or return to the stormwater sewer. Bioretention can reduce local stormwater runoff while also utilizing space established for vegetation, seating, or safe street design.

Bioretention has been shown to reduce runoff volume through evapotranspiration and infiltration of runoff without raising water temperature. Additionally, bioretention has the potential to reduce the local urban heat island by introducing soils and vegetation into urban areas, as well as the added benefit of snow storage and treatment. Bioretention can feasibly be adapted to fit into many different development contexts to provide effective removal of many pollutants as a result of sedimentation, filtering, soil adsorption, microbial processes, and plant uptake.

Components of all bioretention structures include filter beds comprised of sand and organic material, mulch ground cover, and plants adapted to a stormwater area. Although there are some concerns with some bioretention designs, including groundwater and soil contamination, vegetation maintenance, and mosquitos, proper design can mitigate some of these challenges. For example, features that enhance pollutant removal rates include filter beds being deeper than 750 mm, a properly sized underdrain system, multiple bioretention cells, highly dense landscaping, filter media comprised of sand and organic matter, and a filter surface covered with mulch and vegetation. The Rain Garden Manual of New Jersey, another product of Rutgers Water Resources, is an excellent source for plant selection in any of these types of bioretention designs, beyond rain gardens. The manual is also an excellent source for rain garden design.

Implementation & Funding

Fig.22. A residential rain garden in Hamilton, NJ (150 square feet and 6 inches deep)

Like previous recommendations, bioretention projects are eligible for funding under NJDEP's Green Acres, Clean Water State Revolving Fund, and the Nonpoint Source Program (319(h)). Additionally, the New Jersey Department of Transportation funding for resurfacing or construction projects can be used for bioswales, infiltration/detention planters, and other bioretention projects that are part of a comprehensive road design.

Perhaps more critically, free training and technical support is available through the Rutgers Cooperative Extension Water Resources. This program hosts workshops on design, maintenance, and funding, among other topics, and provides free design and construction assistance to municipalities across the state.

Street Trees (Retain & Redirect)

Street trees provide a range of benefits, not only to the surrounding community, but also to the wider city as part of a network. Street trees can reduce the heat island effect, provide habitat, slow runoff, and clean polluted water and air, among other services. Street trees can also be combined with infiltration planters or bioswales.

The ideal street tree provides an arching canopy, tolerates pollution well, is broad-leaved for maximum shade, tolerates both flooding and drought, tolerates soil compaction, and does not bear messy fruit that will fall on the sidewalk. Of increasing concern are pests that have begun to threaten entire species of trees, like the emerald ash borer; ash trees are no longer recommended as street trees for this reason. Popular street tree species include zelkova, thornless honey locust, littleleaf linden, ginkgo (male only due to female fruit), and London plane. Callery pears have been popular in the past in this region of New Jersey, but can be quite brittle and break in strong winds. As major storms increase in number and severity, brittle trees like the Callery pear should be avoided.

Implementation & Funding

Street trees are often funded with municipal funds, but private grant programs, such as through The Nature Conservancy, are also available.

Street Design & Green Infrastructure (Retain & Redirect)

Permeable pavements, bioretention designs, and shade trees can all be incorporated into Perth Amboy's streets and public parking lots while providing the many co-benefits outlined above. Common designs include landscaped islands in parking lots, parking lot edges, traffic islands, medians, pedestrian bump-outs, bioswales, stormwater planters, and any pervious areas between buildings and sidewalks.

Incorporating green infrastructure into street design comes with manifold co-benefits. Pedestrian bump-outs shorten the crossing distance for pedestrians, make them more visible to motorists, and give motorists a visual cue to lower their speed. Bump-outs create more space for pedestrians and for green space, often in areas that are currently underutilized by cars, such as at corners where parking is not permitted. Enhanced pedestrian safety designs serve Perth Amboy's large population without access to a vehicle.

Figure 23 illustrates a pedestrian bump-out that includes both an infiltration planter and seating. In Perth Amboy, pedestrian bump-outs may be most appropriate in commercial areas and near the train station, where there is likely to be higher pedestrian traffic.

Fig.23. Pedestrian Bump-Out with Infiltration Planter

Implementation & Funding

For green infrastructure within street rights-of-way, NJDOT funds design and construction of road projects in their purview.

Fig.24. Curb Extension with Infiltration Planting
Credit: NACTO

Salt Marsh/Wetland Restoration near Riverview Drive (Redirect)

When creating green infrastructure on the sites of historic wetlands and streambeds, a wetland restoration project is an ideal option. Perth Amboy has a promising potential wetland restoration site just north of Riverview Drive, a local arterial road that cuts off tidal water flow into the area (Figure 25). This site can be a good candidate for culvert replacement, a process that replaces smaller existing culverts with larger ones to restore tidal flow (Figure 26). [23] If seawater and suspended sediments are allowed to flow in and out with the tides, then the hydrologic and soil conditions necessary for salt marsh formation may develop on their own over time. Planting salt marsh grasses (Spartina alterniflora, Spartina patens, Juncus gerardii) would stabilize the new soils and encourage further establishment of marsh vegetation (ibid).

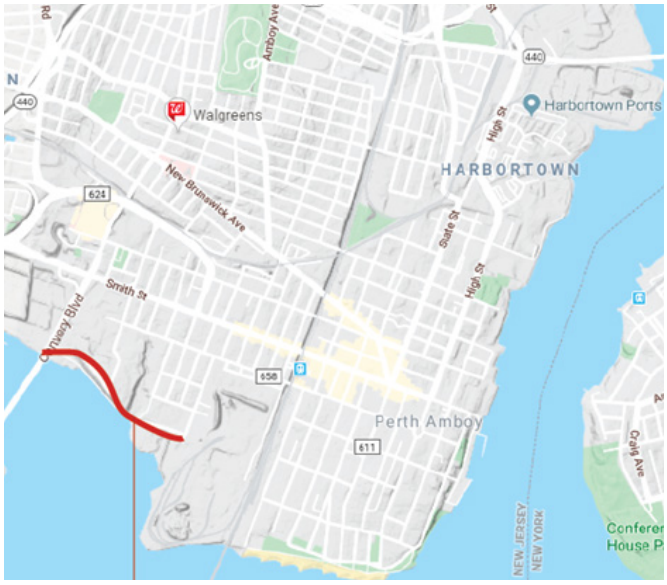


Fig.25. Section of Riverfront Drive that may be a good candidate for culvert replacement.

Fig.26. A culvert replacement project enacted to restore Little River Salt Marsh in North Hampton, NH.
Credit: Natural Resource Conservation Service, USDA

Encouraging the natural establishment of a salt marsh brings many social and ecological benefits that will help Perth Amboy become more climate resilient. Salt marshes are known for their capacity to act as protective buffers against severe storms and coastal flooding; they also filter and redirect stormwater, thus mitigating flooding from precipitation and improving water quality.[24] The creation of a new salt marsh will also provide important habitat for a wide variety of bird and fish species (ibid). One recently explored service provided by salt marshes is carbon sequestration; salt marshes can remove carbon from the atmosphere at over 10 times the rate of tropical rainforests, making these coastal marshes invaluable carbon sinks on a global scale.[25] Finally, salt marshes and other wetland restoration projects provide aesthetic value to Perth Amboy public spaces, and thus may encourage healthy outdoor recreation among residents. Figure 27 shows an example of how wetland restoration can be implemented in conjunction with other public parks and green spaces to ensure public accessibility.

Fig.27. New Brighton Park Shoreline Habitat Restoration Project, Port of Vancouver, illustrates that salt marsh restoration and recreation can be combined into a single park design

Credit: https://www.portvancouver.com/development-and-permits/development/new-brighton-park-shoreline-habitat-restoration-project/

Implementation & Funding

The NJDEP programs Green Acres, the Clean Water State Revolving Fund, and Nonpoint Source Program (319(h)) can be used for salt marsh restoration. An additional NJDEP program is the "Water Bank" (previously titled the Environmental Infrastructure Trust) which provides low-cost financing for larger projects, such as salt marsh restoration, though it is a financing and not a grant program.

Wildflower Meadows (Retain & Redirect)

Establishing wildflower meadows supports pollinators, can help clean up environmental waste, and reduces water, fuel, fertilizer, and pesticide usage. These meadows save money and time, all while creating a more ecologically sustainable community. Perth Amboy can reduce its landscaping maintenance costs, as multiple projects have documented. Additionally, wildflower meadows along public highways, train tracks, and in parks can enhance native landscapes on both a visual and ecological level.

However, proper planning, installation, and management are imperative to ensure the survival of the meadows. For long term sustainability and low maintenance, the meadow must be designed as a functional plant community rather than a flower garden. The seed mixes should be determined on a site-by-site basis, emphasizing native plant species. A complete list of native plants to the Northeastern U.S. with their growth requirements can be found on the NJ Agricultural Experiment Station website (https://njaes.rutgers.edu/fs1140/) and the Rutgers Gardens website (https://rutgersgardens.rutgers.edu/gardens/pollinator-garden/).

Implementation & Funding

While wildflower and native plant projects have been eligible uses of federal highway funding since the 1960s, a new bill called the Monarch and Pollinator Highway Act may actually fund these projects. This funding would be funneled through NJDOT.

Rainwater Harvesting/Cisterns (Reuse)

Interest in adapting rainwater harvesting to urban areas is increasing, as it provides the combined benefits of conserving potable water and reducing stormwater runoff. The rain that falls upon a catchment surface is collected and transported into a storage tank. Storage tanks are available in sizes ranging from 190-400 L (rain barrels for residential land uses) to large cisterns for industrial or commercial uses. With a simple pretreatment system, the captured rainwater can be used for non-potable water applications, such as irrigation, pressure washing, and to flush toilets or urinals. It is estimated that these applications alone can reduce household municipal water consumption by up to 55%. [26]

By providing a consistent and renewable source of water, rainwater harvesting systems can also help reduce demand on municipal water resources; lowered energy use for pumping and treating water and lowered consumer water bills can also result in significant savings. Proper planning and education will eliminate issues associated with standing water, child safety, and winter freezing. Rainwater harvesting systems can be used throughout the year if they are located underground or indoors to prevent problems associated with freezing, ice formation and subsequent system damage. Similarly, placing screens over inlets and outlets will prevent mosquitos. An example of a rainwater harvesting manual can be found for many states, such as Texas (http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rd edition.pdf).

Fig.28. A cistern installed at a public works department in Clark, NJ. The rainwater is harvested from the rooftop of the building and used as part of a green car wash system.

Implementation & Funding

Like previous recommendations, these projects are eligible for funding under NJDEP's Green Acres, Clean Water State Revolving Fund, and the Nonpoint Source Program (319(h)). Additionally, the New Jersey Department of Transportation funding for resurfacing or construction projects can be used for bioswales, infiltration/detention planters, and other bioretention projects that are part of a comprehensive road design.

Rutgers Cooperative Extension Water Resources is also a useful partner for implementing rainwater harvesting.

Which of these green infrastructure projects is best to choose?

The below decision matrix from Rutgers Water Resources Green Infrastructure Guidance Manual can assist with selecting the best type of green infrastructure to construct based on site characteristics.

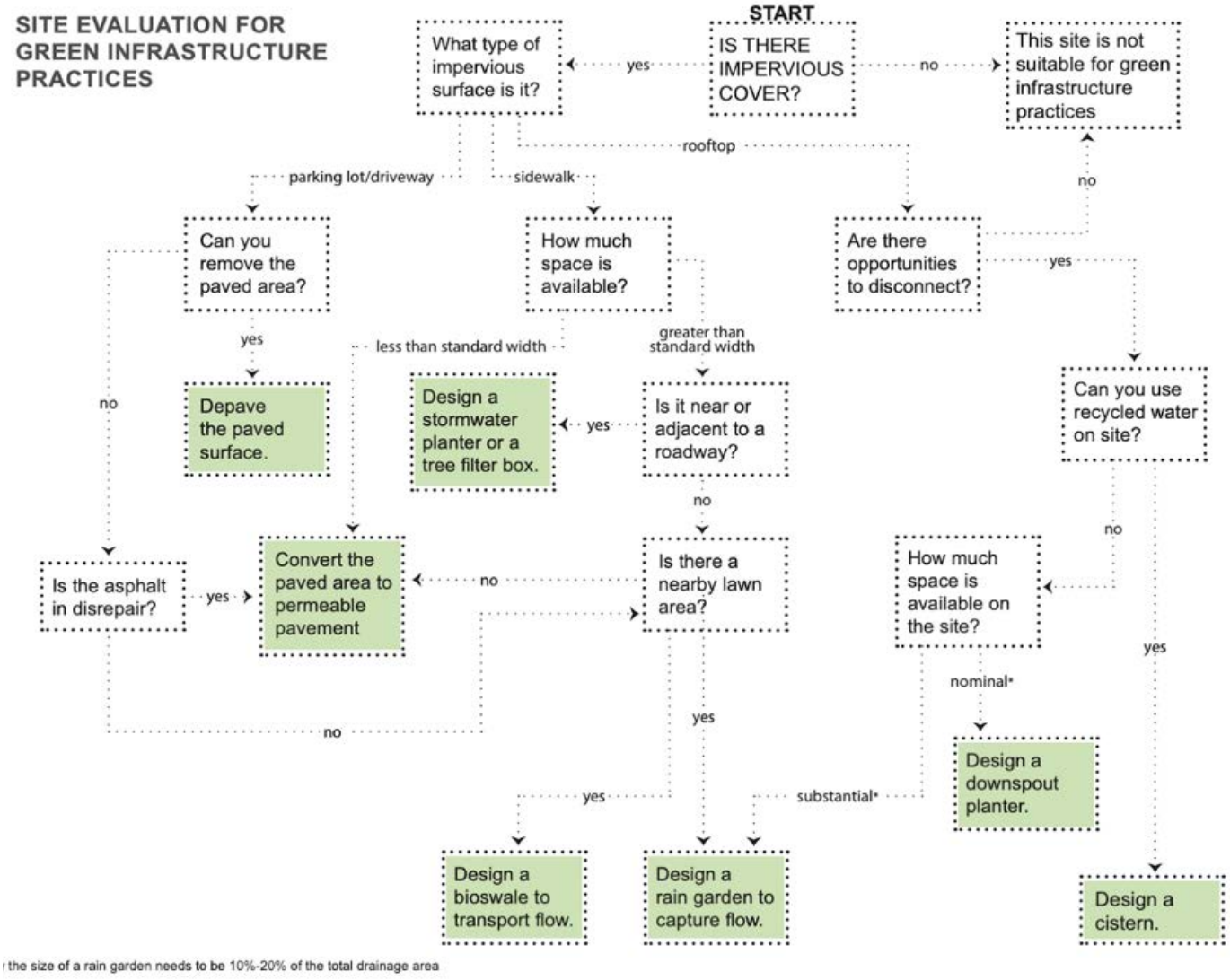


Fig.29. Decision matrix for green infrastructure projects based on site evaluation

Credit: Rutgers Water Resources Green Infrastructure Guidance Manual

Chapter 8. Recommendations: Green Jobs & Economic Development

Recommendations: Green Jobs & Economic Development

Introduction

A rapidly changing climate poses significant threats to Perth Amboy's economy. Weather related loss to physical assets and hampered economic growth are of increasing concern. The effects of climate change are projected to cause damage to homes and businesses, decrease household disposable incomes, affect worker productivity, limit agricultural production and access, and contribute to overall loss in local Gross Domestic Product. [27]

While climate change poses multiple threats, it also provides an opportunity for economic improvement in Perth Amboy. It is critical that the city commits to exploring resilient economic strategies to position itself for major transformations in energy and industrial trends. Lower-income communities contribute the least to climate change but will be the most exposed to stressors. Therefore, resilient economic growth should follow the Just Transition movement in that, "workers and communities impacted first and worst must lead the transition first to ensure it is just." [28]

Perth Amboy faces many challenges that hinder economic growth. Limitations to transportation; a lack of industrial diversity in employment; and low economic mobility indicators are some of the issues facing residents. In addition, most potential sites in Perth Amboy require remediation due to pollution. However, Perth Amboy has many assets including a marina and waterfront; tax incentive overlay zones; and strong anchor institutions. Moreover, the city benefits from its prime location along the northeast corridor and within the New York City metropolitan area. The Green Jobs and Economic Development section seeks to address Perth Amboy's challenges and leverage its assets through the lens of forthcoming climate conditions so Perth Amboy can become resilient and experience sustained economic prosperity.

Green Jobs

Green jobs provide a dual benefit of environmental gain and employment generation. Perth Amboy can encourage local green job creation by preparing its workforce for rising industries and focusing on jobs that do not require a bachelor's degree. Focusing on training for these types of jobs is necessary because 70% of residents lack a degree higher than high school level. It is projected that there will be significant growth in resilient related industries including construction, building operations and maintenance sectors, flood risk reduction, installation and repair, and energy-efficient building operations. [29] These industries will require a workforce that is trained in a new set of skills and Perth Amboy's construction workforce will prove beneficial to these new industries. Climate change will force shifts in energy generation and food production that will create economic opportunities as new industries emerge. Recommendations in this report include preparing the City's workforce for the energy and urban agriculture industries as climate change will create a high employment demand in these sectors.

Team vision statement

We seek to surface Perth Amboy's economic assets to attract green jobs and prepare existing industries for the effects of climate change, ensuring economic

opportunity for legacy residents. Perth Amboy should encourage resilient economic growth through a focus on green jobs in the energy and urban agriculture sectors and leverage its existing strength in the healthcare industry. This can be achieved by establishing a green task force, developing workforce retraining, and improving transportation. Through these strategies, Perth Amboy will position itself as a regional example of effective urban coastal resilience.

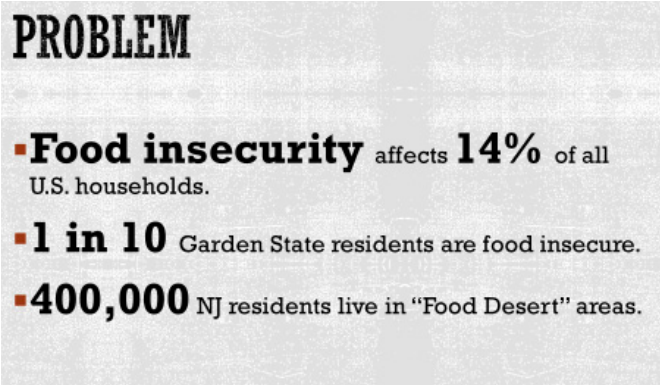


Fig.30. Food Insecurity Problem

Food Security

Food accessibility and insecurity have emerged as significant national public health priorities. The lack of access to healthy food - predominantly in areas deemed "food deserts" - is recognized as a key factor contributing to nutritional disparities and obesity.

Food deserts can be defined as geographic areas where access to healthy and affordable food options are limited, restricted, or nonexistent due to the absence of grocery stores within suitable travelling distances" .[30] New Jersey is replete with over 134 USDA designated food desert areas. The nearly 400,000 New Jersey residents who live in these designated food deserts are significantly more susceptible to obesity related diseases, to which the state of New Jersey spends nearly $600 million each year to combat. [31] Additionally, the prevalence of food deserts aligns with socioeconomic disparities. Multiple studies indicate that there are four times fewer supermarkets in these socioeconomically deprived areas. [32]

Northern Middlesex County represents one highest concentration of working poor in all of New Jersey. A recent study by the United Way found that nearly 42% of all households in Middlesex county, struggle to afford basic necessities, including food, healthcare, transportation and housing. This population are characterized as being "Asset Limited, Income Constrained, and Employed" (ALICE), and do not qualify for poverty assistance, but who struggle to make ends meet. Due to their economic standing, these same families all too often purchase food based on financial necessity rather than nutritional concern. It is also these family's pantries and refrigerators that are nearly empty during weather-related disasters.

A frequently overlooked aspect of the retail food system is the infrastructure required to get food from a farm to a consumers table. During instance of climate related emergencies including hurricanes and winter storms –

Fig.31. Healthy Food Access

essential thoroughfares become impassable resulting in the disruption of the traditional food retail aggregation and distribution system.

In addition to a lack of accessibility, produce found in many retailers often originates from thousands of miles away. According to the 2018 Locavore Index – a ranking system using indicators related to local food consumption and production - New Jersey stands as #42 in the country in its commitment to local and regional food. [33] This disappointing statistic stands in stark contrast to the state's thriving agriculture industry. Each year NJ ranks in the top 10 states for growing such items as cranberries, bell-peppers, and tomatoes. In fact, NJ has some of the most productive preserved farmland in the country – making farming an important economic driver in the state.

The Northern New Jersey Regional Foodshed Resiliency Plan identifies significant potential for increasing local food production and consumption. Only 88 of the 10,000 crop producing farms located within NJ participate in localized distribution or community supported agriculture programs. [34] Food hubs have recently emerged as a viable means of increasing access to local, fresh, and nutritious foods in underrepresented, low-income, "food desert" areas.

1. Background:

Local food hubs function as an intermediary between food producers and local markets. Effective food hub networks are comprised of institutional purchasers such as schools, local governments, restaurants grocery store chains, and co-op food markets. Food hubs are also socially just, reinforcing participatory practices while informing health-based, and culturally sensitive systems.

2. Regional/Community Benefits - Food hubs offer numerous other local and regional benefits, including job creation and expanded market prospects. [35] This dynamic food sourcing and supply model can increase networking prospects for small to medium-scale farms, improving their economic viability and the downstream growth of processing and wholesale facilities. The community emphasis of successful food hubs across the country creates a tangible humanistic and health-centric atmosphere. The food co-op and retail nodes of food hub networks represent the possibility for consumer and community proprietorship, rather than producer ownership. Community food hubs foster an atmosphere of support, providing growth to local producers while allowing for easier access to low-income consumers, resulting in a more equitable food system.

Fig.32. Photo

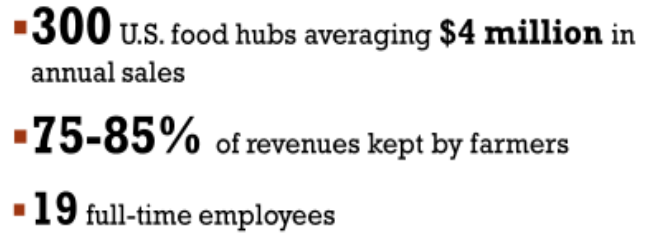


Fig.33. Regional Benefits

3. Supply chain – Food hubs help coordinate more efficient food supply chains, helping produce move from field to table more sustainably. These refigured food hub supply chains target the areas of aggregation, marketing, and distribution. Food hubs promote aggregated distribution - permitting multiple producers to combine their products for wholesale shipment in volumes greater than most producers are capable of handling on their own. Combining local producers in a retail-oriented food hub system has the potential to create denser, year-round food markets – exposing and educating local consumers about locally produced food. Also, marketing operations are transferred from small farms to the food hub network – allowing farms to concentrate on production and creation of value-added products. A recent USDA study concluded that farmers who utilize established food distribution methods and third part supply chains kept only around 17% of consumer revenue – this is far lower than the 75% to 85% kept by farmers who leverage food hub supply chain services. This additional revenue can be transformative for local and rural communities.

4. Sustainability - The networks contained within these food systems also effectively provide technical assistance to producers. Season extension, production planning, and sustainable production practices are central aspects of successful food hub systems. Because the distribution system of food hubs is more regionalized, transportation emissions can be reduced – which can align with New Jersey's CO_2 reduction goals. Traditional food service or supply organizations typically focus on only one of the three pillars of sustainability (environmental, social, economic). Utilizing a more holistic sustainable approach, food hub systems establish demographic linkages, encourage economic development, and decrease land-use stress.

5. Agricultural Urbanism - From the perspective of policy, planning, and urban design, the community-centric food hub approach provides a vast spectrum of land use and design opportunities. The emerging movement known as "agricultural urbanism" centers around the idea of integrating sustainable food-systems with the design of the urban environment. [36] Focusing on both the aesthetics and services of food hubs can serve to attract diverse audiences interested in specialty, artisanal, and local products – resulting in additional revenue to support economic access and services for food-insecure low-income populations.

6. Health Benefits - Evidence also indicates that participation in farmers' markets and community supported agriculture (CSA) projects encourages healthy dietary choices. Many established food hub networks integrate innovative alternative systems including mobile farm stands, urban/community agriculture, and "pick your own plots" – resulting in the increased exposure of healthy food choices, especially to children. [37] Obesity resulting from unhealthy dietary choices are especially widespread among children in the US. The Institute of Medicine has indicated that children may have a lower life expectancy than their parents along with a decreased quality of life as a result of being obese or overweight. [38] With the 21st highest obesity rate for youth ages 10 to 17, the population of New Jersey would benefit from a food hub network proven to decrease obesity risks.

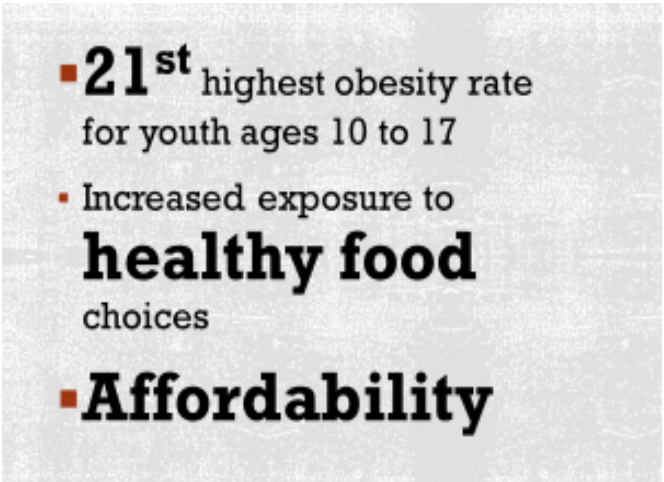


Fig.34. Health Benefits

Case Studies

Food hubs are growing throughout the United States. Communities are motivated by some of the issues mentioned above to promote sustainable local agriculture and improve access to healthy foods. The University of the District of Columbia (UDC) development an exemplary Urban Food Hub concept designed as network of food security islands throughout the D.C area. This project has found success by supporting local business development in historically underrepresented communities, lowering unemployment and improving nutritional health among its residents.

The nonprofit Connecticut food hub organization Wholesome Wave created the "Healthy Food Commerce Initiative" which underscores the intersection between health and value-added retail in a community-owned food market.

Another prominent example of a food hub network focusing on strengthening a healthy regional food supply through its 250 independent merchants and vendors is The Local Food Hub in Charlottesville, VA which serves more than 40,000 residents. These examples illustrate both the effectiveness and capabilities of a regional food hub system.

Regional food hub networks have been proven to mitigate the pervasive problems of food insecurity and slow the growth of food deserts across the United States. Food hub networks increase access to healthy foods, especially in at-risk communities like Perth Amboy. Along with providing a means to promote sustainable development, this emerging and innovative system of food production, marketing, and distribution has the potential to transform Perth Amboy's local economy while improving the health and wellbeing of residents.

Recommendations

Creating a new food culture in Perth Amboy is integral for a successful transition to an integrated and resilient food hub system supported by policy. The following three items can be easily addressed at the municipal level prior to state-led legislative actions:

1. Education in the areas of nutrition, diet, and produce must be part of the city-wide curriculum and colloquial community information initiatives;

2. Existing food intensive institutions including schools, hospitals, and food pantries must be engaged early to become centralized distribution facilities that can easily transitioned to become nodes of the food hub system;

3. Communication with local farms of all sizes must be established early to gather information, exchange ideas, and understand the unique difficulties and opportunities present within the states robust agricultural sector.

Indoor Agriculture

Current methods of industrialized agriculture are consistently exposed to unpredictable socio-economic and climate-related perturbations. In the face of these uncertainties, farming operations must deal with both urgent and long-term disturbances to their crop yield. Controlling specific environmental conditions has been the standard approach to mitigate these exogenic impacts. Unfortunately, modern intensive farming relies quite heavily on mineral fertilization, intensive irrigation and pesticides to ensure healthy and robust productivity per square foot of farmland.

hile these distresses demand urgent global attention, the United Nations Food and Agriculture Organization (UNFAO) asserts that the most immediate issue

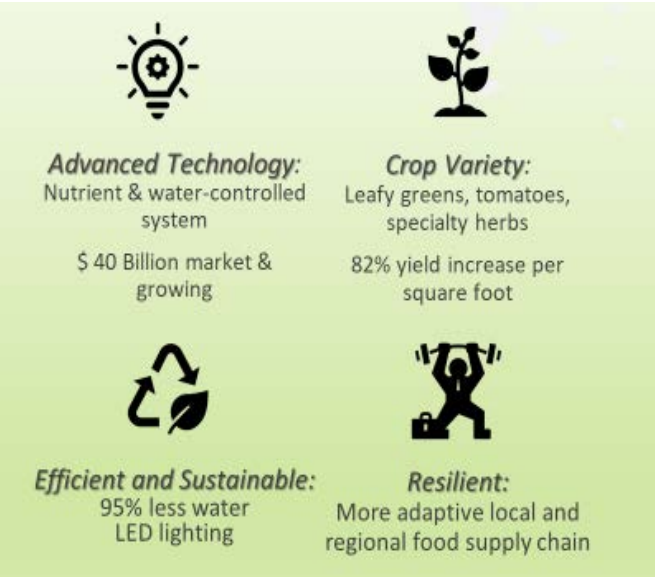


Fig.35. Regional Benefits

facing society is the problem of food insecurity and food system resiliency. As formally mentioned in the introduction to Food Hub systems, food insecurity and poverty are interconnected. From a resiliency prospective, issues associated with healthy food access, transportation, and income constraints are prevalent within the city of Perth Amboy. In combination with a food hub network, urban and indoor farming enterprises must be considered to provide a more resilient food system for Perth Amboy residents.

Indoor agriculture, by way of greenhouses and vertical farming techniques have emerged as a more resilient approach to agricultural production. As an integral part of this new vision, scientists have made significant improvements to the methodologies associated with achieving optimal artificial conditions for fruit and vegetable growth. Indoor farming technologies have moved out of the laboratory into private enterprises which have proven both effective and profitable.

Case Studies

Irving Fain, founder and CEO of the New Jersey indoor farming company Bowery recognized both the great potential and urgency concerning implementation of urban based agriculture. In a recent interview by FoodNavigator-USA.com, Fain remarked that "six billion pounds of pesticides are used each year while 70% of the world's water goes to agriculture resulting in a 30% loss of arable land globally in the last 40 years." [39]

Bowery prides itself on using no chemicals or pesticides in its proprietary vertical nutrient film growing process. With funding from a mix of public and private sources, Bowery Farming was able to hone their technology and techniques at their Kearny, NJ based research and development facility. Over the course of one year, Bowery has been able to grow and sell over eight types of leafy greens to supermarkets and has set ambitious expansion goals. [40] Attracting the eye of additional investments, Bowery's expansion appears more feasible; helping to deliver more produce to urban area food deserts.

Another indoor farming enterprise has been making significant strides in production and future expansion only 20 miles from Perth Amboy. Aerofarms, the 15-year-old Newark based business is one of the pioneers of indoor farming. With a sustainable distribution range of 50-miles from the source of production, Aerofarms integrates well into a hyper-local food hub-based system. With recent funding from Google and Amazon, a recent valuation put Aerofarms ahead of the pack at $500 million. [41] Aerofarms recent financial success was the impetus to announce a goal of "25 new farms within five years." This has many cities vying for a resident like Aerofarms.

Fig.36. Aerofarms Interior

Fig.37. Aerofarms

Aerofarm's 70,000 square foot vertical farming facility and headquarters in Newark has produced nearly 2 million pounds of leafy greens annually over the past two years. In 2015, the New Jersey Economic Development Authority awarded a $2.2 million grant under the Economic Redevelopment and Growth Program. Their funding, along with a $6.5 million tax credit from the Grow New Jersey and the affordability of real estate in the brownfield strewn area of the Ironbound, made Newark an attractive home for Aerofarms. The result of this enterprise is a revitalized and remediated section of the Ironbound; not only an area solely dedicated to Aerofarm's profitability, but an aesthetically pleasing and community-oriented hub of activity.

As noted in the infographic, these regional indoor farming enterprises have experienced growth in funding, profitability, and employment. Although requiring some specialized labor, most jobs incorporate translatable skills. Electricians, logistic specialists, and warehouse workers encompasses a large percentage of the hundred plus jobs at each of these facilities.

Fig.38. Indoor Agriculture Business on the Rise

Recommendations

In order to bolster an integrated, resilient, and local food-hub-based food system, it is our recommendation that the city of Perth Amboy attract an indoor farming private enterprise. Although the economic benefit to the city will not be immediate, latching on to this fast-growing sector may prove essential for future local economic growth. In addition to the recommendations provided in the above food hub section, this report provides additional suggestions below to make the city more attractive to an indoor farming enterprise.

1. Establish an impartial Green Economic Task Force under the purview of the Office of Economic & Community Development with the mission to:

a) Conduct an assessment and categorize "strategic development areas" which include the 124 identified contaminated sites

b) Report findings to the Office of Economic & Community Development.

2. Plan for site specific reuse according to green redevelopment priorities.

3. Apply for remediation funding through the expanded NJ Brownfield loan program.

4. Rezone selected areas to attract the indoor/ urban agriculture sector.

5. Initiate community, academic, & private sector partnerships to better involve residents and facilitate a cooperative urban agriculture vision for the city of Perth Amboy.

a) Incorporate urban agriculture programs within the public-school system.

6. Incorporate urban and indoor agriculture within a city-wide strategic vision for a Foodhub"

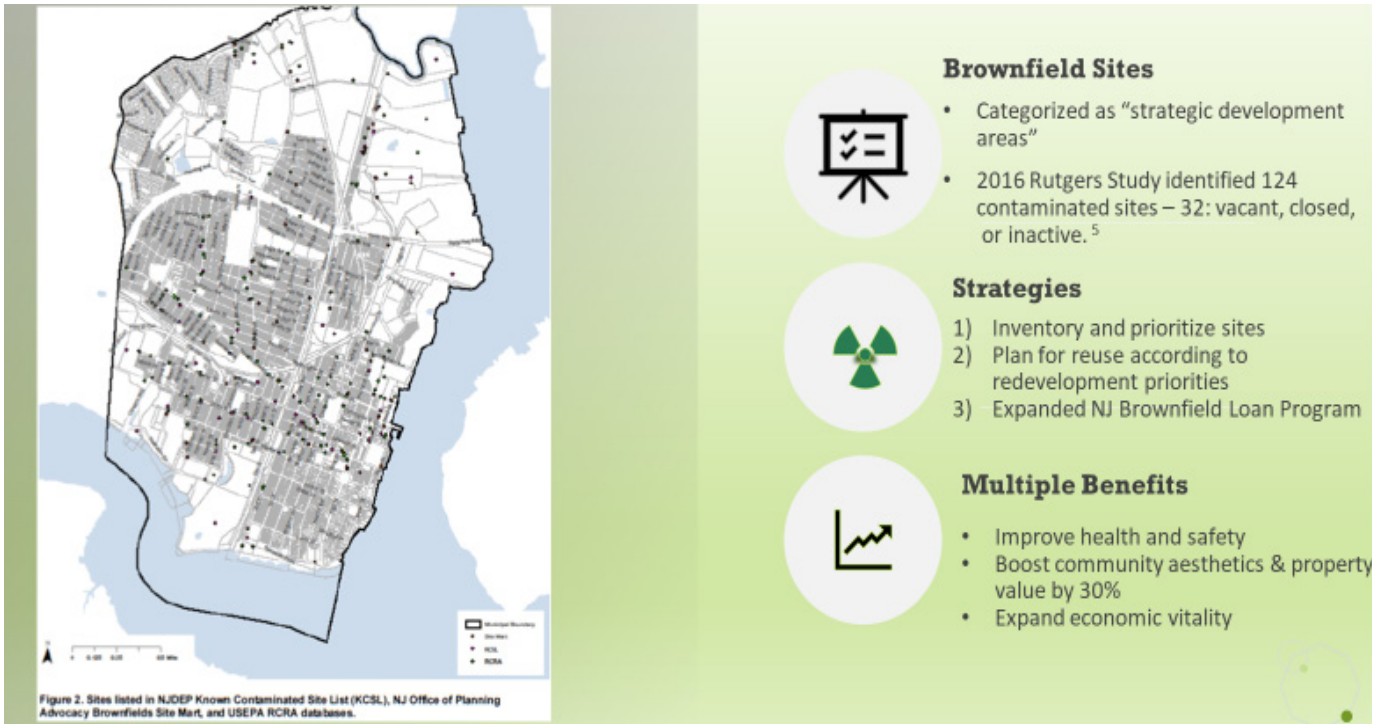


Fig.39. Adaptive Reuse

Energy

The United States Climate Alliance was formed by a coalition of states in an attempt to uphold the Paris Agreement objectives to hold the increase in global average temperature below 2°C below pre-industrial levels. [42] These 17 members, including New Jersey, aim at an emission reduction of 26% from 2005 levels by 2025. As a result, New Jersey has a goal of a 100% clean energy economy by 2050 to reduce climate change effects and secure clean energy for the future. [43] This aggressive goal demonstrates New Jersey's commitment to clean energy and will drive the state's investments into clean energy.

This resilience strategy is aimed at fostering economic growth through job creation in New Jersey's energy and building sectors. Perth Amboy should prepare for this massive energy transition as an opportunity for local job creation and funding for improvements in the city's energy infrastructure. Strategies should include both mitigation and adaptation in order to reduce emissions and protect against threats to energy supply. These resilient energy strategies include promoting energy efficiency, investing in grid resiliency, and attracting renewable energy industries to establish in Perth Amboy. These strategies will provide economic benefits through job creation, savings for consumers and businesses, and energy security.

According to a U.S. Department of Energy report on jobs in the energy sector, the shift in electric generation mix from 2015-2016 led to a 13% increase of employment in the electric power sector. [44] This is due to the building of new plants, replacing aging equipment and investment in new technology. There are now 2.2 million people working in the energy-efficiency sector and a majority of which are in construction (1.4 million), and manufacturing (290,000). Increases in employment are likely to occur with increases in investments and general interest in grid modernization.

Promoting Energy Efficiency

New Jersey is a densely populated state and ranks 15th in the nation for total energy consumption. [45] The state's total consumption accounts for 9.4% of the total U.S. energy consumption, with the majority from the commercial sector, and then transportation and residential are a close second and third. The state relies heavily on petroleum products, ranking among the top 10 states in the US. The current average residential electricity rate is 15.78¢/kWh, which is 32.8% greater than the national average.

The goal of this strategy is to promote energy efficiency in order to decrease the overall demand for electricity and provide savings for businesses, consumers, and the city. Problems associated with aging infrastructure in Perth Amboy will be exacerbated by damage from climate change events. Increasing efficiency will allow for resiliency by preparing Perth Amboy for increasing electricity demand from development and electrification. In addition, improving energy efficiency is the cheapest and most immediate way to reduce fossil fuel consumption. For example, making efficiency upgrades provide an average of 5-30% savings on annual utility bills. [46] This strategy recommends promoting energy efficiency in Perth Amboy by focusing on setting standards for new developments and retrofitting public buildings.

In the 2003 Perth Amboy Master Plan, the conservation element included recommendations that align with this goal including incorporating energy conservation initiatives in city operations and promoting building design for public and private developments. [47] This previous plan recognized that energy consumption has an impact on the city's economy and surrounding environment.

Perth Amboy's population has grown between 1990-2010 increasing 23% from 41,976 to 51,765. Growth is an opportunity for both economic development and resiliency by establishing efficiency standards. These standards will help mitigate future stress on infrastructure due to additional demand for electricity and will help maintain quality of life for Perth Amboy residents. Public buildings, such as public institutions, municipal government buildings, schools etc. should be retrofitted for higher efficiency. These entities can reduce energy consumption and incur energy cost savings by installing higher efficiency systems including lighting, sensors, HVAC equipment, renewable energy and demand management controls.

Reducing the public building's carbon footprint will allow the city to lead by example and encourage efficiency improvements in other sectors by demonstrating the feasibility and cost savings. Energy efficiency can also

prepare Perth Amboy for further changes in energy infrastructure and climate threats. Money saved through efficiency improvements can be re-spent back into the community. [48] In addition, setting energy efficiency goals in Perth Amboy will create a demand for local jobs especially during initial construction and investment periods. These jobs include auditors, project managers, and various jobs in the construction trades. Jobs handling energy efficient equipment require higher-skilled labor that with proper training will allow for high paying employment.

Fig.40. LEED Certified Building, 118 Madison Street, Hoboken
Credit: Jersey Digs

Investing in Grid Resiliency

Climate change is expected to bring an increase in the severity of extreme weather events including tropical storm systems. [49] Hurricane conditions will become a more prominent challenge to the country's energy sector and may disrupt energy production and distribution. According to data from the U.S. Department of Energy, 58% of outages observed from 2002 to 2014, and 87% of outages which affected 50,000 customers or more were directly attributed to severe weather events including hurricanes, blizzards, and thunderstorms.[50] During Superstorm Sandy, Perth Amboy sustained a city-wide power outage. High winds caused the majority of damage due to fallen tree limbs on overhead power lines. Most areas lost power for at least 30 to 48 hours and there were 50 locations of downed power lines throughout the city. [51] The flooded power station in Sewaren caused delay to repairs for the system and problems for the Budapest area.

Fig.41. A fallen tree at the corner of High Street and Water Street in Perth Amboy, NJ in the aftermath of Superstorm Sandy on 10/30/12.
Credit: Star Ledger

Damage to the electrical grid infrastructure can cause interruption to business operations and a loss of income for hourly workers. Power outages cause risks to the safety and health of individuals, especially the elderly. In addition, there is a need to move reliance off of non-renewable sources to ensure access to energy. The inclusion of a critical facilities microgrid in Perth Amboy would provide uninterrupted electric service to critical community assets in Perth Amboy. The development of this independent local grid system would also allow for renewable energy integration and the installation of emergency backup power.

A community facilities microgrid will provide resiliency for Perth Amboy's energy system, improve renewable energy use, and provide cost-effective methods. This strategy will help to minimize risk from catastrophic events that may challenge Perth Amboy's quality of life, security and operations, and economic activity. This strategy will promote green job creation through microgrid planning, installation, and upgrades to existing infrastructure.

Fig.42. Critical facilities identified in Perth Amboy. These facilities should be considered for Community Microgrid planning.

Attract Renewable Energy Industries

Offshore wind has the potential to become the predominant energy contributor to domestic energy supply and is estimated to be greater than 1000GW for the United States. [52] This industry has the unique ability to compete in populated coastal markets like New Jersey where onshore wind is unavailable. New Jersey has a total of 7,477 km2 area of state waters with a minimum average wind speed of 7m/s [53] and its strategic central east coast location, long coastline, shallow continental shelf, steady wind resource, and an educated workforce is appealing to the offshore wind industry. [54]

As part of New Jersey's goal of 100% clean energy by 2050, Governor Murphy has signed an executive order increasing New Jersey's offshore wind goal to 7500 MW by 2035. [55] To reach this goal, there will be a state-wide rapid mobilization including investments in port infrastructure, supply chain, operations and maintenance, and other sectors. This mobilization is anticipated to generate billions of dollars in investment in New Jersey and create thousands of jobs. The New Jersey Board of Public Utilities has awarded its first offshore wind project Ocean Wind- a 1,100 MW farm located 15 miles off the coast of Atlantic City. New York has also awarded two offshore wind projects totaling 1700MW. The Empire Wind Project off of Long Island, in addition to other New York Bight Call Areas, are in close proximity to Perth Amboy.

Both New York and New Jersey are looking to create regional hubs for the offshore wind industry. [56] The Wind Innovation and New Development Institute is in charge of developing a plan that creates a regional hub for NJ's offshore wind industry. This strategy recommends that Perth Amboy be positioned for offshore wind as a major economic development opportunity. Perth Amboy should prepare site assessments for the facilities that are needed by offshore wind including marshaling operations and maintenance (O&M) and manufacturing sites as they become available. In addition, Perth Amboy should emphasize skills needed by offshore wind in green job training programs and provide transportation to job sites. Perth Amboy has many assets for the offshore wind energy industry including proximity to the water, a large workforce with construction skills, tax incentive overlay zones, and transportation infrastructure. However, investment should be considered to improve marinas other needed sites. Investment may include brownfield remediation, targeted marketing, site improvement and expanded access to tax incentives.

Offshore wind sites will be assessed on waterfront access, size, depth of the existing berth and navigational channel, and bridge height limitations. Currently, the only planned facility in New Jersey is in Paulsboro, which is proposed to be a turbine foundations plant. Marshalling facilities must be capable of supporting heavy equipment and have no obstructions to the wind farm. The area must include a large amount of storage for material assembly and transport. O&M facilities will be used for a long-life span and do not require as large of an area but must be located within a few hours from the wind farm and should support vessel operations. Manufacturing facilities should provide access to materials, mostly imported from Europe and a skilled workforce.

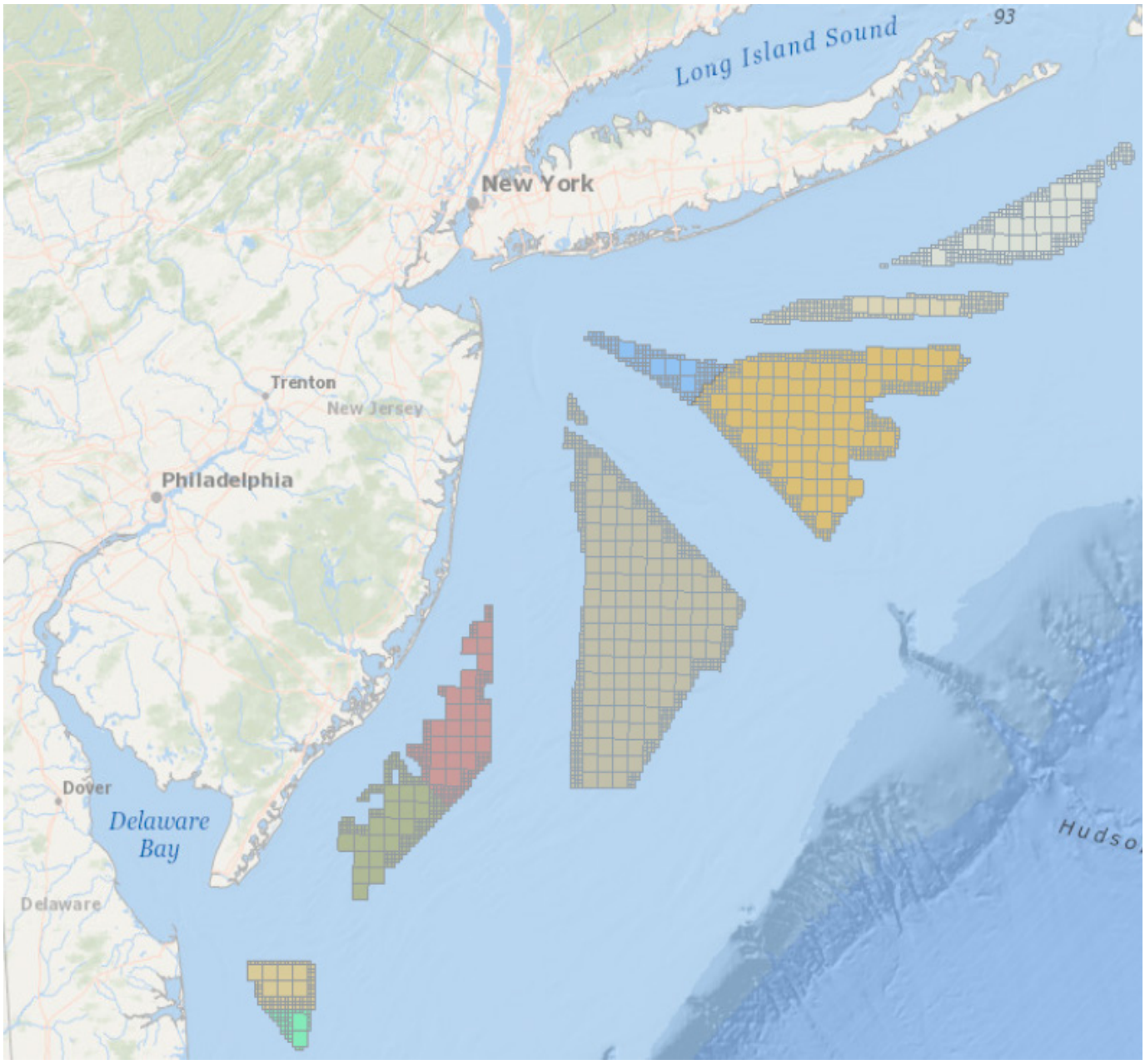


Fig.43. BOEM identified Lease and Planning Areas for Offshore Wind Energy
Credit: Mid-Atlantic Ocean Data Portal

Fig.44. Vacant lot at 980 High Street, Perth Amboy.
Credit: NJParcels.com

Fig.45. Proposed offshore Wind Terminal Assembly Facility in Staten Island.
Credit: https://www.silive.com

Potential sites

This lot is located at 980 High Street block 426, lot 3.04 in Perth Amboy, Middlesex county. It is listed as vacant land near the Outerbridge Crossing which has a clearance of 143 feet. This lot contains 73.78 acres and is owned by Duke Realty Eport Urban Renewable LLC. This property has waterfront access, however, contains multiple flood prone designations. This site is an example of a site that could be used for an offshore wind facility.

The Coast Guard recovered 780,000 gallons of an oily mixture from Kinder Morgan's Perth Amboy terminal after damage from Superstorm Sandy. As the shift to renewable energy continues, this facility may no longer be needed and efforts should be made to remediate and use it for renewable energy. Its waterfront access, lot size, height clearance, and proximity to lease areas make it advantageous for the offshore wind industry. In addition, there is a proposed offshore wind terminal assembly facility, Arthur Kill Terminal, located south of the Outer Bridge Crossing in Staten Island. As facilities are built near Perth Amboy, transportation and job training should be provided to connect residents to employment opportunities.

Recommendations:

1. Adopt efficiency and design standards recommended by the LEED rating system [57]

2. Create policy to ensure standards are implemented for new development in Perth Amboy

3. Install Energy Conservation measures in public buildings to reduce energy consumption and create savings for the city.

4. Conduct feasibility study of microgrid including assessment of critical facilities. Consider the Energy Surety Design Methodology Framework (ESDM). [58]

5. Improve resiliency of current grid infrastructure including raising substations, relocating key assets, burying power lines, expanding tree-maintenance programs and improving transmission line conductors

6. Consider installation of emergency backup power and renewable energy integration in compatibility with micro-grid planning

7. Encourage the deployment of smart-grid technologies to enable outage detection, sensors, and controls

8. Begin site assessment for renewable energy industries, especially for offshore wind facilities

9. Consider investment to improve sites for offshore wind including remediation, targeted

marketing, port and marina improvements, and expanded access to tax incentives

10. Ensure transportation and job training for offshore wind jobs and facilities in close proximity to Perth Amboy

11. Create policy to help residents secure green jobs and enforce living wage employment for renewable industries establishing in Perth Amboy

Implementation:

1. Efficiency standards for new development should be implemented immediately. Job training to fill these roles should be created to ensure residents can fulfill the demand.

2. Retrofitting of public buildings should begin with the use of the ESIP funding mechanism created by the Board of Public Utilities. [59] This funding mechanism will allow for energy conservation measures in public buildings without capital expenditure.

3. Feasibility studies for microgrid installation and improvements to grid infrastructure can occur at a medium timeframe. Planning should follow the guidelines set by ESDM and recommendations made by the South Ironbound Resiliency Action Plan and Hoboken Sustainability Plan. Efforts should be in coordination with utility companies. Funding may become available from the Board of Public Utilities Energy Master Plan strategy to support community energy planning and action in underserved communities.

4. Site assessment for offshore wind facilities and job training should begin immediately. Next, targeted marketing and expanding tax incentives should be considered. Planning for investments to improve facilities can occur between a medium to long time frame.

5. Transportation to nearby sites should be planned as it becomes known where facilities will be located.

6. Funding opportunities that may be useful for Perth Amboy for renewable energy include:

- The New Jersey Board of Public Utilities Clean Energy Program: Offers grants for up to 20% of the cost of large-scale renewable energy facility development

- Port Authority Local Assistance Program: PANYNJ program to support economic development in Port area communities could contribute resources for marketing the City or wayfinding.

- Port Authority Portfields Initiative PANYNJ program helps communities transform brownfield sites into warehouse and distribution centers.

- Offshore wind technical assistance program: launched by the New Jersey Economic development authority to support local companies and develop the skills needed to participate in the offshore wind industry

Workforce Development

People-Centered Approach

At its core, an inclusive Perth Amboy must pursue people-centered and people-driven projects, services, and investment. The City must also recognize the different needs of its diverse population in designing and delivering services, projects, and investments to realize maximum impact, inclusion, and sustainability. The goal of economic development and green jobs in Perth Amboy must fortify the existing job sectors and diversify the workforce and employment opportunities, as well as reposition the skilled and unskilled workforce for green jobs that already exist or are likely to exist in the future. Fortunately, a lot of “green collar” jobs, like building retrofits, already exist--albeit with some new materials and techniques. Without deliberate planning and intervention, entry-level jobs will fail to develop into higher-wage, higher-skill careers, even if they did go to targeted jobseekers.

A well-designed career ladder is founded on a program for worker readiness. This should include improving academic skills in a meaningful context, development of soft skills and self-esteem, and a comprehensive understanding of the field. Once ready, an individual can be trained in the classroom or on the job for an entry-level position.

Employment Challenges

Employment figures demonstrate that Perth Amboy is performing well overall: a low unemployment rate, thriving small business along the city's commercial corridors, and strong employment clusters in growing industries like healthcare and transportation and warehousing. However, a relatively high poverty rate suggests a significant portion of the population is not making a living wage. Addressing inclusive, resilient economic growth will need to improve access to residents subject to in-work poverty and forms of employment that do little to improve their health and wellbeing. Temporary contracts and the "gig economy" provide employment opportunities, but often subject employees to limited autonomy, a lack of skills development, and limit upward mobility. People-centered growth redirects strategies of simply creating jobs to creating better outcomes for people through skills training and education. This means:

» Initiatives to improve the health and wellbeing of children in early years, supporting positive health choices and higher-education attainment
» Providing affordable childcare, offering low- to moderate-income families and single parents the opportunity to work or to develop skills that enable better job prospects
» Improving apprenticeship starts, quality training and completions, including completion of certificate programs and associate's degrees
» Developing a well-connected workforce development pipeline that addresses the needs of local employers by empowering the local workforce with the requisite skill set.

Furthermore, community residents face challenges beyond the direct scope of workforce development. A lack of stable housing, limited transportation options and childcare support, as well as financial barriers inhibit the potential of a thriving workforce.

Resilient Jobs Best Practices

Resilience is the ability to prepare for and adapt to changing conditions and overcome disruptions. This includes the ability to plan for and ensure good-paying jobs. By enhancing workforce support programs, through training, placement services, and community support, the City can prepare its workforce with the flexible skills to withstand economic shifts brought on by climate and market changes. A strong workforce support program accomplishes the following:

» Engages employers, community organizations, and workforce training programs to align training with employer needs and ensure that training is connected to real jobs
» Identifies programs for workforce education and bridge training
» Focuses on occupations that pay a living wage and provide opportunities for further career advancement
» Improves career advice and support for parents and young people to understand what training and skills are required for high-quality, local jobs
» Closes gaps in the transportation system connecting residents to potential occupations
» Promotes disaster preparedness and planning for households and small businesses
» Recognizes local and regional dependencies on a single or few industries
» Actively attracts or develops new industries and recognizes developing competitive advantages in current industries
» Promotes the development of enterprises and technologies that support disaster preparedness and recovery
» Considers natural hazard vulnerabilities of commercial development sites

Current Workforce Development Gaps

Although Perth Amboy has a strong network of providers, there are several gaps in the local workforce system including:

» Limited employer involvement in defining training needs, designing programs, and connecting training program graduates to their jobs;
» Insufficient supply of bridge program graduates to their jobs;
» Coordination among education organizations to align their programs, fill service gaps, create career pathways, and improve the overall ecosystem

Growth Sectors in Perth Amboy

The U.S. economy has changed dramatically from a predominantly manufacturing employment base to a more service-oriented workforce. Moreover, as the country grapples to adapt to a changing workforce, there is a growing disparity between labor supply and demand. The state of New Jersey currently has a shortage of middle-skill workers with the skills needed in today's economy and a surplus of workers at the high and low ends of the skills spectrum.

Key Findings

» Despite a high employment growth rate, the Transportation/Warehousing industry has experienced a 27% decrease in real wages between 2010 and 2018, the poorest performance of all private sector industries studied in this report
» 34% of private sector jobs in Perth Amboy are in the Health/Social sector
» Total private sector jobs in Perth Amboy increased by 10% between 2010 and 2018
» The fastest growing private sector industries between 2010 and 2018 are Transportation/Warehousing (55%), Health/Social (26%) and Construction (21%) (Figure 46)
» The private sector industries that have contracted the most between 2010 and 2018 are Finance/Insurance (-7%), Admin/Waste Remediation (-5%), and Retail Trade (-5%)

After an analysis of major employers in Perth Amboy and industry data from the North American Industry Classification System (NAICS), this report identifies two major job clusters with potential for enhanced economic resiliency: healthcare and construction. These two industries experienced significant growth (over 20%) between 2010 and 2018 and are identified by the New Jersey Department of Labor and Workforce Development (LWD) as growth occupations. This section represents high-level research, which may be further researched and implemented into a comprehensive workforce development strategy for the City of Perth Amboy.

Healthcare

Graduates of health care programs have, on average, more opportunities than other industries not only because of increased demand in hospitals and health care systems, but because there are growing needs in nursing homes and home health for continuity of care. As anchor institutions with considerable purchasing and employment powers, hospitals play a vital role in creating and advancing policies, programs, and practices that provide valuable employment opportunities for local residents in the health-care sector.

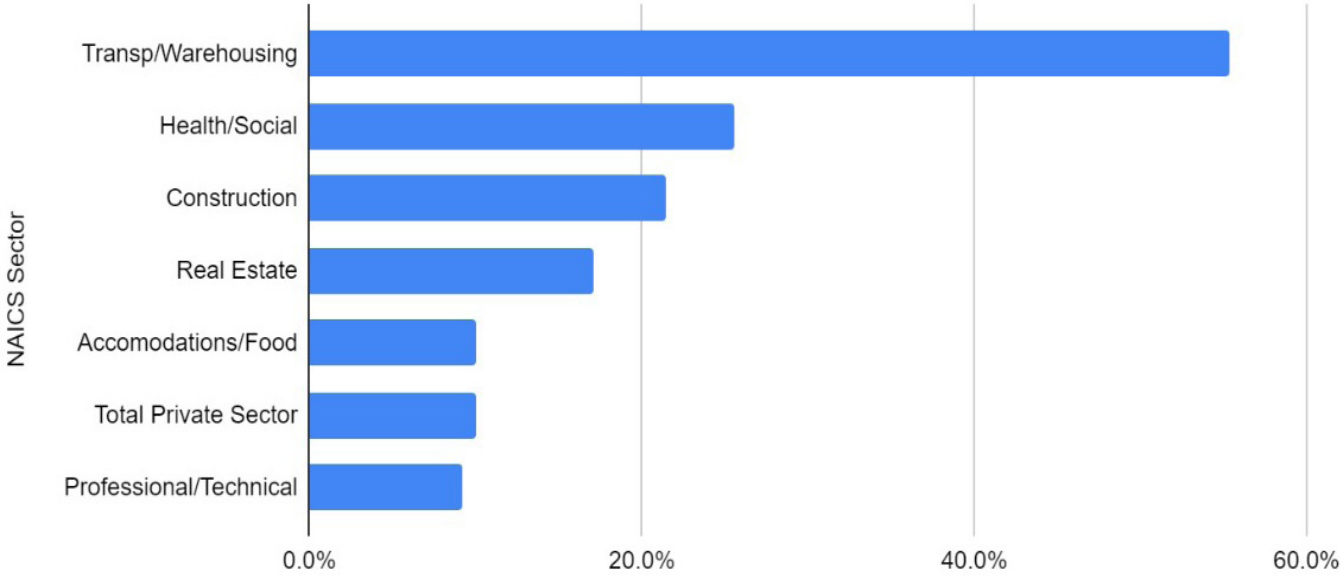


Fig.46. Fastest Growing Occupations in Perth Amboy (2010-2018)
Credit: N.J. Department of Labor and Workforce Development

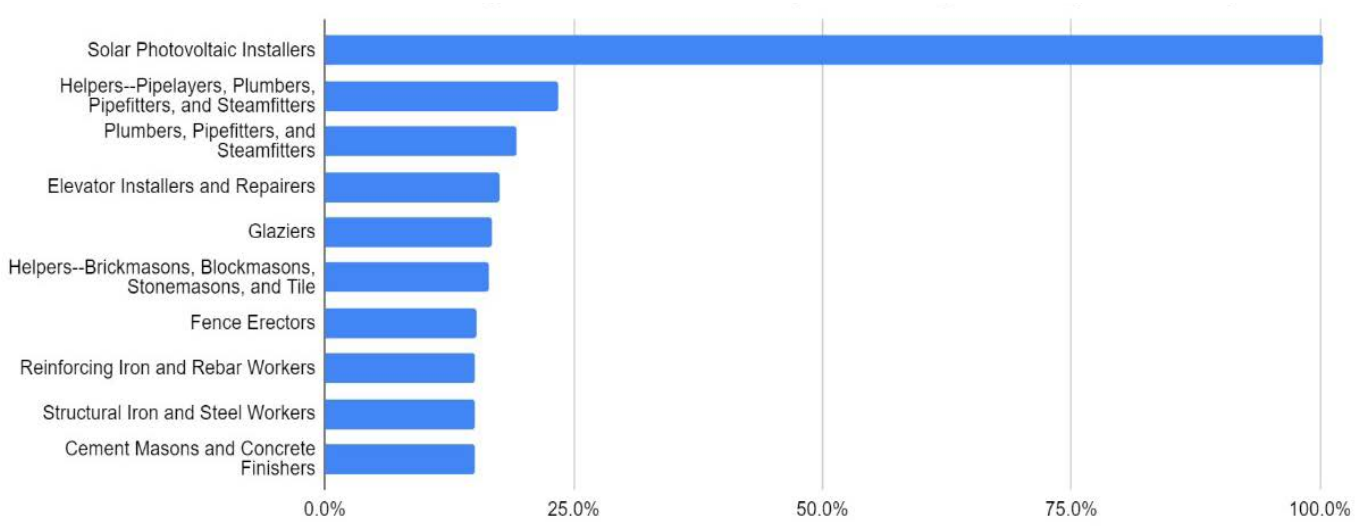


Fig.47. NJ Construction Occupation Projections (2016-2026)
Credit: N.J. Department of Labor and Workforce Development

Construction

The construction industry faces significant obstacles in the short- and long-term—finding and retaining talent, volatile material costs, and a rapidly expanding use of technology that are collectively changing how the industry will operate in the future. Moreover, as approximately 40% of the construction workforce will be of retirement age in the next five years, the City of Perth Amboy has an unprecedented opportunity to enhance its existing construction workforce and prepare the workforce pipeline for the windfall of career opportunities the City is poised to gain. Construction careers offer both higher earnings and potential for advancement and do not rely on a traditional four-year degree.

Inclusive Workforce Development

Research clearly indicates that as educational attainment increases, so does access to jobs with benefits and stability. The nature of work is changing as technological advances and global competition transform the workplace, requiring advanced and diversified skills and knowledge.

Increasingly, some form of postsecondary education or training is essential to obtaining marketable skills that pay off in the local labor market, including technical degrees or certificates and occupational training programs. Studies show that workers with little education and few skills can rarely work their way out of low-wage, dead-end jobs without job-connected education or training.

Career pathways programs target industry clusters and are tailored to the demands of local labor markets, and integrate academic and employability in a coordinated progression of rigorous learning activities. The curriculum, ranging from K-12 to adult education, establishes and demonstrates clear connections between education and training programs and jobs at different levels. Ideally, career pathways programs align education services to meet both high school exit and postsecondary education entry requirements, without the need for remedial or developmental courses at postsecondary institutions.

Recommendations

1. Enhance Early Education Workforce Training

Successful investments in the workforce development pipeline depend largely on the early education experience. The first years of a child's life establish the building blocks for skill development during school and beyond. The achievement gap between children from more advantaged environments and those from disadvantaged situations is established before children enter kindergarten and widens somewhat during their time in school. As Perth Amboy considers its child care policies, it is critical to thoroughly evaluate the

landscape of early childhood education. The data that can be compiled from directors and teachers are an essential part of a comprehensive workforce analysis that enables the City to identify the greatest concerns facing the existing regional workforce and future workforce pipeline, and it should be a major source of decision-making and program development in the field.

The City should explore establishing a curriculum in an existing middle- or high school that delivers foundational introductory course to resiliency topics, job opportunities, and potential career paths. This short session might take place as an introductory piece or at the beginning of a longer job training program. While this course would not necessarily increase occupational skill development, it would generate awareness among Perth Amboy residents that the resiliency field exists, and open up new career paths for those who would have otherwise never heard anything about "green" or "resilience." Curriculum is best supplemented by inviting employers to speak to course enrollees about the green jobs field. Employers and potential employees would be exposed to one another, without the pressure of immediate hiring.

2. Expand Existing Adult Basic Education (ABE) Training

Career pathway programs must provide a systematic framework for reconfiguring education programs to meet the current and projected needs of employed and unemployed learners. Basic skills are taught within the context of employment and specific job tasks, problems and situations. Here, contextualized instruction is critical. ABE programs report that students learn basic skills at a higher rate, retain their knowledge longer, and have higher rates of both retention and graduation if they learn basic skills in the context of particular occupational tasks, and if they can witness immediate benefits in terms of mastering knowledge and skill requirements of an occupation or higher education.

The rapidly growing Latino population in Northern New Jersey is accelerating the demand for bilingual nurses and other healthcare professionals. The need

Occupation	Average Wage	Typical Education	Work Experience	Job Training	Metro LQ	Projected Growth (NJ)
Respiratory Therapists	$78,870	Associate's degree	None	None	0.69	22.70%
Dental Hygienists	$86,790	Associate's degree	None	None	0.8	12.60%
Radiologic Technologists	$72,650	Associate's degree	None	None	0.93	9.80%
Emergency Medical Technicians, Paramedics	$44,660	Postsecondary non-degree award	None	None	1.01	8.70%
Pharmacy Technicians	$35,230	High school diploma or equivalent	None	Moderate-term on-the-job	0.74	8.70%
Surgical Technologists	$58,070	Postsecondary non-degree award	None	None	0.78	9.80%
Licensed Practical and Vocational Nurses	$55,640	Postsecondary non-degree award	None	None	0.8	12.50%
Dental Assistants	$40,990	Postsecondary non-degree award	None	None	0.96	12.60%
Medical Assistants	$37,720	Postsecondary non-degree award	None	None	0.75	23.00%
Medical Equipment Preparers	$43,540	High school diploma or equivalent	None	Moderate-term on-the-job	1.28	11.70%

Fig.48. Entry-Level Healthcare Occupations
Credit: N.J. Department of Labor and Workforce Development

for bilingual Certified Medical Assistants (CMAs) is a recurring concern in community clinics and long-term care facilities throughout the region. The City of Perth Amboy should consider partnering with a local healthcare company and/or educational institution to build out an existing instructional program that teaches ESL, and enhance the program to incorporate ESL for Healthcare as contextualized intermediate-level English as a second language that ultimately prepares students for certification as Certified Medical Assistants. The program can establish a curriculum with two distinct career pathways: coursework that starts at the Certified Nursing Assistant (CNA) certification level and advances to pre-college and college levels in Math and English; and coursework that prepares participants for CMA certification and employment as a CMA in a community clinic or long-term care facility.

3. Target Vocational Education and Training (VET) to Growth Sectors

Educators can develop curriculum and teach general education subjects, but employers know which skills matter and are often more adaptive to train entry-level workers with skilled workers. Optimized education-employment linkage results from a general balance of power between the educational system and the employment system when creating an effective Vocational Education and Training program. This includes designing and updating curricula to reflect the changing needs of the targeted employment sector and combining the educational capacity of student-oriented infrastructure with employers' state-of-the-art equipment, money for wages, and real-life production environments.

A successful linkage process in any VET program should include three critical phases: curriculum design, curriculum application, and curriculum updating. In the curriculum design phase, the shared power between employer and educator should define the standards by which pupil mastery should be evaluated, as well as how many companies should participate in the design process and in what capacity. The curriculum application phase exist processes that relate to program delivery: where students learn, what regulations protect them at work, how costs are divided and shared, and what the examination is like. Lastly, the updating phase requires

Occupation	Average Wage	Typical Education	Work Experience	Job Training	Perth Amboy Employers	Projected Growth (NJ)
Electrical and Electronics Engineering Technicians	$88,580	Associate's degree	None	None	3	6.30%
Electro-Mechanical Technicians	$64,360	Associate's degree	None	None	3	9.90%
Welders, Cutters, Solderers, and Brazers	$51,160	High school diploma or equivalent	None	Moderate-term on-the-job training	2	10.10%
Crane and Tower Operators	N/A	High school diploma or equivalent	Less than 5 years	Moderate-term on-the-job training	0	9.10%
Excavating and Loading Machine and Dragline Operators	$79,130	High school diploma or equivalent	Less than 5 years	Moderate-term on-the-job training	1	8.70%
Motorboat Operators	$60,150	Postsecondary non-degree award	Less than 5 years	None	0	15.30%
Structural Iron and Steel Workers	$89,000	High school diploma or equivalent	None	Apprenticeship	1	15.10%
Pile-Driver Operators	N/A	High school diploma or equivalent	None	Moderate-term on-the-job training	0	5.00%
Painters, Construction and Maintenance	$52,690	No formal educational credential	None	Moderate-term on-the-job training	12	7.20%
Plumbers, Pipefitters, and Steamfitters	$76,030	High school diploma or equivalent	None	Apprenticeship	6	19.30%

Fig.49. Occupations with Transferrable Skills for Offshore Wind Employment
Credit: N.J. Department of Labor and Workforce Development

involvement from employers to gather information on graduates and assess current labor demand, as well as establishing when to trigger a curriculum update.

The construction sector in New Jersey is projected to grow between now and 2026. However, outside of a handful of training programs in unions and community organizations, the pipeline for construction workforce development, particularly in the area of green retrofits, is limited. Physical buildings directly impacted by Superstorm Sandy will always need to be shored up in the event of future storms. As such, awareness is high regarding the need for greener, more resilient operations and maintenance practices. The City of Perth Amboy should explore community and industry partnerships to create a Resilient Building Operations & Maintenance Academy. The Academy would recruit, screen, and train individuals interested in career pathways such as porters, operations engineers, and HVAC installers.

4. Develop Private-Sector Partnerships for Employer-Based Training

As the industries like construction grapple with a major labor shortage due to recent and impending retirements among the Baby Boomer generation, apprenticeships offer a solution. They provide a means to upskill entry level employees, helping address the growing labor shortage. They also offer a means of attracting the unemployed population back into the workforce. The US Department of Labor has estimated that workers who successfully participate in apprenticeship programs earn an average starting salary of $50,000 per year.

Employee training for trades like construction improves safety, employee retention, and overall workforce quality. Moreover, training should not be a one-time experience during the onboarding process, but rather a continuously evolving element of an employee's career. Employer-based training is also a powerful recruitment tool that allows the hiring organization to gauge learning capacity and soft skills, ultimately providing a more robust labor supply.

In the short term, the City of Perth Amboy should consider reforming its procurement policy to incorporate a local apprenticeship category when evaluating proposals for construction and maintenance contracts across projects for the City, School District, and Housing Authority. A successful policy would build out the point-based evaluation factors of its Request for Proposal (RFP) processes to entice RFP responses to account for local hiring and on-site training.

In the long term, the advent of offshore wind development in New York and New Jersey presents an opportunity to develop from scratch a workforce pipeline for a new industry. As of this writing, concrete plans for offshore wind staging and operations facilities with proximity to Perth Amboy have yet to materialize. However, the City of Perth Amboy stands to benefit from a surge in labor demand for manufacturers, construction workers, project managers, developers, engineers, educators and businesspeople. Indeed, a major obstacle to offshore wind development in the United States is a critical lack of skilled labor, while skilled employees from trades including electricians, painters, plumbers, craftsmen, and ironworkers are positioned to gain from employment in the offshore wind industry. Already, offshore wind developers are exploring strategies to work with union partners to provide construction training opportunities and establish apprenticeship programs to train local residents with an immediate interest in joining the offshore wind industry. Establishing early partnerships with offshore wind development firms, and demonstrating the value of Perth Amboy's construction and manufacturing labor supply, could yield significant investment in the future.

5. Explore Potential Wrap-Around Services

Wrap-around services for workforce development involve a holistic intervention to engage individuals with complex needs that often result in barriers to employment so that they can further their career or educational attainment. These individuals, due to lack of education, language skills, criminal history, etc., are often labeled "hard-to-employ." Successful wrap-around models deploy services throughout the employment process. Key components include life skills training (resume writing, interview training, how to conduct a job search), job retention resources and counseling, and child- and elderly care support--all of which combine to help people keep their jobs. These wrap-around services, provisioned either independently or in partnership with local organizations, would provide the support needed to facilitate job placement and retention in the resiliency field.

The City should partner with a local foundation or educational institution to conduct a needs-assessment

survey targeting “hard-to-employ” individuals as well as employers to glean which wrap-around services would best serve residents of Perth Amboy.

6. Reintroduce Ferry Service

Implemented correctly, a ferry service would further provide an affordable and convenient transit option to job opportunities that are inaccessible to existing public transportation. An easy “win” for the City of Perth Amboy would be to reintroduce the ferry service from Perth Amboy to Tottenville in Staten Island. However, the City should conduct a comprehensive analysis for an optimized route, accounting for integration of recreational and commuter service, comparisons to premium express bus service, a comparison of subsidies to other transit modes, and a review of funding options. Existing funding options include:

» Passenger Ferry Grant Program – administered by the Federal Transit Administration (FTA) (Section 5307)
» Ferry Boat Formula Program - Department of Transportation and Federal Highway Administration

Implementation would require permitting approvals and consultation from state and federal agencies including, but not limited to, New Jersey Department of Transportation, the US Army Corps of Engineers, U.S. Coast Guard, and The Port Authority of New York and New Jersey.

7. Leverage Existing Economic Development Zones

Perth Amboy is benefits from a suite of place-based economic development incentives that can be utilized to attract employers. The incentives include tax abatements and deferrals as well as grant opportunities from the N.J. Economic Development Authority. To better position the city to recruit employers, the City of Perth Amboy should execute a well-planned marketing strategy that broadcasts the municipality’s economic incentives. This could include publishing a “Developer’s Guide” or an “Employer’s Guide” to Perth Amboy, detailing economic overlay zones, project approval processes, and department contacts ensure business relocation to Perth Amboy is as seamless as possible..

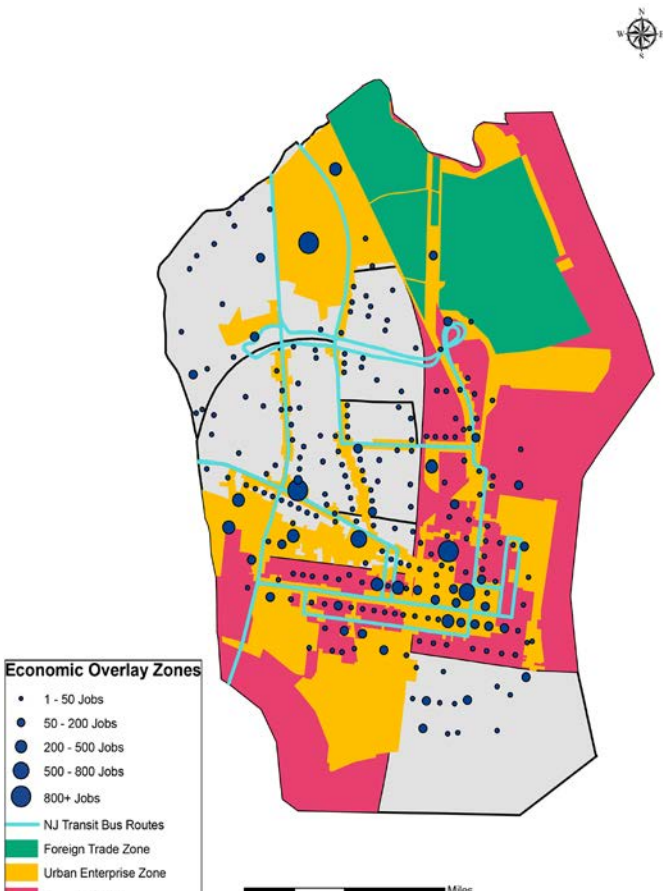


Fig.50. Economic Overlay Zones in Perth Amboy

Chapter 9. Recommendations: Housing & Climate Gentrification

Recommendations: Housing & Climate Gentrification

Introduction

Housing is part of the essential fabric of any community, and one of the most important aspects of an individual's life. Improving housing means it must be built with essential qualities in mind: improving public health and safety, combating inequality, dismantling systemic racism, and limiting pollution and greenhouse gases. Housing should be located near to jobs, open space, and other natural resources. Whether new or existing housing, steps need to be taken to make sure homes are safe, secure, resilient, efficient, and can provide for a good quality of life.

Climate Gentrification is displacement that results from green investment. Often with the best of intentions, investing in a community in a way that makes it greener, or sustainable, makes the location more desirable. This phenomenon can lead to higher prices for homes, and rentals. This can lead to the displacement of long-time citizens of a community.

Green investment in Perth Amboy will yield positive results for the city's residents and especially residents most vulnerable to negative climate effects. The Housing and Climate Gentrification section outlines steps that will lead to a more sustainable city, and recommends measures that will prevent displacement.

Fig.51. Housing in Perth Amboy
Credit: Ellen O. White

Vision Statement

The following recommendations would help the City of Perth Amboy achieve climate resilience for its households and prevent displacement from climate gentrification by:

1. Increasing and preserving access to safe and affordable housing;

2. Building up the community's adaptive capacity to cope with environmental and climate hazards; and

3. Requiring new development and retrofitting existing development to be resilient and sustainable.

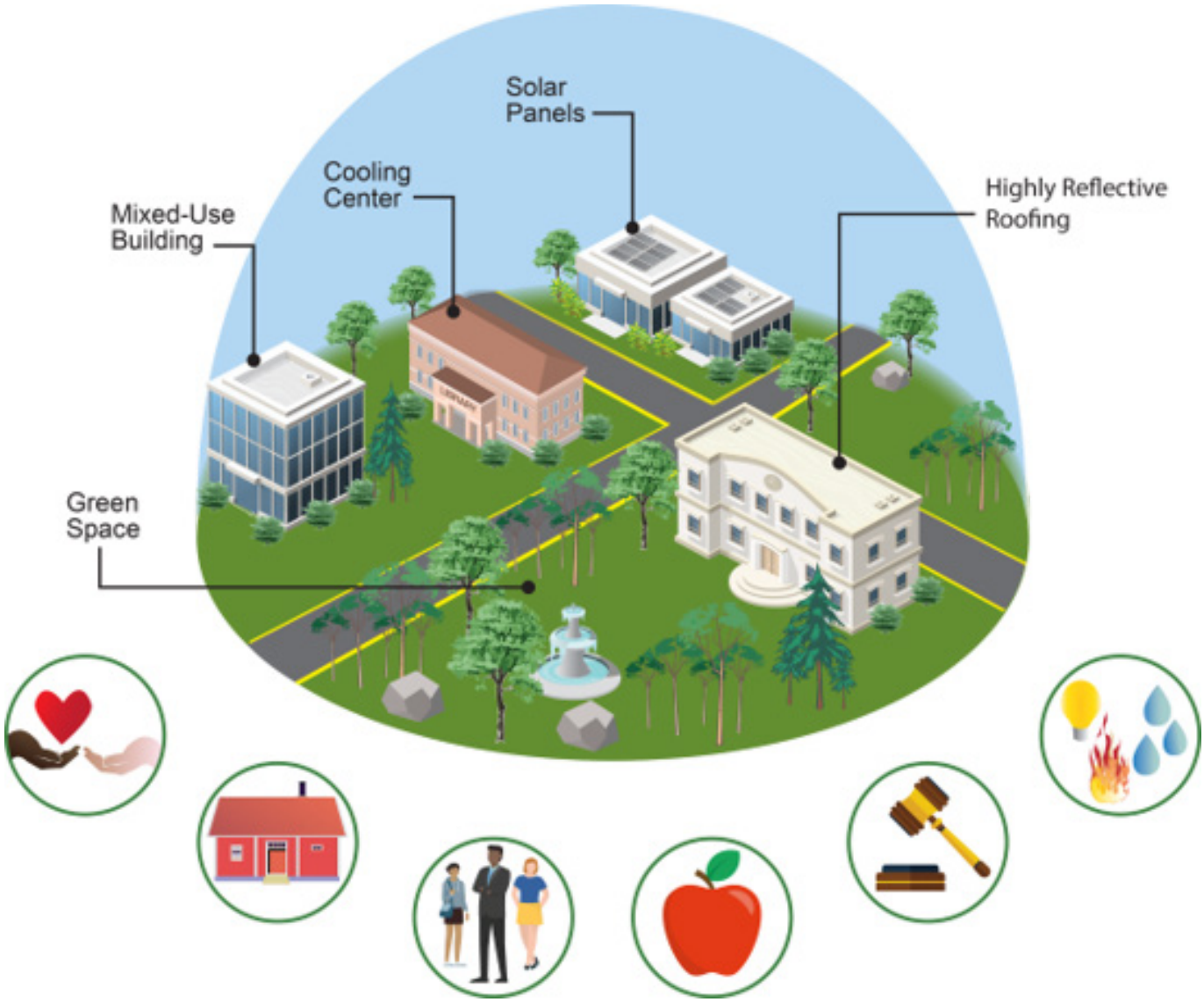


Fig.52. A Sustainable Community
Credit: US Global Change Research Program

Relevant Background Information for Housing and Climate Gentrification

Physical Analysis

The City of Perth Amboy is a majority renter community: 71% of occupied housing units were renter-occupied as of 2017. That said, a majority (65%) of the current housing stock in Perth Amboy come from one-and two-family homes: as of 2017, 34% of all housing units were single-family, and 31% of all housing units were two-family. The city also has high percentages of large multifamily residence: 15.5% of all housing units were in structures of 5 to 19 units, and 10.2% of all housing units were in structures with 20 or more units. [60]

The Development Trends Viewer tool provided by the New Jersey Department of Community Affairs (NJDCA) helps municipalities understand the construction and demolition trends in their city. The following figure represents the number of building permits by type from 2004 to 2018. Overall, there was a significant trend of multi-family development. The number of permits for multifamily dwellings outweighed the number of permits for single and two-family residential dwellings in all years except 2004, 2007, 2008, and 2018. Over the decade from 2008 to 2017, there were 104 building permits for one-and two-family dwelling units; during the same period, there were 696 permits for multifamily units. It is also interesting to note that no mixed-use was housing constructed in Perth Amboy from 2004 to 2018. [61]

While the City of Perth Amboy has invested in multifamily housing, the city still suffers from overcrowding. Two hundred fifty housing units (1.58% of occupied housing units) in Perth Amboy were identified as having 1.51 or more occupants per room as of 2017. Perth Amboy residents also have larger households than the rest of the county. In 2017, the U.S. Census Bureau estimated 3.28 persons per household in Perth Amboy as compared to 2.84 persons per household in Middlesex County. [62]

Illegal Occupancy and Unsafe Housing Conditions

The building of apartments or rooms in parts of a home not usually considered a habitable space constitutes illegal housing. Basements, attics, and garages are the typical non-habitable rooms of a home which are converted into spaces with illegal occupancy. Unauthorized additions to the home and the conversion of one bedroom into multiple bedrooms also constitutes illegal occupancy and is just as common. Perth Amboy

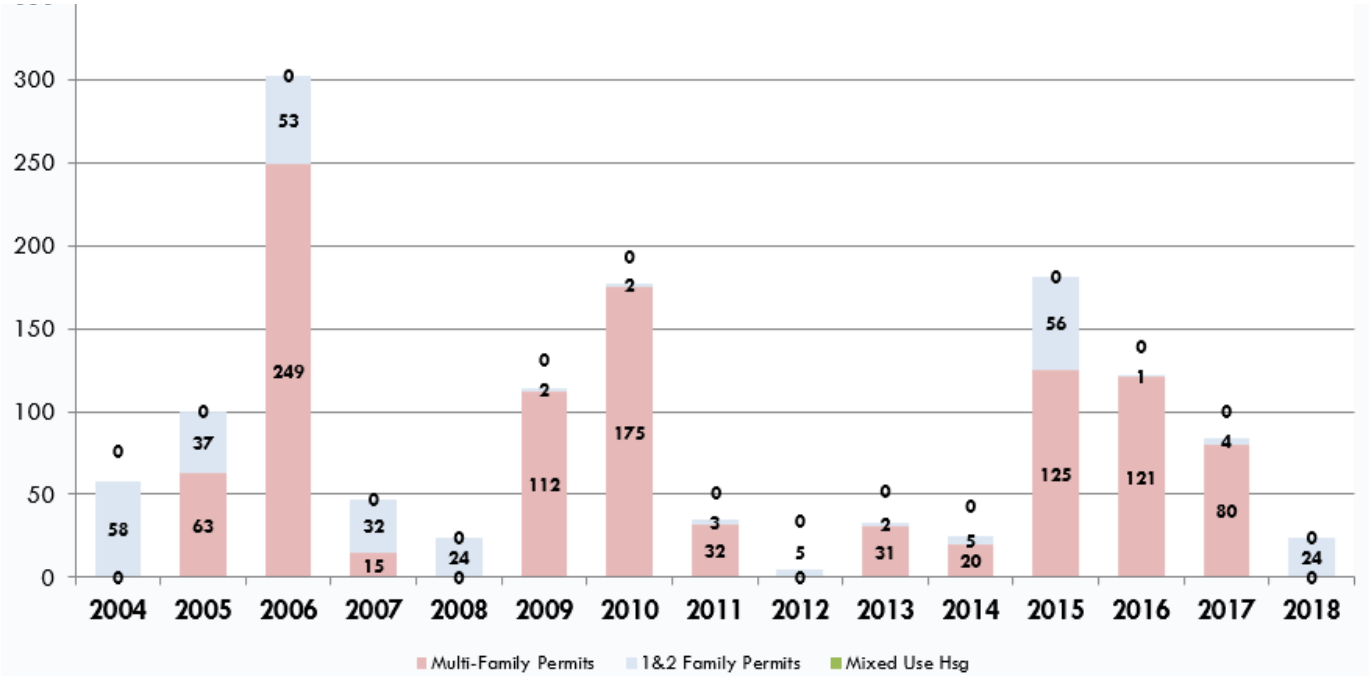


Fig.53. Perth Amboy City Housing Units - Building Permits by Type 2004-2018
Credit: NJ Development Viewer

code explicitly prohibits basements, attics, cellars, and garages to be utilized as habitable spaces, and has requirements to ensure housing remains habitable. The city can inspect work completed on homes, require homeowners to correct defects, require homes to remain free of pests, and fine homeowners who fail to follow code. Regardless, many still seek to construct and rent out illegal dwellings for additional income.

The issue in both Perth Amboy and New Jersey is exacerbated by rising housing costs. [63] A lack of housing affordability has made the rental of illegally constructed dwellings common, despite potential safety hazards.[64] The average cost of renting an apartment in Perth Amboy is $1,250. The city has a high poverty rate of 20.50% with a household income of just $50,883, indicating many residents cannot keep up with rising rent costs, thereby popularizing illegal housing as an affordable option. Additionally, most Perth Amboy residents do not own property and are dependent on rental properties which compose most of the housing stock. At least 71% of housing units in Perth Amboy are renter occupied. [65]

Illegal housing can be dangerous for renters because it may lead to a myriad of issues such as overcrowding due to the rental of one home to multiple people and a lack of proper amenities such as heat, hot water, and at times, running water. The overcrowding which often accompanies illegal housing may lead to poor sanitary conditions due to pest infestations. The utilization of non-habitable spaces as bedrooms, particularly spaces which are dank and enclosed like basements, may lead to increased health issues due to a higher likelihood of encountering mold. Mold issues are likely to be exacerbated in Perth Amboy due to increased climate threats like flooding. Lack of proper egress can trap individuals during an emergency like a fire, flood, or major storm like Superstorm Sandy. A lot of illegally built housing may be structurally unsafe or have faulty electrical wiring because it has not followed city code or been inspected.[66] Perth Amboy is working to bring these illegal dwellings up to code. This report emphasizes supplementing code enforcement with the construction of affordable housing to mitigate the issue of displacement, as well as enforce penalties to discourage landlords from continuing the illegal housing trend.

Fig.54. An example of illegal occupancy
Credit: mycentralnj.com

Recommendations

Mixed-Use, Transit-Oriented Redevelopment

To create a resilient Perth Amboy, the City should consider mixed-use and transit-oriented development as ways create and maintain affordability for low- and moderate-income households while also providing transit access for car-less residents. In their 2019 Housing Policy Guide, the American Planning Association advocates for preserving affordable housing "along current and future transit corridors, downtowns, and village or community centers" to ensure "that transit-dependent populations" can access near jobs and amenities. [67] Further, transit-oriented development can help Perth Amboy lower their greenhouse gas emissions by locating housing "in walkable, transit-rich areas" thereby encouraging public or active transit. Moreover, "compact development and mixed-use housing" support resilience goals as they "reduce impacts on watersheds and environmentally sensitive areas and in areas prone to natural disasters and hazards". [68] For these reasons, the City of Perth Amboy should build and preserve permanently affordable mixed-use housing around their NJ Transit train station.

Residential development should also be outside of FEMA's Special Flood Hazard Area and outside of Category 1 to Category 4 storm surge inundation zones. Locating residential development outside of coastal hazard areas reduces the population's possible exposure to natural hazards. Residential development should be

concentrated away from the waterfront and thus away from coastal hazards. Waterfront development should instead be for open space, recreation, water-dependent uses, and economic activities.

A Strategic Vision Plan for the City of Perth Amboy recommended areas of the city fit for mixed-use, transit-oriented development. [69] Current redevelopment efforts underway include the Transit District Downtown Redevelopment and neighborhood revitalization efforts on the Smith Street corridor, a part of the GATEWAY Neighborhood Collaborative (GNC) initiative . Both A Strategic Vision Plan for the City of Perth Amboy (2014) and the Perth Amboy Bay City Transit District Strategy: A Local Demonstration Project (2013) support the conversion of the upper floors of commercial buildings to residential housing, effectively creating mixed-use housing, in the "Transit District Downtown Focus Area". [70]

Fig.55. Example of TOD in Addison, TX
Credit: http://www.tod.org/projects.html

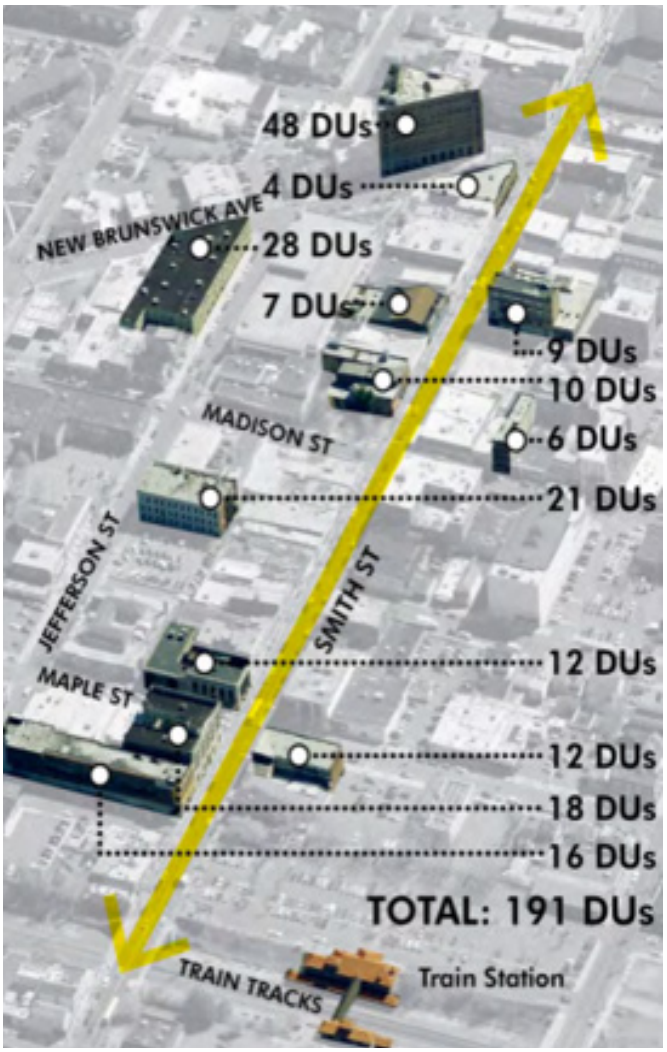


Fig.56. New Potential Units in Downtown Perth Amboy
Credit: Together North Jersey (2013). Perth Amboy Bay City Transit District Strategy: A Local Demonstration Project

Fig.57. Transit-Oriented Development in Perth Amboy
Credit: Together North Jersey (2013). Perth Amboy Bay City Transit District Strategy: A Local Demonstration Project

Code Enforcement

This report builds on the suggestions from A Strategic Vision Plan for the City of Perth Amboy to require all landlords to register all rental units in a database maintained by the City of Perth Amboy's Office of Code Enforcement. [71] However, to avoid greater displacement issues, the City should consider granting amnesty for previously unregistered units.

The City of Perth Amboy can partner with the Middlesex County Department of Public Safety and Health to train social services professionals and residents on detecting environmental hazards in their homes. Similar initiatives have been implemented in Queens with the ABCs of Environmental Home Health Hazards Training and in Los Angeles with the Healthy Homes Initiative. [72] This initiative may be a critical means of preventing illness and death from code violations in overcrowded and illegal units, such as deaths due to lack of fire safety or carbon monoxide poisoning.

Finally, code enforcement officials in the City of Perth Amboy should create and enforce minimum temperature control standards ensuring all residential units have a minimum standard of cooling measures and ventilation for extreme heat events. [73]

Energy Efficiency

The City of Perth Amboy would benefit from publicizing the energy assistance programs in the private and public sectors. This report recommends that the City of Perth Amboy partner with PSE&G to educate residents and landlords about PSE&G's Solar Loan Program, which provides loans to cover up to 70% of the cost of installing solar panels on their buildings to be repaid via solar renewable energy credits (SRECs). Promoting solar installation has the dual benefits of lowering energy bills while also moving the city towards a clean energy future. [74]

Fig.58. NJ Board of Public Utilities Logo
Credit: NJBPU Facebook

Energy Assistance

The City of Perth Amboy should explore the option of performing a robust public outreach process to educate and sign up low-income residents for energy assistance programs offered by the New Jersey Board of Public Utilities, Department of Community Affairs, and Department of Human Services. Multiple programs offered help households that are struggling financially to pay their energy bills. Meanwhile, the Winter Termination Program ensures that households eligible for many federal and state social safety net programs have access to their utilities throughout the winter months (November 15th-March 15th) . [76] Ensuring every household can afford heating and cooling their homes mitigates the negative effects of extreme temperature events.

Zoning Changes, Rehabilitation, and Increasing Housing Supply

Adopting form-based zoning code will encourage the growth in supply of available housing and reduce the rate of illegal occupancy and overcrowding citywide. It is defined as a zoning code that determines regulations based on a certain aesthetic appearance, or the form of the development rather than the use of the development. The intended results of this system of coding would be an achievement of a cohesive aesthetic character to each neighborhood or locality which would help avoid a sterile "cookie-cutter" reality.

Form-based code has been adopted in New Jersey communities such as Haddonfield, Plumsted, Ocean City, and Metuchen. In an older city like Perth Amboy, this new code would encourage developers to construct projects that enhance the beauty of its locality and to offer opportunities for mixed-use within their new constructions, with building height fitting within the scale of its surrounding buildings. The enhanced aesthetic quality would give each building value beyond their initial use, give them adaptability that would follow the changing needs of the community, increase the value and desirability of the surrounding homes, and provide more opportunities for jobs and businesses to grow. The developer would be able to subdivide each development according to the expected number of demanded units which would increase supply and help keep homes affordable.

Finally, form-based coding would help to regulate the construction of "missing-middle" housing, or multifamily units which fit within the moderate-density scale of most Perth Amboy neighborhoods, without the need to build oversized apartment buildings or low capacity single family units. Missing-middle construction will no longer have ambiguous permissions, and will be constructed more often as a result, which will increase housing capacity for each building lot. [77]

Under form-based code, homeowners and landlords may be encouraged to build accessory-dwelling units upon their properties to further increase supply. In line with these recommendations on code enforcement, the City should pursue a strategy of incentive rather than retribution. [78]

In the case of restoring and rehabbing derelict homes, the Reinvestment Fund and the National Neighborhood Indicators Partnership have both proven to be critical resources to help track and address vacant properties in various cities. Organizations such as the Wells Fargo Foundation have helped provide funding to property owners to rehab or upkeep the properties . [79] Preservation of historic buildings helps improve the value of nearby properties and strengthens local identity and it is a better solution to the challenge of vacant properties than demolition.

Brownfield Redevelopment

Perth Amboy has many brownfield sites that serve as potential development sites for housing. The Environmental Protection Agency (EPA) defines a brownfield as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant". [80] While these sites require proper remediation before development can occur, they do serve as plausible sites for development. A study done by Rutgers University identified over one hundred such locations in Perth Amboy, some of which are in desirable areas of the city. [81]

One specific site recommendation is 320 Convery Boulevard. This site is relatively close to public transportation, and near to existing housing. It can potentially be developed into dense, mixed-use, multifamily housing. The NJEDA sponsors the Brownfields Loan Program, [82] which provides low interest loans to applicants, including local government redevelopers up to $5 million toward remediation of a brownfield. The long-term benefits of brownfield remediation into housing include the amount of housing units increasing, while also cleaning up a contaminated site that reduces hazard risk.

Anti-Displacement Using the "3 P's", Protections, Production, and Preservation

In an article written for the publication Shelterforce, Anna Cash and Miriam Zuk describe an Anti-Displacement framework called the Three P's, which describe Protections, Production, and Preservation. [83] These policies, which will be described below, are especially pertinent in our discussion of Perth Amboy, a city that is ripe with possibilities, and so is also fertile ground for possible gentrification and displacement. Many communities suffer from displacement as a result of public and private investment. The "3 P's" framework will ensure that long term residents will enjoy the benefits of investments in their communities without having to fear losing their community, or their place in it.

Protections

The first of the Three P's is Protections. The authors state, "Tenants need protection from ever-rising rents, eviction pressures, and myriad other displacement pressures. Two proactive strategies are rent stabilization, which protects tenants from rent hikes, and requiring landlords to have a just cause to evict, which protects tenants from arbitrary evictions." [84] The goal of these

Fig.59. The Marquette Park Neighborhood in Chicago
Credit: shelterforce.org

two policies is to protect tenants from displacement in the future in an environment where Perth Amboy becomes too expensive for existing members of the community. Cash and Zuk also recommend "Responsive strategies...One increasingly popular effort is guaranteeing a tenant's right to counsel in evictions cases-cases tenants would likely lose without proper representation, something many low-income tenants are unlikely to be able to afford." [85] Though the data is scarce, examples do show that tenants with lawyers decrease their likelihood of eviction.

Production

The second of the Three P's, Production, refers to "the production of permanently affordable housing... Proactively, acquiring land for affordable housing production before a major investment is announced is a smart strategy to promote neighborhood affordability". [86] In a separate piece by Zuk and Karen Chapple , [87] their research found that "At the regional level, both market-rate and subsidized housing reduce displacement pressures, but subsidized housing has over double the impact of market-rate units." Perth Amboy should focus on the development of permanently affordable housing, which can take the form of public housing, or market rate housing that includes Section 8 subsidized units.

Producing more affordable housing will require reform to zoning and permitting. One strategy can be to up zone for density in the area around Perth Amboy's train station. This will create more dense housing in what can be a high land value area. This housing, or at least some portion of this housing, should be made permanently affordable.

Preservation

The final of the Three P's is Preservation, referring to the preservation of the existing affordable housing stock. Cash and Zuk refer to an example from Denver, Colorado where a neighborhood coalition preempted rising housing costs in the Globeville and Elyria-Swansea neighborhoods by establishing a Community Land Trust (CLT). CLTs acquire land and maintain ownership permanently, allowing prospective homeowners entering into long-term renewable leases of the land with the chance to build equity.

Two other programs that aid in the creation of CLTs are the Small Sites program in San Francisco, and the Tenant Opportunity to Purchase Act in Washington, D.C.[88] The former works with non-profits and residents to take their units off the speculative market, and utilizing subsidized loans, convert their rentals into a cooperative. The latter gives tenants the right to be the first buyer of their building if it goes up for sales by its landlord. The tenant can then purchase the building, or work with a nonprofit to help them purchase the site and are aided in setting up a cooperative or condo association.

The notion of Preservation should also incorporate "Improvement", and encourage the amelioration of existing affordable housing, especially in the face of flash flooding, extreme heat, and other Climate Change effects that Perth Amboy is susceptible to.

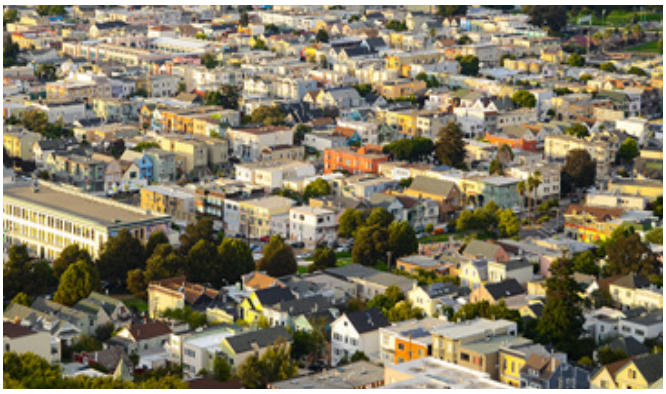


Fig.60. San Francisco Small Sites Units
Credit: shelterforce.org

A Note on Production of Housing and School Capacity

One of the obvious challenges around constructing housing is conveying to residents how new housing, and potentially new residents, may affect a town and its assets. The most common concerns center around school capacity. Fortunately, there is data available that allows a community to estimate the amount of school aged children that come with new housing.

When constructing new housing that does bring in new residents, it is important to understand how that can impact local communities and its assets. Rutgers University produced a report titled Who Lives in New Jersey Housing , [89] which features demographic multipliers based off data collected from the American Community Survey and other sources. While the dense report contains too much information to completely cover in this segment, it does contain one table that summarizes expected estimates of school aged children based on specific types of new housing.

Housing Type	*Housing Size (Bedrooms)*	*Household Size (HS)*	*School-Age Children (SAC)*	*Public School Children (PSC)*
Single-Family Detached (Own and Rent)	3 BR	2.762	0.446	0.385
	4-5 BR	3.780	1.044	0.848
Single-Family Attached (Own and Rent)	2 BR	2.311	0.274	0.226
	3 BR	3.002	0.572	0.477
Multifamily (Own)				
5–49 Units	0–1 BR	1.352	0.012	0.012
	2 BR	1.796	0.086	0.058
50+ Units	0–1 BR	1.318	0.003	0.003
	2 BR	2.011	0.078	0.039
Multifamily (Rent)				
5–49 Units	0–1 BR	1.568	0.127	0.127
	2 BR	2.512	0.368	0.339
50+ Units	0–1 BR	1.392	0.020	0.018
	2 BR	2.243	0.148	0.130

Fig.61. Illustrative NJ Statewide Residential Demographic Household Size and School Multipliers (2016-Newer Units Built 2000-2016) (All Housing Values)
Credit: Who Lives in New Jersey Housing

This table shows the amount of school aged children that are likely to come along with a new home of a specific type. If differentiates between home size, detached homes, attached homes, multifamily homes, ownership, and rentals. It also identifies school aged children, and further breaks out students who will be attending public schools vs. private schools.

It is important to note that this data represents data from the entirety of New Jersey, and so is not specific to Perth Amboy. Further, this data represents a snapshot in time, and needs to be updated overtime in order to maintain its accuracy. The city of Perth Amboy could assuage resident fears by passing an ordinance requiring developers produce a fiscal impact analysis accounting for the impact of the development on water, wastewater, school, and other public facilities as well as how development will affect the tax base

Non-Potable Water Reuse

One method of creating a more sustainable community, while also providing relief from the threat of flash flooding that is experienced in Perth Amboy, is installing onsite non-potable water reuse systems (ONWS) on new and existing housing. The EPA defines onsite non-potable water reuse as systems that "capture and treat water sources generated from within or surrounding a building, such as wastewater, greywater, stormwater, or roof collected rainwater. The treated water is then reused onsite or locally for non-drinking purposes, such as toilet flushing, clothes washing, and ornamental plant irrigation." [90]

Utilizing ONWS has many benefits. It can extend the life of existing, centralized urban water systems by reducing the amount of stormwater that enters the centralized systems as it is instead used for other onsite purposes,

thus deferring capital costs into the future. [91] Further regarding stormwater, ONWS "may reduce surface flooding and prevent combined sewers from overflowing into and polluting local waterways." [92] This helps Perth Amboy directly by delaying water flowing into its sewer system. ONWS can increase the capacity of drinking water within a centralized system as other water uses are met by the reuse of non-potable sources. [93] It can help structures, districts and communities to meet regulatory requirements and reach conservation goals. [94] Finally, it can also foster resilience "by integrating ONWS in buildings, utilities can improve their ability to respond to disruptions in water service delivery that may come as a result of drought, increased storm events, or other impacts of changing climates." [95]

San Francisco, California provides an exemplary model of ONWS integration. The entire city does not run on ONWS, but the city has created a regulatory framework that allows for the adoption and expansion of ONWS. According to the San Francisco Public Utilities Commission, "San Francisco's Non-potable Water Program creates a regulatory framework and streamlined permitting process for commercial, multi-family, and mixed-use developments in San Francisco to collect, treat, and reuse alternate water sources for toilet flushing, irrigation, and other non-potable uses." The City of Perth Amboy can utilize a similar framework, developing an ordinance requiring new construction to include rain capture and ONWS. The City can also subsidize and encourage the retrofitting of existing structures with similar ONWS units.

Fig.62. A diagram of residential non-potable water reuse
Credit: William J. Worthen Foundationl

Climate Proofing

To ensure homes in Perth Amboy are resilient to the two climate threats most likely to affect the city (storms and oppressive heat), the following climate proofing techniques are recommended to be retrofitted on older homes and included in all new construction:

White Roofs

A white roof is coated with a solar reflective white coating that will reflect up to 90% of sunlight. Traditional black roofs only reflect 20% of sunlight at most. Like most cities, Perth Amboy is vulnerable to the Urban Heat Island effect. Most cities use 5-10% of their summer electricity to compensate for the effect. White roofs can reduce the total Urban Heat Island effect by 1° to 2° F and reduce summer energy use by 10-40%, thus reducing the risk of brownouts and blackouts. [96]

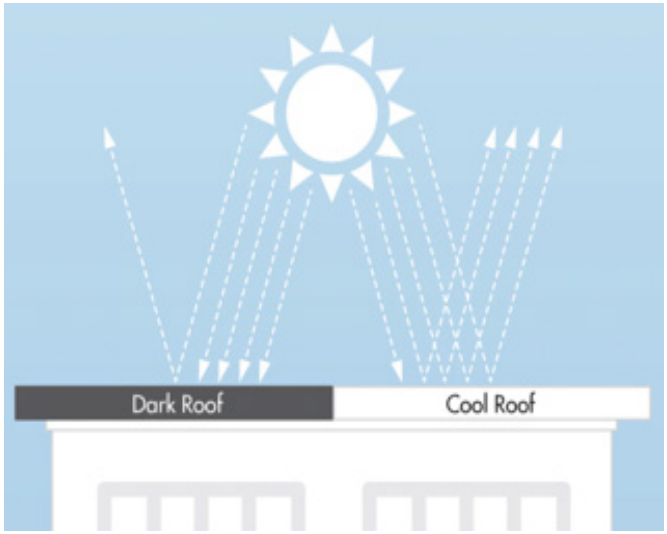


Fig.63. Alleviate Heat Island
Credit: RPA, 2019

Exterior roller-shutters and fortified glass windows

Homes in Perth Amboy can be fitted with exterior, insulated roller shutters which will control solar heat gain from the outside. This method is more efficient than utilizing traditional interior shutters or shades and has the bonus of providing storm protection. An example of the technology can be seen in use in Kenogami House located in Quebec, Canada. [97] Additional storm protection can be obtained by fitting windows with three layers of 600 pounds of glass. The windows will be energy efficient because they provide insulation and prevent air from escaping. An example of the technology can be seen in use in Sure House, a home built in Hoboken designed to withstand a storm like Superstorm Sandy. [98]

Fig.64. Heat Gain Protection
Credit: RPA, 2019

Install efficient lights and appliances

Perth Amboy is an older city, with most homes built in 1950 or before. As a result, it is likely to have homes with older lighting and appliances which can introduce a lot of unwanted heat. For example, a standard incandescent light bulb converts only about 10% of the electric current into light, the rest is emitted as heat. Fluorescent lights are more energy-efficient than traditional lights, while LED lights tend to be more durable, longer lasting, and utilize less energy than fluorescent lights. Upgrading appliances such as dishwashers, refrigerators, washers and dryers to more efficient versions may also produce less unwanted heat. [99]

Adding Additional Cooling Centers

Perth Amboy currently has three public cooling centers that are made available during days with extreme heat. This report proposes increasing the amount of cooling centers to seven. This report recommends four new locations:

Proposed Cooling Centers in Perth Amboy	
Cooling Center	**Address**
Perth Amboy High School	300 Eagle Avenue, Perth Amboy, NJ
Samuel E. Shull Middle School	380 Hall Avenue, Perth Amboy, NJ
McGinnis Middle School	271 State Street, Perth Amboy, NJ
The Salvation Army Perth Amboy Corps	433 State Street, Perth Amboy, NJ

Fig.65. Proposed Cooling Centers in Perth Amboy

The map below shows the existing cooling center locations, as well as our proposed cooling centers. The proposed cooling centers are mostly schools. Because most high heat days will be in the summer when school is not in session, this report recommends these locations as potential cooling centers.

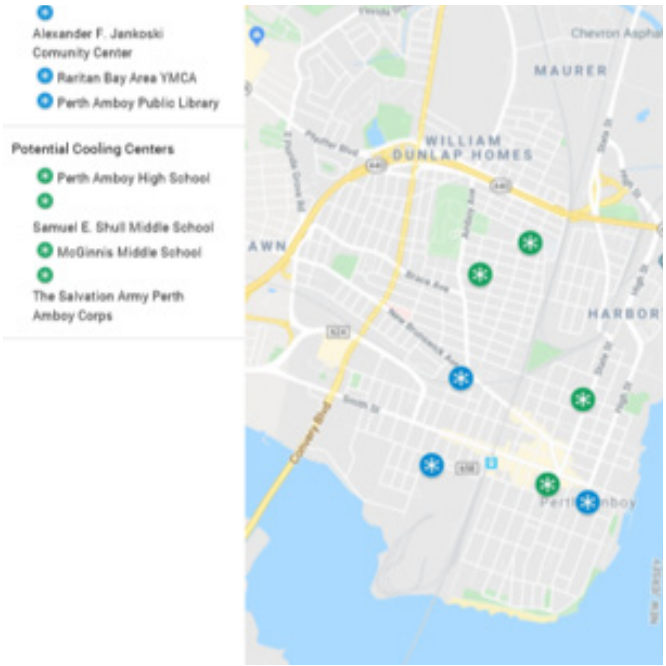


Fig.66. Existing and Proposed Cooling Centers

Social Vulnerability and Community Based Programs

Social vulnerability is defined as the high probability of an individual, family, or group of people to encounter hardship due to lack of access to money, health care, education, or vital information. Not having access to the basics necessary for survival within modern society causes the inability of socially vulnerable people and groups to withstand stressors, such as natural disasters, once exposed. Social vulnerability is often hidden and not apparent until stressors appear, therefore it is imperative that Perth Amboy address any social vulnerability within its community before any additional climate threats surface.

Social vulnerability usually threatens individuals who are lower income and of another ethnic, racial, and cultural background. In the United States, minorities such as Latinos and African Americans are often considered most at risk of being socially vulnerable due to long term systemic racism and economic disenfranchisement. [100] Both Latinos and African Americans compose the majority of Perth Amboy with Latinos constituting 82.2% of the population and African Americans constituting 8.2% of the city. Additionally, 41% of Perth Amboy's population is foreign born, another social vulnerability risk factor, and the city has a high poverty rate of 20.50%. In comparison, Middlesex County's poverty rate stands at half, 8.5%. [101]

The degree of social vulnerability within the city strongly depends on the social and community programs available to its residents. Fortunately, Perth Amboy has a large array of different organizations which play an important role in the community and effectively relieve some aspects of social vulnerability, the most important of which are The Jewish Renaissance Foundation, Catholic Charities, Raritan Area YMCA, Puerto Rican Association for Human Development, Perth Amboy Community Center, Meals on Wheels, and The Housing Authority of the City of Perth Amboy.

The Jewish Renaissance Foundation is the most active organization and offers a multitude of programs through multiple centers. The Bayside Family Success Center offers family activities, resume building classes, ESL classes, financial literacy classes, parenting classes, job search support, citizenship tutoring, healthy living classes, and a mom's support group. The Silver Linings Senior Resource Center focuses on providing aid to

seniors and adults with disabilities in long-term care facilities with transportation, legal services, life skills, healthy living, and housing. The JRF Community Health Center provides preventative and primary medical services to the underserved and uninsured population. They provide annual physicals, blood tests, pediatrics, gynecology, dental care, referrals to specialists, and assistance applying for health insurance. [102]

The Housing Authority focuses on ensuring the residents of Perth Amboy have access to quality housing. The Authority provides 8-hour housing counseling workshops in both Spanish and English which provide essential knowledge for those purchasing a home. The Foreclosure Prevention Program helps homeowners examine options when facing foreclosure, provides financial counseling, helps to facilitate communication with mortgage companies, and provides financial assistance referrals. Its Rental Counseling program seeks to stop homelessness by providing services such as acting as a liaison between tenant, landlord, and other agencies, advising tenants, providing referrals, and educating households on fair housing laws. [103]

The Puerto Rican Association for Human Development focuses on projects which help the city's majority Latino population. The organization offers Mi Escuelita Preschool for 3-4 year-old children with classes taught in a bilingual and bicultural environment. Career development programs are numerous, such as The Work Readiness Program for Latino Youth, a program for Latino youth which provides real work experience and a Carpenters Program which offers free training in carpentry in the evening hours for those who already work. Project BEST provides screenings and preventative care to prevent blindness and the Multi-Service Center provides a homelessness prevention program. [104] The Senior Services Center and The Resources for Independent Living program are both aimed at assisting seniors and developmentally disabled individuals. In addition, Catholic Charities provides services which mostly focus on substance abuse issues. Meals on Wheels, Mercy House, and St. Peters Episcopal Church all provide food banks and pantries.

The City of Perth Amboy should seek to actively partner with these community-based organizations to increase the social and economic resilience of city residents, whether that be through encouraging the continuation of current programs or partnering up to create programs which address other pertinent issues. Community-based organizations often do not have the monetary funds to continue offering these important programs because they depend on donations and grants. Perth Amboy should ensure that community-based organizations have the resources required to provide services for the community before, during, and after a disaster.

Chapter 10. Consistency, Coordination & Integration

Consistency, Coordination & Integration

In accordance with the city's plans for flood mitigation, city officials have recommended that waterfront spaces, specifically the area of the Landings between the existing seawall and Front Street, be preserved as open space. In addition, multiple rezoning suggestions have been made in order to ensure more ready preparedness in the case of another Sandy-level incident. In the issue of residential response to floods, it is recommended that residential homes near the waterfront be raised to FEMA standard elevations. Other rezoning proposals include resuming ferry service at the Tottenville ferry slip, in accordance with our recommendation to create a nautical transportation hub in Perth Amboy. [106] In accordance with our recommendations for a Transit Oriented Development (TOD), the SRPR has proposed creating a pedestrian corridor to link between the ferry slip and the NJ Transit Train Station along Smith Street. [107]

The officials' proposed redevelopment plan encompasses several large brownfield sites. It is arguably necessary to remediate these brownfield sites since they are currently located in low-lying sites vulnerable to flooding, in which case their contamination would harm the ecology of the Arthur Kill and Raritan Bay. The SRPR report has suggested supplementing the city's master plan with a Community Resiliency Element which accounts for the waterfront's dual role as a site for recreation and to protect the city's residents from storms. The master plan supplement also suggests implementing the separation of the sewer system and other best practices for sustainably managing stormwater, including making appropriate use of raingardens and other green infrastructure strategies. [108]

Finally, in relation to the efforts to generate jobs for the city's residents, the mayor has announced her intention to help create four federal Opportunity Zones with the express intent of creating jobs in low-income neighborhoods. In addition, to increase year-round economic activity in the city-center, the mayor also proposed rezoning a row of houses near the waterfront to commercial-mixed use. [109] The Smith Street Business Improvement District is planned in this proposal to be rezoned to allow for residential units to be allowed in the vicinity of the train station, which coincides with the ongoing efforts to implement the Transit Oriented Development being recommended by our group, in which a permanent population would live in walking distance to local transit with a mixed-use element, in order to provide easy access to jobs either within the TOD, or in localities within reach of the transit.

Chapter 11.
Conclusion & References

Conclusion & References

Conclusion

Over the past semester, the Resilient Perth Amboy Studio Class has had the pleasure of researching this wonderful bayside city. We have had the opportunity to research the demographics, physical layout, laws, infrastructure, and climate of Perth Amboy, and determine solutions to some of the city's challenges. Utilizing a multidisciplinary approach, our aim has been to make Perth Amboy more resilient, and our hope has been to create a stronger, more equitable city that builds on its many strengths, and confronts its challenges.

As mentioned throughout this report, resiliency is a term with many meanings. This team has narrowed its focus on a specific idea of resiliency, one that prepares Perth Amboy to recover from any difficulty that comes its way, whether in the form of extreme weather events, community stressors like poverty, and the myriad challenges that cities face. We have reinforced the city's many assets, like its train station, its waterfront, and its community organizations with recommendations to make the city stronger, more resilient, and more equitable.

By focusing on green infrastructure, our team has fashioned solutions and tools to help the city deal with climate events like flooding, and extreme heat. With a vision for green jobs and economic development, we have put Perth Amboy on the path to make a vibrant economy that is future oriented. With a housing philosophy grounded in equity, and safety, we have put forth a plan to help the citizens of Perth Amboy improve their lives, while giving them front row seats to the cities many prized resources.

Our hope is that this plan serves as a template for future development in the city. We believe that by preparing for the future today, Perth Amboy can be a leader in the region tomorrow, and for many decades to come. If Perth Amboy begins transitioning its economy to be future oriented, its citizens will feel the benefits in their daily lives, and in their wallets. By preparing for equity now, the city can be a prosperous and fair community for all its citizens, well into the twenty first century and beyond.

Thank you for giving us the opportunity to work with such a wonderful community!

References

1 - Kahn, M., Mohaddes, K., NG., R., Pesaran, H., Raissi, M., & Yang, J (2019). Long-Term Macroeconomic Effects of Climate change: A Cross-Country Analysis. NBER, No. 26167.

2 - JT Framework Design: Wisdom of Frontline communities and leaders with the support of Movement Generation. Climate Justice Alliance.

3 - Southwest Brooklyn Industrial Development Corporation (2016). Economic Analysis of the Resiliency of the Labor Market.

4 - U.S. Global Change Research Program. (2014). Extreme Weather. https://nca2014.globalchange.gov/highlights/report-findings/extreme-weather

5 - Federal Emergency Management Agency (FEMA). (2019b). Federal Emergency Management Agency Community Status Book Report: Nation: Communities Participating in the National Flood Program. https://www.fema.gov/cis/nation.pdf

6 - Federal Emergency Management Agency (FEMA). (2019a). Appendix F: Community Rating System, April 2019 NFIP Flood Insurance Manual. https://www.fema.gov/media-library/assets/documents/180273.

7 - Federal Emergency Management Agency (FEMA). (2019a). Appendix F: Community Rating System, April 2019 NFIP Flood Insurance Manual. https://www.fema.gov/media-library/assets/documents/180273.

8 -Federal Emergency Management Agency (FEMA). National Flood Insurance Program (NFIP). (2019). Policy and Loss Data by Geography Data as of: 7/31/2019 [Excel Spreadsheet]. https://nfipservices.floodsmart.gov/home/reports.

9 - Runkle, J., K. Kunkel, S. Champion, R. Frankson, B. Stewart, and W. Sweet, 2017: New Jersey State Climate Summary. NOAA Technical Report NESDIS 149-NJ, 4 pp.

10 - Kopp, R.E., C. Andrews, A. Broccoli, A. Garner, D. Kreeger, R. Leichenko, N. Lin, C. Little, J.A. Miller, J.K. Miller, K.G. Miller, R. Moss, P. Orton, A. Parris, D. Robinson, W. Sweet, J. Walker, C.P. Weaver, K. White, M. Campo, M. Kaplan, J. Herb, and L. Auermuller. New Jersey's Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel. Rutgers, The State University of New Jersey. Prepared for the New Jersey Department of Environmental Protection. Trenton, New Jersey.

11 - Pfeifenberger, A., Golden, O., Cavicchi, J., Nolan, K., & Koestner, C. (2018). Weathering Waste: Combined Sewer Overflows, Community Impacts, and Climate Change in New York's Capital Region. (Capstone Project), Skidmore College.

12 - New Jersey Future. (2014). Growing Smart and Water Wise.

13 - Cities of Minneapolis, Saint Paul, South St. Paul, and Metropolitan Council Environmental Services. (1996). Separating Combined Sewers to Improve and Protect Mississippi River Water Quality: A Ten-Year Commitment. Annual Progress Report to the Public - Year Ten. Minneapolis, St. Paul, South St. Paul, MN.

14 - Carey, JM. & Sunding, DL. (2001). "Emerging Markets in Water: A Comparative Institutional Analysis of the Central Valley and the Colorado-Big Thompson Projects". Natural Resources Journal. 41: 283–328.

15 - Atkinson, M. (2015). Fertilizer Ban Starts June 1 – No Nitrogen or Phosphorus Applications. UF, IFAS. http://blogs.ifas.ufl.edu/manateeco/2015/05/27/fertilizer-ban-starts-june-1-no-nitrogen-or-phosphorus-applications/

16 - Department of Ecology Washington State. (2005). Incentives for Industry: Stimulating Waste Reduction, Pollution Prevention, and Increased Secondary Materials Use in Washington Industry. https://fortress.wa.gov/ecy/publications/publications/0504027.pdf

17 - Ricato, M. (2019). Water Pricing - Increasing Block Tariffs. Retrieved Nov. 28, 2019, from SSWM.

https://sswm.info/water-nutrient-cycle/water-use/softwares/economic-tools/water-pricing---increasing-block-tariffs

18 - Curran, W., & Hamilton, T. (Eds.). (2018). Just Green Enough: Urban Development and Environmental Gentrification. New York, NY: Routledge.

19 - Gould, K.A., & Lewis, T.L. (2017). Green Gentrification: Urban Sustainability and the Struggle for Environmental Justice. New York, NY: Routledge.

20 - Checker, M. (2011). Wiped out by the "Greenwave": Environmental gentrification and the paradoxical politics of urban sustainability. City & Society 23(2): 210-229.

21 - eDesign Dynamics (October 2018). Planning and Technical Support for Incorporating Green Infrastructure in Long Term Control Plans. New York, NY: eDesign Dynamics.

22 - Philadelphia Water Department Private Development Services. (2019). 4.6 Blue Roofs. Retrieved from: https://www.pwdplanreview.org/manual/chapter-4/4.6-blue-roofs

23 - USDA. (1999). Little River Salt Marsh Restoration, North Hampton and Hampton, New Hampshire: Plan and Environmental Assessment. Natural Resources Conservation Service. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_015252.pdf

24 - NOAA. (2019). What is a salt marsh? National Ocean Service website, https://oceanservice.noaa.gov/facts/saltmarsh.html.

25 - McLeod, E., Chmura, G.L., Bouillon, S., Salm, R., Bjork, M., Duarte, C.M., Lovelock, C.E., Schlesinger, W.H., & Silliman, B.R. (2011). A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Frontiers in Ecology and the Environment, 9(10), 552-560.

26 - Reids Heritage Homes. (2007). Leeds Home Showcased Features. http://www.ReidsHeritageHomes.com

27 - Kahn, M., Mohaddes, K., NG., R., Pesaran, H., Raissi, M., & Yang, J (2019). Long-Term Macroeconomic Effects of Climate change: A Cross-Country Analysis. NBER, No. 26167.

28 - JT Framework Design: Wisdom of Frontline communities and leaders with the support of Movement Generation. Climate Justice Alliance.

29 - Southwest Brooklyn Industrial Development Corporation (2016). Economic Analysis of the Resiliency of the Labor Market.

30 - USDA - U.S. Department of Agriculture (2014), "Food Deserts," (accessed December 9, 2019), [available at http://apps.ams.usda.gov/fooddeserts/fooddeserts.aspx]

31 - Smith, J. (2012). Encouraging the growth of urban agricultural in Trenton and Newark through amendments to the zoning codes: A proven approach to addressing the persistence of food deserts. Vermont. Journal of Environmental Law, 14, 71.

32 - Handbury, J., Rahkovsky, I., & Schnell, M. (2015). Is the focus on food deserts fruitless? Retail access and food purchases across the socioeconomic spectrum (No. w21126). National Bureau of Economic Research.

33 - The Locavore Index. Brattleboro, VT. Retrieved December 9, 2019, from http://www.strollingofthehe ifers.com/locavoreindex

34 - Foodshed Alliance. (2015, June 2015). Northern New Jersey regional foodshed resiliency plan. Retrieved from http://foodshedalliance.org/wp-content/uploads/2016/02/PlanDesignR1.pdf

35 - Horst, M., Ringstrom, E., Tyman, S., Ward, M., Werner, V., & Born, B. (2011). Toward a more expansive understanding of food hubs. Journal of Agriculture, Food Systems, and Community Development, 2(1), 209-225.

36 - Born, B. (2014). Agricultural Urbanism: Handbook for Building Sustainable Food & Agriculture Systems in 21st Century Cities.

37 - Fischer, M., Pirog, R., & Hamm, M. W. (2015). Food hubs: definitions, expectations, and realities. Journal of hunger & environmental nutrition, 10(1), 92-99.

38 - O'Hara, S. (2015). Food Security: The Urban Food Hubs Solution, The Solutions Journal, Volume 6, Issue 1

39 - Crawford, E. (2019, November 18). Bowery expands indoor farming to Baltimore area with an eye towards more sustainable production globally. Retrieved December 17, 2019, from https://www.foodnavigator-

40 - Bendix, A. (2018, December 13). A Google-backed vertical farm startup just raised another $90 million to build in cities across the US. Retrieved December 17, 2019, from https://www.businessinsider.com/bowery-farm-90-million-raise-food-google-2018-12.

41 - Growth company: AeroFarms is attracting attention, expanding its farming locations - and, maybe, changing the world - ROI-NJ. (2018, June 12). Retrieved December 17, 2019, from http://www.roi-nj.com/2018/06/11/industry/growth-company-aerofarms-is-attracting-attention-expanding-its-farming-locations-and-maybe-changing-the-world/.

42 - United Nations / Framework Convention on Climate Change (2015) Paris Agreement, 21st Conference of the Parties, Paris: United Nations.

43 - Exec. Order No.28, page 1(2018)

44 -DOE (2016). Offshore Wind Technologies Market Report. Office of Energy Efficiency & Renewable Energy. Retrieved from https://www.energy.gov/

45 - (2019). New Jersey State Energy Profile. US. EIA, Analysis.

46 - Casey, Allison (2016). How Much Can You Really Save with Energy Efficient Improvements.? Energy.Gov.

47 - Jacobs Environmental Inc. (2003). Master Plan: City of Perth Amboy

48 - UNEP, ILO (2011). Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World, UNEP.

49 - Knutson, T. R. (2010). Tropical Cyclones and Climate Change. Natural GeoScience, 157-163. doi:doi: 10.1038/ngeo779

50 - Economic Benefits of Increasing Electric Grid Resilience to Weather Outages (2011). Retrieved November 13, 2018, from https://www.energy.gov/downloads/economic-benefits-increasing-electric-grid-resilience-weather-outages

51 - Maser Consulting (2014). Strategic Recovery Planning Report. City of Perth Amboy.

52 - Musial, Himiller, Beiter, Scott, and Draxl (2016). Offshore Wind Energy Resource Assessment for the United States. National Renewable Energy Laboratory. NREL/TP-5000-66599.

53 - DOE (2016). Offshore Wind Technologies Market Report. Office of Energy Efficiency & Renewable Energy. Retrieved from https://www.energy.gov/

54 - RFI-082 (2018). New Jersey Economic Development Authority. Port Infrastructure and Supply Chain Programs Supporting Offshore Wind Development.

55 - Exec. Order No. 92. Page 1 (2019)

56 - Exec. Order No. 73. (2019)

57 - City of Hoboken (2017). City of Hoboken Master Plan: Green Building and Environmental Sustainability Element.

58 - Ironbound Community Corporation (2015). South Ironbound Resiliency Action Plan. Retrieved from https://njplanning.org/cp-assistance-program/south-ironbound-resiliency-action-plan-newark/

59 - NJSA 18:A:18A-4.6(h)(2)

60 - U.S. Census Bureau. 2013-2017 American Community Survey 5-Year Estimates. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_DP04&prodType=table.

61 - NJ Department of Community Affairs (NJDCA). (2019). Development Trends Viewer as of August 14, 2019. [Excel Spreadsheet]. https://www.state.nj.us/dca/divisions/codes/reporter/

62 - U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_DP04&prodType=table

63 - "Welcome to ClerkBase®." City of Perth Amboy, NJ - ClerkBase, https://clerkshq.com/PerthAmboy-nj.

64 - Gurran, Nicole. "Informal and Illegal Housing on the Rise as Our Cities Fail to Offer Affordable Places to Live." Phys.org, Phys.org, 30 Apr. 2019, https://phys.org/news/2019-04-illegal-housing-cities.html.

65 - "U.S. Census Bureau QuickFacts: Perth Amboy City, New Jersey." Census Bureau QuickFacts, https://www.census.gov/quickfacts/perthamboycitynewjersey.

66 - Kiefer, Eric. "'Deplorable Conditions' At Illegal Rooming House In Newark." Newark, NJ Patch, Patch, 23 Jan. 2018,

67 - American Planning Association. (2019). Housing Policy Guide. https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/Housing-Policy-Guide-rev.pdf

68 - American Planning Association. (2019). Housing Policy Guide. https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/Housing-Policy-Guide-rev.pdf

69 - Rutgers University Bloustein School of Planning and Public Policy. (2014). A Strategic Vision Plan for the City of Perth Amboy. https://bloustein.rutgers.edu/wp-content/uploads/2015/02/PerthAmboyVision_FinalReport.pdf

70 - Together North Jersey. (2013). Perth Amboy Bay City Transit District Strategy: A Local Demonstration Project. https://www.perthamboynj.org/government/departments/economic_community_development; Perth Amboy Redevelopment Team for Neighborhood Enterprise and Revitalization. (2019). Gateway Neighborhood Collaborative. https://www.partnernj.org/what-we-do/program-and-services/gateway-neighborhood-collaborative/overview.html

71 - Together North Jersey. (2013). Perth Amboy Bay City Transit District Strategy: A Local Demonstration Project. https://www.perthamboynj.org/government/departments/economic_community_development; Rutgers University Bloustein School of Planning and Public Policy. (2014). A Strategic Vision Plan for the City of Perth Amboy. https://bloustein.rutgers.edu/wp-content/uploads/2015/02/PerthAmboyVision_FinalReport.pdf

72 - Rutgers University Bloustein School of Planning and Public Policy. (2014). A Strategic Vision Plan for the City of Perth Amboy. https://bloustein.rutgers.edu/wp-content/uploads/2015/02/PerthAmboyVision_FinalReport.pdf

73 - Regional Plan Association. (2019). Equitable Adaptation: Building climate change adaptation capacity for Make the Road NY and Central Queens. http://library.rpa.org/pdf/RPA_EquitableAdaptation.pdf

74 - Regional Plan Association. (2019). Equitable Adaptation: Building climate change adaptation capacity for Make the Road NY and Central Queens. http://library.rpa.org/pdf/RPA_EquitableAdaptation.pdf

75 - PSE&G. (2019). Financing Your Solar Installation with PSE&G. https://nj.pseg.com/saveenergyandmoney/solarandrenewableenergy/financingyoursolarinstallation

76 - State of New Jersey Board of Public Utilities. Assistance Programs. https://www.state.nj.us/bpu/assistance/programs/

77 - Regional Planning Association (2010). Form based codes in New Jersey: Issues & opportunities. www.rpa.org

78 - Rutgers, The State University of New Jersey (2014). A strategic plan and vision for the City of Perth Amboy. Edward J. Bloustein School of Planning & Public Policy.

79 - Office of Policy Development and Research (2014). Vacant and abandoned properties: Turning liabilities into assets. PD&R.

80 - Overview of EPA's Brownfields Program. (2019, October 4). Retrieved from https://www.epa.gov/brownfields/overview-epas-brownfields-program.

81 - Ravit , B., Tech-Czarny, Z., Hooper, M., Jones, D., & Hsieh, A. (2016). Perth Amboy Brownfield Inventory Final Report. Rutgers - Center for Urban Environmental Sustainability. Retrieved from https://cues.rutgers.edu/perth-amboy-brownfield-inventory/pdfs/Perth_Amboy_BF_Inventory.pdf

82 - Brownfields Loan Program. (n.d.). Retrieved December 1, 2019, from https://www.njeda.com/financing_incentives/large_business/Brownfields-Loan-Program.

83 - Cash, A., & Zuk, M. (2019, July 12). Investment Without Displacement: From Slogan to Strategy. Retrieved November 1, 2019, from https://shelterforce.org/2019/06/21/investment-without-displacement-from-slogan-to-strategy/.

84 - Investment Without Displacement: From Slogan to Strategy

85 - Investment Without Displacement: From Slogan to Strategy

86 - Investment Without Displacement: From Slogan to Strategy

87 - Zuk, M., & Chapple, K. (2016). Filtering and Displacement: Untangling the Relationships (pp. 1–12). Berkeley, CA: Institute of Governmental Studies, University of California, Berkeley.

88 - Investment Without Displacement: From Slogan to Strategy

89 - Voicu, A., & Listokin, D. (2018). Who Lives in New Jersey Housing? The Profile of Occupants of Residential Development in New Jersey (pp. 1–76). New Brunswick, NJ: Rutgers University: Center for Urban Policy Research.

90 - "Onsite Non-Potable Water Reuse Research." United States Environmental Protection Agency. Accessed November 15, 2019. https://www.epa.gov/water-research/onsite-non-potable-water-reuse-research.

91 - "Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems." San Francisco Public Utilities Commission. September 2014. Accessed March 15, 2019. https://sfwater.org/modules/showdocument.aspx?documentid=6057.

92 - "Making the Utility Case for Onsite Non-potable Water Systems." U.S. Water Alliance. Accessed March 15, 2019. http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC_Utility Case for ONWS_032818.pdf.pdf.

93 - "Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems." San Francisco Public Utilities Commission. September 2014. Accessed March 15, 2019. https://sfwater.org/modules/showdocument.aspx?documentid=6057.

94 - "Making the Utility Case for Onsite Non-potable Water Systems." U.S. Water Alliance. Accessed March 15, 2019. http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC_Utility Case for ONWS_032818.pdf.pdf.

95 - "Making the Utility Case for Onsite Non-potable Water Systems." U.S. Water Alliance. Accessed March 15, 2019. http://uswateralliance.org/sites/uswateralliance.org/files/publications/NBRC_Utility Case for ONWS_032818.pdf.pdf.

96 - "San Francisco's Non-potable Water System Projects." San Francisco Water Power Sewer. July 2018. Accessed November 15, 2019. https://sfwater.org/Modules/ShowDocument.aspx?documentID=7089.

97 - Regional Planning Association (2018) The Fourth Regional Plan: Increase Housing Supply Without Constructing New Buildings

98 - Reynolds, M. (n.d.). The most resilient house in North America. Retrieved from https://www.ecohome.net/guides/1376/ecohomes-kenogami-house-wins-home-of-the-year-award/.

99 - LED vs CFL Bulbs: Which is More Energy Efficient? (2019, July 18). Retrieved from https://blog.constellation.com/2016/03/25/led-vs-cfl-bulbs/.

100 - Doob, Christopher (2012). Social Inequality and Social Stratification in U.S. Society.Pearson Education. p. 225.

101 - "U.S. Census Bureau QuickFacts: Perth Amboy City, New Jersey." Census Bureau QuickFacts, https://www.census.gov/quickfacts/perthamboycitynewjersey.

102 - "Welcome to ClerkBase®." City of Perth Amboy, NJ - ClerkBase, https://clerkshq.com/PerthAmboy-nj.

103 - "Services: Community Action: Anti-Poverty: Perth Amboy, NJ 08861." Social, https://www.jrfnj.org/.

104 - Perth Amboy Housing Authority - Home, http://www.perthamboyha.org/.

105 - Puerto Rican Association for Human Development, Inc., https://www.prahd.org/.

106 - Middlesex County (2015). Hazard Mitigation Plan. Middlesex County, New Jersey. Appendix 16-1-27.

107 - City of Perth Amboy (2014). Strategic recovery planning report. DCA.

108 - City of Perth Amboy (2014). Strategic recovery planning report. DCA.

109 - City of Perth Amboy (2014). Strategic recovery planning report. DCA.