City of Hoboken, New Jersey
Proposed Stormwater Management Plan
Health Impact Assessment (HIA)

Final Report

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The authors of this report are solely responsible for the accuracy of the data, statements and interpretations contained in this document. The views expressed are those of the authors and do not necessarily reflect the views of Project Steering Committee, the City of Hoboken, the Health Impact Project, The Pew Charitable Trusts or the Robert Wood Johnson Foundation.

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LIST OF ACRONYMS

Acronym	***Description***
BMP	Best Management Practice
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease and Prevention
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
FEMA	Federal Emergency Management Agency
HIA	Health Impact Assessment
HUD	United States Department of Housing and Urban Development
LEED	Leadership in Energy and Environmental Design
LTCP	Long Term Control Plan
MGD	Millions of Gallons per Day
NHSA	North Hudson Sewerage Authority
NJSHAD	New Jersey State Health Assessment Data
OEM	Office of Emergency Management
Pew	The Pew Charitable Trusts
RT-DSS	Real Time Decision Support Systems
RWJF	Robert Wood Johnson Foundation
USEPA	United States Environmental Protection Agency
UV	Ultra-Violet
WWPS	Wet Weather Pump Station

EXECUTIVE SUMMARY

Hurricane Sandy made landfall near Atlantic City, New Jersey on October 29, 2012. The storm battered the State with hurricane force winds and record storm surge; resulting in 34 fatalities and damage in excess of an estimated $60 billion in property, infrastructure and related economic losses. A significant proportion of these damages were sustained in coastal areas in the northern and central parts of the State, including the City of Hoboken, located along the Hudson River in Hudson County, New Jersey. The human health impacts of Hurricane Sandy were significant and continue today, more than three years after the storm.

There are a multitude of decisions made by jurisdictions, government agencies, and individuals as part of disaster recovery efforts in the immediate aftermath of the storm and in the months and years that follow. Virtually every decision made in the disaster recovery process has the potential to impact human health. This Health Impact Assessment (HIA) examines the potential positive and negative health consequences of implementing green infrastructure-based stormwater management strategies to address chronic flooding and combined sewer system (CSS) back-ups and overflows in the City of Hoboken.

The geographic scope of the HIA included all neighborhoods in the city; however, special attention was given to the areas of the city most impacted by repetitive flooding and CSS back-ups and overflows. These areas include several neighborhoods in the low-lying western part of Hoboken. Although virtually every city resident is impacted by flooding in some way, within the parts of the city most frequently flooded, low-income individuals and families, older adults, and persons with disabilities were considered to be particularly vulnerable to the negative impacts of flooding and its associated health effects.

For the purposes of the HIA, the following health determinants/pathways were investigated:

1. Exposure to flooding and CSS back-ups/overflows
2. Access to natural features and greenspace
3. Changes in air quality
4. Changes in water quality
5. Changes in urban heat island
6. Exposure to standing water
7. Exposure to contaminated soil
8. Changes to economic conditions, including: access to “green” jobs, property values & rents, energy costs, municipal maintenance costs and taxes
9. Other exposure hazards, including: trip and fall incidents; pests/vermin, graffiti/crime and accumulation of trash/litter

The HIA was supported by a robust program of community and stakeholder engagement, including: an HIA advisory committee made up of Hoboken officials, non-profit leaders and residents; structured interviews with local officials and other stakeholders; resident focus groups; a community-wide resident survey; a pop-up kiosk at a local supermarket; and briefings at public meetings of the Hoboken Planning Board and City Council. Other research methods included a comprehensive literature review and analysis of secondary data.

Key Findings:

- According to the U.S. Census Bureau, Hoboken is home to more than 53,000 residents. The city's population is younger than that of Hudson County or New Jersey as a whole and Hoboken residents are also wealthier, with household incomes well above the average for Hudson County and New Jersey. Approximately 12 percent of the city's residents live in poverty.

- The overall health status of Hoboken residents that completed the community-wide survey conducted as part of the HIA assessment phase is higher than that of Hudson County and New Jersey residents. With the exception of two conditions–asthma and depression–Hoboken residents that completed the survey report lower rates of most chronic disease when compared to Hudson County and New Jersey. These results are consistent with research that shows that younger people and people with higher incomes generally report being in better overall health.

- The State of New Jersey has experienced a statistically significant increase in total precipitation over the past several decades. In addition, the northeast region of the United States has seen a 71 percent increase in heavy precipitation events over the past 40 years. On average, the City of Hoboken receives more than 45 inches of precipitation annually. As a result of these conditions, combined with the city's elevation and topography, parts of Hoboken flood regularly, especially during periods of heavy rainfall and high tide.

- Empirical data on flood frequency in Hoboken was confirmed and supported by data collected in 2015 by a community-wide resident survey conducted as part of the HIA assessment phase. When asked how often regular flooding occurs in the city, 75 percent of survey respondents reported experiencing flooding more than three times per year on average. Another 17 percent reported experiencing flooding 2-3 times per year. When asked how often they were personally impacted by flooding in the city, nearly one quarter (22 percent) reported every time it rains, while 50 percent reported being impacted only during heavy rainstorms. Twenty percent of survey respondents reported being personally impacted by flooding more than three times in the past two years.

- The majority of residents living in poverty and other lower-income Hoboken residents live in low-lying areas which are more susceptible to frequent flooding and CSS back-ups. This includes a significant portion of Hoboken Housing Authority facilities and other HUD-subsidized housing units. Based on data from the community-wide survey, these groups are disproportionately impacted by repetitive flooding in the city.

- The potential impacts of flooding on human health include: infectious disease, respiratory conditions, injury and death by drowning.

- Flooding in Hoboken is often accompanied by CSS back-ups and overflows. As such, the potential exists for Hoboken residents to come in contact with untreated human and industrial waste, toxic materials, and debris found in stormwater runoff. Exposure to the pollution caused by CSS back-ups and overflows can have significant direct impacts on human health. Such impacts can include symptoms such as vomiting, diarrhea, dehydration, respiratory illness, fever, dysentery or even death associated with exposure to pathogens such as bacteria, protozoans and viruses.

- Among the Hoboken residents that completed the HIA community-wide survey, the most frequently cited impact of flooding was sewer back-ups near residents' homes. Sixty percent of survey respondents listed sewer back-ups as a problem when it floods. As a consequence of coming in contact with

contaminated flood waters or sewer back-ups, nearly one third of survey respondents (28 percent) reported experiencing one or more of the following symptoms: headaches; vomiting; abdominal cramping, nausea, or diarrhea; muscle aches; eye irritation/infection; asthma or other respiratory condition; or skin rash. Fifteen percent of respondents reporting seeking medical attention as a result of experiencing one or more of the symptoms.

- A significant number of survey respondents reported an increase in unhealthy personal behaviors immediately before, during and/or immediately after flooding events. Half or more of survey respondents reported engaging in unhealthy behaviors such as eating more junk food, consuming more alcohol, and exercising less. In addition, nearly two-thirds of survey respondents (65 percent) reported experiencing flooding-related stress or anxiety and nearly half (49 percent) reported problems sleeping.

- Several groups living in the city were identified as potentially more vulnerable to the impacts of flooding. These groups include low-income residents, people with disabilities, and older residents. Data from the community-wide survey indicates that these populations experience disparate impacts from flooding. Thirty-six percent of survey respondents in these groups reported being impacted every time it floods compared to 20 percent of the general population. Of those that were impacted by flooding at least one time in the past two years, 24 percent of vulnerable populations reported that their apartment/house was damaged. This compares to 13 percent of the general population. In terms of disruption, vulnerable populations were consistently more likely to report having difficulty attending to activities of daily life such as picking up prescriptions, getting to doctor/medical appointments, picking up food and groceries, and getting to work or school.

- The primary goal of Hoboken's proposed stormwater management plan and ordinance amendments is to reduce flooding and CSS back-ups and overflows in the city. There is a growing body of research that suggests installing green infrastructure best management practices (BMPs) can be an effective way to reduce flooding and stormwater flows entering CSSs during wet weather. In fact, data reviewed for this HIA confirms that the volume of stormwater flow reduction feasible if green infrastructure BMPs were deployed in a manner consistent with the Hoboken Green Infrastructure Strategic Plan exceeds that necessary to mitigate flooding events that have recently occurred in Hoboken.

- The evidence that green infrastructure BMPs can substantially reduce flooding and the volume and flow of stormwater entering the CSS and thereby reduce or eliminate CSS back-ups and overflows is strong. It is very likely that adoption and implementation of Hoboken's proposed stormwater management plan and ordinance will help to significantly reduce flooding and CSS back-ups and overflows. The magnitude of the potential health benefits that may result from fewer flooding and CSS events is high. With proper construction, management and maintenance of the green infrastructure BMPs deployed in the city, the duration of flood mitigation, improved CSS performance and associated health benefits can be long-lasting.

- In addition, given the fact that the some of the areas most affected by flooding and CSS events are where lower-income residents live, the potential distribution of benefits derived from less flooding and improved CSS performance has the potential to be restorative, addressing long-standing disparate impacts from flooding in the city.

- In addition to helping to reduce flooding and CSS back-ups and overflows, there is evidence that implementation of green infrastructure BMPs may result in various changes to the natural, built and social environment that can have positive health consequences. At the same time, some of these changes may also pose minor health risks.

Table ES-1 characterizes the potential health effects that may result from implementing green infrastructure BMPs in Hoboken.

Table ES-1. Assessment and Characterization of the Potential Health Consequences/Outcomes Of Implementing Green Infrastructure BMPs in Hoboken

Health Determinant	Likelihood Health Effect Will Occur	Direction of Health Effect	Magnitude of Health Effect	Duration	Distribution of Health Effects	Evidence Strength
Flood management	Very likely	Positive	High	Long	Restorative effects	Strong
Management of CSOs	Very likely	Positive	High	Long	Restorative effects	Strong
Management of CSS back-ups	Very likely	Positive	High	Long	Restorative effects	Strong
Access to green space	Very likely	Positive	Moderate	Long	Even	Limited
Standing water	Likely	Positive & Negative	Moderate	Long	Disprop. harm	Limited
Air quality	Likely	Positive & Negative	Moderate	Long	Even	Limited
Urban heat island	Very likely	Positive	Moderate	Long	Even	Strong
Water quality	Very likely	Positive	Low	Long	Even	Strong
Soil Quality	Possible	Negative	Moderate	Long	Even	Mixed
Economic conditions:						
- **Access to "green" jobs**	Possible	Positive	Moderate	Medium	Restorative effects	Limited
- **Property values/Rents**	Possible	Positive & Negative	Low	Long	Even/Disprop. harm	Limited
- **Energy costs**	Possible	Positive	Low	Long	Even	Limited
- **Taxes**	Possible	Positive & Negative	Low	Long	Disprop. harm	Limited
Other exposure hazards:						
- **Trip and fall**	Possible	Negative	Low	Long	Even	Limited*
- **Pests/vermin**	Likely	Negative	Low	Long	Even	Limited*
- **Graffiti/crime**	Possible	Negative	Low	Long	Disprop. harm	Limited*
- **Trash/litter**	Likely	Negative	Low	Long	Even	Limited*

Notes: *Evidence is based primarily on resident and stakeholder input related to past experiences with parks and recreational facilities in the city and personal concerns about green infrastructure implementation. There was very limited or no evidence found in the literature regarding these potential exposure hazards.

Conclusion and Recommendations:

It is clear from the HIA that implementation of Hoboken's proposed stormwater management plan and ordinance amendments may have a variety of positive health outcomes. Most importantly, implementation of green infrastructure BMPs, when combined with the North Hudson Sewerage Authority's (NHSA) construction of wet weather pump stations, has the potential to substantially reduce flooding and CSS back-ups and overflows in the city. Fewer flooding and CSS events can have a range of positive health effects. Implementation of green infrastructure BMPs may also have a number of health-related co-benefits and some minor risks.

The recommendations developed as part of the HIA process are aimed at maximizing the potential health benefits and minimizing/mitigating the potential health risks associated with the decision to implement green infrastructure city-wide. The recommendations are based on the findings of the HIA impact analysis, current effective practices and local knowledge. Every effort was made to ensure that the recommended actions are: specific; responsive to predicted impacts; technically feasible; and within the authority of Hoboken officials, representatives from the NHSA and other implementation partners.

The recommendations are as follows:

Recommendations	Suggested Responsibility
1. Ensure the longevity of potential BMP benefits as well as public safety/enjoyment with careful design, monitoring and a robust program of on-going maintenance.	
a) Incorporate clear and consistent green infrastructure inspection and maintenance requirements in city's stormwater management plan and ordinance.	• Department of Environmental Services
b) Develop a checklist of design and siting considerations for each type of BMP being considered for implementation. The checklist should be informed by the potential health benefits and risks highlighted in the HIA.	• Department of Transportation & Parking
c) Require owners of green infrastructure BMPs to prepare and implement green infrastructure operations and maintenance plans that includes regular monitoring and inspections; vegetation management, cleaning; soil testing (where appropriate), and vermin/insect control procedures. The plans should have specific standards, procedures and maintenance schedules for each type of BMP constructed.	• Department of Community Development • Department of Administration
d) Provide funding to support adequate green infrastructure operations and maintenance. Funding and implementation of operations and maintenance should take advantage of public-private partnerships where feasible.	• Mayor & City Council
e) If green infrastructure BMPs are to be implemented by entities other than the city, city officials should put in place an appropriate oversight mechanism to ensure green infrastructure BMPs are properly designed, constructed, and maintained.	• City Council • Planning Board
f) Develop and implement a training and education program for the city's maintenance/public works personnel on the proper care and maintenance of green infrastructure BMPs. The findings of the HIA should be incorporated in the training curriculum. Where feasible, utilize existing training programs and resources.	• Department of Community Development • Department of Environmental Services In partnership with: • Rutgers Cooperative Extension • Hudson County Community College • Hudson County Workforce Investment Board • Nonprofits and community based organizations working on green infrastructure
g) If contractors are used to construct, operate and maintain green infrastructure on public property, ensure that workers are specifically trained and certified in green infrastructure construction, operations and maintenance and give preference to those companies that employ Hoboken residents.	• Mayor & City Council • Department of Administration • Department of Environmental Services • Department of Community Development
h) Require the hiring of trained and certified contractors to install and maintain publically-funded green infrastructure on private property.	• Mayor & City Council • Department of Administration
2. Ensure that the co-benefits of green infrastructure BMPs accrue equitably throughout the city.	
a) Locate green infrastructure BMPs where they can provide the most significant stormwater management/flood reduction benefit, while	• Department of Community Development

remaining aware of the distribution of co-benefits to be derived from specific BMPs.	• Department of Health and Senior Services • North Hudson Sewerage Authority • Private property owners, property managers, developers
b) Use GIS software and mapping to analyze the "benefit buffers" associated with each BMP in relation to where it is to be constructed. Overlay the benefit buffers with population data to ensure that potential co-benefits and risks are shared across neighborhoods and sub-populations.	• Department of Community Development
c) To the extent feasible given engineering and fiscal constraints, use green infrastructure BMPs to improve neighborhood conditions and minimize potential risks in areas where vulnerable populations live, especially in lower income neighborhoods.	• Department of Community Development • Department of Health and Senior Services • North Hudson Sewerage Authority • Private property owners, property managers, developers
3. Leverage investment in green infrastructure construction, operations and maintenance to grow jobs and provide career pathways for city residents, especially low-income populations.	
a) Generate opportunities for local workers and local businesses to participate in green infrastructure implementation by inserting community benefit strategies into green infrastructure installation and maintenance contracts.	• Department of Administration • North Hudson Sewerage Authority • Private property owners, property managers, developers
b) If green infrastructure operations and maintenance responsibilities will be outsourced, consider partnering with local workforce development programs and/or giving preferences to local companies or those that hire local workers.	• Department of Administration • North Hudson Sewerage Authority • Private property owners, property managers, developers
4. Magnify the benefits of green infrastructure BMPs by expanding implementation throughout North Hudson Sewerage Authority (NHSA) service area and beyond.	
a) NHSA should include a robust program of green infrastructure implementation as part of its Long Term Control Plan to manage CSS overflows. This should include construction, operations and maintenance of green infrastructure BMPs throughout the NHSA service area.	• North Hudson Sewerage Authority
b) Share and present the findings and recommendations of the HIA to elected officials, planning board members, local health officials and the public in Union City, Weehawken and West New York as well as Hudson County government. This can help to build support for green infrastructure implementation in communities outside of Hoboken.	• Rutgers University Bloustein School Building Healthy Communities Initiative • Community Development Department • North Hudson Sewerage Authority
c) Create opportunities for peer-to-peer exchange between elected and appointed officials from Hoboken, Union City, Weehawken and West New York to explore opportunities for green infrastructure collaboration.	• North Hudson Sewerage Authority • Hudson County Parks, Engineering and Planning • Rutgers University Bloustein School Building Healthy Communities Initiative
d) Promote green infrastructure implementation throughout Hudson County.	• Hudson County Parks, Engineering

Including but not limited to incorporating green infrastructure implementation as a strategy in the Hudson County Multi-jurisdiction Hazard Mitigation Plan.	and Planning • Hudson County Office of Emergency Management
5. Expand public outreach and engagement to ensure more residents are aware of the city's efforts to implement green infrastructure and understand potential benefits and risks.	
a) Use the HIA final report and executive-level briefing materials as a platform to expand public outreach and engagement related to the pending decision on adopting the proposed stormwater management plan amendments and ordinance.	• Department of Administration
b) Develop a traveling booth display that can be used during community events, fairs, etc.	• Department of Community Development
c) Sponsor a poster or video contest on green infrastructure benefits and risks. The HIA final report and briefing materials can be used to develop a short curriculum for students on flooding and CSS events and how green infrastructure is being used to improve stormwater management in Hoboken and make the city more resilient.	• Mayor & City Council • Hoboken Public School District
d) Foster greater awareness regarding green infrastructure benefits and risks among lower income residents.	• Mayor & City Council • Hoboken Housing Authority
e) Increase green infrastructure awareness among other vulnerable groups, including seniors and people with disabilities.	• Mayor & City Council • Department of Community Development • Department of Health and Senior Services • Nonprofits and community based organizations that work with potentially vulnerable groups and those working on green infrastructure
6. Develop and implement a monitoring and evaluation program to track green infrastructure performance and health outcomes over time.	
a) Create and maintain a GIS inventory and database of public and private green infrastructure BMPs. The inventory should include: basic information regarding the BMP such as: type, ownership, geographic location, materials used, and other relevant descriptive characteristics; information regarding the expected performance characteristics such as stormwater storage/removal capacity and anticipated co-benefits, inspection and maintenance requirements; and actual performance monitoring data.	• Department of Community Development
b) Establish a green infrastructure implementation advisory committee to develop consensus on a manageable set of performance indicators and metrics. The selection of indicators should be informed by the findings of the HIA and include metrics in the following categories: stormwater management/flood reduction; exposure and access to green space/natural features; water quality; soil quality; air quality/heat island; change in household and community economic conditions; exposure to other hazards.	• Mayor and City Council • North Hudson Sewerage Authority • Department of Community Development
c) Utilize the NHSA Long Term Control Plan process to support green infrastructure monitoring and evaluation. This should include data collection and reporting consistent with the green infrastructure monitoring and evaluation program.	• North Hudson Sewerage Authority
d) Collect and report data consistent with the green infrastructure monitoring and evaluation program.	• Department of Community Development • Department of Health & Human

	Services • Department of Environmental Services • Hudson Regional Health Commission • Hoboken University Medical Center • North Hudson Community Action Corporation Health Center
e) Conduct a bi-annual community-wide resident survey to track resident experiences, perceptions and opinions of green infrastructure implementation and performance and associated health-related effects.	• Mayor & City Council • Department of Community Development

CHAPTER 1: BACKGROUND AND INTRODUCTION

Background

Hurricane Sandy made landfall near Atlantic City, New Jersey on October 29, 2012. The storm battered the State with hurricane force winds and record storm surge; resulting in 34 fatalities and damage in excess of an estimated $60 billion in property, infrastructure and related economic losses. A significant proportion of these damages were sustained in coastal areas in the northern and central parts of the State. The human health impacts of Hurricane Sandy were significant and continue today, more than three years after the storm.

In the aftermath of the storm, national tracking surveys used to gauge the health and well-being of U.S. residents found that people residing in areas most impacted by Sandy showed a decrease twice the national average, in exercise activities for the fall and winter seasons immediately following the storm. Other healthy behavior indicators also showed differences, including a decrease in healthy eating and an increase in unhealthy habits such as smoking (1). In Hudson County, data collected by the Hudson Regional Health Commission found a combined 15 percent drop in people reporting that they were in "good" or "very good" health (2). The data also showed a combined 29 percent decrease in respondents reporting "good" or "very good" emotional health (2).

There are a multitude of decisions made by jurisdictions, government agencies, and individuals as part of disaster recovery efforts in the immediate aftermath of the storm and in the months and years that follow. Examples include: where and how to build back housing and infrastructure; what social services are needed to assist disaster victims; how can and should ecosystems be best restored? Virtually every decision made in the disaster recovery process has the potential to impact human health.

The Health Impact Project, a collaboration of the Robert Wood Johnson Foundation (RWJF) and The Pew Charitable Trusts (Pew), promotes the use of Health Impact Assessments (HIAs) and related approaches to help policy-makers in a wide range of fields incorporate health considerations into new policies, programs, plans, and projects, and make decisions that reduce unnecessary health risks, improve health, and decrease costs (3). In 2014, a research team led by the Edward J. Bloustein School of Planning and Public Policy at Rutgers University received funding from The Health Impact Project to explore how HIA could be used as a tool to inform disaster planning and recovery decision-making.

The project, which is one of the first times that HIA was applied to disaster recovery decision-making in the United States, included two HIAs[1]. One examined the potential health-related impacts associated with voluntary property buy-out scenarios in a flood prone neighborhood in Little Egg Harbor, Ocean County, New Jersey. The second–which is the subject of this HIA final report–assessed the potential health impacts of implementing green infrastructure-based stormwater management strategies to address chronic flooding in Hoboken, Hudson County, New Jersey. Both communities were severely impacted by Hurricane Sandy. The project also developed a toolkit that municipalities can use to integrate HIA into local decision-making as part of the Sustainable Jersey™ municipal certification program and made overarching recommendations for how the practice of HIA can be integrated into post-disaster planning and decision-making in the United States.

[1] The U.S. Environmental Protection Agency is also conducting an HIA in the context of Sandy-related recovery and resiliency planning in Suffolk County, NY. The HIA will evaluate potential beneficial and adverse impacts to health that may result from the proposed code changes regarding onsite sewage disposal systems (OSDS) for residential properties.

Flooding in Hoboken

The City of Hoboken is located along the Hudson River, just a few nautical miles from the Atlantic Ocean. When Hurricane Sandy impacted New Jersey in October of 2012, coastal storm surge flooded more than 75 percent of the city's land area. However, due to the city's topography, flooding is not only a concern during catastrophic storms; it is also a chronic problem. Flooding is a common occurrence in the city.

Hoboken was once an island surrounded by the Hudson River to the east and tidal marsh on its western edge. The tidal marsh was drained and filled in the mid-1800s. Today, parts of western Hoboken still lie near or below sea level. During periods of heavy rain and high tide in the Hudson River, water cannot drain into the river, causing some streets and neighborhoods to flood (4). The topography of the city is depicted in Figure 1 with arrows showing the directional flow of stormwater runoff. The areas in light blue show the lowest-lying, most flood prone parts of the city. Streets marked in blue are those most frequently inundated with floodwaters.

According to a recently completed study, "between July 2002 and July 2012 the city recorded 26 dates with greater than 2 inches of precipitation and tides of 4 feet or higher (5). Figure 2 shows just a handful of recent flooding events in the city. A recent severe flooding event occurred in May of 2015. As shown in Figure 3, low-lying areas of western Hoboken were inundated with flood waters.

Source: Hoboken Green Infrastructure Strategic Plan

Figure 1. Hoboken Topography Overlaid with Water Flow & Recurring Flooded Streets

Source: City of Hoboken

Figure 2. Recent Flooding Events in Hoboken

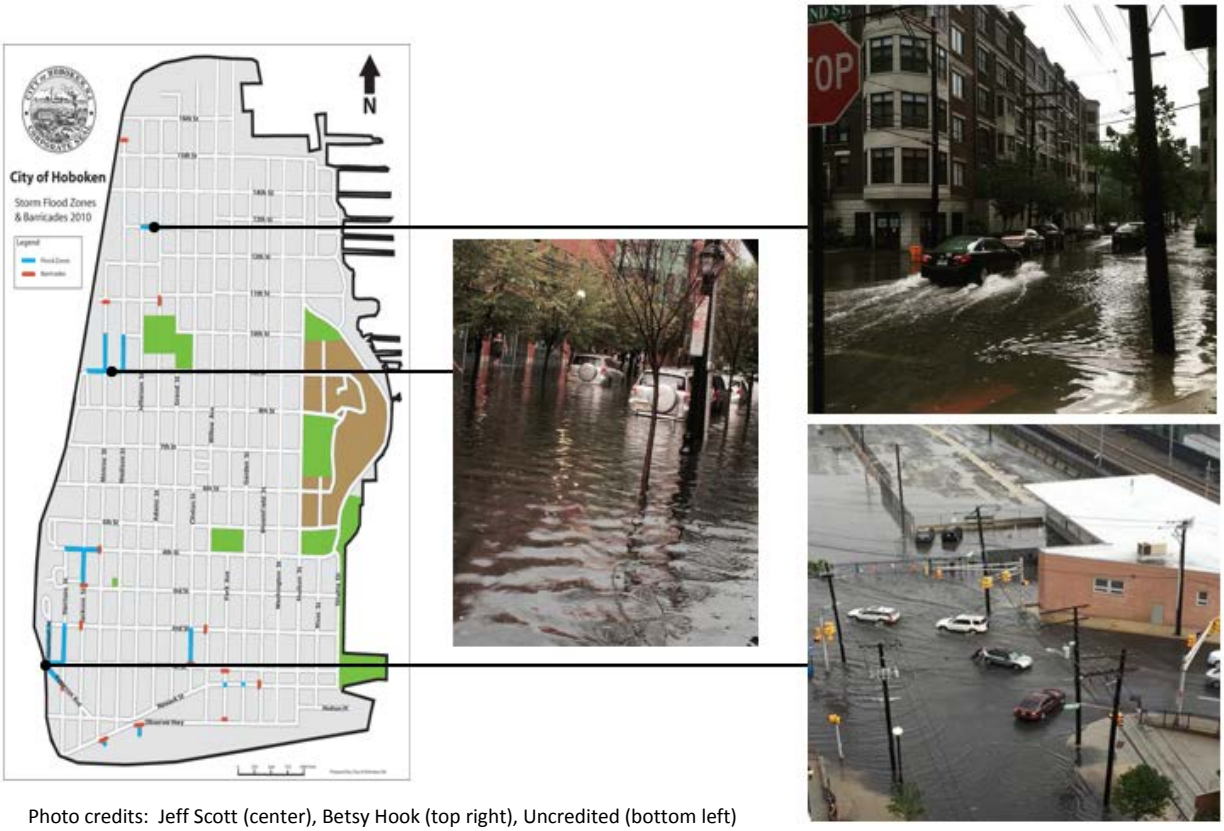
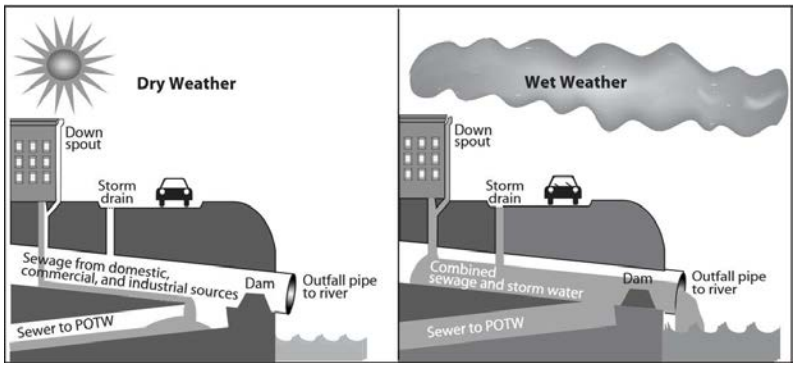


Photo credits: Jeff Scott (center), Betsy Hook (top right), Uncredited (bottom left)

Figure 3. Flooding in Hoboken, May 31, 2015

Hoboken's Combined Sewer System

Wastewater treatment for the City of Hoboken is provided by North Hudson Sewerage Authority (NHSA), which also serves the communities of Union City, Weehawken and West New York. The NHSA operates a Combined Sewer System (CSS). As illustrated in Figure 4, Combined Sewer Systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. During periods of heavy rainfall and high tides in Hoboken, the volume of water flows entering the combined sewer system exceeds the capacity of the NHSA's treatment plant. This results in CSS back-ups that overflow into city streets and the basements of private property and discharge untreated wastewater directly to the Hudson River. These back-ups and overflows contain not only stormwater but may also contain untreated human waste, toxic materials, and debris from runoff. In October of 2015, the New Jersey Department of Environmental Protection issued a final renewal permit to the NHSA that requires the Authority to submit monthly discharge monitoring reports and develop a Long Term Control Plan (LTCP) that will result in a substantial reduction or the elimination of combined sewer overflows. The LTCP must be submitted for State approval by June 1, 2020 (6).



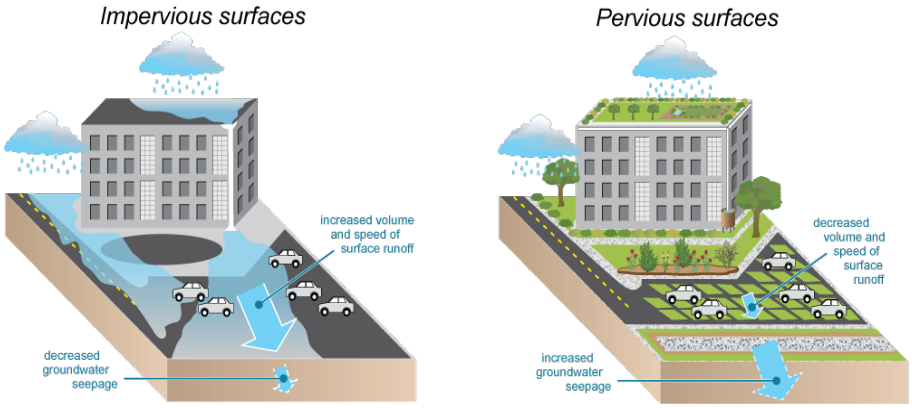
Source: U.S. Environmental Protection Agency

Figure 4. Combined Sewer Systems

Managing Stormwater with Green Infrastructure

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems, including combined sewer systems, and/or discharged directly into nearby water bodies. Stormwater runoff often carries trash, bacteria, heavy metals, and other pollutants from the urban landscape into the combined sewer system or other collection system. When the polluted stormwater is discharged, it can degrade the quality of the receiving waters. Higher amounts of rainfall can also cause erosion and flooding in streets and urban streams, damaging habitat, property, and infrastructure.

As shown in Figure 5, green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments.

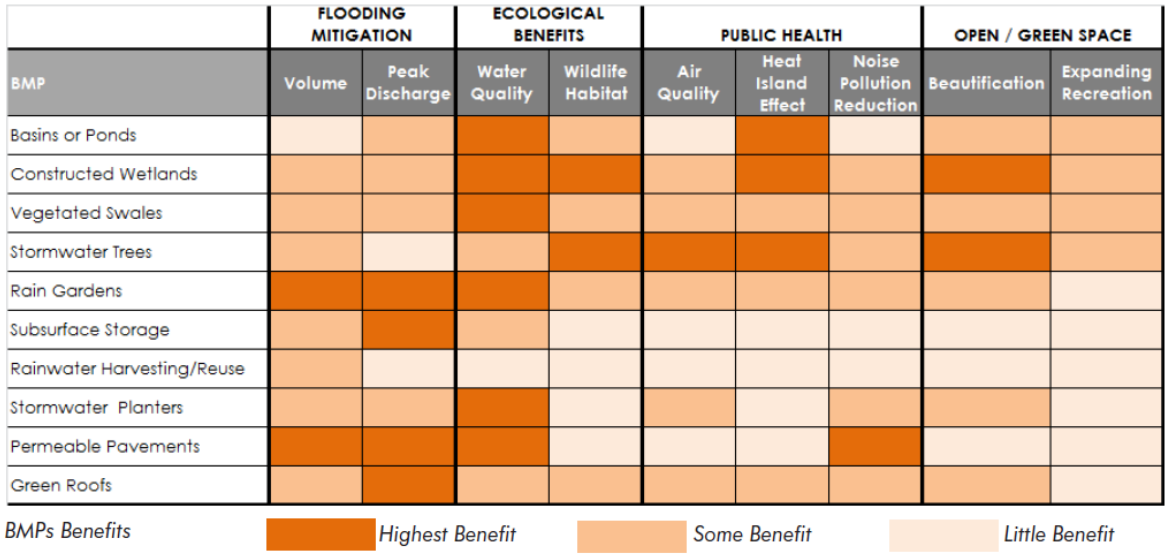


Conceptual diagram illustrating impervious and pervious surfaces. Impervious surfaces are hard and increase stormwater runoff, causing pollutant and sediment delivery in downstream waters. Pervious surfaces are soft and decrease stromwater runoff, which filters out pollutants and sediments before they arrive in downstream waters. Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Chesapeake and Atlantic Coastal Bays Trust Fund, 2013. Stormwater Management: Reducing Water Quantity and Improving Water Quality. IAN press, newsletter publication.

Source: U.S. Department of Environmental Protection

Figure 5. How Green Infrastructure Works

At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. (7) Green Infrastructure Best Management Practices (BMPs) can help reduce flooding, provide ecological benefits, improve public health and increase the amount of open/green space in a community (See Figure 6).



Source: Hoboken Green Infrastructure Strategic Plan Final Report, 2013

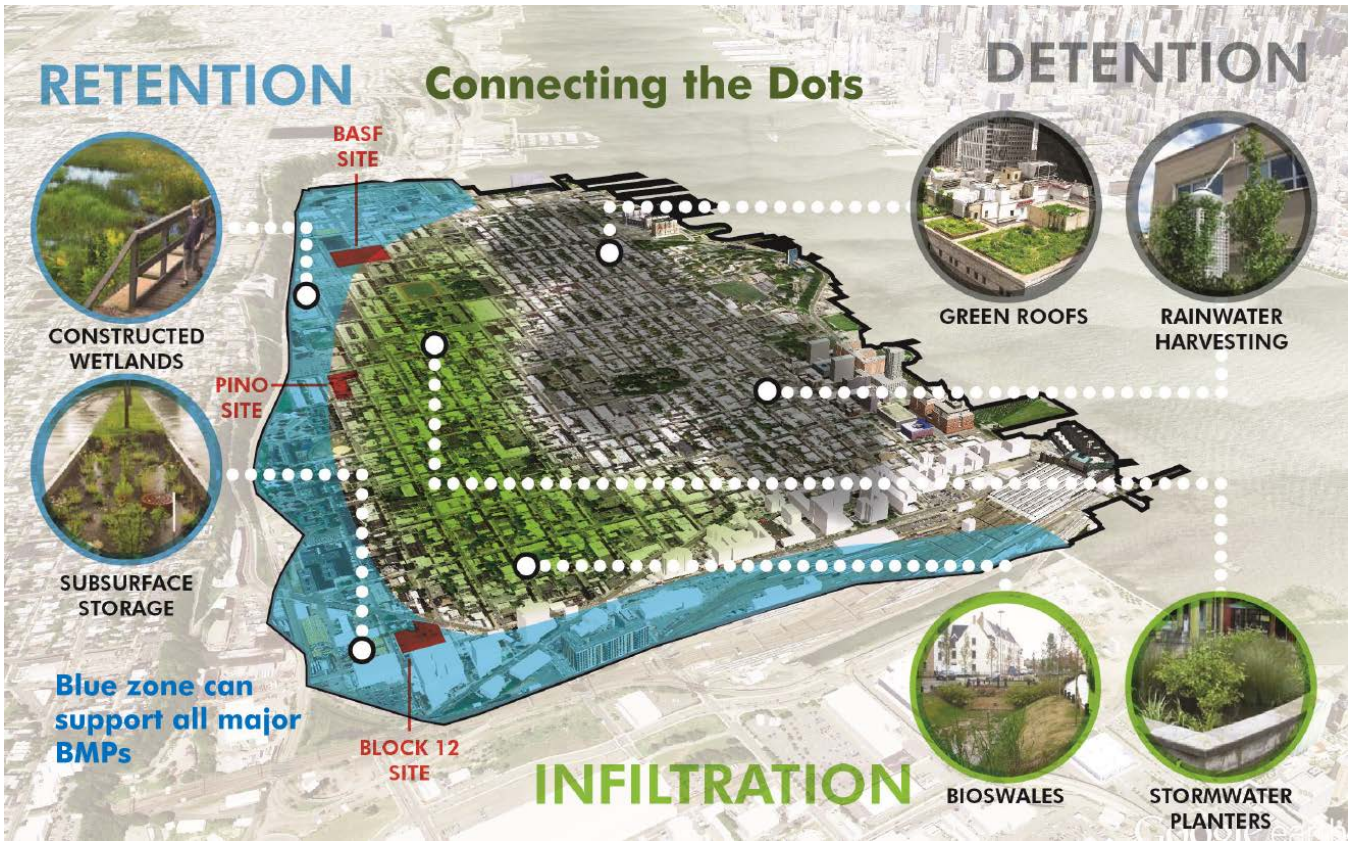
Figure 6. Potential Benefits of Green Infrastructure BMPs

Hoboken's Proposed Stormwater Management Plan and Ordinance Amendments

In 2013, Hoboken received a technical assistance grant from Together North Jersey–a U.S. Department of Housing and Urban Development (HUD)-funded regional planning partnership–to develop the ***Hoboken Green Infrastructure Strategic Plan.*** The plan:

- Creates a framework for green infrastructure implementation on both a city-wide and district by district basis;
- Identifies a suite of cost-effective, place-based stormwater best management practices (BMP) the city can employ to address stormwater management and the anticipated increase in frequency of future flooding events;
- Locates and prioritizes infrastructure assets most in need of protection; and
- Recommends a set of strategies the city can employ to implement the Plan.

The green infrastructure strategy proposed in the plan focuses on implementation of a variety of green infrastructure best management practices to reduce and manage stormwater runoff. The strategy organizes the city into three zone with recommendations regarding the appropriateness of different green infrastructure BMPS for each zone (See Figure 7 and Table 1).



Source: Hoboken Green Infrastructure Strategic Plan Final Report, 2013

Figure 7. Hoboken Green Infrastructure Strategy

Table 1. Hoboken Green Infrastructure Strategy BMPs by Zone

Green Infrastructure BMP	Gray Zone: Detention	Green Zone: Infiltration	Blue Zone: Retention
Rainwater harvesting	✓		
Green roofs	✓		
Bio-swales		✓	
Permeable Pavement		✓	
Rain gardens		✓	
Stormwater infiltration planter/Tree pits		✓	
Basins or Ponds		✓	✓
Subsurface storage		✓	✓
Constructed wetlands			✓

The Green Infrastructure Strategic Plan recommends that the city develop and adopt an amended stormwater management element to the city's Master Plan and a new stormwater management ordinance designed to facilitate implementation of green infrastructure BMPs city-wide as a way to mitigate flooding and reduce CSS events. Amendments to the city's current stormwater management plan element and stormwater ordinance are now pending before the Planning Board and City Council and are the subject of this HIA.

About Health Impact Assessment

Health Impact Assessment (HIA) is a fast-growing practice in the United States that provides practitioners and policymakers with a tool to consider the health outcomes of decisions. The National Research Council of the National Academies defines HIA as "… a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population. HIA provides recommendations on monitoring and managing those effects."

According to the Health Impact Project, HIAs:

- Look at health from a broad perspective that considers social, economic and environmental influences;
- Bring community members, business interests and other stakeholders together, which can help build consensus;
- Acknowledge the trade-offs of choices under consideration and offers decision makers comprehensive information and practical recommendations to maximize health gains and minimize adverse effects;
- Put health concerns in the context of other important factors when making a decision; and
- Consider whether certain impacts may affect vulnerable groups of people in different ways.

As shown in Figure 8, HIAs typically include six steps: Screening, Scoping, Assessment, Recommendations, Reporting and Evaluation.

Rebuild By Design

Hoboken's green infrastructure initiatives are being undertaken within the context and in support of other concurrent and complementary resiliency planning activities, including ***Rebuild by Design***, which began as a design competition run by the U.S. Department of Housing and Urban Development (HUD) in the aftermath of Hurricane Sandy. The competition has transformed into "an innovative process that places local communities and civic leaders at the heart of a robust, interdisciplinary, creative process to generate implementable solutions for a more resilient region." With Hurricane Sandy recovery funding provided by HUD, regional partners are pursuing implementation of a comprehensive urban water strategy designed to make the Hoboken, Jersey City and Weehawken more resilient to flooding, coastal storm surge and sea-level rise. The strategy– which is known as "Resist, Delay, Store, Discharge"– will "deploy programmed hard infrastructure and soft landscape for coastal defense (resist); policy recommendations, guidelines, and urban infrastructure to slow rainwater runoff (delay); a circuit of interconnected green infrastructure to store and direct excess rainwater (store); and water pumps and alternative routes to support drainage (discharge)."

Source: http://www.rebuildbydesign.org/

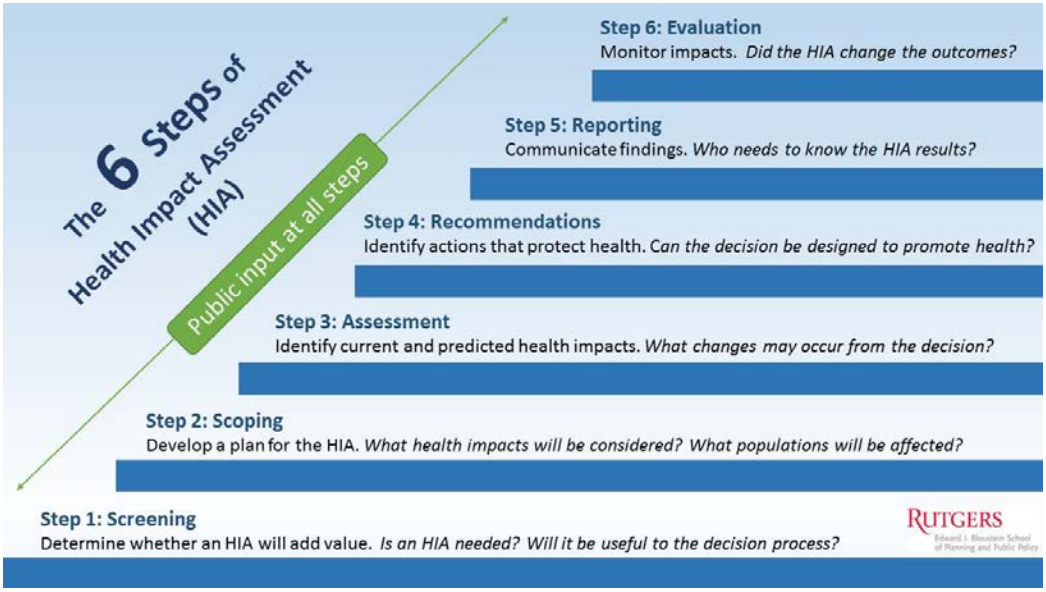


Figure 8. The Six Steps of Health Impact Assessment

About this Report

The purpose of this HIA is to inform the stormwater management planning process as well as the decision-making of the Hoboken City Council as it considers a comprehensive stormwater management ordinance. The HIA considers the possible health effects of flooding and potential exposure to polluted stormwater from combined sewer system back-ups and overflows, as well as the potential effects associated with implementing green infrastructure solutions to address these problems.

This report presents the findings and recommendations of the HIA organized generally around the steps of the HIA process. ***Chapter 2*** presents the results of the HIA screening phase. ***Chapter 3*** describes the scope of the HIA in terms of study area, temporal boundaries, potentially impacted populations, and the potential health effects of implementing green infrastructure best management practices to reduce flooding in the city. ***Chapter 4*** provides an overview of the stakeholder engagement activities conducted throughout the HIA process. ***Chapter 5*** presents the methods used and findings from the HIA assessment phase. ***Chapter 6*** presents a series of recommendations aimed at maximizing the beneficial health effects of implementing green infrastructure BMPs in Hoboken as well as ways to minimize any potentially negative effects. ***Chapter 7*** describes the how the results of the HIA were disseminated and finally ***Chapter 8*** lays out a plan for monitoring and evaluating the short and longer term effects of implementing the proposed stormwater management plan over time.

CHAPTER 2: HIA SCREENING AND PRE-SCOPING PHASE RESULTS

The screening/pre-scoping process for this HIA included consultations with city officials and representatives from Princeton Hydro, the consultant team hired to prepare the city's stormwater management plan amendments. Princeton Hydro's contract covered several elements designed to address flooding issues including continuity of operations, all hazards planning, and development of a stormwater management plan and associated ordinance amendments. As noted previously, this HIA focused only on the proposed stormwater management plan.

As described in more detail in Chapter 3, the purpose of the stormwater management plan amendments is to facilitate implementation of green infrastructure BMPs city-wide. According to city officials, potential health impacts of implementing green infrastructure strategies were not being considered as part of Princeton Hydro's consultant work or the city's deliberations regarding adoption of a stormwater management plan and ordinance.

Adoption of a city-wide stormwater management plan will be accomplished by amending the city's current Master Plan to incorporate this new element and adoption of a new stormwater management ordinance. The first action will require approval by the City Planning Board. Subsequently, the City Council will need to take action to replace the city's current ineffective stormwater management ordinance with a new ordinance intended to implement the recommendations set for in the Master Plan Stormwater Management element.

HIA screening seeks to answer a number of threshold questions to determine the feasibility and efficacy of completing an HIA. These questions and answers are reported below.

- ***What project or decision will the HIA address or inform?*** The primary decision to be addressed by the HIA is adoption of stormwater management plan element to the city's Master Plan, and subsequently, adoption of an updated stormwater management ordinance.
- ***Who are the decision-makers?*** The Hoboken Planning Board is the decision-making body that will take action on adoption of the Stormwater Management Plan. The Hoboken Mayor and City Council are the decision-makers that will take action regarding the adoption of a stormwater management ordinance.
- ***How important to health is the project or decision?*** The combined effects of frequent and persistent flooding and associated Combined Sewer System (CSS) back-ups and overflows are significant hazards in Hoboken. The health risks associated with both are also significant as are the potential health benefits of mitigating flood hazards and less frequent CSS events.
- ***Will the HIA provide new and important information to inform decision-makers?*** Currently, health impacts are not specifically identified for investigation as part of the stormwater management planning process in Hoboken. The HIA has the potential to provide new and important information to inform decision-makers about both the health risks/impacts of flooding and associated CSS back-ups and overflows on city residents and the potential health benefits and risks of green infrastructure approaches to flood mitigation as part of the planning process.
- ***Under what time frame will the decisions be made?*** The Hoboken Stormwater Management Plan will be completed by fall 2015. Decisions related to which mitigation strategies to recommend in the plan are on-going. The Hoboken Planning Board and other stakeholders will consider whether to accept the recommendations, adopt the plan and move forward with implementation in late 2015 or early 2016.

- ***What data or evidence is available to support the HIA analysis?*** A number of past studies have documented the extent and nature of flooding in Hoboken as well as potential mitigation strategies that can be used to address flooding city-wide. Past studies include a variety analyses completed by the North Hudson Sewerage Authority, the Hoboken Green Infrastructure Strategic Plan, the Rebuild By Design disaster recovery design competition, the Hudson County Multijurisdictional Hazard Mitigation Plan and the on-going work of the Princeton Hydro consultant team. There is also a significant body of literature that explores the potential impacts of flooding on human health. Health data for Hudson County is available from a variety of sources; however city/neighborhood level data is not currently available.

- ***Is an HIA feasible given available resources?*** An HIA is feasible given available resources. The decision process spans approximately 12-18 months. This HIA is supported by grant funding from the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts. A team of researchers with expertise in planning, public engagement, public health and health impact assessment has been assembled to undertake the HIA. The City of Hoboken is a committed partner and has made the Princeton Hydro consultant team available to support the HIA.

Based on the above, the decision was made to proceed with the HIA.

CHAPTER 3: HIA SCOPING PHASE RESULTS

The second step in the HIA process is scoping. Scoping is intended to: identify the range of health effects that will be considered in the HIA; the populations potentially affected by the pending decision; the strategies to be used to engage stakeholders and the public in the HIA process; and the sources of data and the methods to be used to assess potential health risks and benefits.

The Hoboken Proposed Stormwater Management Plan HIA focuses on the problems of repetitive flooding and CSS events (back-ups and overflows). As part of the HIA scoping process, the research team conducted a preliminary review of literature on flood risks and impacts of CSS events on the natural environment and human health to identify the health pathways likely present in the Hoboken context. The research team also met with the HIA advisory committee of local stakeholders to: seek input regarding the specific research questions that can/should to be investigated as part of the HIA; identify the health risks and benefits that may be associated with implementing the stormwater management techniques under consideration; discuss what methods can/should be used to for assessing impacts; and what demographic, geographic and temporal boundaries should be set to help define the scope of the HIA analysis. The sections that follow summarize the results of the HIA scoping phase.

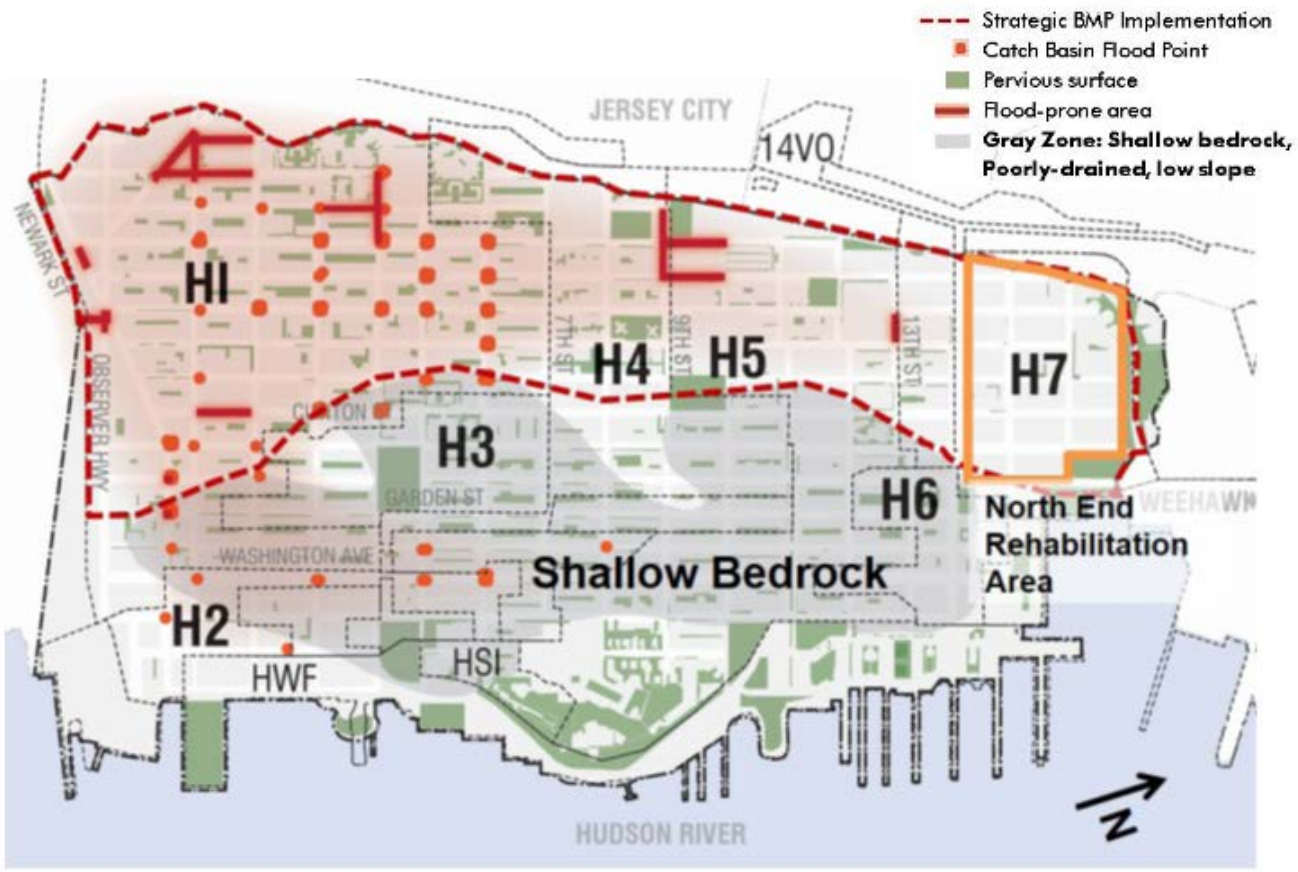
Goals of the HIA

The following goals for the Hoboken Proposed Stormwater Management Plan HIA were developed with input from the HIA advisory committee:

- Understand better the health impacts of flooding and CSS events in Hoboken;
- Understand better the potential health risks and benefits of stormwater management and flood mitigation strategies under consideration;
- Identify the distribution of health impacts related to flooding and CSS events to assess potential inequities in terms of how heath risks and benefits accrue;
- Identify opportunities to maximize benefits and minimize risks associated with implementing proposed green infrastructure approaches to stormwater management;
- Engage with city officials regarding health impact assessment;
- Connect housing authority residents to resiliency planning efforts in the city;
- Influence decision-making related to stormwater management planning in Hoboken and in other jurisdictions;
- Inform the broader context of existing efforts related to hazard mitigation and resiliency planning; and
- Identify opportunities to transfer knowledge and lessons learned during the HIA process to other jurisdictions.

Geography and Focus of HIA

As already described, this HIA focuses on the problem of repetitive flooding and regular inundation from high tides. The geography of the HIA includes the jurisdiction of the City of Hoboken. However, special attention was given to the areas of the city most impacted by repetitive flooding and the impacts of CSOs. These areas include the H1-Southwest Sewershed, the western portions of the H4-Midtown Sewershed, the western portion of the H5-Northwest Sewershed and the H7-Northwest Sewershed. See Figure 9.



Source: Hoboken Green Infrastructure Strategic Plan Final Report, 2013

Figure 9: City of Hoboken Flood Prone Areas

Temporal Scope of the HIA

Full implementation of green infrastructure BMPs in Hoboken will likely take several decades. As such, the potential health benefits and detriments of implementing green infrastructure in the city will be incremental and not fully realized for many years. The HIA will consider both short and longer term impacts from green infrastructure implementation.

Potentially Affected Population

Although virtually every city resident is impacted by flooding in some way, within the parts of the city most frequently flooded, there are a number of groups that may be disproportionately impacted by flooding and its associated effects. These groups include low-income individuals and families, older adults, and persons with disabilities.

Potential Health Determinants

The proposed Hoboken Stormwater Management Plan Amendments Health Impact Assessment (HIA) was conducted to examine the potential positive and negative health effects if the City of Hoboken decides to adopt amendments to the city's stormwater management plan and ordinances that would implement the recommendations of the Hoboken Green Infrastructure Strategic Plan. Implementation of "green infrastructure" BMPs is intended to mitigate chronic flooding in the city and to help reduce the sanitary sewer back-ups and CSS events that often occur along with the flooding. The following is a summary of the potential health effects and outcomes that could result from the decision to move ahead with the stormwater management plan changes as proposed. The health determinants were identified in the literature and by stakeholders participating in the HIA planning process. They include:

1. Exposure to flooding, and related impacts such as dampness and mold growth
2. Exposure to Combined Sewer System back-ups and overflows
3. Access to natural features and green landscape
4. Changes in air quality
5. Changes in water quality
6. Changes in urban heat island
7. Exposure to standing water
8. Exposure to contaminated soil
9. Changes to economic conditions:
    a) Access to "green" jobs
    b) Property values
    c) Rents
    d) Taxes
10. Other exposure hazards:
    a) Trip and fall incidents
    b) Pests/vermin
    c) Graffiti/crime
    d) Accumulation of trash/litter

As part of the scoping process the HIA research team developed two health pathway diagrams to guide inquiry during the assessment phase. These are included at the end of the report as Appendix 2: Flooding/CSO health pathways Diagram; and Appendix 2a: Green Infrastructure BMPs Health Pathways Diagram.

CHAPTER 4. STAKEHOLDER ENGAGEMENT

A variety of methods aimed at facilitating public participation in the HIA process were employed in each phase of the HIA. Following is a description of the methods used, the phase of the HIA in which they were employed, and their purposes.

Scoping Phase

During the HIA scoping phase, the project team established and convened an *HIA Advisory Committee*. Advisory committee members were selected for: their knowledge of the community, representation of community interests, understanding of the city's management and administration, emergency preparedness, local business and development interests, provision of essential services, or their experience with community health issues. The advisory committee met one time during this phase for a HIA kick-off workshop. At the meeting, the group identified specific populations for the project team to focus on, including residents in the areas that experience chronic flooding, low-income individuals and families, older adults, and people with Limited English Proficiency. The group also participated in an exercise to identify key health determinants and pathways related to flooding and then added new pathways based on the proposed green infrastructure solutions being contemplated by the city.

Assessment Phase

Focus Groups

During the HIA Assessment Phase, the project team conducted two resident focus groups– one with low-income residents living in Hoboken Housing Authority properties and one with senior citizens aged 65 and over living throughout the city. The purpose of the focus groups was to collect primary data related to flooding experience and its effects on individual health and mental health as well as to solicit community input on potential flood mitigation strategies. The focus groups were intended to ensure for potentially vulnerable populations to provide input into the HIA process.

Community-wide Resident Survey

In addition to the focus groups, the project team also designed and administered a community-wide resident survey. The survey included up to 58 questions addressing respondent's experiences dealing with chronic flooding in Hoboken, the impacts of flooding on their health and well-being, their opinions on green infrastructure, and their general health status. Surveys were available in both English and Spanish. They were delivered in electronic format through the internet and via hard copy surveys distributed through various outlets. These outlets included outreach through project partners and the steering committee as well as media and the delivery of hard copy surveys via government offices, senior housing facilities and private businesses.

Additional outreach was also conducted at the kiosk set up at Shop Rite either directing individuals to the survey website, or providing hard copy surveys in person. The hard copy surveys included an envelope and paid postage for ease of returning the survey. To encourage participation, respondents were provided the opportunity to enter into a random drawing to win a gift card at the end of the survey. The survey opened June 14, 2015 and the last response included in the data analysis was received on August 30, 2015. In total, 395 surveys were completed.

Structured interviews

The project team conducted structured interviews to collect pertinent background information and data related to health and flooding in Hoboken. Individuals that were interviewed included: Frank Sasso from the Hoboken

Health Department; Christina Butieb Bianco from the Hudson Regional Health Commission; Fred Pocci from the North Hudson Sewerage Authority; Vito Veneruso from the North Hudson Community Action Corporation; and Marisa Mustachio Gerke from HOPES CAP.

Advisory Committee Meetings

The advisory committee met three times during the assessment phase (both in-person and web-based formats were used for these meetings). At the meetings, the committee reviewed relevant documents, provided input and came to agreement on items such as the: goals for the HIA; strategy for community outreach, including specific contacts and methods; online survey protocol, questionnaire; and key findings from the survey. The committee members were invaluable in helping the project team recruit individuals for the survey and the focus groups. Individuals with technical expertise on planning and designing green infrastructure recommended specific studies that contributed to the literature review and the draft recommendations.

Hoboken Planning Board Briefing

Also at the beginning of the assessment phase, the project team made a short presentation before the Hoboken Planning Board to brief them on the HIA project and solicit input. Planning board members contributed ideas regarding potentially vulnerable populations to be included in the HIA and suggested health impacts of greatest concern.

Kiosk at Shop Rite

At the recommendation of the advisory committee, the project team set up a kiosk at the ShopRite located on Madison Street in Hoboken on Sunday, June 14. The group selected that location as it attracts a wide array of residents and it is also itself in a highly flood prone part of the city. The kiosk was setup from 10am until 2pm at which time all flyers were distributed. While at the kiosk, the project team members encouraged Shop Rite patrons to participate in the survey handing out hard copy surveys as well as flyers. Flyers were provided in both English and Spanish directing individuals to the web-based survey. In addition to survey outreach, the project team answered questions and received feedback about the project.

Recommendations and Reporting Phase

The advisory committee met twice during the Recommendations Phase. Both meetings were held to review the results of the assessment phase and to discuss preliminary recommendations. The first meeting was in-person and the second was web-based to accommodate the schedules of several committee members. In both cases, the advisory committee provided critical guidance on how to make the information easier to understand and provided a ground-truthing of the scope of the recommendations. The committee met again on February 23, 2016 to review and provide input on the final draft of the HIA report. After incorporating the committee's input, in August 2016, the project team presented the report and recommendations at two public meetings, one before the Hoboken Planning Board and the other before Hoboken City Council. In addition, the HIA final report was disseminated to a range of Hoboken stakeholders and made available to the public on the New Jersey Future and Rutgers University websites. Hard copies were placed at document repositories located at City Hall and the Hoboken Public Library.

CHAPTER 5: HIA ASSESSMENT PHASE FINDINGS

The potential impacts of flooding on human health, including infectious disease, respiratory conditions, injury and death are well documented in the literature (8) (9) (10) (11) (12) (13) (14). In addition, as noted above, flooding in Hoboken is often accompanied by CSS events such as sanitary sewer back-ups and CSOs. During CSS events, the potential exists for humans to come in contact with untreated human and industrial waste, toxic materials, and debris. Exposure to the pollution caused by CSS events can have significant direct impacts on human health. According to the USEPA, such impacts can include symptoms such as vomiting, diarrhea, dehydration, respiratory illness, fever, dysentery or even death associated with exposure to pathogens such as bacteria, protozoans and viruses (8).

In addition to polluted runoff and sewer system back-ups and overflows, flooding can cause damage to buildings and may create significant disruptions to community life in the city, including: stranded residents and dislocation; power failure; disruptions of transportation services; disruptions to social services; disruption of police and fire services; and loss of business activity. Such disruptions can have significant negative impacts to physical and mental health (8) (15) (16) (17) (18) (19) (20). On the positive side, green infrastructure solutions to stormwater management problems can improve air quality, reduce heat island effects and improve water quality (21) (22) (23) (24) (25) (26) (27) (28) (29). All of these things can have positive health effects.

As part of the scoping process the HIA research team identified two sets of questions to guide the assessment phase. The first was intended to help the research team understand baseline conditions and foundational relationships related to flooding and flooding/CSS impacts in the City of Hoboken. The second set was more specifically related to how flood mitigation and green infrastructure BMPs may positively and negatively impact human health over time. See Figure 10.

HIA ASSESSMENT QUESTIONS

I. Understanding Baseline Conditions

a. What is the current health status of residents and vulnerable sub-populations?

b. What is the extent of the recurrent flooding problem in Hoboken?
   i. How frequently do flooding events occur and how severe are those events?
   ii. What parts of the city are most impacted and are any populations more acutely impacted than others?

c. How frequently do CSS events occur in Hoboken?
   i. What causes these events to occur?
   ii. Where are CSO discharge outfalls located?
   iii. What is the typical volume of effluent discharged to the Hudson River?
   iv. To what extent do CSS events result in backups in city streets as well as residential and commercial properties?
   v. What contact do residents have with potentially polluted water (e.g., do they swim, boat etc. in areas proximate to the outfalls?
   vi. Does sewage effluent include industrial waste? If yes, what is the nature of the waste?

d. How much are green infrastructure BMPs expected to reduce flooding and CSO events?
   i. In what parts of the city are the benefits mostly likely to accrue?

II. Assessing Potential Health Impacts

a. What are the potential health/mental health impacts of flooding?

b. What are the potential health impacts of CSS events?

c. What are the potential health risks and benefits of green infrastructure BMPs and to whom will the benefits/risks most likely accrue?

Figure 10. Assessment Questions

Research Methods

HIA standards of practice recommend that the assessment of potential health impacts associated with a plan, program or project be based on a synthesis of the best available evidence, including: existing data, empirical research, professional expertise and local knowledge as well as the products of original investigations (30). For this HIA, the research team utilized the several methods to assess the potential positive and negative health effects that may derive from implementation of the proposed Hoboken stormwater management plan amendments and revised ordinance.

- Review and analysis of secondary data – The research team compiled, analyzed and/or mapped data from a variety of secondary data sources including but not limited to: U.S. Census Bureau; National Oceanic and Atmospheric Administration; NJ Department of Health; NJ Department of Environmental Protection; Hudson County Regional Health Commission; City of Hoboken; North Hudson Sewerage Authority; Together North Jersey; Community Collaborative Rain, Hail and Snow Network; and Intellicast among others to create an appropriate understanding of existing conditions in the city and its various neighborhoods.
- Structured interviews – The research team conducted a series of structured interviews with key stakeholders including representatives from: City of Hoboken Office of Community Development, Department of Health and Human Services, City of Hoboken Planning Board, North Hudson Sewerage Authority, Hoboken Housing Authority, Hoboken public health officials, Hudson County health officials, representatives from the North Hudson Community Action Corporation. These individuals brought important subject matter expertise and local knowledge to the HIA assessment process.

- Literature review and knowledge scan – The research team conducted a detailed review of available empirical research regarding the health pathways and likely health outcomes associated with chronic flooding in the city and the proposed solutions to the flooding problem. This included evidence related to reductions in impervious cover, implementation of stormwater BMPs, increased access to green space, and other areas defined as part of the scoping process. Weight was given to peer-reviewed studies; however, local knowledge and stakeholder expertise was also included.

- Resident surveys and focus groups – The research team conducted a community-wide resident survey to collect data on the current health status of Hoboken residents, residents experience with flooding in Hoboken and resident knowledge of and opinions about green infrastructure BMPs. The survey included a battery of demographic questions that were used to help document existing health disparities and any disparities related to flooding impacts. The team also conducted two focus groups, one each with senior citizens and housing authority residents. The focus groups provided insights into the range of flooding impacts experienced by Hoboken residents, the extent to which conditions have changed over time, and the degree to which residents are aware of Hoboken's stormwater management approach, and more specifically if they understand what green infrastructure is and how it may reduce flooding in the city. A copy of the survey methods and results report, including the survey questionnaire can is provided in Appendix 3.

Baseline Conditions

As part of any HIA process, it is important to understand existing conditions within the study area and in relation to the populations potentially impacted by the decision being considered. As noted in Figure 10, the research team developed a series of key questions to guide documentation of baseline conditions in the city. These questions included:

a. Who lives in Hoboken and where, including socially vulnerable populations such as low-income residents, older adults and people with disabilities?
b. What is the current health status of Hoboken residents?
c. What is the extent of the recurrent flooding problem in Hoboken?
d. How frequently do CSS events occur in Hoboken?

The following subsections present the best available information data in relation to these key questions.

Table 2. City of Hoboken Quick Facts

	Hoboken	Hudson County	New Jersey
Population Characteristics			
Total Population, 2014 estimate	53,312	669,115	8,938,175
Persons under 18 years, percent, 2010	12.2%	20.7%	23.5%
Persons 65 years and over, percent, 2010	6.3%	10.4%	13.5%
Female persons, percent, 2010	49.5%	50.5%	51.3%
Race/Ethnicity			
White alone, percent, 2010 (a)	82.2%	57.2%	68.6%
Black or African American alone, percent, 2010 (a)	3.5%	14.7%	13.7%
Asian alone, percent, 2010 (a)	7.1%	14.5%	8.3%
Two or More Races, percent, 2010	2.6%	4.4%	2.7%
Hispanic or Latino, percent, 2010 (b)	15.2%	42.2%	17.7%
White alone, not Hispanic or Latino, percent, 2010	73.2%	30.8%	59.3%
Language/Education			
Foreign born persons, percent, 2009-2013	14.8%	41.2%	21.2%
Language other than English spoken at home, pct age 5+, 2009-2013	20.3%	59.2%	30.0%
High school graduate or higher, percent of persons age 25+, 2009-2013	92.6%	81.9%	88.1%
Bachelor's degree or higher, percent of persons age 25+, 2009-2013	73.5%	36.3%	35.8%
Income and Poverty			
Median Household Income, 2009-2013	$107,366	$58,442	$71,629
Employment percent of population 16 years old and over, 2009-2013	75.6%	61.7%	59.7%
Persons below poverty level, percent, 2009-2013	11.7%	16.8%	10.4%
Housing Characteristics			
Housing units, 2010	26,855	270,335	3,553,562
Homeownership rate, 2009-2013	32.7%	32.6%	65.6%
Housing units in multi-unit structures, percent, 2009-2013	94.7%	83.5%	36.0%
Median value of owner-occupied housing units, 2009-2013	$550,700	$347,200	$327,100
Households, 2009-2013	23,997	243,875	3,186,418
Persons per household, 2009-2013	2.06	2.61	2.71
Geography			
Land area in square miles, 2010	1.28	46.19	7,354.22
Persons per square mile, 2010	39,219.6	13,731.4	1,195.5

Notes: (a) Includes persons reporting only one race; (b) Hispanics may be of any race, so also are included in applicable race categories.
Source: US Census Bureau State & County QuickFacts

Hoboken Population Characteristics

The City of Hoboken, located in Hudson County, New Jersey is home to more than 53,000 residents. As shown in Table 2, the city's population is younger than that of Hudson County or New Jersey as a whole, with only 6.3 percent of the population over the age of 65. In terms of race and ethnicity, Hoboken's population is significantly less diverse than Hudson County and the State. More than 82 percent of Hoboken's population is White. Hoboken residents are highly educated, with 74 percent of the population having a Bachelor's degree or higher. Rates of employment in the city are notably higher than the Hudson County or the State, with 76 percent of working age Hoboken residents employed. Average household income in Hoboken is $107,366, well above the average in Hudson County ($58,442) and New Jersey ($71,629). At the same time, approximately 12 percent of the city's residents live in poverty.

The majority of residents living in poverty and other lower-income Hoboken residents live in Hoboken's lower-lying neighborhoods which are most susceptible to frequent flooding and CSS back-ups (Sewersheds H1 and H4). Figures 11-13 show Census block groups with the highest rates of poverty, the location of Hoboken Housing Authority facilities and the location of HUD-subsidized housing units in the city. As shown in Figures 14 and 15, Hoboken residents with disabilities and minority residents are also concentrated in more flood prone areas. Because of individual and family resource constraints, these groups are likely to be more vulnerable to negative consequence of flooding and CSS back-ups and stand to gain the most benefit from actions that may reduce flooding in the city.

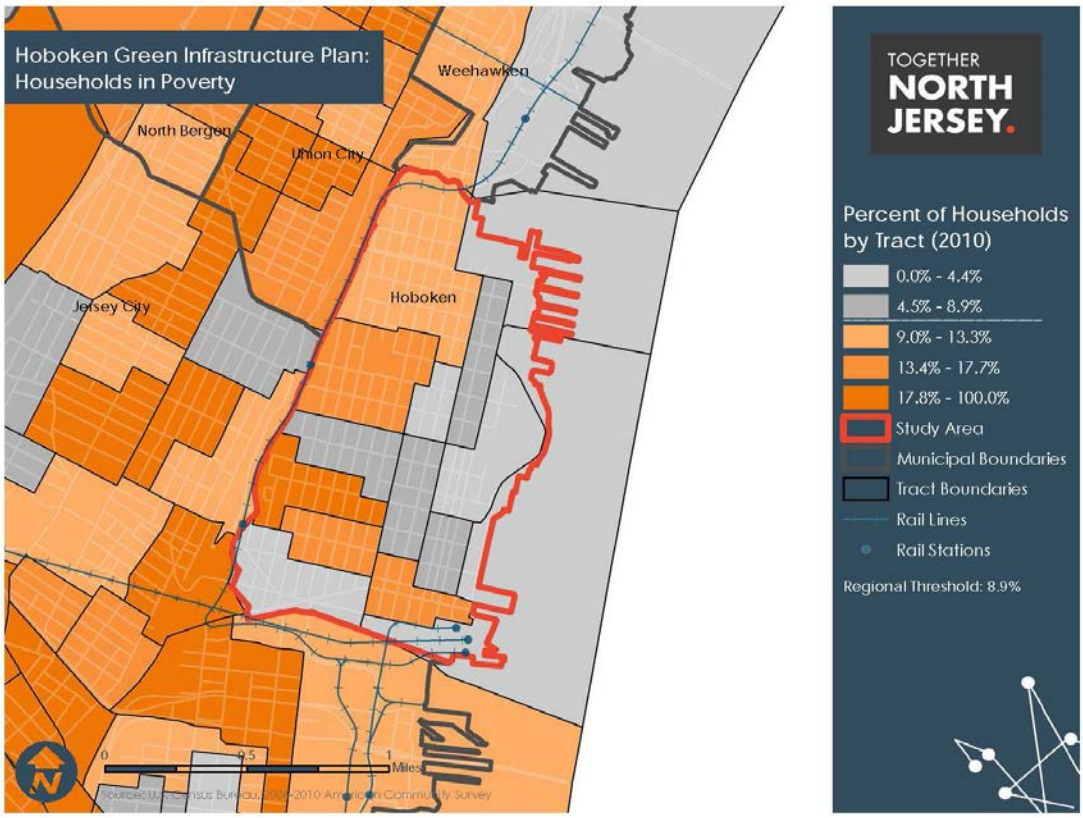


Figure 11. People living in poverty in Hoboken

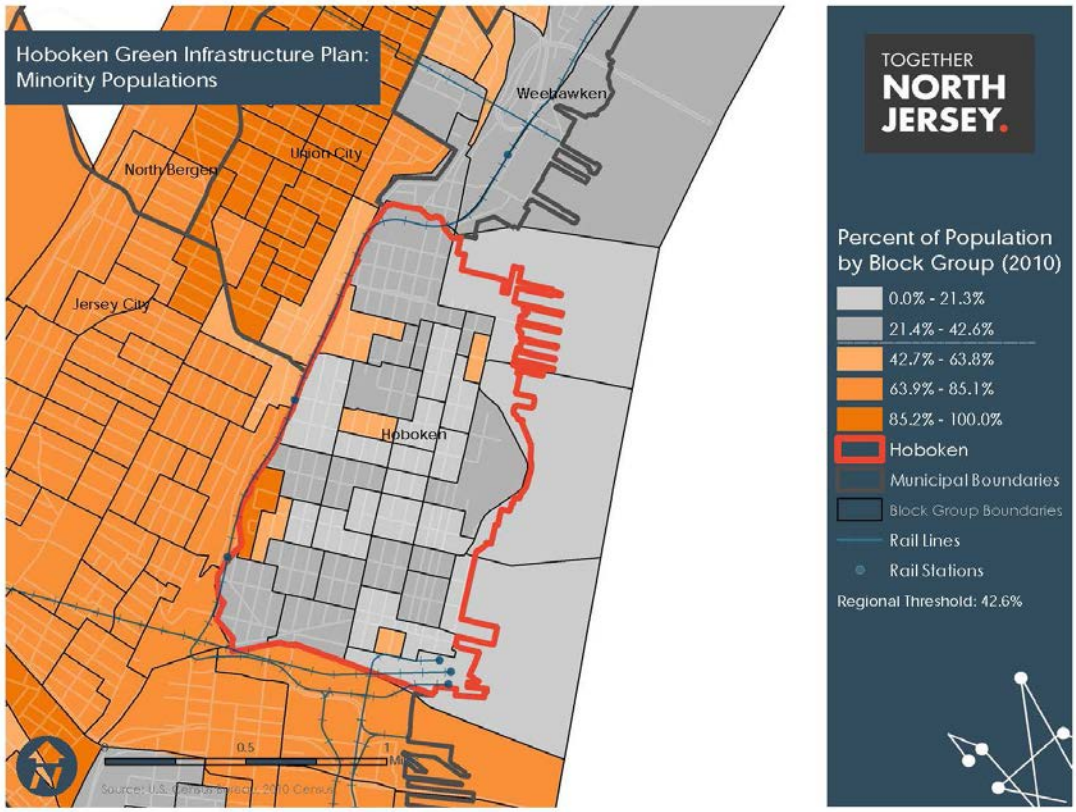


Figure 12. Minority populations in Hoboken

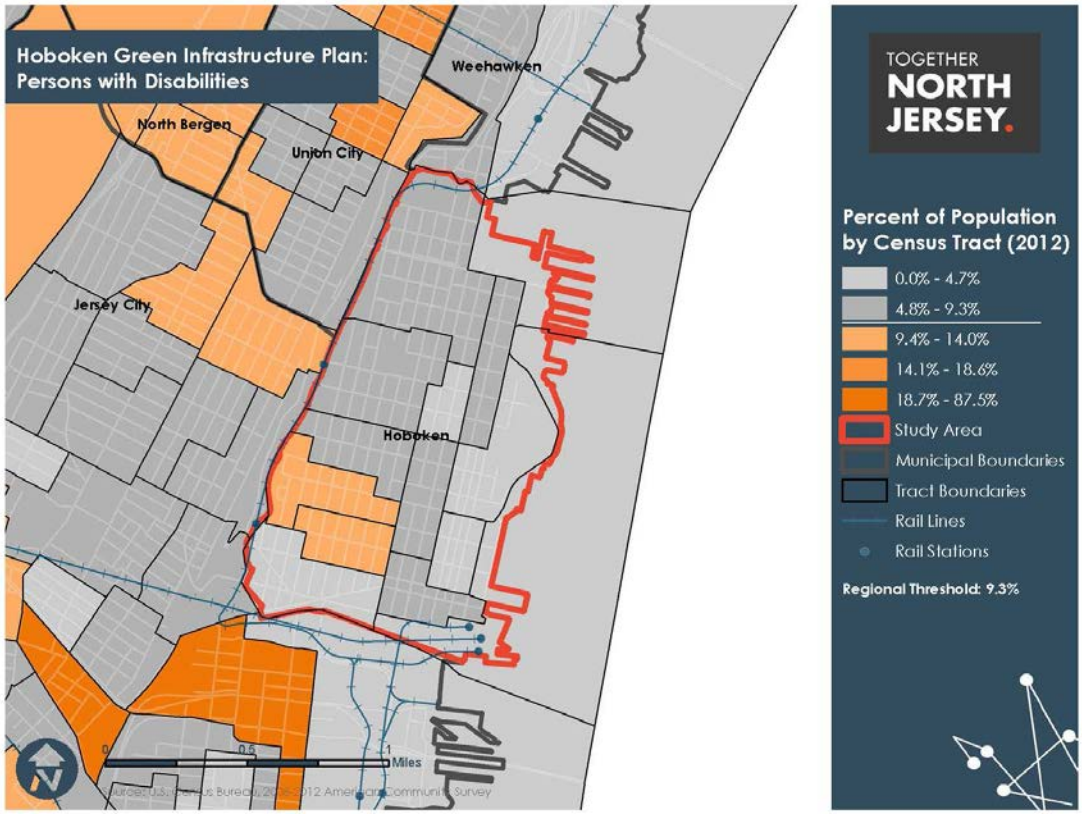


Figure 13. People with disabilities living in Hoboken

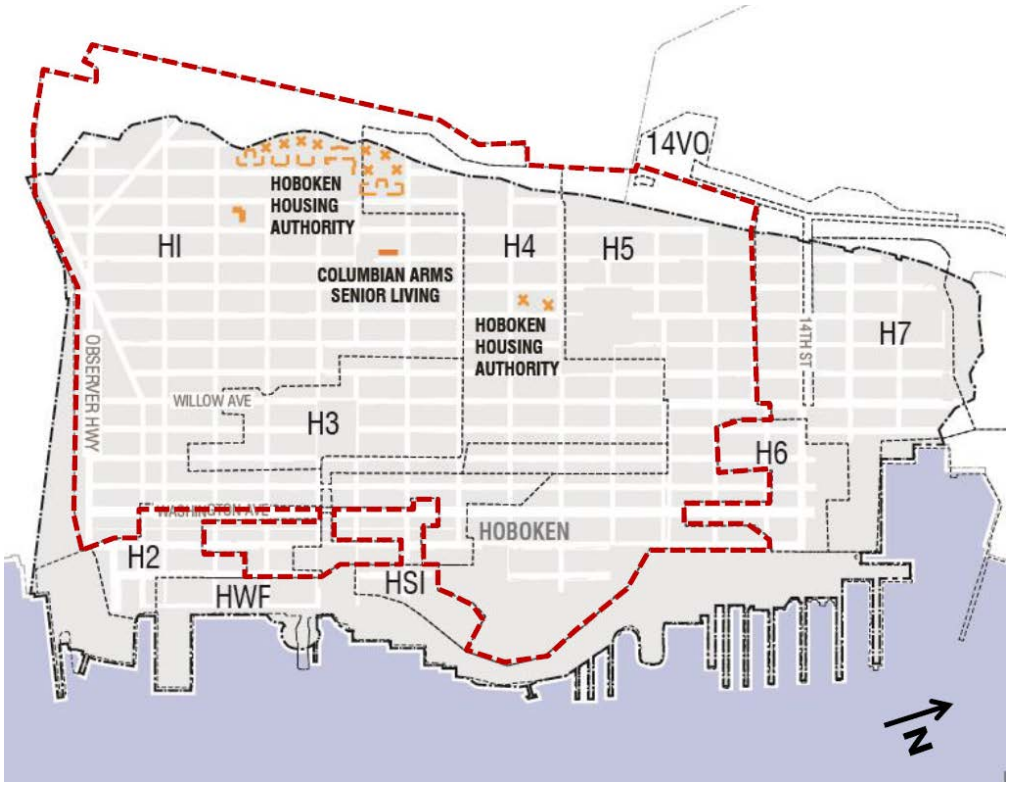


Figure 14. Location of Hoboken Housing Authority Properties

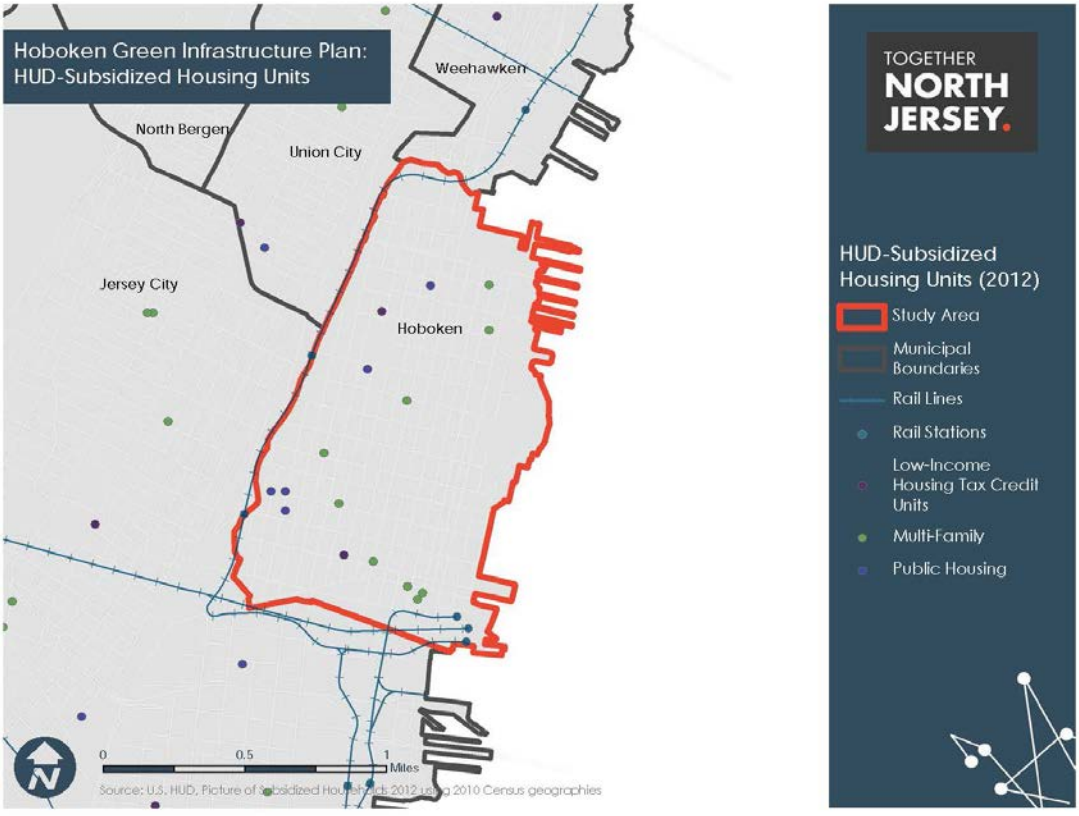


Figure 15. HUD subsidized housing in Hoboken

Current Health Status of Hoboken Residents

The most comprehensive data available on individual and community health status is from the Behavioral Risk Factor Surveillance System (BRFSS), a nation-wide health survey partially funded by the Centers for Disease Control and Prevention (CDC). The BRFSS monitors major behavioral risk factors and chronic conditions associated with disability and death among adults, aged 18 and over who live at home (i.e., not in dormitories, jails, hospitals, nursing homes, or other similar group quarters). BRFSS results are used to monitor selected health conditions and behaviors as reported by survey participants. According to the NJ Department of Health, the NJ-BRFSS has been in operation since 1991 and includes statistics through the year 2013, the latest year for which data is available.

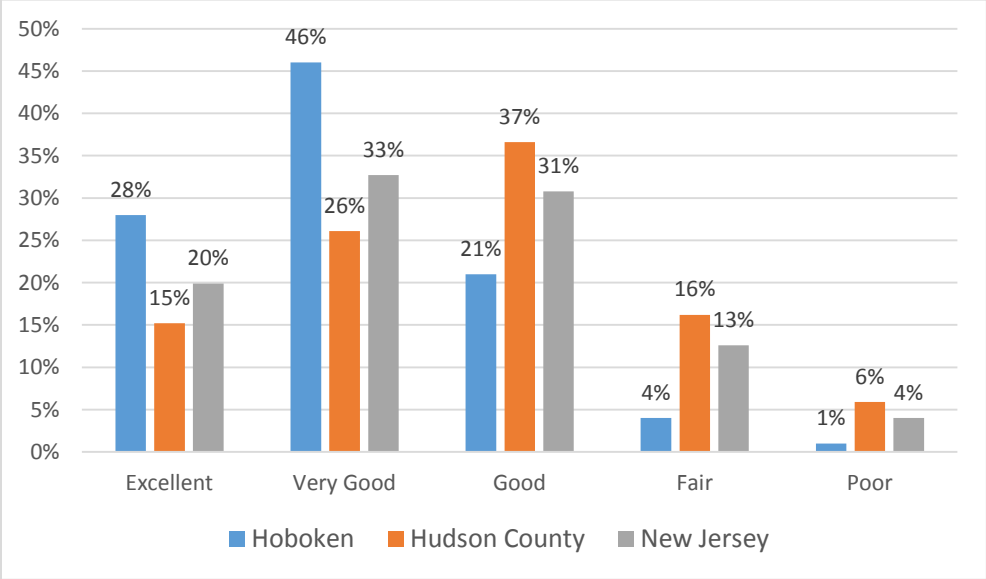
Unfortunately, with the exception of data for the cities of Newark and Jersey City, only county- and State-level data are available in New Jersey. No Hoboken-specific health data was identified from available data sources. Given this constraint, the research team included a battery of health status questions in the community-wide resident survey conducted for the HIA in 2015. The health-related questions included in the resident survey mirrored the BRFSS questionnaire to facilitate data comparisons.

The health status characterization contained in this section includes data from the NJ-BRFSS database and data collected via the Hoboken HIA resident survey. It should be noted that the data collected for Hoboken was derived from a convenience sample of residents that completed the community-wide survey on-line. The individual characteristics of residents that completed the survey in terms of age, gender, race and income were broadly representative of Hoboken's overall population but the pool of survey respondents does not represent a randomly selected sample of residents. Consequently, the survey results may contain biases that make it inappropriate to generalize the results to Hoboken's overall population. The survey methods report contained in Appendix 3 includes a more detailed explanation of data constraints and presents weighted data for a number of key health-related indicators. The process of weighting the data to correct for difference in population characteristics and make the results more generalizable resulted in some minor adjustments to the survey results.

As shown in Figure 16, the overall health status of Hoboken residents that completed the survey is higher than that of Hudson County and New Jersey residents. Ninety-five percent of Hoboken survey participants report being in excellent, very good or good health. This compares to 78 percent of Hudson County residents and 83 percent of New Jersey residents. Only 5 percent of Hoboken residents that completed the survey reported their health status to be fair or poor. This compared to 22 percent of Hudson County residents and 17 percent of New Jersey residents. There are a number of possible demographic reasons that could help to explain these differences. In particular, age and income are leading indicators of reported health status. Hoboken's population is younger and tends to be higher income than Hudson County and State residents overall (see Table 1). This was true of Hoboken survey respondents as well. Research shows that younger people and people with higher incomes generally report being in better overall health (31) (32) (33)

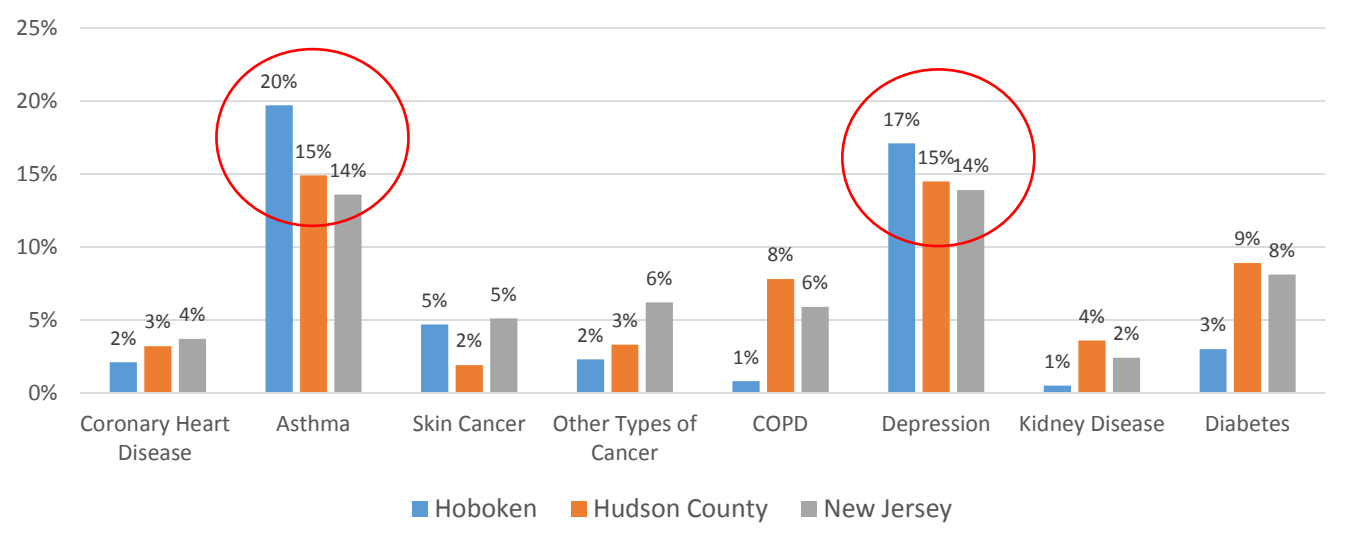
In addition to overall health status, BRFSS tracks prevalence of chronic health conditions in the general population. A sampling of tracked conditions include: asthma, chronic obstructive pulmonary disease (COPD), diabetes, depression, kidney disease, skin cancer and other types of cancer. As shown in Figure 17, health data indicate that there is a lower prevalence of coronary heart disease, COPD, kidney disease and diabetes among Hoboken residents that completed the survey when compared to the population of Hudson County and New Jersey. In addition, the incidence of skin cancer diagnoses among Hoboken residents completing the survey is on par with the State and somewhat higher than that of Hudson County residents. However, the prevalence of two conditions–asthma and depression–are notably higher among Hoboken residents that completed the survey

than in Hudson County and New Jersey. As discussed, later in this chapter, flooding and exposure to contaminated flood waters has the potential to exacerbate asthma. In addition, for the chronically ill, flooding can disrupt access to healthcare services such as medical appointments and dialysis as well as limit access to prescription medications. Frequent flooding can also cause stress and anxiety which can result in or worsen symptoms associated with depression.



Sources: Hoboken Stormwater HIA Community-wide Survey, 2015; New Jersey Behavioral Risk Factor Survey (NJBRFS). New Jersey Department of Health, Center for Health Statistics, New Jersey State Health Assessment Data (NJSHAD) [online], 2013. Accessed at http://nj.gov/health/shad on 8/10/15.

Figure 16. General Health Status of Hoboken Residents vs. Hudson County and New Jersey

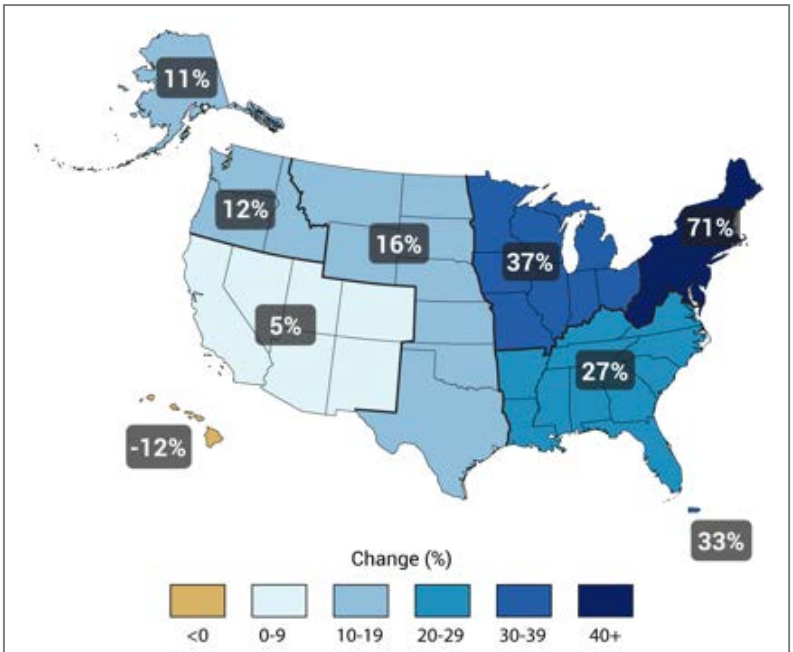


Sources: Hoboken Stormwater HIA Community-wide Survey, 2015; New Jersey Behavioral Risk Factor Survey (NJBRFS). New Jersey Department of Health, Center for Health Statistics, New Jersey State Health Assessment Data (NJSHAD) [online], 2013. Accessed at http://nj.gov/health/shad on 2/15/16

Figure 17. Prevalence of Chronic Health Conditions in Hoboken vs. Hudson County and New Jersey

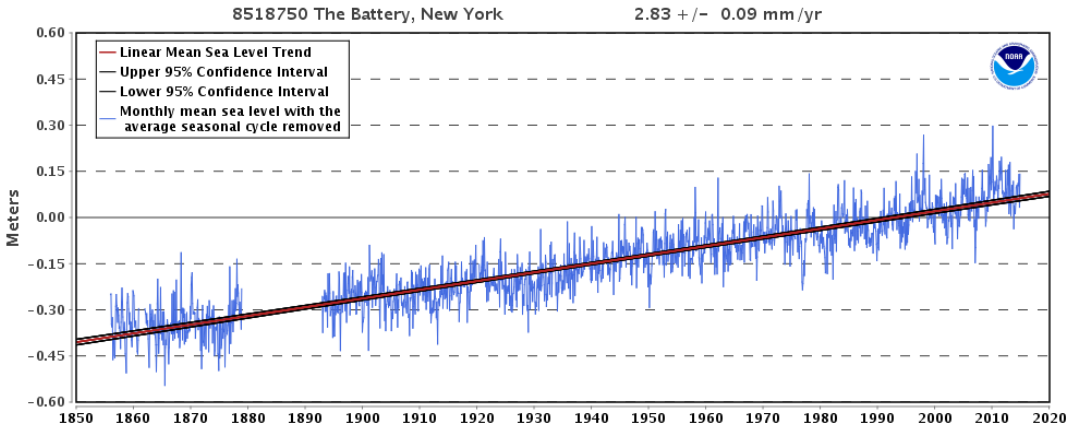
Environmental and Climate Conditions

On average, the City of Hoboken receives more than 45 inches of precipitation annually (34). According to the State Department of Environmental Protection, New Jersey has experienced a statistically significant increase in total precipitation over the past several decades. (35) In addition, as shown in Figure 18, over the past 40 years, the Northeast region of the United states has experienced a 71 percent increase in very heavy precipitation events (add citation http://climatenexus.org/learn/regional-impacts/northeast). To make matters worse, tide gauge data (see Figure 19) collected by the National Oceanic and Atmospheric Administration shows that tide levels at Battery Park, NY and Sandy Hook, NJ have increased the equivalent of 1 inch and 1.33 feet respectively over the past 100 years (36). These conditions and trends result in frequent and recurring flooding in Hoboken.



Source: http://climatenexus.org/learn/regional-impacts/northeast

Figure 18. Observed Change in Heavy Precipitation (1958-2012)



Source: National Oceanic and Atmospheric Administration, http://co-ops.nos.noaa.gov/sltrends/sltrends.shtml

Figure 19. Mean Sea Level Rise, Battery Park, New York

Frequency of Recurrent Flooding in Hoboken

The City of Hoboken is broken into seven drainage basins as shown in Figure 20. The conditions vary from basin to basin in terms of elevation, flood frequency and flood severity. Historically, minor to moderate flooding in Hoboken occurred multiple times per year, with the most frequent flooding occurring in the H1 drainage basin and more occasional flooding occurring in H4, H5 and H7 basins.

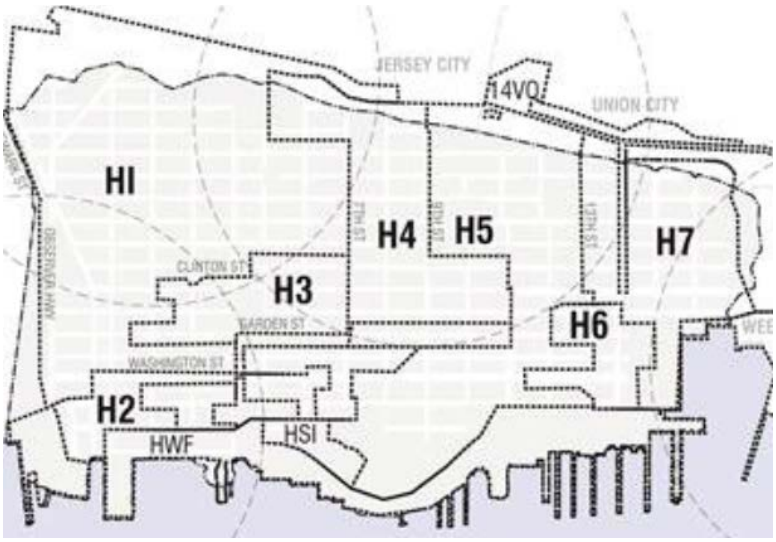
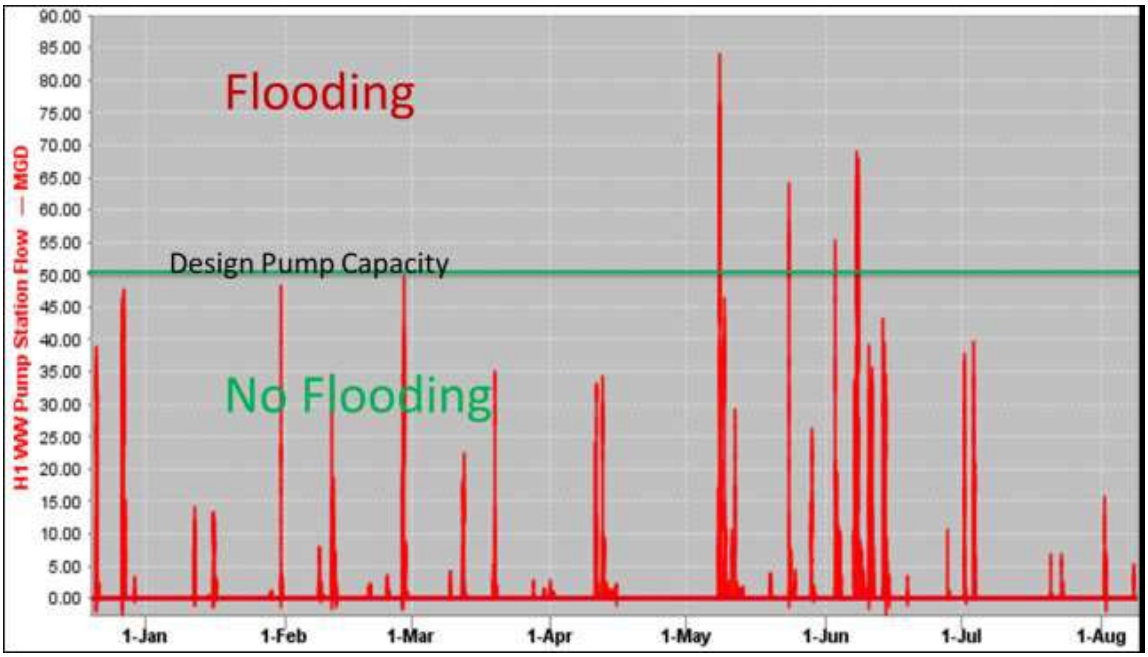


Figure 20. Hoboken Drainage Basins/Sewersheds

The best available empirical data on historic patterns of flooding in the city can be found in a 2002 study conducted by the NHSA and a follow up study conducted in 2012. The 2002 study concluded that "significant" flooding–which was defined as flooding depths of 1.5 feet or more–regularly occurs more than once per year in the H1 drainage basin (37). The study further concluded that flooding can be anticipated in the city's H1 drainage basin each time a 3-month, 1 year, 2-year and 5-year storm occurs. This is largely due to the fact that parts of basin–mainly along Marshall and Harrison Streets, between 1st and 2nd Streets– are only 2.0 feet above mean sea level (37). Based on these findings, the NHSA installed a wet weather pump station (WWPS) to alleviate at least some of the recurrent flooding in the H1 drainage basin.

In late 2012, the NHSA deployed a "real time decision support system (RT-DSS) throughout Hoboken." (38) The purpose of the deployment was to evaluate the performance of the H1 WWPS. Based on the collected data through the RT-DSS, the NHSA found that "The H1 WWPS was utilized 36 times between December 20, 2012 and August 1, 2013. In all but 4 storm events, the pump station was able to prevent flooding city-wide. Flooding only occurred when the flows to the pump station exceeded 50 MGD." (38) As shown in Figure 21, all four flood events that exceeded the pump station capacity occurred between May and July of 2013. Detailed data on the characteristics of these four events in shown in Table 3. It should also be noted that flooding occurred twice during the month of June 2013 in areas not protected by the H1 WWPS, including parts of the H4, H5 and H7 drainage basins.



Source: EmNet, 2013

Figure 21. Flood frequency from Dec 20, 2012 through Aug 10, 2013

Table 3. Description of Storm Events Resulting in Flooding (Dec 20, 2012 to Aug 10, 2013)

Storm	Total Rain (inches)	Duration (hour)	Max Intensity (in/hr)	Storm Designation
May 8, 2013	2.44	11.3	2.28	1 year, 12 hr. 1 year, 1 hr. peak
May 23, 2013	1.19	1.5	2.64	1 year, 1 hr. peak
June 2-3, 2013	1.22	19.2	2.40	Almost 1 year
June 6-8, 2013	3.99	31.5	1.08	Tropical Storm Andrea 4 year, 12 hr.

Source: Adapted from EmNet, 2013

This empirical data on flood frequency is confirmed and supported by data collected in 2015 as part of a community-wide resident survey conducted for this HIA. The survey asked residents about their individual experiences with flooding in Hoboken and the impacts of flooding they most often experienced. Three hundred and ninety-five Hoboken residents responded to the survey.

When asked how often regular flooding occurs in the city, 75 percent of survey respondents reported experiencing flooding more than three times per year on average. Another 17 percent reported experiencing flooding 2-3 times per year. When asked how often they were personally impacted by flooding in the city, nearly one quarter (22 percent) reported every time it rains, while 50 percent reported being impacted only during heavy rainstorms. Twenty percent of survey respondents reported being personally impacted by flooding more than three times in the past two years. Another 14 percent reported being personally impacted three times. Nineteen percent were impacted twice and another 20 percent reported being impacted just one time.

How often are you personally impacted by flooding in Hoboken?

	Vulnerable Population	General Population
Every time it floods	36%	20%
Only during very heavy rainstorm	44%	50%
Almost never	17%	23%
I am not affected by flooding in Hoboken	3%	7%

In the past two years, how many times were you personally impacted by flooding?

	Vulnerable Population	General Population
Never	18%	27%
Just one time	16%	20%
Two times	17%	19%
Three times	19%	14%
More than three times	29%	20%

Figure 22. Impact of flooding on vulnerable populations

The survey data showed that vulnerable populations, including low-income residents, people over the age of 65 and individuals with physical, mental or emotional limitations were disproportionately impacted by flooding. Vulnerable populations were more likely to report being personally impacted by flooding every time it rains and being more frequently impacted by flooding over the past two years. See Figure 22.

Health Impacts of Flooding and CSS Back-ups and Overflows

There is significant epidemiological evidence that severe flooding and flood disasters cause health impacts (12). The CDC recognizes a serious health risk to individuals can result from flood waters and even standing water. These include infectious disease, injuries and even death (10). Though many of these health effects result from major flooding disasters, negative health effects have also been associated with routine flood events. For example, the CDC points to the risks associated with children playing and/or swallowing contaminated flood waters, or even just playing with toys that have been in contact with flood waters. They further note that even in shallow standing water, drowning is a risk for people–especially children–that cannot swim (10).

However, due to variability in the intensity and severity of flood events–from routine to catastrophic–health authorities are cautioned to characterize potential health-related impacts of flooding on an event by event basis. Such an approach would take into account contamination sources and the uses of areas inundated with flood waters (9). The CDC therefore recommends cautioning the public "to avoid standing water, areas saturated with floodwater, and areas with visible debris." These areas create the most risk for injury and microbial exposure and may also cause other public safety concerns (9).

Standing water can pose many health risks (13), including exposure to microbial pathogens in flood waters, especially when mixed with stormwater discharged from combined sewer systems (8) (9). These pathogens, which are often found in CSS back-ups and overflows, may cause a number of health conditions and symptoms, including: rashes, respiratory issues such as asthma, eye irritation, gastrointestinal conditions such as vomiting and abdominal pain, muscle aches, and headaches (8) (10) (11) (39) (40) (41) (42). Standing water also encourages mosquito growth (43) (44) (45). Mosquito can transmit vector-borne diseases include protozoan diseases and a range of viruses (46).

Other potential contaminants often found in floodwaters include a variety of toxics typically found in roadway runoff (8). Sources include: motor fuels (Lead, Nickel), tires (Zinc, Cadmium), and moving engine parts (Copper, Iron, Chromium, Manganese); as well as road salt, pesticides, preservatives and other day-to-day materials (9). In addition, some heavy metals, chemicals and organic compounds may bio-accumulate in aquatic life and in humans through ingestion or absorption into the skin (8).

When combined sewer systems discharge effluent into to nearby waterways, water quality may be degraded to the point where swimming, boating and fishing become hazardous. Swimming has been shown to have a direct link to illness caused by microbial pathogens (8). Exposure to pathogens occurs through all human orifices, including: eyes, ears, nose, anus, genitourinary tract, mouth and open cuts/abrasions (8). Exposure to pathogens in contaminated waters has been associated with a number of health impacts to swimmers respiratory system, gastroenteritis, eyes, ears and more. In addition, pollutants causing beach closures extend beyond pathogens and include floatables which create aesthetic and safety issues. Some debris includes medical and personal hygiene products including syringes, condoms and tampon applicators (8). Appendix 4 presents a summary table of possible floodwater contaminants and their associated health risks and potential impacts.

The populations most at risk from exposure to pollutants are the elderly, children, and pregnant women (8) (41). The elderly are at risk as a result of a weakened immune system that comes with age. Children and infants have immature immune systems and are also likely to participate in activities that raise exposure risk. For example, playing in contaminated water puts children at risk for ingesting contaminated flood water. Women who are pregnant may or may not experience illness after contracting a virus but regardless may transmit illness to their fetus, during birth or shortly thereafter (8). Other individuals with compromised immune system such as those with AIDS, cancer and individuals that have undergone organ transplants are also at higher risk (8). These populations are most likely to suffer from diarrhea resulting from waterborne or foodborne illness (8). It should be noted however that, overall, research is mixed on drawing direct causal relationships between the source of exposures and the resulting health impacts.

Repeated flooding that enters building structures, saturating carpets, insulation and sheetrock in homes can lead to mold growth. “People with asthma, allergies or other respiratory conditions may be more sensitive to mold. People with weakened immune systems or with chronic lung diseases can develop mold infections in their lungs.” (11) A meta-analysis that reviewed 33 studies determined that “dampness and mold are associated with approximately 30–50% increases in a variety of respiratory and asthma-related health outcomes.” (47)

There is considerable evidence that flooding causes mental health impacts. Severe flooding events, in particular, have been widely studied and have been found to cause an array of mental health issues including but not limited to: stress, depression, anxiety disorders and sleeplessness (12) (15) (16) (48) (49) (50). One study also found that social effects of flooding can include the trauma associated with the loss and damage to possessions and property, disruption and deterioration in the quality of individual, family and community life, time off work and the financial consequences, and fears of future flooding events (16).

Studies also show that mental health impacts, especially stress, can result from routine flooding not just catastrophic events such as Hurricane Sandy (17) (51) (52) (53) (54). Flooding can damage cars, homes and businesses alike even in routine instances (17) (55) (56) (57) (58). Impacts to transportation and utility infrastructure can also occur (55) (58) (59) (60) (61). Businesses may be disrupted and health impacts can lead some to miss work and lose the financial benefits of working (15) (17).

This type of economic impact is well known and widespread the City of Hoboken. "The flood hazard areas of the City of Hoboken are subject to periodic inundation which can result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety, and general welfare." (18) Further, the New Jersey Department of Environmental Protection has documented that "flooding causes major social disruptions." (18) This includes the simple movement of people to work, school or even the grocery store (19) (20). Further, studies have shown that flooding may also exacerbate unhealthy lifestyle choices such as a decrease in exercise and an increase in the consumption of junk food (62) and increases substance (alcohol, tobacco and drugs) use and abuse (49). These findings are supported by data collected as part of the community-wide resident survey conducted for this HIA.

Impacts of Flooding and CSS events on Hoboken Residents

As shown in Figure 23, the most frequently cited impact of flooding was sewer back-ups near residents' homes, which likely exposes residents to a range of health risks. Sixty percent of survey respondents listed sewer back-ups as a problem when it floods. As a consequence of coming in contact with contaminated flood waters or sewer back-ups, nearly one third of survey respondents (28 percent) reported experiencing one or more of the following symptoms: headaches; vomiting; abdominal cramping, nausea, or diarrhea; muscle aches; eye irritation/infection; asthma or other respiratory condition; or skin rash. Twenty-three percent of respondents reporting seeking medical attention as a result of experiencing one or more of the symptoms. See Figure 24.

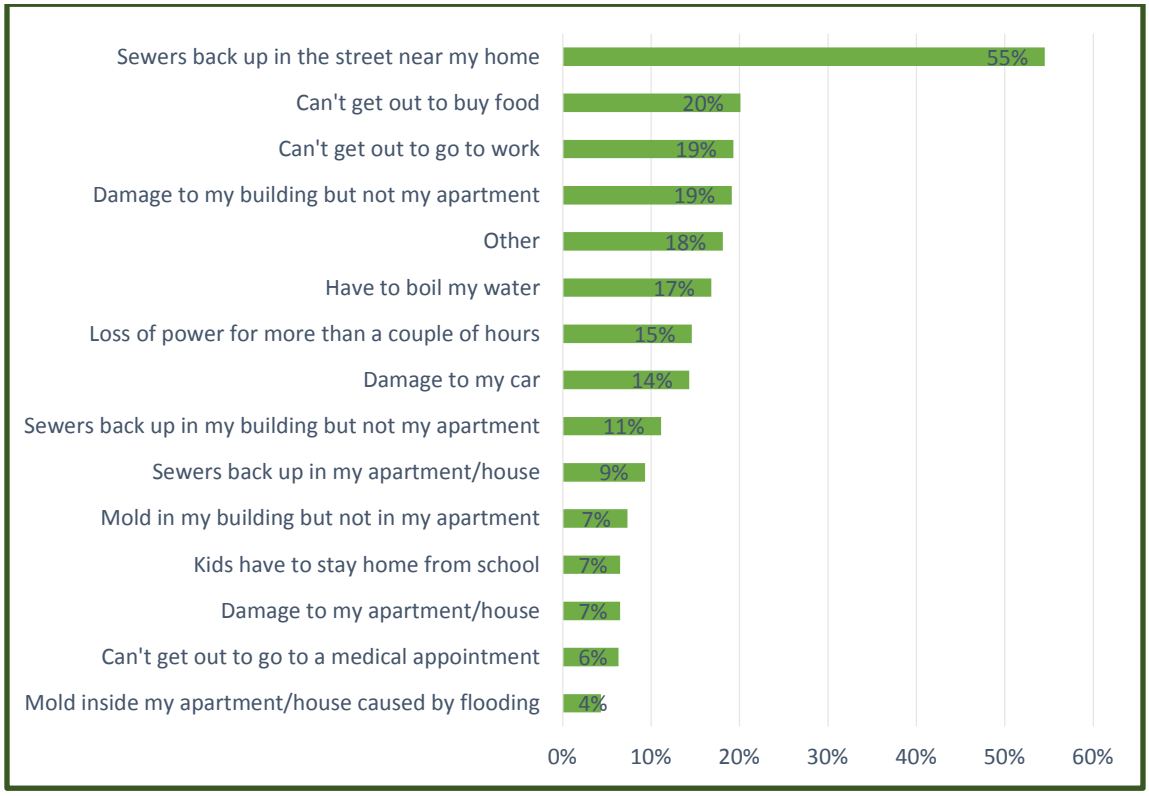


Figure 23. Most frequently cited impacts of flooding in Hoboken

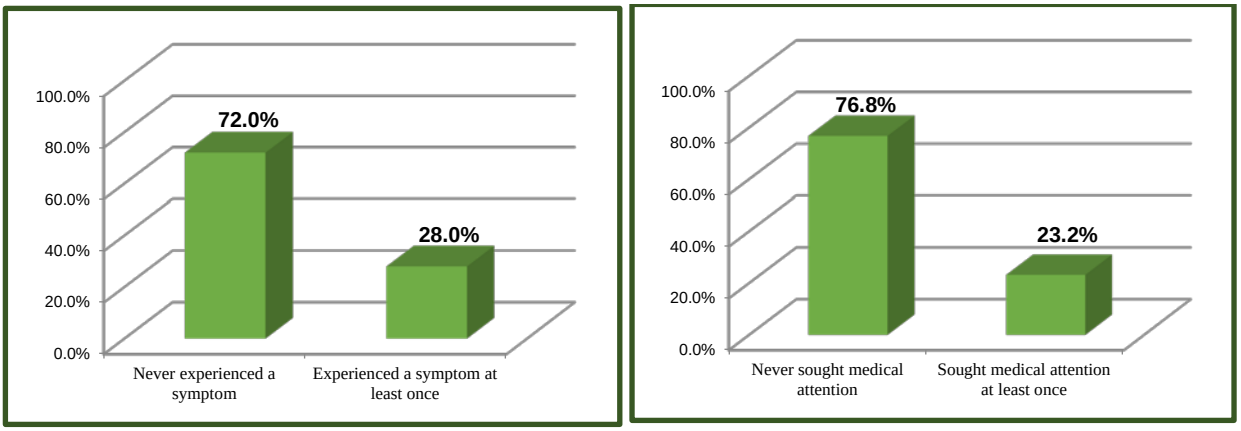


Figure 24. Percent of survey respondents experiencing flooding-related illness symptoms

Only a small percentage of Hoboken residents reported experiencing an injury requiring medical attention because of regular flooding (3 percent) and a similarly small percentage (2 percent) reported seeking counseling or other mental health services to help them cope with regular flooding. However, a significant number of survey respondents reported engaging in unhealthy personal behaviors immediately before, during and/or immediately after flooding events. As shown in Figure 25, with the exception of smoking more cigarettes and using illegal drugs, half or more of survey respondents reported engaging in unhealthy behaviors such as eating more junk food, consuming more alcohol, and exercising less. In addition, nearly two-thirds of survey respondents (65 percent) reported experiencing flooding-related stress or anxiety and nearly half (48 percent) reported problems sleeping.

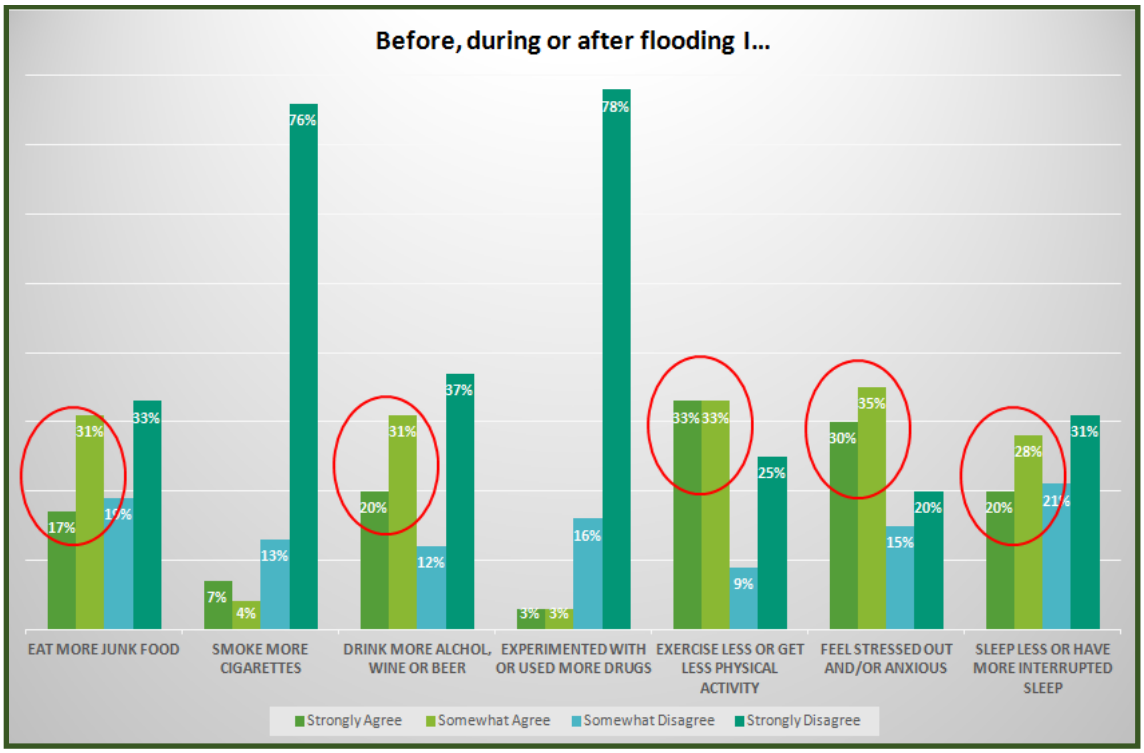


Figure 25. Association between unhealthy personal behaviors and flooding

Impacts of Flooding on Vulnerable Groups

As noted in Chapter 3, several groups living in the city were identified as potentially more vulnerable to the impacts of flooding. These groups include low-income residents, people with disabilities, and older residents. To understand whether the flooding experiences of these population groups are different from the general population, the research team conducted a more detailed analysis of the survey data. To support this analysis, survey respondents were divided into two groups. Group 1, identified as vulnerable populations, included survey respondents with household incomes of $25,000 or less; individuals that reported having activity limitations deriving from physical, mental and emotional problems; and residents aged 65 and over. Group two, identified as the general population, included all other survey respondents. In total, 72 individuals or 18 percent of the survey population reported having one or more of vulnerable population characteristics.

It is clear from the analysis that vulnerable populations experience disparate impacts from flooding. As shown in Table 4, 36 percent of vulnerable populations reported being impacted every time it floods compares to 20 percent of the general population. Of those that were impacted by flooding at least one time in the past two years, 24 percent of vulnerable populations reported that their apartment/house was damaged. This compares to 13 percent of the general population. In terms of disruption, vulnerable populations were consistently more likely to report having difficulty attending to activities of daily life such as picking up prescriptions, getting to doctor/medical appointments, picking up food and groceries, and getting to work or school.

Table 4. Flooding impacts on Vulnerable Populations vs. the General Population

Survey Question	Vulnerable Population	General Population
How often are you personally impacted by flooding in Hoboken?		
Every time is floods	36%	20%
Only during very heavy rainstorms	44%	50%
Almost never	17%	23%
I am not affected by flooding in Hoboken	3%	7%
In the past two years, how many times were you personally impacted by flooding?		
Never	18%	27%
Just one time	17%	21%
Two times	17%	19%
Three times	19%	13%
More than three times	29%	20%
If you were impacted by flooding in the past two years, was your apartment/house damaged?		
Yes	24%	13%
No	76%	87%
When it floods in Hoboken, it is at least somewhat difficult to do the following things[1]:		
Pick up prescriptions	51%	31%
Get to my doctor or other medical appointment	54%	30%
Pick up food/groceries	70%	57%
Get to work	61%	58%
Get to school	30%	19%

Notes: 1 – Percent includes response options very difficult, difficult and somewhat difficult. Survey respondents were permitted to select all that apply. As a result percentages will not sum to 100%.

Predicted Health Impacts Associated with Adopting and Implementing Hoboken's Proposed Stormwater Management Plan and Ordinance Amendments

The primary purpose of any HIA is to predict the potential positive and negative health consequences/outcomes of a particular policy, program or project and assess the base of evidence by which potential health impacts will be evaluated. To accomplish this purpose, the research team conducted a comprehensive review of available literature and collected qualitative data and information through structured interviews with subject matter experts, HIA advisory committee meetings, resident focus groups and a community-wide resident survey.

In the case of this HIA, the principal decision being examined is the adoption of changes to Hoboken's stormwater management plan and ordinance to encourage the implementation of green infrastructure BMPs in order to address chronic, repetitive flooding and CSS back-ups and overflows. The ***decision*** to adopt changes to Hoboken's stormwater management plan and ordinance may have primary, secondary and tertiary effects that impact human health. ***Primary effects*** are those that result directly from the decision. These may include direct health consequences or changes in the natural, built or social environment that eventually lead to positive and negative health consequences or outcomes. If primary effects lead to further changes to the natural, built or social environment, these subsequent changes can be thought of as ***secondary and tertiary effects***. Figure 26 presents a simple flow diagram that illustrates the relationship between a decision and the eventual health consequences or outcomes associated with that decision.

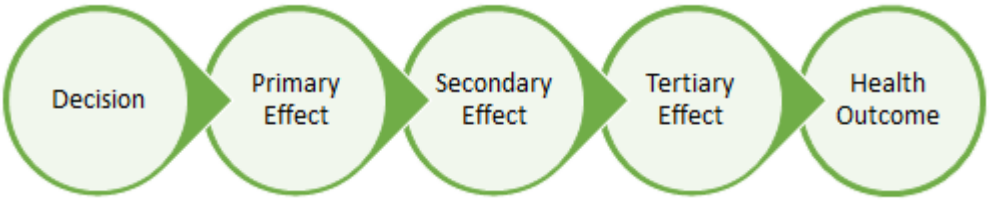


Figure 26. Decision effects lead to health outcomes

Implementation of green infrastructure BMPs in Hoboken are expected to have a number of primary, secondary and tertiary effects that result in positive and negative health consequences/outcomes. For example, the most significant primary effect of green infrastructure implementation is expected to be reduced flooding. A direct health consequence/outcome of reduced flooding may be lower risk of flooding-related injuries and deaths due to drowning. Reduced flooding could also have a number of potential secondary effects, such as reduced exposure to microbial pathogens and other contaminants often found in flood waters; reduced exposure to mold after flooding occurs; and fewer community disruptions like lost power or closed roadways that prevent residents from getting to work, going doctor appointments or buying groceries. The potential health outcomes of these secondary effects include: fewer incidents of exposure-related illness due to residents coming into contact with contaminated flood waters; improved respiratory health because there is less flood-related mold, dust and debris; and improved mental health because there is less flood-induced stress affecting residents.

Table 5 presents a summary of predicted health outcomes associated with implementing green infrastructure BMPs. The table is organized around the health determinants/pathways identified during the HIA scoping process. Health determinants include a range of personal, social, economic, and environmental factors that influence health status and outcomes. The health determinants deemed important for this HIA are presented in column 1, followed by potential primary, secondary and tertiary effects in columns 2 through 4 and finally, potential positive and negative health consequences/outcomes in column 5.

Table 5. Potential Health Pathways and Outcomes Related to Implementing Green Infrastructure BMPs in Hoboken

Health Determinant	Primary Effect	Secondary Effect	Tertiary Effect	Health Consequence/Outcome
Flood management	• Fewer flooding events	• Reduced exposure to microbial pathogens and other contaminants • Reduced exposure to mold • Reduced community disruption		• Fewer injuries/deaths due to drowning • Fewer incidents of exposure-related illness • Improved respiratory health • Improved mental health
Management of CSOs	• Fewer CSO events	• Reduced risk of exposure to microbial pathogens and other contaminants, especially recreational water users		• Fewer incidents of exposure-related illness
Management of CSS Back-ups	• Fewer sewer back-ups	• Reduced exposure to microbial pathogens and other contaminants • Reduced exposure to mold		• Fewer incidents of exposure-related illness • Improved respiratory health • Improved mental health
Access to greenspace	• Increased opportunities for recreation • Improved streetscape/ walking environment • Increase in wildlife habitat • Increased access to open water	• Improved community aesthetics and quality of life • Increase in physical activity • Increased exposure to nature, flora and fauna	• Decrease in crime • Decrease in rates of obesity • Increase risk of exposure to animal and insect bites	• Improved mental health • Decrease rates of chronic disease • Improved life expectancy • Increased risk of exposure to vector-borne disease • Increase risk of drowning
Air quality / Urban Heat-Island Effect	• Increased vegetative cover	• Reduced airborne pollutants • Reduced GHG emissions • Increase in shade coverage • Increased biogenic emissions • Increased exposure to allergens such as pollen	• Reduced ambient air temperature • Reduced exposure to UV rays.	• Improved respiratory health • Reduced heat-related illness and mortality • Fewer incidents of UV ray exposure related illness • Reduced respiratory health

Water/soil quality	• Increased opportunity for infiltration and absorption of rain water	• Reduced surface puddling and standing water where insects breed • Reduced pollution in runoff • Trapping/bio-magnification of toxins and pathogens in soil, detention facilities, and harvested rainwater	• Reduced risk of exposure to insect bites • Increased risk of exposure to toxins and pathogens	• Reduced risk of exposure to vector-borne disease • Increase in toxics exposure-related illness • Increase in pathogen exposure-related illness
Changes in Economic conditions	• Improved access to "green jobs" • Increase in property values • Increase in costs to build and/or meet building requirements • Increase of municipal maintenance cost • Increase in building energy efficiency	• Higher wages • Reduced heating/cooling energy costs • Increase in municipal tax revenue • Increase in housing costs (rents/purchase prices) • Higher taxes (owners)	• Greater financial stability • More disposable income available to purchase healthcare services, healthier food, better housing • Less disposable income available to purchase healthcare services, healthier food, etc.	• Decrease in rates of chronic disease • Improved life expectancy • Improved mental health • Reduced mental health • Increase in rates of chronic disease • Reduced life expectancy
Other Exposure Hazards:	• Increased risk of trips and falls • Increase opportunity for loitering/graffiti • Accumulation of trash and litter	• Increase in real/perceived crime • Reduced quality of life		• Increase in rates of injury • Reduced mental health • Increase in rates of chronic disease • Decreased life expectancy

Note: Items listed in red represent potential negative effects/health risks.

The subsections that follow present the best available evidence regarding the benefits and risks associated with implementing green infrastructure BMPs. The evidence base includes information found in academic articles and manuscripts; government reports and guidance documents; other gray literature resources; as well as qualitative data and information provided by subject matter experts, local officials, and Hoboken residents. Each subsection also includes an assessment of the evidence base in the context of implementing green infrastructure BMPs in the City of Hoboken. The evidence was evaluated against six criteria:

- Likelihood – How certain is it that the decision will effect health determinants or outcomes?
- Direction – Will the decision have a positive or negative effect on health outcomes?
- Magnitude – How much may health outcomes change as a result of the decision?
- Duration – For how long will the positive or negative health effects or outcomes last?
- Distribution – How will the positive and negative effects be distributed across populations?
- Evidence – How strong is the body of evidence supporting the effect characterization?

Table 6 provides a summary assessment potential health consequences/outcomes based on the six criteria presented above. A more detailed description of the criteria is provided in Appendix 5. It should be noted that the six criteria listed in Table 6 refer to potential health consequences/outcomes rather than the primary, secondary or tertiary effects of implementing green infrastructure BMPs. Table 5 and Table 6 are best interpreted together. Table 5 summarizes the anticipated health-related effects of implementing green infrastructure BMPs, while Table 6 describes the characteristics of the potential health consequences/outcomes.

Table 6. Assessment and Characterization of the Potential Health Consequences/Outcomes Of Implementing Green Infrastructure BMPs in Hoboken

Health Determinant	Likelihood Health Effect Will Occur	Direction of Health Effect	Magnitude of Health Effect	Duration	Distribution of Health Effects	Evidence Strength
Flood management	Very likely	Positive	High	Long	Restorative effects	Strong
Management of CSOs	Very likely	Positive	High	Long	Restorative effects	Strong
Management of CSS back-ups	Very likely	Positive	High	Long	Restorative effects	Strong
Access to green space	Very likely	Positive	Moderate	Long	Even	Limited
Standing water	Likely	Positive & Negative	Moderate	Long	Disprop. harm	Limited
Air quality	Likely	Positive & Negative	Moderate	Long	Even	Limited
Urban heat island	Very likely	Positive	Moderate	Long	Even	Strong
Water quality	Very likely	Positive	Low	Long	Even	Strong
Soil Quality	Possible	Negative	Moderate	Long	Even	Mixed
Economic conditions:						
- **Access to "green" jobs**	Possible	Positive	Moderate	Medium	Restorative effects	Limited
- **Property values/Rents**	Possible	Positive & Negative	Low	Long	Even/Disprop. harm	Limited
- **Energy costs**	Possible	Positive	Low	Long	Even	Limited
- **Taxes**	Possible	Positive & Negative	Low	Long	Disprop. harm	Limited
Other exposure hazards:						
- **Trip and fall**	Possible	Negative	Low	Long	Even	Limited*
- **Pests/vermin**	Likely	Negative	Low	Long	Even	Limited*
- **Graffiti/crime**	Possible	Negative	Low	Long	Disprop. harm	Limited*
- **Trash/litter**	Likely	Negative	Low	Long	Even	Limited*

Notes: *Evidence is based primarily on resident and stakeholder input related to past experiences with parks and recreational facilities in the city and personal concerns about green infrastructure implementation. There was very limited or no evidence found in the literature regarding these potential exposure hazards.

Management of Flooding and CSS back-ups and Overflows

The primary goal of Hoboken's proposed stormwater management plan amendments is to reduce flooding and CSS events in the city. There is a growing body of research, including studies conducted in other jurisdictions, that suggests installing green infrastructure BMPs can be an effective way to reduce flooding and stormwater flows entering CSSs during wet weather (5) (22) (63) (64). In some studies, implementation of green infrastructure such as swales, porous pavement and other infiltration strategies has completely mitigated localized chronic flooding from large rainfall events (64).

Another study conducted by American Rivers, the Water Environment Federation, the American Society of Landscape Architects and ECONorthwest examined a range of green infrastructure systems in a variety of locations. The investigators concluded that green infrastructure BMPS have the potential to "target the capture and infiltration of runoff associated with 90 to 95% of storm events that occur annually in most U.S. communities." (22) At the same time, the authors noted that while green infrastructure systems can significantly reduce flooding impacts and peak flow rates they may not fully mitigate high volume rainfall events (22). At least two studies found that reduced flooding and lower peak flow rates attributable to green infrastructure BMPs also reduced health impacts associated with flooding (22) (63).

The City of Hoboken Green Infrastructure Strategic Plan estimated that green infrastructure BMPs, if implemented city-wide, have the potential to capture as much as 4.2 million cubic feet of stormwater during a typical 1 year storm event (5). As shown in Table 7, this equates to eliminating or storing more than 31 million gallons of stormwater that contributes to flooding during rainstorm events. This level of reduction has the potential to significantly reduce the frequency and severity of flooding events in Hoboken.

Table 7. Estimated Stormwater Flow Reduction from Green Infrastructure by Sewershed

Drainage Area	Cubic Feet Captured in 1 Year Storm Event	Gallons	MGD
H1	**2,319,133**	**17,348,274**	**17.3**
H2	41,284	308,825	0.3
H3	26,284	196,617	0.2
H4	**440,472**	**3,294,951**	**3.3**
H5	**351,404**	**2,628,678**	**2.6**
H6	10,944	81,867	0.08
H7	**1,011,581**	**7,567,132**	**7.6**
Citywide Total	4,201,102	31,426,344	31.4
Northern Area Total (Sum of H4, H5, H7)	**1,803,457**	**13,490,760**	**13.5**

Source: Hoboken Green Infrastructure Strategic Plan, 2013;
Conversion note: 1 cubic foot = 7.4805 US gallons

The most flood prone areas of the city include the H1, H4, H5 and H7 drainage basins. According to a flood mitigation study conducted in 2013 by EmNet, LLC, four flooding events occurred in Hoboken between December 20, 2012 and August 1, 2013. In each of these events the volume of wastewater and stormwater entering the city's CSS exceeded the capacity of the system, including the wet weather pump station located in the H1 drainage basin. The study concluded that an additional flood volume storage capacity of 4.2 MG in the H1 drainage basin and 4.3 MG in the Northern Area of the city, which includes the H4, H5 and H7 drainage

basins, could have mitigated all four of the flooding events that occurred during the six month analysis period (38). As shown in Table 7, the volume of stormwater flow reduction feasible if green infrastructure BMPs were to be deployed in a manner consistent with the Hoboken Green Infrastructure Strategic Plan exceeds that necessary to mitigate the four flooding events that occurred between December 20, 2012 and August 1, 2013.

Table 8. Additional Flood Storage Needed to Mitigate Flooding vs. Stormwater Flow Reductions Possible with Green Infrastructure BMPs

Storm Event	H1 Peak Flood Storage Volume Required to Mitigate Flooding	H1 Potential Stormwater Volume Captured by Green Infrastructure	Northern Area (Sum of H4, H5, H7) Peak Flood Volume Required to Mitigate Flooding	Northern Area (Sum of H4, H5, H7) Potential Stormwater Volume Captured by Green Infrastructure
May 8, 2013	4.2 MG	17.3 MG	4.3 MG	13.5 MG
May 23, 2013	1.7 MG		0.1 MG	
June 2-3, 2013	1.0 MG		0.6 MG	
June 6-8, 2013	1.4 MG		1.0 MG	

Sources: Hoboken Green Infrastructure Strategic Plan, 2013; Final Report: An Evaluation of I/I and Illicit Flow in West New York, NJ and Flood Mitigation in Hoboken, NJ, 2013

Based on this analysis, which is supported by the literature and documented in several reports prepared on behalf of the city, the likelihood that implementation of green infrastructure citywide as intended in the proposed stormwater management plan amendments and ordinances can significantly reduce the frequency and severity of flooding in Hoboken over time appears very high. This level of flood mitigation has the potential to eliminate nearly all the negative health impacts associated with flooding in the city. The magnitude of the potential health benefits to be derived from the decision is therefore also high. With proper management and maintenance, the duration of flood reduction and the associated health benefits provided by the decision can be long-lasting.

It is clear from the results of the community-wide resident survey that repetitive flooding in the Hoboken has a significant negative impact on the lives and health of Hoboken residents, especially vulnerable populations including low-income residents, seniors and people with disabilities. These individuals experience a disproportionate burden in terms of flooding impacts. More than one-third of survey respondents (36 percent) indicated that in the past two years, they have been impacted three or more times by flooding. Twenty-two percent of survey respondents and 32 percent of socially vulnerable respondents reported being personally impacted by flooding every time it rains. While the impacts of flooding varied, the most frequently cited impact was sewer back-up near residences, disruptions in residents' ability to buy food and groceries or get to work and damage to residential structures. As such, the potential distribution of flood reduction benefits has the potential to be restorative in nature. Finally, the evidence that green infrastructure BMPs have the potential to deliver these results is strong.

The likelihood that adoption and implementation of Hoboken's proposed stormwater management plan and ordinance will result in less frequent combined sewer system back-ups and overflows is similarly high. Again, the magnitude of the potential health benefits to be derived from the decision is high. With proper management and maintenance of the green infrastructure BMPs deployed in the city, the duration of improved CSS performance and associated health benefits will be long-lasting. And like with flood reduction, given the

fact that the some of the areas most affected by CSS events are where lower income residents live, the potential distribution of benefits derived from improved CSS conditions has the potential to be restorative. Finally, the evidence that green infrastructure BMPs can substantially reduce the flow of stormwater entering the CSS and thereby reduce or eliminate CSS events is strong. As noted above, the volume of stormwater flow reduction feasible if green infrastructure BMPs were to be deployed in a manner consistent with the Hoboken Green Infrastructure Strategic Plan exceeds that necessary to mitigate most, if not all, of routine flooding events that have occurred over the past several years.

Potential Health-related Co-benefits and Risks Associated with Green Infrastructure BMPs

To identify and document the potential health-related co-benefits and risks associated with Hoboken's proposed stormwater management plan amendments and ordinance, the research team investigated each green infrastructure BMP being considered for implementation. These included: rainwater harvesting, green roofs, bio-swales, permeable pavement, rain gardens, stormwater infiltration planters, stormwater tree pits, basins/ponds, subsurface storage, and constructed wetlands.

Access to Green Landscape and Natural Areas

A number of green infrastructure BMP's have the potential to increase residents' access to natural areas and greenspace. Whether in the form of raingardens, new street trees, stormwater infiltration planters, basins/ponds, constructed wetlands, or a new park on top of a subsurface stormwater detention facility, access to natural features and vegetation can have a positive impact on human health. Even green roofs have the potential to increase access to green space if only visually and/or for the residents/tenants of the building on which the green roof is construction.

A literature review conducted by Tzoulas, et. al. found empirical evidence that natural features and open space can provide important health benefits to communities and individuals (65). Well maintained green space and the presence of street trees have been shown to reduce crime in neighborhoods (24) (66). Use of tree pits and practices increase landscaping along streets can enhance pedestrian safety by providing a buffer between the sidewalks and the street and calming traffic (67). Green space and natural elements are amenities that bring beauty to a community which can increase a person sense of community and well-being (24) (25) (65).

Although it is difficult to demonstrate direct causality, the relationship between well-being, health and green space has been shown in a number of studies in a number of disciplines. For example, green space has been linked to longevity amongst senior citizens (23) (65). Individuals that use parks and experience open space on a regular basis have perceived higher levels of overall health (65). This may be in part due to increased levels of physical activity. There are a growing number of studies that highlight the role a high quality physical environment plays in the activity levels of neighborhood residents (65).

The mental health benefits of greening an urban environment is also evident in the literature. Simply having views of natural environments and elements such as trees and vegetation reduces stress levels and improves mental health in general (22) (23) (65). Reduced stress can even lead to lowered blood pressure (22) (65). A green landscape has been shown to have a calming effect on and increase the focus of children with attention deficit disorder (22) (24) (65).

Constructed wetlands provide an opportunity to create larger green spaces and natural areas in an urban environment such as Hoboken. Wetland areas not only provide a location to divert stormwater, they provide wildlife habitat and, if designed well, they can serve as a destination for physical activity, passive recreation such as bird watching, personal respite, education, and community programming which can all have positive health

effects (23) (26) (68) (69) (70). Simply walking regularly can reduce risk of cardiovascular risks, diabetes, cancer, mental health among others (22) (23).

At the same time, green infrastructure BMPs, including constructed wetlands and others must be well maintained. Overgrown vegetation and accumulation of trash and litter can lead to resident anxiety as perception of crime increases (65) and in some cases public access can result in real public safety concerns (68). For example, wetlands and open water basins and ponds can increase the chance of drowning (69), especially among children and others that cannot swim. Such risks can be mitigated with proper design (e.g., handrails along walkways) and public education (69).

Street trees may create the increased chance that branches may fall on power lines. The immediate safety hazards from downed wires are obvious but secondary impacts such as loss of power can cause additional negative effects (71). Over time, tree roots can raise sidewalks and create trip and fall hazards. Furthermore, use of vegetation adjacent to buildings can increase the risk of fire. Such concerns can be mitigated through proper selection of tree and plant species (71).

Trees, landscaping and constructed wetlands can expand and/or enhance habitat for birds, small mammals and insects. This may result in both positive and negative health impacts. On the positive side, increased access to wildlife, flora and fauna can improve quality of life and mental health (27). On the negative side, wildlife may be perceived as a nuisance and can create public health concerns such as exposing the public to insect- and rodent-spread diseases (8) (45) (65). Again, proper design and maintenance can help to mitigate these concerns. For example, properly designed and cared for wetlands, basins and ponds can support fish and other wildlife that can be used to control insects such as mosquitoes. Other mitigation options include pre-treatment and maintenance of the water entering wetlands and waterbodies (69).

The likelihood that the decision to adopt and implement Hoboken's proposed stormwater management plan and ordinance will result in increased access to green space and natural features for Hoboken residents is very high. As described above, the magnitude of potential health benefits to be derived from increased access to greenspace can be considered moderate. With proper management and maintenance, green infrastructure can provide an important amenity that increases community quality of life, encourages physical activity and provides opportunities for respite and passive enjoyment. The duration of these likely benefits is expected to be long. The potential health benefits associated with these positive effects include: improved mental health, a decrease in chronic disease and increased life expectancy. It is anticipated that the distribution of these benefits will largely be even throughout the population; although, individuals living more proximate to the green infrastructure amenities may experience somewhat higher benefit. Finally, while intuitive, the evidence that green infrastructure BMPs have the potential to deliver these results is somewhat limited. Drawing direct causal relationships between increased access to greenspace and positive health outcomes is difficult.

In addition to the potential benefits described above, there was some evidence found in the literature and concern expressed by Hoboken residents that increased access to green space and natural features could have some negative effects. For example, increased risk of exposure to animal and insect bites which may spread disease and increased risk of drowning if BMPs create situations where the public has access to open water. These risks, while real, can largely be mitigated through careful design, proper management and maintenance and through public education.

Air Quality and Urban Heat Island

Vegetation, especially trees, used in green infrastructure BMPs help to clean the air we breathe by filtering out airborne pollutants such as nitrogen dioxide, ozone, sulfur dioxide, dust and other particulate matter (22) (23)

(24) (25) (26) (28) (71). These pollutants exacerbate respiratory ailments such as asthma (72) (73), bronchitis, emphysema (22) (23) and other infections and wheezing (73). Additionally, research has demonstrated an association between these pollutants and lung cancer and cardiopulmonary mortality in children (23) (74). Cleaner air can result in improved respiratory health (29).

Green roofs provide similar benefits. "A 2008 study of green roofs in the City of Portland, Oregon found that each square foot of green roof removed 0.04 pounds of dust and particulate matter out of the air. Their analysis found that one 40,000 square foot green roof would remove 1,600 pounds of particulate matter from the air every year." (22) Another source indicates that "5.5 million square feet of green roofs [is] estimated to capture 1,300 lbs. of PM10 each year - equivalent to the emissions of more than 10,000 cars." (67) In studies conducted in Toronto and Florida respectively, summertime green roof temperatures were found to be about 35°F and 39°F cooler than conventional roofs (22).

The benefits of vegetation and trees also include their ability absorb heat and provide shade, which can reduce ambient air temperatures (22) (24) (25) (26) (27) (28). Exposure to excessive temperatures can result in heat stress, heat stroke and death (75). A study conducted by the CDC found that between 1979 and 2003, an estimated 8,000 deaths were attributed to excessive heat (76). Children and the elderly, along with those with respiratory illnesses are more vulnerable to the impacts of high heat days (75).

Shaded areas may help reduce surface temperatures by 20–40°F (22). By reducing the surface level temperatures, a reduction in heat related illness and mortality may also be expected (66) (75) (77). In addition, trees can provide relief from exposure to UV rays. Those susceptible to UV health impacts such as skin cancer and eye damage may derive relief from shade trees and tree canopies (71).

The likelihood that the decision to adopt and implement Hoboken's proposed stormwater management plan and ordinance will increase vegetative cover in the city, which can reduce airborne pollutants and greenhouse gas emissions, as well as reduce ambient air temperatures and exposure to UV rays is high. The magnitude of the potential health benefits to be derived from these effects can be considered moderate and, with proper management and maintenance, the duration of benefits can be long. The potential positive health benefits associated with cleaner air and lower ambient air temperatures include: improved respiratory health; reduced heat-related illness and mortality; and fewer incidents of UV ray exposure related illness, such as skin cancer.

It is anticipated that the distribution of these benefits will once again be evenly distributed; however, individuals living more proximate to the green infrastructure amenities may experience somewhat higher benefit. It is important to note though that the evidence that green infrastructure BMPs have the potential to deliver these results is somewhat mixed, except in the case of the potential for green infrastructure, especially street trees, to reduce the effects of urban heat island. In this case the evidence is strong. In addition, as was the case with access to natural features and green space, green infrastructure BMPs present some potential for negative air quality-related health effects. For example, vegetation can result in biogenic emissions and increased exposure to allergens such as pollen. These can reduce respiratory health, especially for those with asthma.

Water and Soil Quality

As described briefly in Chapter 1, impervious land cover such as roads, buildings, parking lots and sidewalks reduce or eliminate the ability for rain to infiltrate the ground. When it rains, stormwater travels across these surfaces and captures various types of pollutants from multiple sources, including: oil and fluids from vehicles on roadways; fertilizers and lawn care chemicals from yards; metals and other materials from gutters and built infrastructure; and other sources that give off residual pollution. The stormwater then is collected by

stormwater conveyance systems. As a result, many of these pollutants end up in nearby water bodies as the untreated stormwater is discharged (21) (78).

Green infrastructure BMPs can help reduce stormwater runoff and associated pollution by increasing the amount of permeable area and restoring some of the natural functions performed by vegetation and trees. An increase in permeable surfaces reduces the volume of polluted runoff and thereby reducing the risk of human exposure to the contaminants in the runoff (21) (78). Properly maintained permeable pavement can promote infiltration which allows soils to reduce trace amounts of biodegradable pollutants (24). Permeable pavements also allows snow melt to drain faster reducing icing during freeze-thaw cycles (22), and can minimize puddling and standing water that provide breeding grounds for mosquitoes and other insects (24).

Street trees also reduce stormwater runoff and associated pollution (25). Tree pits can enhance the stormwater reduction provided by trees by allowing pits to act like "mini-reservoirs" which can collect runoff and begin the infiltration process, which provides trees with a source of water over a longer period of time (24). As a result, tree pits may enhance bioremediation of runoff breaking down pollutants such as "metals, organic compounds, fuels, and solvents." (24) Tree leaves also absorb rainwater and provide an added benefit of minimizing the rain that actually reaches the ground (22).

Vegetated swales provide similar run-off relief. Through infiltration, swales have the ability to absorb and breakdown many runoff pollutants, which can reduce the flow of pollutants into the CSS. In some instances smaller storms may create flows through swales in which infiltration completely removes runoff during conveyance (21). These benefits can be enhanced through the use of check dams which slow the flow of runoff, providing additional time for infiltration and evapotranspiration to take place (24).

Constructed wetlands, basins and/or ponds, and subsurface storage are designed to retain or detain stormwater and slowly release it back into the environment and/or CSS at times of lower flow rates. These BMPs can provide benefits similar to permeable pavements, swales and trees in that pollution may be absorbed naturally into vegetated areas. In addition, they provide the benefit of trapping suspended sediments (79).

Unfortunately, constructed wetlands, basins/ponds and subsurface storage facilities can also trap pathogens, some of which may have prolonged survival in sediment such as bacteria and viruses (79). Additional pathogens that can result in the transmission of disease include fungi and parasites (69). Additionally, retention basins and wet ponds provide permanent pools of water. These pools and permanent structures may enhance breeding and natural habitats for insects such as mosquitoes (21) (69).

Another concern is the potential accumulation of toxic chemicals collected and retained over time in sediment. Constructed wetland and other vegetation can incorporate some toxins into biological tissue; however, "if chemical levels exceed the normal tolerance limits of the wetland or other biota, problems such as chronic or acute toxic effects may result. Some toxic chemicals are prone to bio-magnification in ecological food chains and, when present in elevated concentrations in wastewaters entering a wetland, they may result in effects at higher trophic levels." (69)

Pollution which can bio-magnify includes heavy metals (e.g. copper, chromium, lead, nickel, zinc, tin) many of which collect in stormwater runoff (80). The resulting bio-magnification can negatively impact human health (81). A notable example of the human health impacts is the direct linkages of metals entering fish muscle tissue. Humans absorb lead through food but children may be more likely to absorb a high percentage and can take years to be released by the body. Lead poisoning attacks nervous systems resulting in headaches, irritability, abdominal pain, sleeplessness and restlessness (82). As a result children may experience behavioral issues such as learning and concentration difficulties. In severe cases, mental health deteriorates as acute psychosis and

confusion may set in and memory begins to become affected (82). With appropriate mitigation measures, these risks can be managed. Technology solutions and proper maintenance and management can help control, though not eliminate, toxicity in wetlands (76).

Water quality may also be a concern when harvesting rainwater. Harvested rainwater may be used indoors to supply toilets or provide exterior irrigation. Health concerns are mostly focused on cross contamination of potable water and the harvested rain water when used indoors (83). "When rainwater is integrated as a significant supply source for a non-potable indoor use, a potable make-up supply line is needed for dry periods and when the collected rainwater supply is unable to meet water demands. The make-up supply to the cistern is the point of greatest risk for cross-contamination of the potable supply." (83) However, this risk can be managed by "limiting rainwater reuse to water closets, urinals and hose bibs." (83)

Many of the best management practices being considered for implementation in Hoboken use green infrastructure to allow stormwater to be absorbed by plant materials, infiltrate into surrounding soils and or evaporate. As noted previously, the process of stormwater infiltration and uptake by plant materials and trees effectively clean pollutants out of the stormwater. As a result, collection and capturing of pollutants can over time result in contaminated soils and sediment (21). Pollutants such as heavy metals which are element based do not naturally breakdown in soil and can have negative health effects. (82) (84) (85)

Captured bacteria can also be a potential problem. "Typically, it takes 2–3 months for enteric bacteria to significantly reduce in soil, with certain exceptions. Environmental factors including temperature, soil desiccation, pH, soil characteristics, and sunlight influence microbial survival and persistence. Microbial survival in soil and the resulting potential for human exposure is difficult to predict because of natural variability in those environmental factors and varying microbial susceptibilities. For example, shigella has survived in soil at room temperature for 9–12 days and cryptosporidium oocysts may survive in a moist environment for 60 –180 days. Spore-forming microbes such anthrax spores can survive in soil for many years. Aside from the microbe's ability to survive, availability is another important factor to consider. Certain microbes can sorb to stable soil, which may lengthen their survival time." (9)

Although soil contamination over time is a potential risk to human health, mitigation techniques are available to reduce soil contamination. Simple maintenance of vegetation through pruning may reduce contamination found in plant matter. Other management techniques include the use of mulch and mediums which can catch pollutants and be removed on a regular basis and replaced (9) (21). "Small areas of gross contamination (i.e., sewage with visible solid material) should be cleaned, and treatment with hydrated lime maybe considered. Hydrated lime can be applied to increase pH to a level that kills microbes." (9) Other remedial and control options such as depositing new soil on top of the affected soil and compacting, planting new grass, watering to flush organisms out of the upper soil layers and applying dust-suppressant products where air dispersion is a concern can also be considered (9). Some research suggests that plants can be used for phytoremediation which suggests having the plants take in the soil contaminants which cannot be broken down naturally in the soil and then removing and disposing of the plan material (21) (84) (86).

As noted above, a co-benefit of green infrastructure is known to be the ability of green infrastructure BMPs to filter some but not all pollutants out of stormwater before the water enters the ground water supplies. This is particularly important in places where stormwater infiltration helps to replenish underground aquifers that supply the public with drinking water. This is not the case in Hoboken where drinking water supplies come from source unrelated to nearby ground and surface waters. As such, both the benefit of cleaner water entering groundwater supplies and the potential risk of some pollutants found in stormwater not being filtered out entering drinking water supplies is low.

Nonetheless, the likelihood that green infrastructure BMPs deployed in Hoboken will filter pollutants from stormwater runoff is high. The magnitude of the potential health benefits to be derived from stormwater filtering, in the case of Hoboken, is generally low because residents do not receive their drinking water from aquifers or surface waters proximate to the city. Despite the low level of benefit likely to be derived, with proper management and maintenance, the duration of stormwater filtering benefits provided by green infrastructure BMPs is likely to be long. It anticipated distribution of benefits is neutral. Finally, the evidence that green infrastructure BMPs have the potential to filter pollutants from stormwater is strong.

As noted above, there is some evidence that suggests pollutants, including some toxics, heavy metals and resilient bacteria can be retained in the soil and plant matter used in green infrastructure BMPs. Without careful planning and proper maintenance, contaminants can build-up in the soil and plant matter causing potential risk of exposure to contaminants that can impact human health. This risk is largely dependent on the mix and concentration of contaminants found in the stormwater being filtered through the BMPs. Data on the contaminants contained in Hoboken stormwater were not available at the time that this HIA was prepared. Given the limited nature of the evidence in this regard it appears that the other benefits of green infrastructure BMPs outweigh this potential risk.

Changes in Economic Conditions – Green Jobs, Affordability, Energy Costs and Maintenance Costs

Green Infrastructure construction and maintenance can provide a platform for improving labor market conditions for local workers and connecting urban residents with needed jobs. Installation, inspection and maintenance of many improvements require a range of skilled and unskilled labor categories. These range from landscapers to LEED-certified professionals. These jobs can provide immediate employment-related social benefits to low-income households and a career pathway to higher wages (66). In 2009, the U.S. Environmental Protection Agency published a catalog of training opportunities for green infrastructure technologies. In the publication, EPA notes that "(t)he implementation of green infrastructure in wet weather management programs across the country is creating the potential for a new wave of jobs. The potential is notable, not just for initial design and installation of practices such as bio-retention and permeable pavements, but also for long-term operation and maintenance." (87)

In 2013, the organization Green for All–a national organization working to build an inclusive green economy strong enough to lift people out of poverty– in partnership with American Rivers–a leading organization working to protect and restore the nation's rivers and streams–published *Staying Green and Growing Jobs*. The authors note that "the operations and maintenance of green infrastructure represents a significant opportunity to create entry-level jobs in the green sector for individuals from disadvantaged communities." (88)

Regardless of who is hired for constructing and implementing green infrastructure, simply having a job and additional income provides a series of potential health benefits. Financial insecurity causes stress which can negatively impact mental and physical health (51) (52) (53). Stress can lead to psychological effects which tend to affect lower wage earners more (51) (52). Stress has been associated with sleep deprivation which can in turn result in changes in blood pressure, eating habits, and Cortisol, insulin, and leptin levels among other many other human body effects (54). Other studies show that reducing stress has physical health benefits such as lower rates of coronary heart disease (89).

As outlined above, green infrastructure BMPs, especially street trees can reduce urban heat islands by reducing ambient air temperatures (22) (24) (25) (26) (27). Trees have an innate ability to reduce air temperatures. In a study conducted by the USDA Forest Service, a series of trees were planted around homes in the City of Sacramento. An average of 3 trees were planted within 10 feet resulting in one percent cooling energy savings and two percent heating energy savings per tree (71). Other studies show high savings with total savings ranging

from 8-18 percent in cooling savings and 2- 8 percent in heating savings (71). The heat savings result primarily from wind shielding (22) (71). Furthermore, the use of green roofs also improves energy efficiency results in energy cost savings. Studies have found green roofs absorb less energy/heat than traditional roofs and as a result are 39-60 percent cooler than traditional roofs (22). Energy use savings results in lower utility costs which can increase disposable income for residents to spend on healthcare services, healthy food and other items that contribute to positive health outcomes.

As noted on several occasions, many green infrastructure BMPs require ongoing management and maintenance. For example, the collection of stormwater may require pruning of vegetation and removal of soil and/or mulch regularly to prevent the build-up of contaminated soils and sediment. If constructed wetlands, basins or ponds permit public access, there will be costs to maintain those areas. Other maintenance costs associated with green infrastructure includes watering vegetation, pest and vermin control, vegetation removal and the potential for the need to repair infrastructure from roots and fallen branches (71). Roots may crack and damage sidewalks while more trees may affect power lines during storms and high wind days (71). Overgrown vegetation and poorly maintained and patrolled green space can lead to public perceptions of and real opportunities for crime, which can cause physical harm and emotional stress (65). Finally, some practices such as permeable pavements require special maintenance techniques and sometimes equipment to maintain their beneficial function (21) (5).

Proximity to green infrastructure amenities and increases in municipal or private owner construction and/or maintenance costs could result in higher property values, taxes and/or rents. Unlike with energy savings if housing costs rise, residents may face displacement and have less disposable income available to spend on healthcare services, healthy food and other items that contribute to positive health outcomes. It should be noted however, that there are many factors influencing the high cost of housing in the City of Hoboken, including proximity to New York City, walkability, a high level of public transit accessibility and other amenities such as views of the New York City skyline, shops, restaurants and public access to the Hudson River waterfront. Property value and rent increases associated with the introduction of green infrastructure are expected to be marginal in comparison to the other forces influencing housing cost in the city.

The evidence related to these benefits and risks is generally limited. The likelihood of these benefits and risks materializing, while possible is uncertain at best. In addition, the magnitude of potential health benefit/risk associated with these outcomes ranges from moderate to low. The duration of the benefits/risks would likely be long and the distribution might range from restorative to disproportionate harm, depending on the risk/benefit being considered.

Other Exposure Hazards

It should be noted that local stakeholders and residents raised a number of concerns about green infrastructure implementation. Some were confirmed in the literature. Others were more localized concerns not found in the literature but deserving of acknowledgement nonetheless.

First, residents that participated in the low-income resident focus group expressed the concern that new green spaces will invite graffiti and loitering which will negatively impact quality of life in those areas. They observed that there are a number of examples, where existing nearby parks are not well patrolled by police. The parks attract drug dealers and others “up to no good.” They suggested that if large cisterns are used to capture and store rainwater, they could become “eyesores” and magnets for graffiti. Low income residents were also concerned that without active maintenance, trash and litter would undoubtedly accumulate in rain gardens, swales, ponds, tree pits, etc. They expressed skepticism that the green infrastructure, once installed would be properly maintained. As evidence, they observed that streets near their residences are not even cleaned

following flooding events. As a result, the sewage and other contaminants in the flood waters dry on the streets, become dusty and airborne when cars drive by and ultimately contribute to people becoming sick. Finally, low-income residents expressed suspicion that the more attractive green infrastructure such as rain gardens would be installed in wealthier parts of the city, not in their neighborhoods.

Participants in the senior citizens focus group expressed similar concerns regarding potential public safety issues; however, they were more worried that on-going maintenance and upkeep of green infrastructure BMPs would increase property taxes. Residents that participated in the community-wide survey were also concerned about the costs of implementation and on-going maintenance; loitering and crime; as well as higher taxes. They raised additional concerns about: potential smells from standing water; being more bothered by mosquitoes and vermin; more opportunities for pet refuse to go uncleaned; increased problems with allergies caused by an increase in vegetation and loss of parking.

The evidence related to these risks is mostly limited to the past experiences and concerns of residents that participated in the HIA focus groups and community-wide resident survey. The likelihood of these risks materializing was deemed to range from likely to possible but all are uncertain. In addition, the magnitude of potential health risk associated with these outcomes was deemed to be low. The duration of the risks would likely be long and the distribution would range from evenly distributed to disproportionate harm for those living most proximate to the BMPs once constructed.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

It is clear from the HIA that implementation of Hoboken's proposed stormwater management plan and ordinance amendments may have a variety of positive health outcomes. Most importantly, implementation of green infrastructure BMPs, when combined with the NHSA's construction of wet weather pump stations, has the potential to substantially reduce flooding and CSS back-ups and overflows in the city. Fewer flooding and CSS events can have range of positive health effects. Implementation of green infrastructure BMPs may also have a number of health-related co-benefits and some minor risks.

The HIA research team worked with the HIA advisory committee to develop short and longer term recommendations to inform stormwater management planning in Hoboken. The recommendations developed as part of the HIA process are aimed at maximizing the potential health benefits and minimizing/mitigating the potential health risks associated with the decision to implement green infrastructure city-wide. The recommendations are based on the findings of the HIA impact analysis, current effective practices and local knowledge. Every effort was made to ensure that the recommended actions are: specific; responsive to predicted impacts; technically feasible; and within the authority of Hoboken officials, representatives from the NHSA and other implementation partners. The recommendations are as follows:

1. **Ensure the longevity of potential BMP benefits as well as public safety/enjoyment with careful design, monitoring and a robust program of on-going maintenance.**
   Several recurring themes emerged from the HIA analysis. One was how important it is to carefully design and construct BMPs to ensure their proper function. Two was the need to regularly monitor BMP performance; and a three was the need to manage and maintain BMPs on an on-going basis. Green infrastructure BMPs are essentially mini-environmental systems that need to be thoughtfully engineered, appropriately installed and properly maintained to ensure their efficient and safe functioning over time. The following actions can/should be taken to maximize the potential health benefits and manage the potential risks associated with implementing green infrastructure BMPs in Hoboken:

Recommendation Action	Suggested Responsibility
a) Incorporate clear and consistent green infrastructure inspection and maintenance requirements in city's stormwater management plan and ordinance.	• Department of Environmental Services
b) Develop a checklist of design and siting considerations for each type of BMP being considered for implementation. The checklist should be informed by the potential health benefits and risks highlighted in the HIA.	• Department of Transportation & Parking
c) Require owners of green infrastructure BMPs to prepare and implement green infrastructure operations and maintenance plans that includes regular monitoring and inspections; vegetation management, cleaning; soil testing (where appropriate), and vermin/insect control procedures. The plans should have specific standards, procedures and maintenance schedules for each type of BMP constructed.	• Department of Community Development • Department of Administration
d) Provide funding to support adequate green infrastructure operations and maintenance. Funding and implementation of operations and maintenance should take advantage of public-private partnerships where feasible.	• Mayor & City Council
e) If green infrastructure BMPs are to be implemented by entities	• City Council

other than the city, city officials should put in place an appropriate oversight mechanism to ensure green infrastructure BMPs are properly designed, constructed, and maintained.	• Planning Board
f) Develop and implement a training and education program for the city's maintenance/public works personnel on the proper care and maintenance of green infrastructure BMPs. The findings of the HIA should be incorporated in the training curriculum. Where feasible, utilize existing training programs and resources.	• Department of Community Development • Department of Environmental Services In partnership with: • Rutgers Cooperative Extension • Hudson County Community College • Hudson County Workforce Investment Board • Nonprofits and community based organizations working on green infrastructure
g) If contractors are used to construct, operate and maintain green infrastructure on public property, ensure that workers are specifically trained and certified in green infrastructure construction, operations and maintenance and give preference to those companies that employ Hoboken residents.	• Mayor & City Council • Department of Administration • Department of Environmental Services • Department of Community Development
h) Require the hiring of trained and certified contractors to install and maintain publically-funded green infrastructure on private property.	• Mayor & City Council • Department of Administration

2. Ensure that the co-benefits of green infrastructure BMPs accrue equitably throughout the city.

The HIA impact analysis highlighted the fact that some neighborhoods and populations in Hoboken are more burdened by the impacts of flooding than others. In particular, those living in the lowest-lying areas on the western edge of the city, including low-income residents living in these neighborhoods, people with disabilities and older Hoboken residents. Residents living in the lowest-lying, most frequently flooded neighborhoods in the city will likely experience the biggest benefits of green infrastructure BMPs in terms of flood reduction and the health benefits associated with less frequent flooding and fewer CSS events. However, it is important to recognize that many of the co-benefits of green infrastructure BMPs are likely to accrue to residents that live proximate to where the BMPs are installed. With this in mind, decision-makers in Hoboken can help to ensure that the full benefits of green infrastructure implementation accrue evenly throughout the city by taking the following actions:

Recommendation Action	Suggested Responsibility
a) Locate green infrastructure BMPs where they can provide the most significant stormwater management/flood reduction benefit, while remaining aware of the distribution of co-benefits to be derived from specific BMPs.	• Department of Community Development • Department of Health and Senior Services

	• North Hudson Sewerage Authority • Private property owners, property managers, developers
b) Use GIS software and mapping to analyze the "benefit buffers" associated with each BMP in relation to where it is to be constructed. Overlay the benefit buffers with population data to ensure that potential co-benefits and risks are shared across neighborhoods and sub-populations.	• Department of Community Development
c) To the extent feasible given engineering and fiscal constraints, use green infrastructure BMPs to improve neighborhood conditions and minimize potential risks in areas where vulnerable populations live, especially in lower income neighborhoods.	• Department of Community Development • Department of Health and Senior Services • North Hudson Sewerage Authority • Private property owners, property managers, developers

3. **Leverage investment in green infrastructure construction, operations and maintenance to grow jobs and provide career pathways for city residents, especially low-income populations.**
The HIA analysis regarding potential economic co-benefits of green infrastructure BMPs revealed an interesting and potentially impactful approach to green infrastructure implementation. There are several guidance documents and case study examples that demonstrate how to connect green infrastructure construction, operations and maintenance with workforce development initiatives in order to maximize the potential positive benefits of "green job" growth, especially the benefits that accrue to low-income and other disadvantaged workers. In that regard, decision-makers in Hoboken responsible for advancing green infrastructure implementation can/should take the following actions:

Recommendation Action	Suggested Responsibility
a) Generate opportunities for local workers and local businesses to participate in green infrastructure implementation by inserting community benefit strategies into green infrastructure installation and maintenance contracts.	• Department of Administration • North Hudson Sewerage Authority • Private property owners, property managers, developers
b) If green infrastructure operations and maintenance responsibilities will be outsourced, consider partnering with local workforce development programs and/or giving preferences to local companies or those that hire local workers.	• Department of Administration • North Hudson Sewerage Authority • Private property owners, property managers, developers

4. **Magnify the benefits of green infrastructure BMPs by expanding implementation throughout North Hudson Sewerage Authority (NHSA) service area and beyond.**

The HIA impact analysis highlights the potential for green infrastructure implementation to significantly reduce the flow of stormwater entering Hoboken's combined sewer system. However, the sewage treatment plant in Hoboken operated by the NHSA receives wastewater and stormwater flows from other nearby communities, including Union City. The potential benefits of green infrastructure deployment in Hoboken could be magnified by expanding implementation of green infrastructure BMPs throughout the NHSA service area. Toward that end, the following specific actions can/should be undertaken:

Recommendation Action	Suggested Responsibility
a) NHSA should include a robust program of green infrastructure implementation as part of its Long Term Control Plan to manage CSS overflows. This should include construction, operations and maintenance of green infrastructure BMPs throughout the NHSA service area.	• North Hudson Sewerage Authority
b) Share and present the findings and recommendations of the HIA to elected officials, planning board members, local health officials and the public in Union City, Weehawken and West New York as well as Hudson County government. This can help to build support for green infrastructure implementation in communities outside of Hoboken.	• Rutgers University Bloustein School Building Healthy Communities Initiative • Community Development Department • North Hudson Sewerage Authority
c) Create opportunities for peer-to-peer exchange between elected and appointed officials from Hoboken, Union City, Weehawken and West New York to explore opportunities for green infrastructure collaboration.	• North Hudson Sewerage Authority • Hudson County Parks, Engineering and Planning • Rutgers University Bloustein School Building Healthy Communities Initiative
d) Promote green infrastructure implementation throughout Hudson County. Including but not limited to incorporating green infrastructure implementation as a strategy in the Hudson County Multi-jurisdiction Hazard Mitigation Plan.	• Hudson County Parks, Engineering and Planning • Hudson County Office of Emergency Management

5. Expand public outreach and engagement to ensure more residents are aware of the city's efforts to implement green infrastructure and understand potential benefits and risks.

The community-wide resident survey conducted during the HIA assessment phase revealed that approximately 65 percent of resident respondents had heard about green infrastructure before taking the survey. Of those, about 84 percent were aware of Hoboken's efforts to use green infrastructure to address chronic flooding and to make the city more resilient. Awareness among low-income residents, seniors and people with disabilities was somewhat lower, with just about 50 percent reporting they were familiar with green infrastructure and the city's effort in that regard. Based on these results, it would appear that about one third to a half of city residents could benefit from expanded outreach and engagement to educate all city residents about the potential benefits and risks of green infrastructure as city decision-makers move ahead with plans to adopt a new approach to stormwater management. To ensure Hoboken residents are well informed, the following actions can/should be undertaken:

Recommendation Action	Suggested Responsibility
a) Use the HIA final report and executive-level briefing materials as a platform to expand public outreach and engagement related to the pending decision on adopting the proposed stormwater management plan amendments and ordinance.	• Department of Administration
b) Develop a traveling booth display that can be used during community events, fairs, etc.	• Department of Community Development
c) Sponsor a poster or video contest on green infrastructure benefits and risks. The HIA final report and briefing materials can be used to develop a short curriculum for students on flooding and CSS events and how green infrastructure is being used to improve stormwater management in Hoboken and make the city more resilient.	• Mayor & City Council • Hoboken Public School District
d) Foster greater awareness regarding green infrastructure benefits and risks among lower income residents.	• Mayor & City Council • Hoboken Housing Authority
e) Increase green infrastructure awareness among other vulnerable groups, including seniors and people with disabilities.	• Mayor & City Council • Department of Community Development • Department of Health and Senior Services • Nonprofits and community based organizations that work with potentially vulnerable groups and those working on green infrastructure

6. Develop and implement a monitoring and evaluation program to track green infrastructure performance and health outcomes over time.

Implementation of green infrastructure BMPs in Hoboken is expected to be incremental, will likely take many years and will involve a range of implementation partners, including the city, NHSA, community-based organizations and private property owners. Monitoring and evaluating the performance of green infrastructure BMPs and their associated health impacts will require a collaborative partnership and sustained effort. The frequency and rigor of monitoring and evaluation activities will be determined by available resources, but should include on-going periodic performance assessments. The following actions can/should be undertaken:

Recommendation Action	Suggested Responsibility
a) Create and maintain a GIS inventory and database of public and private green infrastructure BMPs. The inventory should include: basic information regarding the BMP such as: type, ownership, geographic location, materials used, and other relevant descriptive characteristics; information regarding the	• Department of Community Development

expected performance characteristics such as stormwater storage/removal capacity and anticipated co-benefits, inspection and maintenance requirements; and actual performance monitoring data.	
b) Establish a green infrastructure implementation advisory committee to develop consensus on a manageable set of performance indicators and metrics. The selection of indicators should be informed by the findings of the HIA and include metrics in the following categories: stormwater management/flood reduction; exposure and access to green space/natural features; water quality; soil quality; air quality/heat island; change in household and community economic conditions; exposure to other hazards.	• Mayor and City Council • North Hudson Sewerage Authority • Department of Community Development
c) Utilize the NHSA Long Term Control Plan process to support green infrastructure monitoring and evaluation. This should include data collection and reporting consistent with the green infrastructure monitoring and evaluation program.	• North Hudson Sewerage Authority
d) Collect and report data consistent with the green infrastructure monitoring and evaluation program.	• Department of Community Development • Department of Health & Human Services • Department of Environmental Services • Hudson Regional Health Commission • Hoboken University Medical Center • North Hudson Community Action Corporation Health Center
e) Conduct a bi-annual community-wide resident survey to track resident experiences, perceptions and opinions of green infrastructure implementation and performance and associated health-related effects.	• Mayor & City Council • Department of Community Development

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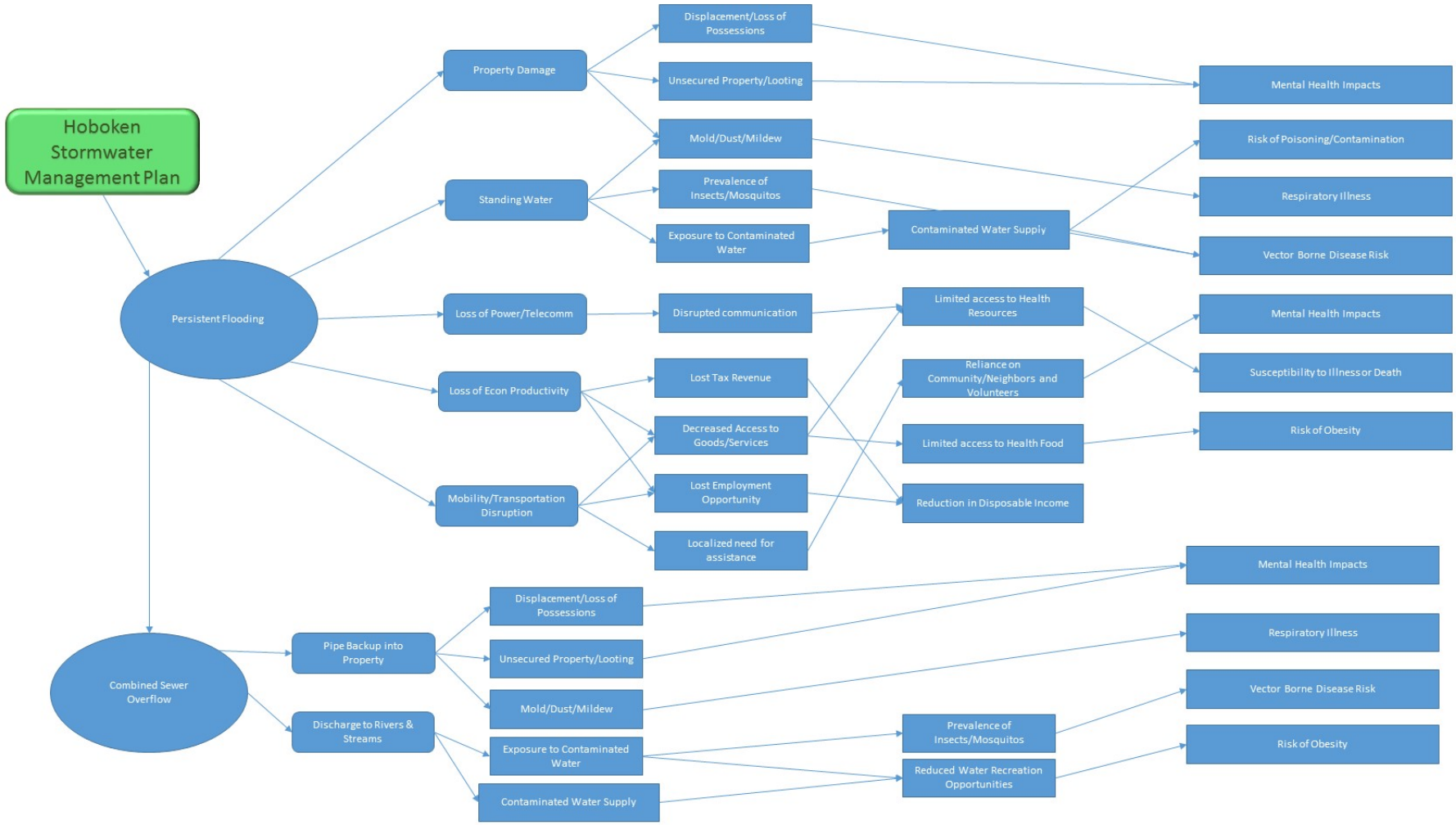
Appendix 2a: Preliminary Flooding/CSO health pathways Diagram (Developed as part of Scoping Phase)



Appendix 2b: Preliminary Green Infrastructure BMPs Health Pathways Diagram (Developed during Scoping Phase)

Appendix 3

City of Hoboken, New Jersey
Proposed Stormwater Management Plan
Health Impact Assessment (HIA)

Community-wide Survey Methods and Results Report

BACKGROUND AND OBJECTIVES

The stakeholder engagement plan for the Hoboken, NJ Proposed Stormwater Management Plan and Ordinance Amendments HIA included a community-wide resident survey. The purpose of the survey was to collect data to help the HIA research team to better understand resident experiences with chronic flooding in Hoboken, the impacts of flooding on their health and well-being, their opinions on green infrastructure, and their general health status. These data were used to document the current health status of residents and document the health effects of flooding in Hoboken residents. These data were also used to predict the potential health benefits and risks of implementing green infrastructure best management practices to reduce flooding and combined sewer system back-ups and overflows in the city.

SURVEY METHODS

The survey included a total of 58 questions and was administered on-line using Qualtrics on-line survey software. Survey responses were collected using a convenience sampling approach that included email recruitment, social media announcements, word-of-mouth, traditional media outreach, flyers, community outreach via area non-profits and a public kiosk set up at a local grocery store. Surveys were available in both English and Spanish. In addition to being administered on-line, hard copies of the survey were distributed through various outlets including Hoboken City Hall, Hoboken Housing Authority properties, senior housing facilities and private businesses. The hard copy surveys included an envelope and paid postage for ease of returning the survey. To encourage participation, respondents were provided the opportunity to enter into a random drawing to win a $100 gift card at the end of the survey. The survey was open June 14, 2015 through August 30, 2015.

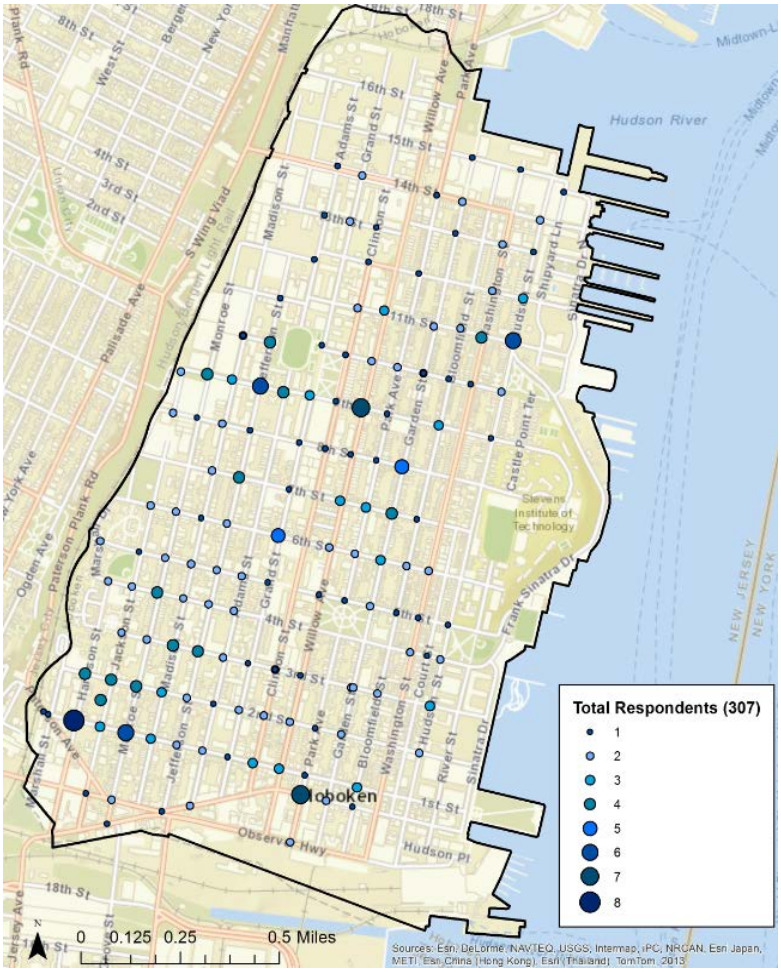


Figure AP3-1: Location of Hoboken HIA Survey Respondents by Nearest Intersection

SURVEY RESULTS - Demographic Comparison

In total 654 individuals visited the survey site. A total of 398 completed survey responses were received. This represents a 60 percent completion rate. Figure 1 shows the geographic distribution of survey participants based on the information they provided for the nearest intersection to their place of residence. In addition to mapping the distribution of survey responses, the research team compared the demographic data provided by survey participants to population and demographic data from the U. S. Census Bureau. Tables 1 through 4 summarize the findings of this comparative analysis:

Table AP3-1. Age – Survey Sample vs. Census

	Survey	Census*
Under 18	0%	0%
18-35	53%	56%
36-50	28%	26%
51-65	17%	11%
66-75	2%	4%
Over 75	0%	3%
* Percentage of those over 18		

Source: U.S. Census American Community Survey 2014 – Raw Data

Table AP3-2. Race/Ethnicity – Survey Sample vs. Census

	Survey	Census
White	87%	85%
Black/African American	2%	3%
Asian	3%	8%
Multiracial	3%	3%
Other	5%	1%

Hispanic	12%	17%

Source: U.S. Census American Community Survey 2014 – Raw Data

Table AP3-3. Household Income – Survey Sample vs. Census

	Survey	Census
Less than $25,000	7%	14%
$25,000-50,000	9%	9%
$50,001-$75,000	16%	10%
$75,001-$100,000	16%	13%
Over $100,000	52%	54%

Source: U.S. Census American Community Survey 2014 – Raw Data

Table AP3-4. Gender – Survey Sample vs. Census

	Survey	Census
Male	37%	50%
Female	63%	50%

Source: U.S. Census American Community Survey 2014 – Raw Data

DATA WEIGHTING & ANALYSIS

The survey sample for this survey was not drawn from a random population of Hoboken residents. As such, statistical adjustments must be made to make the results generalizable to the overall population of the city. The following data weighting procedures were applied and are presented below for key data points:

- Gender: weights the data to be representative of the gender population distribution of Hoboken.
- Income: weights the data to be representative of the income population distribution of Hoboken.
- Hispanic: weights the data to be representative of the Hispanic population distribution of Hoboken.
- Race: weights the data to be representative of the race population distribution of Hoboken.
- Age: weights the data to be representative of the age population distribution of Hoboken.
- Combined: weights the data to be representative of the population distribution of Hoboken based on gender, Hispanic population, race, and income.[2]

The following script was developed within the statistical analysis software used to weight the survey data:

```
data test1;
set HobokenHIADD;

/* Population weights: Hobo has 51979 people and survey has 398 respondents
*/
   popwght=51979/398;

/* Sex weight: Q56=Sex */
if Q56=1 then sexwght=(49.5/37.5);
if Q56=2 then sexwght=(37.5/49.5); else sexwght=sexwght;
if Q56=. then sexwght=1; else sexwght=sexwght;

/* Population times sex weight */
popsexwght=popwght*sexwght;

/* Hispanic weight */
if Q47=1 then Hispwght=17.0/11.7;
if Q47=2 then Hispwght=83.0/88.3; else Hispwght=Hispwght;
if Q47=. then Hispwght=1; else Hispwght=Hispwght;

/* Population times Hispanic weight */
PopHiswght=Hispwght*popwght;

/* AGE WEIGHT: Q46=AGE */
IF Q46=1 THEN AGEWGHT=(55.6/52.8);
IF Q46=2 THEN AGEWGHT=(25.7/27.8); ELSE AGEWGHT=AGEWGHT;
IF Q46=3 THEN AGEWGHT=(11.4/17.5); ELSE AGEWGHT=AGEWGHT;
```

[2] Age was not included in the combined weighting due to the limited survey sample for those aged between "66 and 75" and "Over 75".

```
IF Q46=4 THEN AGEWGHT=(4.0/1.5); ELSE AGEWGHT=AGEWGHT;
IF Q46=5 THEN AGEWGHT=(3.3/0.3); ELSE AGEWGHT=AGEWGHT;
IF Q46=. THEN AGEWGHT=1; ELSE AGEWGHT=AGEWGHT;


/* Race weight */
if Q48=1 then Racewght=84.7/86.6; else racewght=racewght;
if Q48=2 then Racewght=3.0/2.1; else racewght=racewght;
if Q48=4 then Racewght=8.0/2.6; else racewght=racewght;
if Q48=3 or Q48=5 or Q48=6 then Racewght=4.2/8.8; else racewght=racewght;
if Q48=. then Racewght=1; else racewght=racewght;

/* Population times Race weight */
PopRacewght=racewght*popwght;

/* Income weight */
if Q51=1 then Incwght=14.1/6.8; else incwght=incwght;
if Q51=2 then Incwght=8.9/9.0; else incwght=incwght;
if Q51=3 then Incwght=10.5/16.1; else incwght=incwght;
if Q51=4 then Incwght=12.6/15.8; else incwght=incwght;
if Q51=5 then Incwght=53.9/52.3; else incwght=incwght;
if Q51=. then Incwght=1; else incwght=incwght;

/* Population times Income weight */
PopIncwght=Incwght*popwght;

/* Now try two comprehensive weight, the first without population weight, the
second with population weight */

AllWght1=sexwght*Hispwght*Racewght*Incwght;
AllWght2=popwght*sexwght*Hispwght*Racewght*Incwght;

data test2;
set test1;
keep id popwght sexwght popsexwght Hispwght PopHiswght Racewght PopRacewght
Incwght PopIncWght
AllWght1 Allwght2;
proc print data=test2 (obs=100);
run;
```

For the purposes of the Health Impact Assessment, the research team also utilized survey data to determine the extent to which the impacts of flooding in Hoboken might be disparately impacting vulnerable subgroups. The groups identified as “vulnerable populations” included survey respondents that self-reported in one or more of the following categories: people over the age of 65, low-income residents (those residing in households with less than $25,000 in annual household income) and individuals with physical, mental or emotional limitations.

ANALYSIS RESULTS FOR KEY SURVEY QUESTIONS

Utilizing the various weights developed, the research team analyzed the data using each weight. The results of the analysis utilizing the weights as well as an "unweighted" data for key survey questions are summarized below.

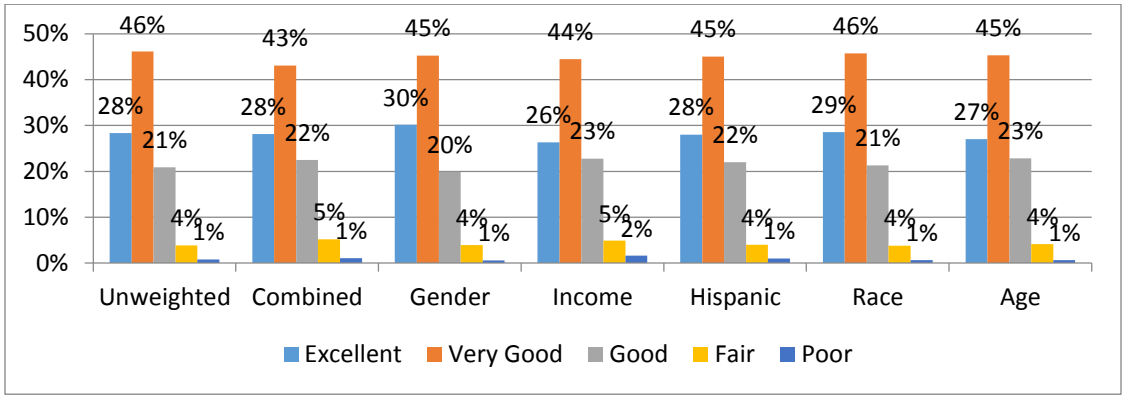


Figure AP3-2. General Health Status – Would you say that your health in general is…

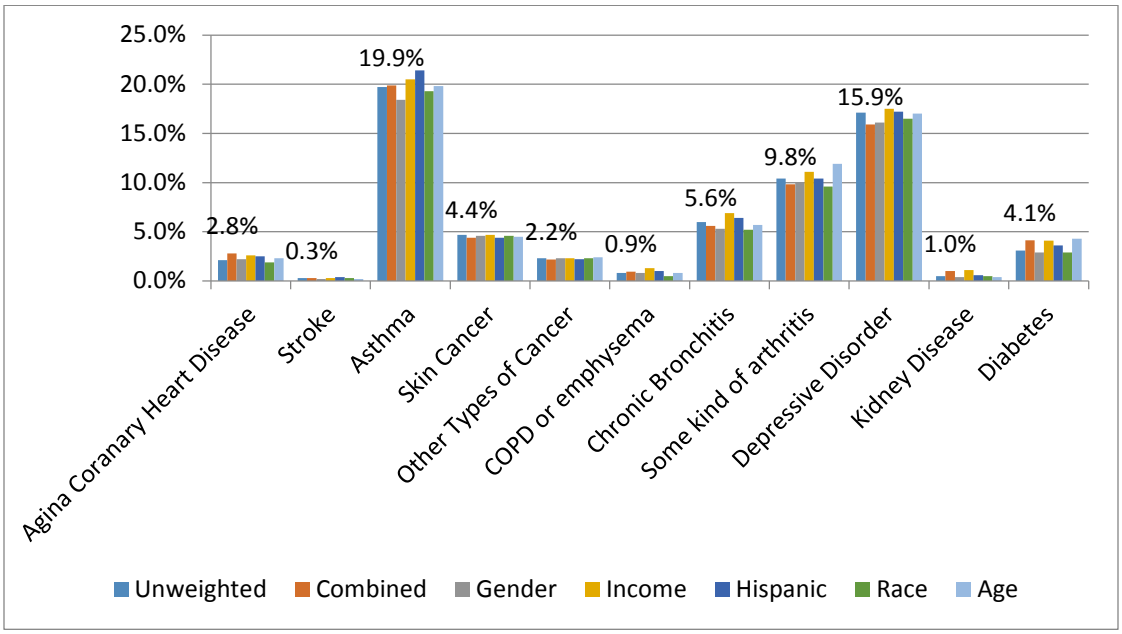


Figure AP3-3. Chronic Health Conditions – Has a doctor, nurse or other health professional EVER told you that you had any of the following…[3]

[3] Displayed data points represent the "combined" weighted data.

Table AP3-5. How often are you personally impacted by flooding in Hoboken?

	Vulnerable Population							General Population						
	Unweighted	Combined	Gender	Income	Hispanic	Race	Age	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Every time it floods	36%	37%	34%	39%	37%	36%	38%	20%	19%	20%	20%	20%	18%	19%
Only during very heavy rainstorms	44%	43%	43%	44%	44%	45%	60%	50%	52%	51%	50%	51%	52%	49%
Almost never	17%	16%	18%	15%	17%	16%	21%	23%	23%	23%	23%	23%	23%	21%
I am not affected by flooding in Hoboken.	3%	3%	4%	6%	3%	3%	6%	7%	6%	6%	6%	7%	7%	7%

Table AP3-6. In the past two years, how many times were you personally impacted by flooding?

	Vulnerable Population							General Population						
	Unweighted	Combined	Gender	Income	Hispanic	Race	Age	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Never	18%	16%	20%	16%	17%	18%	16%	27%	26%	27%	27%	26%	28%	26%
Just one time	16%	18%	18%	18%	17%	15%	28%	20%	21%	21%	21%	22%	20%	22%
Two times	17%	21%	15%	16%	17%	21%	16%	19%	19%	19%	18%	19%	20%	19%
Three times	19%	16%	20%	19%	19%	19%	16%	14%	13%	14%	14%	13%	13%	14%
More than three times	29%	28%	27%	32%	31%	27%	24%	20%	21%	20%	20%	20%	20%	20%

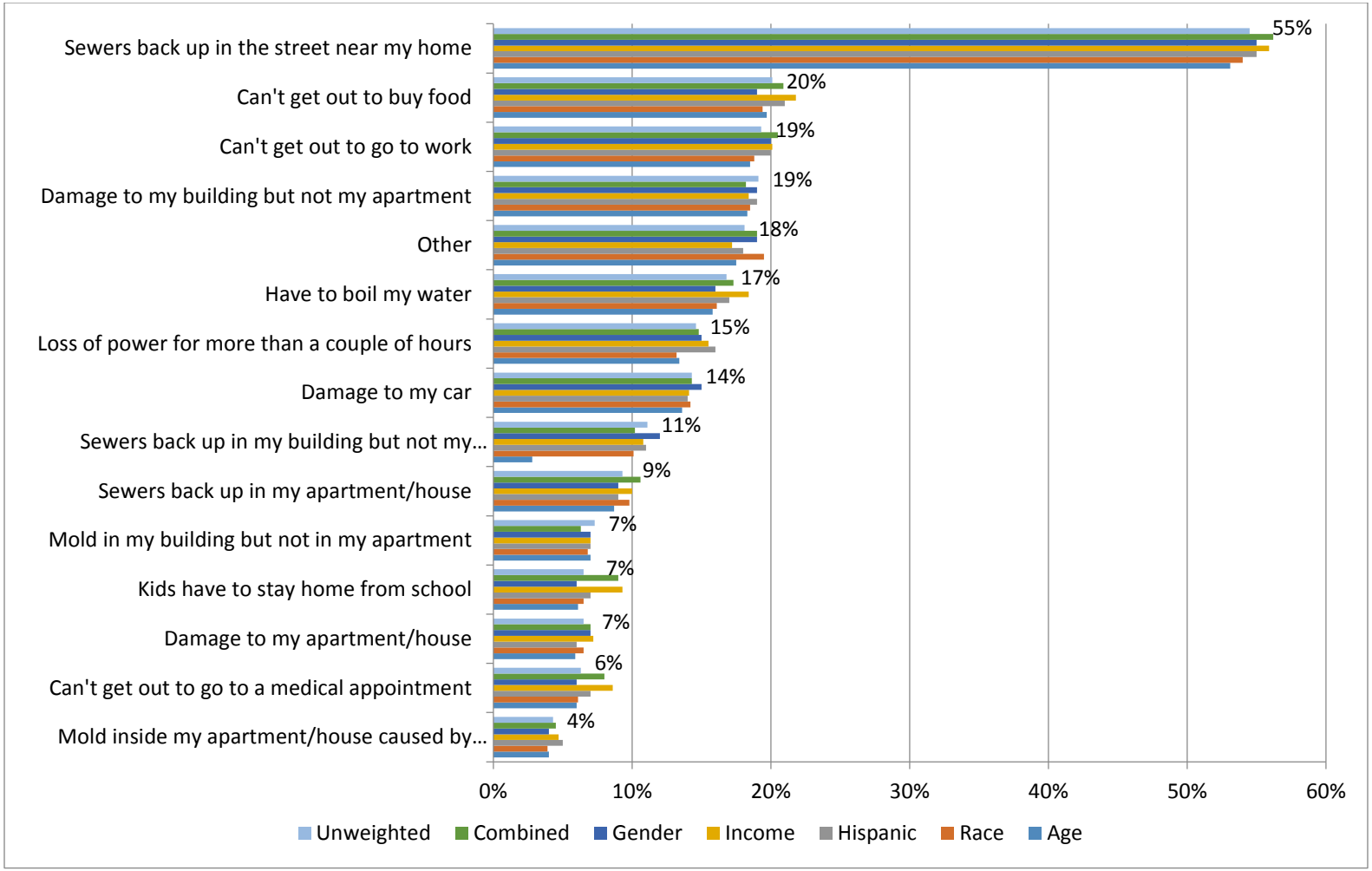


Figure AP3-4. What types of impacts do you regularly experience?[4]

[4] Displayed data points represent the unweighted data.

Table AP3-7. In the past two years, how many times have you experienced a one of the following medical conditions? (Skin rash; Asthma or other respiratory condition; Eye irritation/infection; Muscle aches; Abdominal cramping, nausea or diarrhea; Vomiting; Headaches)

	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Never experienced a Symptom	72.0%	71.1%	72.7%	69.3%	70.7%	73.2%	73.9%
Experienced a symptom at least once	28.0%	28.9%	27.3%	30.7%	29.3%	26.8%	26.1%

Table AP3-8. In the past two years, how many times have you sought medical attention for one of the following medical conditions? (Skin rash; Asthma or other respiratory condition; Eye irritation/infection; Muscle aches; Abdominal cramping, nausea or diarrhea; Vomiting; Headaches)

	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Never sought medical attention	76.8%	75.5%	77.0%	75.1%	74.3%	77.5%	78.6%
Sought medical attention at least once	23.2%	24.5%	23.0%	24.9%	24.2%	22.5%	21.4%

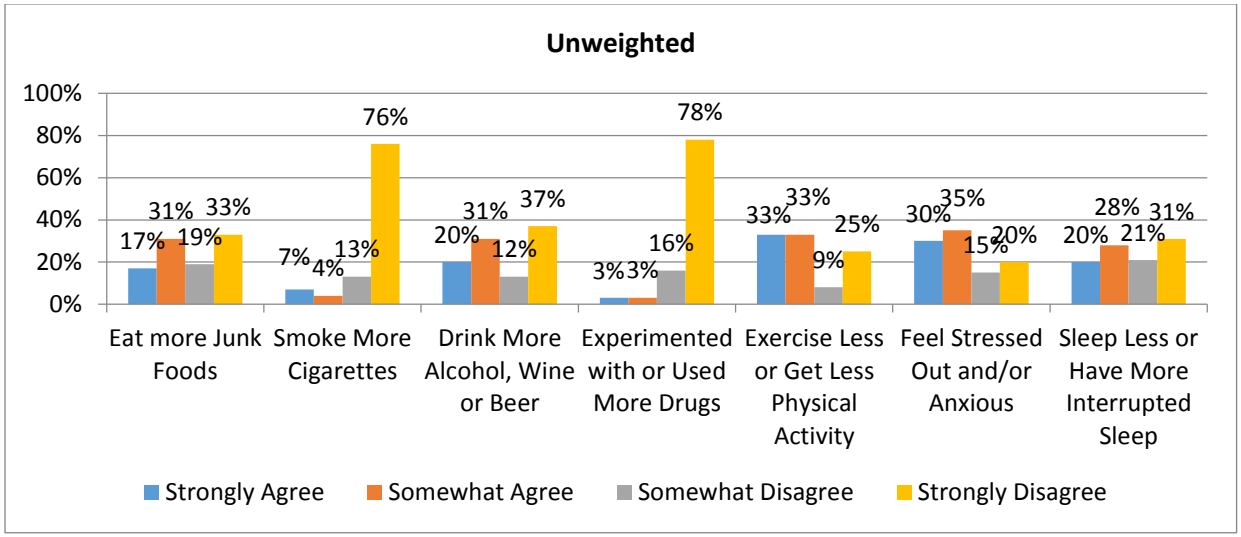


Figure AP3-5a. How much do you agree with the following statements?

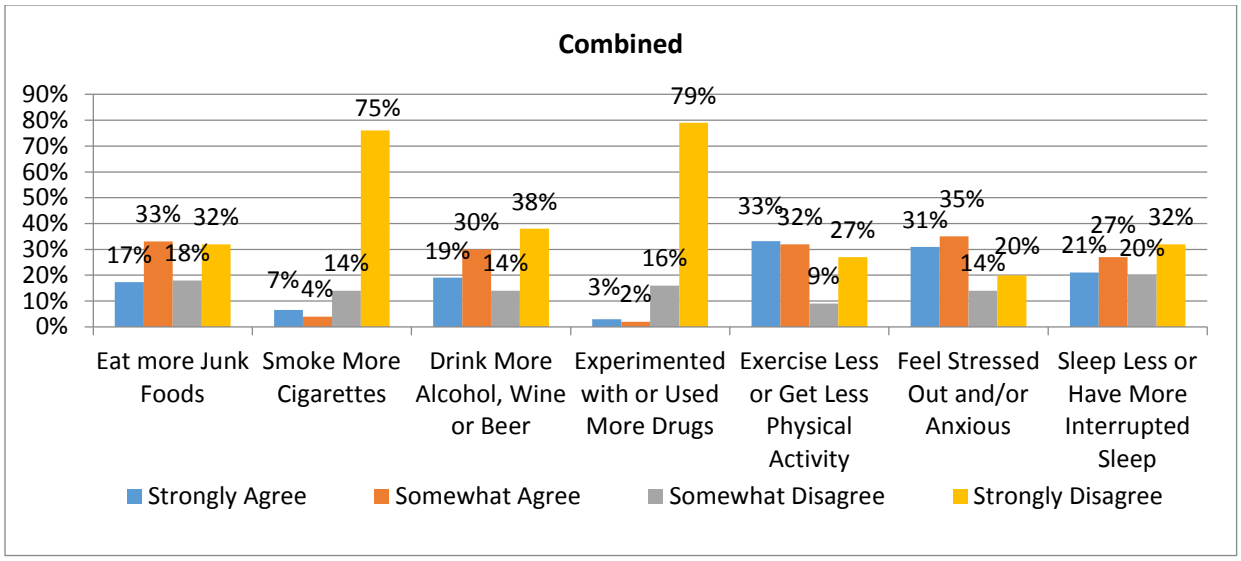


Figure AP3-5b. How much do you agree with the following statements?

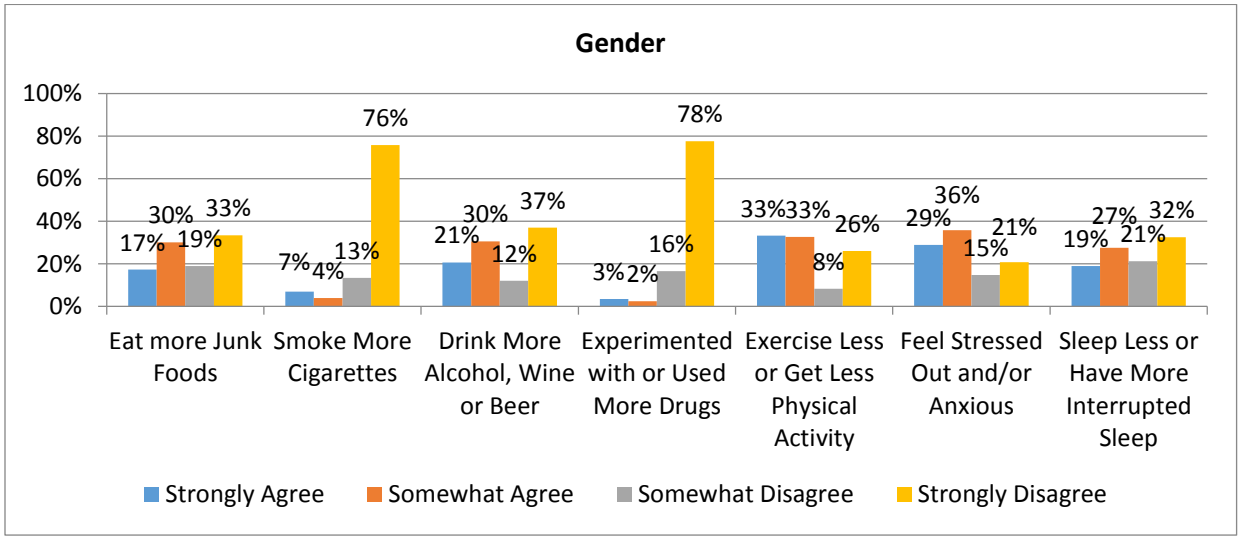


Figure AP3-5c. How much do you agree with the following statements?

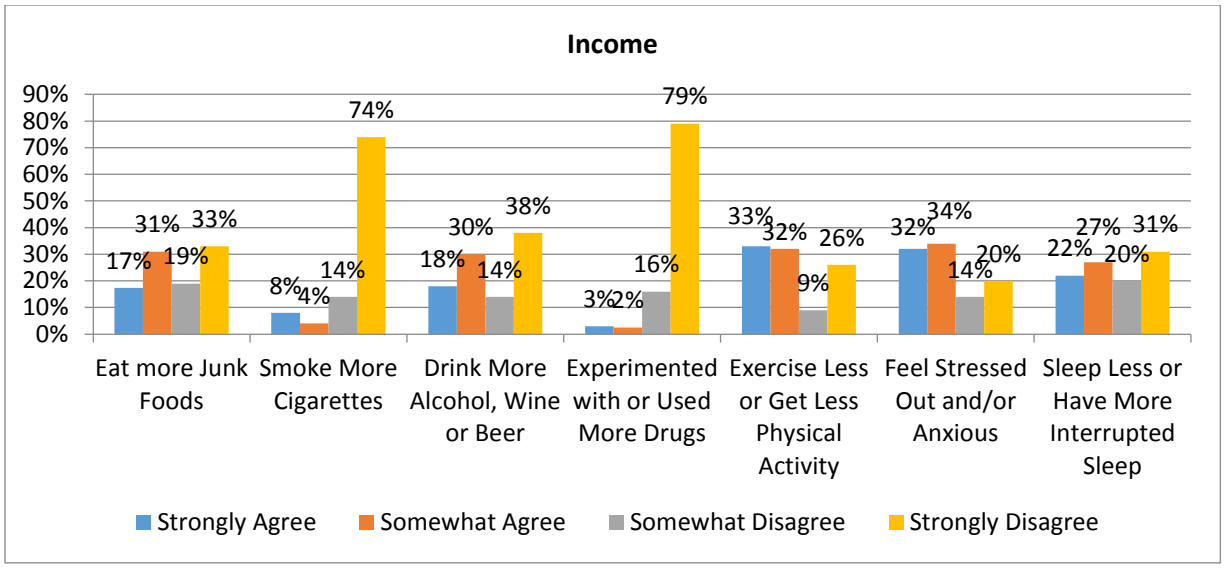


Figure AP3-5d. How much do you agree with the following statements?

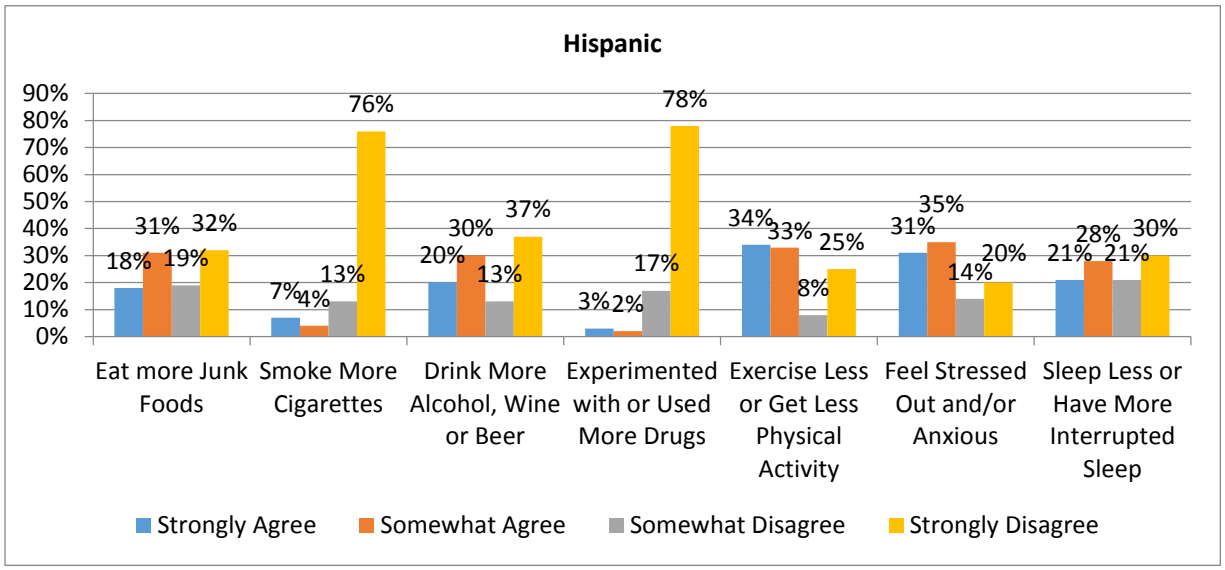


Figure AP3-5e. How much do you agree with the following statements?

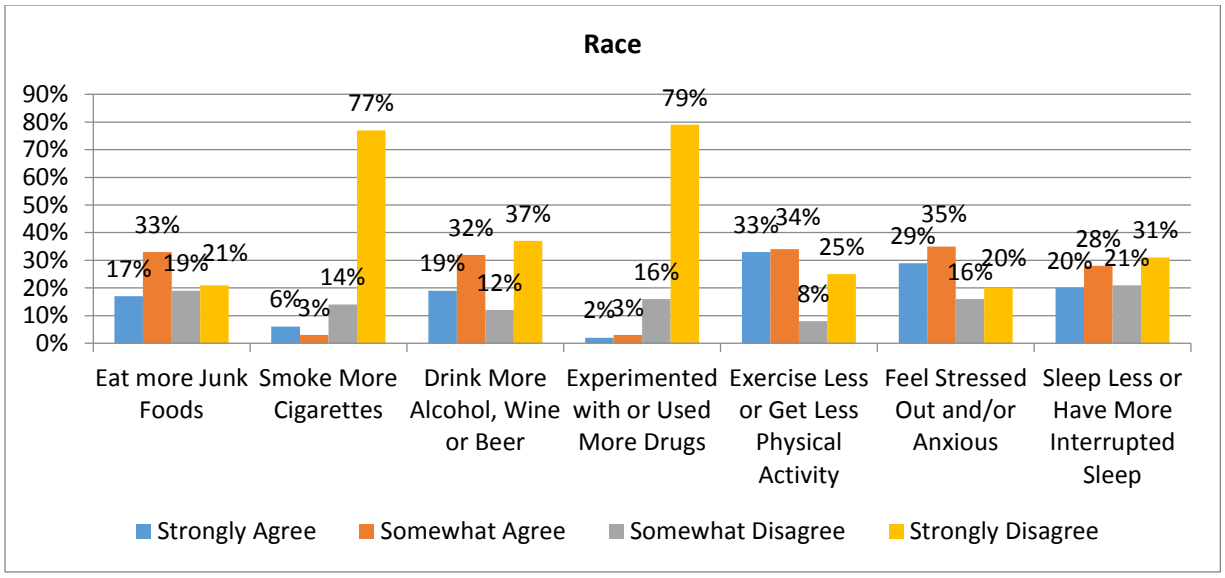


Figure AP3-5f. How much do you agree with the following statements?

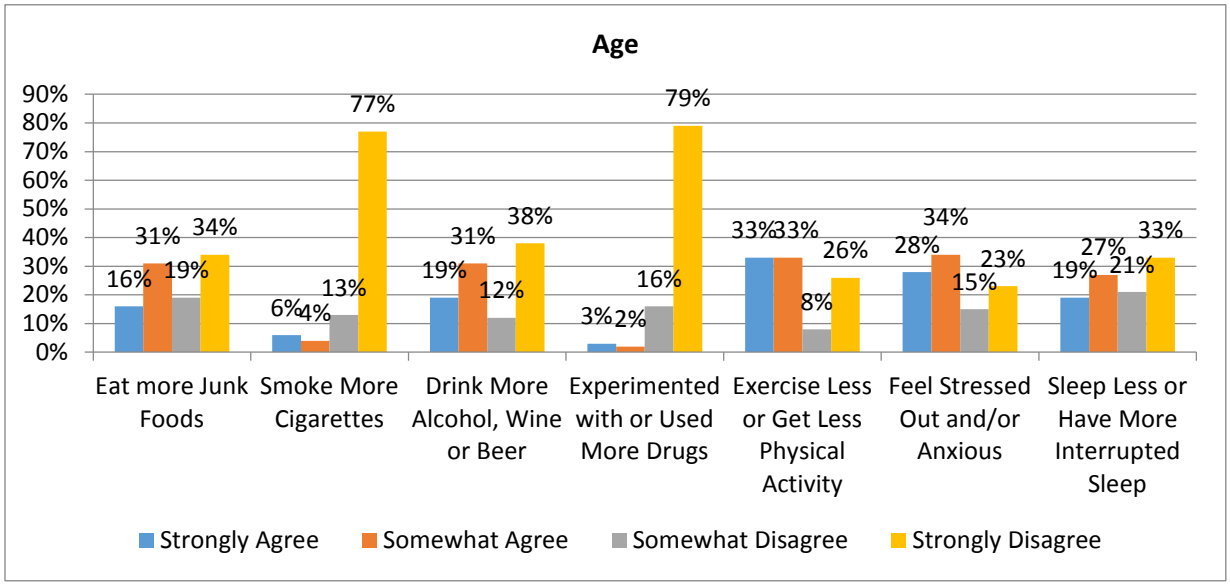


Figure AP3-5g. How much do you agree with the following statements?

Table AP3-9. Was your apartment/house damaged by flooding in the past two years?

	Vulnerable Population							General Population						
	Unweighted	Combined	Gender	Income	Hispanic	Race	Age	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Yes	23.7%	25.4%	22.2%	23.8%	24.2%	25.5%	17.6%	13.4%	12.4%	13.2%	13.1%	13.2%	12.9%	12.7%
No	76.3%	74.6%	77.8%	76.3%	75.8%	74.5%	82.4%	86.6%	87.6%	86.8%	86.9%	86.8%	87.1%	87.3%

Table AP3-10. When it floods in Hoboken, it is at least somewhat difficult to do the following things:

	Vulnerable Population							General Population						
	Unweighted	Combined	Gender	Income	Hispanic	Race	Age	Unweighted	Combined	Gender	Income	Hispanic	Race	Age
Pick up prescriptions	51%	52%	45%	57%	52%	50%	43%	31%	31%	31%	30%	31%	31%	31%
Get to my doctor or other medical appointment	54%	52%	48%	57%	57%	51%	45%	30%	30%	30%	29%	30%	30%	30%
Pick up food/groceries	70%	69%	67%	72%	72%	72%	59%	57%	59%	58%	57%	57%	58%	58%
Get to work	61%	58%	58%	59%	62%	60%	49%	58%	58%	58%	57%	58%	58%	59%
Get to school	30%	31%	26%	33%	32%	28%	24%	19%	22%	19%	19%	19%	19%	18%

Attachment A: Hoboken Resident Community Health and Resilience Survey

INFORMED CONSENT

You are being invited to participate in a research study that is being conducted by the New Jersey Health Impact Collaborative at Rutgers University's Bloustein School for Planning and Public Policy. The study is being funded by the Health Impact Project in collaboration with the Pew Charitable Trusts and the Robert Wood Johnson Foundation to investigate how to include public health considerations in decisions made before and after natural disasters. Although you will not receive any direct benefit from participating in this survey, your answers will help the research team understand better how community decision-making around disaster preparedness and recovery can be changed to improve public health outcomes.

This survey is anonymous. Anonymous means that no personal information about you will be recorded when you take the survey. There will be no way to link your responses back to you. The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see your responses, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only summarized results will be stated. All study data will be kept for three years.

The survey should take about 15 minutes to complete. Your participation is completely voluntary. You may choose not to answer any questions you are not comfortable answering and if at any time you wish to stop taking the survey, you are completely free to do so. As part of the survey you will be asked to remember back to how past flooding events in Hoboken–including Hurricane Sandy–may have impacted you and your family. Depending on how these events impacted you and your family it may be stressful to think about these things. If after taking the survey you for any reason feel like you could benefit from assistance, counseling or other storm-recovery services, resources are available from the Hudson County Long-term Recovery Committee and NJ Mental Health Cares. You may access these resources by calling 211. There are no other foreseeable risks to participation in this study.

This survey is anonymous. Anonymous means that no personal information about you will be recorded when you take the survey. There will be no way to link your responses back to you. The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see your responses, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only summarized results will be stated. All study data will be kept for three years.

At the end of the survey you will be asked if you want to be entered to win a $100 Visa gift cards. Gift cards will be awarded to two randomly selected individuals that complete the survey. We estimate that your chances of winning a gift card will be 1 in 250. If you choose to enter, you will be asked to provide us with your contact information. This information will be kept confidential.

If you have any questions about the study or study procedures, you may contact Jon Carnegie at Voorhees Transportation Center, 33 Livingston Ave., New Brunswick, NJ, 08901, 848-932-2840, carnegie@ejb.rutgers.edu.

If you have any questions about your rights as a research subject, you may contact the IRB Administrator at Rutgers University, Arts and Sciences IRB at:

Institutional Review Board
Rutgers University, the State University of New Jersey
Liberty Plaza / Suite 3200
335 George Street, 3rd Floor
New Brunswick, NJ 08901
Phone: 732-235-9806
Email: humansubjects@orsp.rutgers.edu

If you are 18 years of age or older, understand the statements above, and agree to participate in the study, check "Yes" If not, please check "No".

- ❍ Yes
- ❍ No (Not eligible to participate. Stop.)

EXPERIENCES WITH CHRONIC FLOODING IN HOBOKEN

This section is about your experiences with chronic flooding in Hoboken. This means flooding that occurs regularly when it rains hard. For the purpose of this study, we are NOT talking about big storms like Hurricane Sandy that had a storm surge from the ocean that caused massive flooding in Hoboken. When answering questions in this section, we want you to think about the problems and impacts you experience from regular flooding that occurs during and after heavy rain storms.

1. About how often would you say regular flooding occurs in Hoboken after periods of heavy rain?
   - ☐ Once per year
   - ☐ 2-3 times per year
   - ☐ More than 3 times per year.

2. How often are you personally impacted by flooding in Hoboken?
   - ☐ Every time it floods
   - ☐ Only during very heavy rainstorms
   - ☐ Almost never
   - ☐ I am not affected by flooding in Hoboken

3. What type of impacts do you regularly experience? (Check all that apply).
   - ☐ Damage to my apartment/house
   - ☐ Damage to my building but not my apartment
   - ☐ Mold inside my apartment/house caused by flooding
   - ☐ Mold in my building but not in my apartment caused by flooding
   - ☐ Sewers back up in my apartment/house
   - ☐ Sewers back up in my building but not my apartment
   - ☐ Sewers back up in the street near my home
   - ☐ Loss of power for more than a couple of hours
   - ☐ Have to boil my water
   - ☐ Damage to my car
   - ☐ Can't get out to go to work
   - ☐ Can't get to out to buy food
   - ☐ Can't get out to go to a medical appointment
   - ☐ Kids have to stay home from school
   - ☐ Other

4. In the past two years how many times were you personally impacted by flooding? Remember, the period we are interested in is the past two year **AFTER** Hurricane Sandy.
   - ☐ Never (Skip to question 10)
   - ☐ One time
   - ☐ Two times
   - ☐ Three times
   - ☐ More than three times

5. Was your apartment/house damaged by flooding in the **past two years**?
   - ☐ Yes
   - ☐ No (Skip to question 10)

6. If your apartment/house was damaged by flooding, what was the approximate total cost to make all repairs and/or replace household/personal items that were destroyed by all the flooding events during the **past two years, not including Hurricane Sandy**?
   - ☐ $500 or less
   - ☐ $501 to $1,000
   - ☐ $1,001 to $3,000
   - ☐ $3,001 to $5,000
   - ☐ $5,001 to $7,500
   - ☐ $7,501 to $10,000
   - ☐ $10,001 to $20,000
   - ☐ $20,001 to $30,000
   - ☐ More than $30,000

7. If your apartment/house was damaged in the **past two years**, did you have renters/homeowners or flood insurance that covered the costs of making repairs or and/or replacing household/personal items?
   - ☐ Yes
   - ☐ No (Skip to question 10)
   - ☐ Don't know / Not sure

8. If your apartment/home was damaged did/does insurance cover the cost of making repairs and/or replacing household/personal items?
   - ☐ Insurance covered all costs
   - ☐ Insurance covered some of the costs
   - ☐ Insurance did not cover the costs
   - ☐ Don't know / Not sure

9. If insurance covered all or part of the costs, what was the total cost of the insurance deductible(s) you paid for all insurance claims?
   - ☐ I did not pay a deductible
   - ☐ Less than $500
   - ☐ $500 to $999
   - ☐ $1,000 to $1,499
   - ☐ $1,500 to $2,000
   - ☐ More than $2,000, specify amount _____
   - ☐ Don't know / Not sure

10. When flooding is expected, do you regularly evacuate from your home? Remember, we're talking about regular flooding not during a big storm like Hurricane Sandy.
    - ☐ Yes
    - ☐ No (Skip to question 13)
    - ☐ Don't know / Not Sure

11. Where do you go?
    - ☐ Stayed with a friend or family member in Hoboken
    - ☐ Stayed with a friend or family member outside of Hoboken
    - ☐ An emergency shelter in Hoboken
    - ☐ An emergency shelter outside of Hoboken
    - ☐ A hotel/motel
    - ☐ Other _____

12. When you evacuate, how long do you usually stay at some other location?
    - ☐ 24 hours or less
    - ☐ 1-2 days
    - ☐ 3-4 days
    - ☐ More than 5 days

IMPACTS OF FLOODING ON HEALTH/WELL-BEING

This section is about how chronic flooding in Hoboken affects the lives of you and your family. Remember, for the purpose of this study, we are NOT talking about big storms like Hurricane Sandy that had a storm surge from the ocean that caused massive flooding in Hoboken. When answering questions in this section, we want you to think about the problems you experience from regular flooding that occurs during and after heavy rain storms.

13. When it floods in Hoboken, how difficult do you find it to do the following things:

Activity	Very difficult	Difficult	Somewhat Difficult	Neutral	Somewhat Easy	Easy	Very Easy	Not Applicable
Pick up prescriptions								
Get to my doctor or other medical appointment								
Pick up food/groceries								
Get to work								
Get to school								

14. In the **past two years**, how many times have you missed a medical appointment because of flooding?
    - ☐ I did not miss a medical appointment
    - ☐ One time
    - ☐ Two times
    - ☐ Three times
    - ☐ More than three times
    - ☐ Don't know / Not sure

15. How much do you agree with the following statements? Before, during or after flooding I …….

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
Eat more junk foods				
Smoke more cigarettes				
Drink more alcohol, wine or beer				
Experimented with or used more drugs				
Exercise less or get less physical activity				
Feel stressed out and/or anxious				
Sleep less or have more interrupted sleep				

16. Have you ever experienced an injury requiring medical attention because of **regular flooding** in Hoboken? For example, slipping and falling.
    - ☐ Yes
    - ☐ No
    - ☐ Don't know / Not sure

17. Have you ever sought counseling or other mental health services to help you cope with **regular flooding** in Hoboken?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know/Not Sure

18. **In the past two years**, have you ever come in physical contact with flood waters or sewer back-ups caused by flooding in Hoboken?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know/Not Sure

19. **In the past two years**, have you ever had to clean-up after flooding or sewer back-ups caused by flooding?
    - ☐ Yes
    - ☐ No (Skip to question 21)
    - ☐ Don't know/Not Sure

20. If you had to clean up after flooding or sewer back-ups, what precautions did you take to protect your health when cleaning up?
    - ☐ None / I took no precautions
    - ☐ Wore rubber gloves
    - ☐ Wore a face mask
    - ☐ Wore protective clothing
    - ☐ Other: Specify_____

21. In the **past two years**, how many times have you sought medical attention for any of the following conditions after you came in contact with flood waters, sewer back-ups, had to clean up after flooding or came in contact with the mud, sludge or dry residue after flooding or a sewer back-up caused by flooding?

	Never	1 time	2 or more times
Skin rash			
Asthma or other respiratory condition			
Eye irritation/infection			
Muscle aches			
Abdominal cramping, nausea or diarrhea			
Vomiting			
Headaches			

22. In the **past two years** how many times have you personally experienced but did not seek medical attention for any of the following conditions after you came in contact with flood waters, sewer back-ups, had to clean up after flooding or came in contact with the mud, sludge or dry residue after flooding or a sewer back-up caused by flooding?

	Never	1 time	2 or more times
Skin rash			
Asthma or other respiratory condition			
Eye irritation/infection			
Muscle aches			
Abdominal cramping, nausea or diarrhea			
Vomiting			
Headaches			

23. In the **past two years**, have any of your family members, friends, neighbors or others you know experienced any of the following conditions after they came in contact with flood waters, sewer back-ups, had to clean up after flooding or came in contact with the mud, sludge or dry residue after flooding or a sewer back-up caused by flooding?

	Yes	No	No Sure / Don't Know
Skin rash			
Asthma or other respiratory condition			
Eye irritation/infection			
Muscle aches			
Abdominal cramping, nausea or diarrhea			
Vomiting			
Headaches			

24. Do you actively participate in any of the following water-based recreational activities in and around Hoboken? Select all that apply.
    - ☐ Swimming
    - ☐ Kayaking/canoeing
    - ☐ Fishing
    - ☐ Other: Specify _____

25. How long do you wait after flooding events to take part in these activities?
    - ☐ I do not wait
    - ☐ 1-2 days
    - ☐ 3-4 days
    - ☐ 5-7 days
    - ☐ More than a week

26. Are you currently...?
    - ☐ Employed for wages
    - ☐ Self-employed
    - ☐ Out of work for 1 year or more
    - ☐ Out of work for less than 1 year
    - ☐ A Homemaker (Skip to question 28)
    - ☐ A Student not working (Skip to question 28)
    - ☐ Retired (Skip to question 28)
    - ☐ Unable to work (Skip to question 28)

27. At your main job or business, how are you generally paid for the work you do. Are you–
    - ☐ Paid by salary
    - ☐ Paid by the hour
    - ☐ Paid by the job/task (e.g. commission, piecework)
    - ☐ Paid some other way
    - ☐ Don't know / Not sure

28. If you were employed in the past two years, how many days have you missed work because of **regular flooding** in Hoboken?
    - ☐ I have not been employed for the past two years (Skip to question 30)
    - ☐ I did not miss work because of flooding (Skip to question 30)
    - ☐ 1 day/shift
    - ☐ 2 days/shifts
    - ☐ 3 days/shifts
    - ☐ More than 3 days/shifts, please specify _____

29. What was the main reason you missed work because of **regular flooding** in Hoboken?
    - ☐ Got sick
    - ☐ Had to clean-up damage
    - ☐ Could not get to work because I lacked transportation
    - ☐ My place of work was closed due to flooding or the threat of flooding
    - ☐ School or childcare was closed and I had to care for me children
    - ☐ Other, please specify _____

30. In the **past two years**, how often have you restricted the outdoor play activities of your children because of flooding, sewer back-ups caused by flooding or because you were worried that your children might come in contact with the mud, sludge or dry residue left after flooding or a sewer back-up caused by flooding?
    - ☐ Never
    - ☐ One time
    - ☐ 2-3 times
    - ☐ 4-5 times
    - ☐ More than 5 times

OPINIONS ABOUT "GREEN INFRASTRUCTURE"

This set of questions is about something called "Green Infrastructure." Stormwater running off of roofs, streets and parking lots when it rains is a major cause of water pollution and flooding in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground.

In most urban areas, stormwater is drained through storm drains and pipes and discharged into nearby waterbodies. The stormwater carries with it trash, bacteria, heavy metals, and other pollution, degrading the quality of the receiving waters. Higher amounts of rainfall can also cause flooding in streets and urban streams, damaging habitat, property, transportation, power supplies and other community assets.

Green infrastructure uses vegetation, trees, soils, and natural processes to manage storm water and create healthier urban environments. The City of Hoboken is considering how they can use green infrastructure to help reduce stormwater runoff, flooding and sewer back-ups. The following pictures show the types of green infrastructure city officials are considering. After you have looked at these pictures, please click CONTINUE.

Note: Please see attachment at back of survey to view images.

31. Before taking this survey, had you ever heard about green infrastructure?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know/Not Sure

32. Were you aware that the City of Hoboken was considering how to use green infrastructure to reduce stormwater runoff, flooding and sewer back-ups.
    - ☐ Yes
    - ☐ No
    - ☐ Don't know/Not Sure

33. How much do you agree with the following statements? Using green infrastructure in Hoboken can/will…..

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
Help to reduce stormwater runoff				
Help to reduce flooding in my neighborhood				
Help to reduce sewer-back ups				
Provide more green space in the City				
Help to improve air quality				
Reduce temperatures in the summertime				
Improve quality of life in the city by providing more greenery, parks and natural areas				
Make me more likely to be active because it will be more pleasant to walk or improve my access parks and natural places to enjoy.				
Improve the health of city residents				
Take money away from other needed services				

34. How do you think the City of Hoboken should pay for installing and maintaining green infrastructure? Select all that apply.
    - ☐ Apply for and use state and federal grant money
    - ☐ Use some of the City's tax dollars
    - ☐ Make developers pay for it when they build/renovate buildings
    - ☐ Other, please specify: _____

35. What other benefits do you think green infrastructure can provide in Hoboken?

_____

36. What concerns do you have about using green infrastructure in Hoboken to reduce stormwater runoff, flooding and sewer back-ups?

_____

GENERAL HEALTH STATUS

This set of questions is about your general state of health. Your answers to these questions will give the research team a better idea about the current health of Hoboken residents in general. Remember, your answers to ALL the questions in this survey are anonymous. There will be no way to connect you with your answers.

37. Would you say that in general your health is?
    - ☐ Excellent
    - ☐ Very good
    - ☐ Good
    - ☐ Fair
    - ☐ Poor
    - ☐ Don't know/Not sure

38. During the past month, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?
    - ☐ 0 days
    - ☐ 1-3 days
    - ☐ 4-6 days
    - ☐ 7-10 days
    - ☐ More than 10 days
    - ☐ Don't Know/Not sure

39. Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, government plans such as Medicare, or Indian Health Service?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know / Not sure

40. How often in the past 12 months would you say you were worried or stressed about having enough money to pay your rent/mortgage? Would you say
    - ☐ Always
    - ☐ Usually
    - ☐ Sometimes
    - ☐ Rarely
    - ☐ Never
    - ☐ Don't know / Not sure

41. How often in the past 12 months would you say you were worried or stressed about having enough money to buy nutritious meals? Would you say
    - ☐ Always
    - ☐ Usually
    - ☐ Sometimes
    - ☐ Rarely
    - ☐ Never
    - ☐ Don't know / Not sure

42. Has a doctor, nurse, or other health professional EVER told you that you had any of the following?:

	Yes	No	Don't Know / Not Sure
Myocardial infarction?			
Angina or coronary heart disease?			
Stroke?			
Asthma?			
Skin cancer?			
Other types of cancer?			
Chronic Obstructive Pulmonary Disease or COPD, emphysema or			
Chronic bronchitis?			
Some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?			
Depressive disorder, including depression, major depression, dysthymia, or minor depression?			
Kidney disease? Do NOT include kidney stones, bladder infection or incontinence.			
Diabetes?			

43. Are you limited in any way in any activities because of physical, mental, or emotional problems?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know / Not Sure

44. During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?
    - ☐ Yes
    - ☐ No (Skip to question 46)
    - ☐ Don't know / Not sure (Skip to question 46)

45. If yes, how many times did you take part in this activity during the past month?
    - ☐ Once
    - ☐ Twice
    - ☐ 3-4 Times
    - ☐ More than 4 times

TELL US ABOUT YOURSELF

The last set of questions are about you as an individual. Your answers to these questions will help the research team understand the range of people that filled out the survey and whether the answers to the questions were different depending on the individual characteristics of survey participants.

46. What is your age?
    - ☐ 18 – 35
    - ☐ 36 – 50
    - ☐ 51 – 65
    - ☐ 66 - 75
    - ☐ Over 75

47. Are you Hispanic, Latino/a, or Spanish origin?
    - ☐ Yes
    - ☐ No

48. Which one or more of the following would you say is your race? Select all that apply.
    - ☐ White
    - ☐ Black or African American
    - ☐ American Indian or Alaska Native
    - ☐ Asian
    - ☐ Multiracial
    - ☐ Other, please specify:

49. How many children less than 18 years of age live in your household?
    - ☐ Zero
    - ☐ 1-2
    - ☐ 3-4
    - ☐ 5 or more

50. What is the highest grade or year of school you completed?
    - ☐ Never attended school or only attended kindergarten
    - ☐ Grades 1 through 8 (Elementary)
    - ☐ Grades 9 through 11 (Some high school)
    - ☐ Grade 12 or GED (High school graduate)
    - ☐ College 1 year to 3 years (Some college or technical school)
    - ☐ College 4 years or more (College graduate)

51. What is your annual household income from all sources?
    - ☐ Less than $25,000
    - ☐ 25,000 – 50,000
    - ☐ 50,001 – 75,000
    - ☐ 75,001 – 100,000
    - ☐ 100,001 +

52. What town do you live in? _____

53. What is the zip code where you live? _____

54. What is the nearest street intersection to where you live?
    Street #1 _____ / Street#2_____

55. Do you own or rent your home?
    - ☐ Own
    - ☐ Rent
    - ☐ Other arrangement
    - ☐ Don't know / Not sure

56. What is your sex?
    - ☐ Male
    - ☐ Female
    - ☐ Transgender/Other

57. Do you want to enter to win a $100 Visa Gift Card?
    - ☐ Yes
    - ☐ No (Skip to end of survey)

58. What is your contact information?
    - ☐ Last Name _____
    - ☐ First Name _____
    - ☐ Phone Number _____
    - ☐ Email address _____

Thank you for participating!

Appendix 4: Summary Table of Possible Floodwater Contaminants and Their Associated Potential Health Risks and Impacts

Pollutant	Pollutant Sub-Types	Sub-Type Examples	Human Exposure Health Impact Examples
Microbial Pathogens	Bacteria	• Fecal coliform (1) • E. coli (1) (2) • Enterococcus (1) (3) • Adenoviruses (3) • Citrobacter freundii (3) • Aeromonas ichtiosmia (3) • Actinomycetes (3) • Fecal Streptococci (3) • Coliphage (3) • Tetanus (2)	• Gastrointestinal Illnesses (1) (2)(4) (5) (6) -abdominal cramps -diarrhea -fever -vomiting • Dysentery (4) • Pneumonia (1) • Bronchitis (1) • Swimmer's Ear (1) (6) • Headache (2) • Muscle Aches & Spasms (7)
	Viruses[5]	• Picornaviridae -Poliovirus (1) (8) -Coxsackie (1) (8) -Hepatitis A (1) (2) (4) (5) (8) • Adenoviridae (8) -Adenovirus Strains • Caliciviridae (8) -Norwalk • Reoviridae -Rotoviruses	• Vomiting (1) (2) (8) (9) • Diarrhea (1) (2) (4) (8) (9) • Skin Rash (1) (10) • Muscle Aches (2) • Headache (9) • Abdominal Pain (4) (9) • Fever (1)(8)(9)(10) • Respiratory Infection (1) (8) • Liver Infection (1) • Diabetes (8) (11) • Mouth Sores/Blisters (10) • Intestinal Inflammation (4)
	Parasites	• Parasitic Protozoa (1) (4) -Giardia -Cryptosporidium -Entameoba • Helminths (1) (4) • Ectoparasites (2)	• Gastrointestinal Illnesses (4) (12) -Acute & Chronic Diarrhea (1) (12) -Abdominal Pain (4) (12) -Vomiting (12) • Giardiasis (1) • Infections (1) • Round-, Tape, Hook-, & Whip-worms (1) • Ectoparasite diseases (2)
Oxygen Depleting Substances (BOD5)	In/Organic Matter	• Human Excrement (1) • Kitchen Waste (1) • Industrial Waste (1)	• Gastrointestinal Illnesses (13) -Acute & Chronic Diarrhea (1) (12) -Abdominal Pain (4) (12) -Vomiting (12)
Total Suspended Solids (TSS)	Surface & Suspended in Water Particles/Solids	• Decaying Plant Matter (1) • Decaying Animal Matter (1) • Industrial Wastes (1) -Chemicals (15) • Bacteria (15) • Silt (1)	• Health impacts may be considered the same as those found with microbial pathogens and toxics. (14) (15)

[5] More than 120 viruses may be found in sewage. (1)

Toxics	Metals (16)	• Arsenic (1)(17) • Cadmium (1) • Chromium (1) (17) • Copper (17) • Lead (1)(17) • Manganese (17) • Mercury (1) • Nickle (17) • Silver (17) • Zinc (17)	• Brain, Liver, Fat & Kidney Damage (1) • Dermatitis (1) (18) (19) (20) • Hair Loss (1) • Gastrointestinal Illness (1) (18) (19) • Bone Disease (1) • Developmental Illnesses (1)
	Synthetic Organic Chemicals	• Chlorinated Aromatic Hydrocarbons (21) -polychlorinated biphenyls (PCBs) (1) (16) • Chlorinated Hydrocarbons -pesticides (1) (16) • Polycyclic Aromatic Hydrocarbons (1) (16) • Bis(2-ethylhexyl) phthalate (17) • Pharmaceuticals[6] -Antibiotics (22) (23) -Non-prescription Drugs (23) -Steroids & Hormones (23)	• Skin Rash (1) (2) • Anemia (1) • Nervous System Effects (1) • Blood Effects (1) • Liver & Kidney Effects (1) • Reproductive Difficulties (1) • Increased Risk of Cancer (1) • Fetus Reproductive System Effects (24) • Headaches (2) • Dizziness, Nausea, Fatigue, Weakness, Excitability (2) • Respiratory Illness (24) -Asthma -Eczema -Rhinitis
Nutrients	Nitrogen	• N/A	• Rashes (25) • Stomach Illness (25) • Liver Illness (25) • Respiratory Effects (25) -Blue Baby Syndrome (25) • Neurological Effects (25) • Death (25) • Reproductive Effects (25) • Development Effects (25) • Cancer (25)
	Phosphorus	• N/A	
Floatables	Debris/Trash	• Litter (1) • Sanitary Waste (from toilets) (1)	

[6] Additional research is needed to determine what, if any, health impacts may result in humans from exposure.

Attachment A: Appendix 4 References

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Appendix 5: Health Effects Evaluation Criteria

Table AP5-1. Health Effects Evaluation Criteria

Direction	What type of health effects may occur if the decision is made to move ahead with the proposal?	Likelihood	How certain is it that the decision will effect health determinants or outcomes, irrespective of the frequency, severity or magnitude?
Positive	The decision could have positive health effects.	**Unlikely/Implausible**	Logically implausible effect; substantial evidence against mechanism of effect
Negative	The decision could have negative health effects.	**Possible**	Logically plausible effect with limited or uncertain supporting evidence
Positive & Negative	The decision could have both positive and negative health effects.	**Likely**	Logically plausible effect with substantial and consistent supporting evidence, however there is some uncertainty
Insufficient Evidence / Not Evaluated	-	**Very likely / Certain**	Adequate evidence exists for a causal and generalizable effect
		Insufficient Evidence / Not Evaluated	-

Table AP5-2. Health Effects Evaluation Criteria

Magnitude	How much will health outcomes change as a result of the decision? (i.e., what is the expected change in the population frequency of the symptoms, disease, illness, injury, disability, or mortality)?	Duration	For how long are the positive/negative health effects or outcomes expected to last?
Low	Logically implausible effect; substantial evidence against mechanism of effect	**Short**	The effects are expected to be short-term (less than one month) and/or occur with low frequency
Moderate	Logically plausible effect with limited or uncertain supporting evidence	**Medium**	The effects are expected to last more than one month but less than one year or occur with intermediate frequency

High	Logically plausible effect with substantial and consistent supporting evidence, however there may be some uncertainty	**Long**	The effects are expected to last longer than one year or occur with consistent frequency
Insufficient Evidence / Not Evaluated	-	**Insufficient Evidence / Not Evaluated**	-

Table AP5-3. Health Effects Evaluation Criteria

Distribution	Will the effects, whether adverse or beneficial, be distributed equitably across populations. Will the decision reverse or undo baseline or historical inequities?	Evidence	How strong is the body of evidence (literature, stakeholder input, local data) supporting the effect characterization?
Disproportionate Harm	The decision may result in disproportionate adverse effects to populations defined by demographics, culture, or geography	**Limited**	There is some evidence found in academic and grey literature but the evidence is not overwhelming; and/or the effect characterization is based on local expert knowledge and/or data
Even	The benefits and burdens of the decision are likely to distribute near evenly across the affected population	**Mixed**	The evidence found in the academic and grey literature shows mixed results and or there are conflicting local expert opinion and/or contradictory data
Disproportionate Benefits	The decision may result in disproportionate beneficial effects to populations defined by demographics, culture, or geography	**Strong**	The evidence found in academic and grey literature appears to be conclusive with little or no evidence to the contrary; the opinions of local expert and the public are nearly unanimous.
Restorative Equity Effects	The decision has the potential to reverse or undo existing or historical inequitable health-relevant conditions or health disparities	**None found / Not Evaluated**	-
Insufficient Evidence / Not Evaluated	-		

Appendix 6

City of Hoboken, New Jersey
Proposed Stormwater Management Plan
Health Impact Assessment (HIA)

Focus Group Topic Guide and Summary Notes

INTRODUCTION

During the HIA Assessment Phase, the project team conducted two resident focus groups– one with low-income residents living in Hoboken Housing Authority properties and one with senior citizens aged 65 and over living throughout the city. The purpose of the focus groups was to collect primary data related to flooding experience and its effects on individual health and mental health as well as to solicit community input on potential flood mitigation strategies. The focus groups were intended to ensure for potentially vulnerable populations to provide input into the HIA process.

FOCUS GROUP TOPIC GUIDE

[Focus Group Runtime = 90 minutes]

I. INTRODUCTION (5 minutes)

1. Moderator introduces self and identifies Rutgers University and NJ Future as the research facilitators.

2. Explain what focus groups are for and how they work:
   - Groups have common denominators; focus closely on a topic.
   - We use a "Topic Guide," but it is primarily an open discussion.
   - Observers/recording; only one person speaks at a time, and please start your comments by saying your name first.
   - We are interested in everyone's opinion; no right or wrong answers to the questions.

3. Time Limit – we'll be done and you'll be on your way home around 8:30.
   - Incentives – you'll receive the incentive when we're finished with the discussion, just as you leave.

4. Provide brief overview of the HIA process and the Hoboken project

5. <u>Our purpose tonight</u>: To discuss how chronic flooding in Hoboken affects the lives of City residents and their health and how proposed changes to the City's stormwater management plan may affect health over the long term.

II. STATEMENT OF CONFIDENTIALITY (5 min)

Moderator: Before we begin, I want to make three points.
First, your participation is in this focus group is completely voluntary; however, your opinions are highly valued and will be a critical part of our success. You may choose not to answer any questions you are not comfortable answering. If at any time during our conversation you wish to stop participating, you are completely free to do so.

Second, your participation is confidential. Confidential means that the research records will include some information about you, such as your name and your contact information. The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated.

Finally, as part of the focus group discussion I will be asking you to remember back to how past flooding events in Hoboken–including Hurricane Sandy–may have impacted you and your family. Depending on how much these events impacted you and your family it may be stressful to think about these things. If after today's discussion or for any reason you feel like you could benefit from mental health counseling or other storm-recovery services, there are resources available from the ***Hudson County Long-term Recovery Committee*** and the ***NJ Mental Health Cares***. I have a flyer with me tonight that provides information and contact information on how to access services.

III. BASIC INFORMATION (10 min)

Assistant moderator flips page on easel to show the following items pre-listed on the next page:

1. To get to know each other a little, let's go around the room and share with each other this basic information.
    a. Your first name or nickname?
    b. In what part of Hoboken do you live?
    c. How long have you lived in Hoboken?

Now please write your first name on the tent card in front of you.
Now that we all know each other a little better, let's begin our discussion.

IV. INITIAL WRITTEN SCRIPTS (2.5 min)

Assistant Moderator: Hand out one large index card to each participant.

I'd like each of you to jot down up to three "bullet points" that tell us anything you want us to know about your experience with flooding in Hoboken. That could be about the number of times you have been flooded, how the flooding impacted you personally, or anything else that you would like us to discuss this evening.

[Runtime to this point = 22.5 minutes]

V. EXPERIENCES DURING HURRICANE SANDY (5 min)

1. How many of you lived in Hoboken during Hurricane Sandy?
2. What were some of your experiences during and after Hurricane Sandy?
    a. Did you evacuate?
    b. Were you without power?
    c. Was your home or apartment damaged?
    d. How was it damaged?
    e. Have there been any lasting effects of the damage to your home?
    f. What other impacts did you experience?

VI. EXPERIENCES WITH CHRONIC FLOODING IN HOBOKEN (10 min)

1. How often do you witness flooding in Hoboken?
2. How often are you personally impacted by flooding in Hoboken?
    a. Would you say you have become accustomed to the flooding?
    b. What adjustments do you make when you expect flooding to occur?
3. Do any of you regularly evacuate when you expect flooding?
    a. Where do you go?
    b. How long do you stay?
    g. What was your experience like staying were you stayed?
4. Do you have own a car/truck or other vehicle that you keep in the City?
    a. Do you have to move your vehicle because of chronic flooding?
    b. How would you describe the impacts of having to do this?

VII. IMPACTS OF CHRONIC FLOODING ON HOUSE/HOME (10 min)

1. Has your home/apartment ever been impacted by flooding?
    a. What type of impacts do you experience?
    b. About how often?
    c. Do you have renters/homeowners insurance?
    d. Did/does insurance cover the damage?
2. What do you do to limit damage from chronic flooding?

VIII. IMPACTS OF CHRONIC FLOODING ON WORK/WAGES (5 min)

1. Have you missed work because of flooding in Hoboken?
    a. About how often?
    b. Why did you miss work?
        i. Got sick
        ii. Had to clean-up damage
        iii. Could not get to work because I lacked transportation
        iv. My place of work was closed due to flooding or the threat of flooding

IX. IMPACTS OF FLOODING ON HEALTH/WELL-BEING (15 min)

1. Does regular flooding impact your health in anyway?
    a. Were you or members of your family injured in any way by passed flooding events?
    b. Is it difficult to get prescriptions and or other needed medical care after flooding events?
    c. Is it difficult to access healthy food options during and after flooding events?
    d. Do you regularly have any restrictions on the use of drinking water?
    e. Are your toilets/bathroom facilities functioning during and after flooding events?

f. When you anticipate or experience flooding would you say you smoke more?
g. When you anticipate or experience flooding do you consume more alcohol?
h. Does flooding cause you to be stressed, depressed or anxious?
i. Have you ever sought counseling or other services to help you cope with flooding?

2. Have you ever come in contact with flood waters?
    a. What were the circumstances?
    b. Do you believe you became sick as a result?
3. Have you ever experienced sewers backing up during or after flooding events?
    a. How frequently?
    b. Did you come in contact with materials from sewer-back-ups?
    c. Do you believe you became sick as a result?
4. Are you responsible for or have you ever had to clean up after being flooded or experience sewer back-ups?
    a. Did you take precautions to protect your health when cleaning up flood waters or sewer backups?
    b. What kind of precautions do you take?
    c. Do you think you have the information you need to clean up safely?
5. Do you feel flooding has impacted your health in any other way?
6. Do you actively participate in water-based recreational activities in and around Hoboken?
    a. What kind of activities?
    b. How long do you wait after flooding events to take part in these activities?
    c. Do you ever recall any warning about the safety of water quality in the Hudson River during or after flooding events?

X. GREEN INFRASTRUCTURE BENEFITS AND RISKS (20 min)

[INTRODUCTION: Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby waterbodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, degrading the quality of the receiving waters. Higher amounts of rainfall can also cause erosion and flooding in streets and urban streams, damaging habitat, property, and infrastructure.]

1. Have you ever heard the term “Green Infrastructure”

    [Recite DEFINITION of GI: *Green infrastructure uses vegetation, soils, and natural processes to manage storm water and create healthier urban environments.*

    Distribute print-outs of Green Infrastructure strategies: *We are now going to look at a series of pictures and briefly discuss different types of Green Infrastructure strategies that the City of Hoboken is considering to help reduce chronic flooding and sewer back-ups and overflows during periods of heavy rain.]*

2. What are your reactions to these strategies?
    a. Do you think implementing these strategies will make a positive contribution to the city?
        i. What benefits to you think they might provide?

1. Would having more trees, plants and green space be positive for you and your family?
2. Would you utilize new parks and walking/biking trails?
    a. How do you think you would use them and how often?

b. Do you have any concerns about implementing any of these strategies?
    i. What are your concerns?
c. How do you think implementing these strategies might impact your health?
    i. What positive impacts might there be?
    ii. What about negative impacts?

XI. WRITTEN POST-SCRIPTS (2.5 min)

Assistant Moderator: Hand out one large index card to each participant.

Finally, I'd like each of you to jot down up to three "bullet points" that tell us w about your experiences with chronic flooding in Hoboken and what the City is doing to address flooding. These could be the most important things you think were mentioned tonight, or it could be things we did not mention but you would like us to know about, or anything you'd like.

XII. ADJOURN FOCUS GROUPS

Thank you for participating. Your help and input is extremely valuable to us. Now, please leave the index card at your seat, and move into the next room where we will distribute the incentives. Again, thank you for your help.

Hoboken Housing Authority Residents Focus Group

Meeting Notes

Date/Time/Location:
Tuesday, March 10, 2015
7 PM – 8:30 PM
Adams Street Residence Meeting Room

Facilitator: Jon Carnegie, Rutgers University
Staff support: Teri Jover, New Jersey Future; Ryan Whytlaw, Rutgers University

Participants:
Eight (8) individuals participated as part of this focus group.

I. Introduction

The focus group facilitator introduced himself and the project staff and provided an overview of the HIA project, emphasizing that the analysis will focus on chronic flooding and how it relates to health and the city's proposed stormwater management plan. He explained what focus groups are and how they work, including a few meeting ground rules.

II. Statement of Confidentiality

Participants were instructed regarding the need for them to provide consent to participate in the focus group. The facilitator highlighted that participation is voluntary and confidential. He also acknowledged that talking about past flooding experiences can bring up stressful memories and offered referrals for mental-health counseling or other storm-recovery services. Participants were then asked to review and sign the informed consent form and received a hand-out with information on how to access mental-health and other services if needed.

III. Experiences During Hurricane Sandy

Participants were asked to describe their experiences during Hurricane Sandy. Among the comments:

Extent of the flooding:

- Looking out window on 9th St between Jefferson and Adams, looking east to Washington Street: assumption was that the water would come from east, but saw man running from Jefferson to 9th and a wave of water came around the corner and within seconds cars were underwater.
- Water came down 2nd St like a whistle (live on Harrison by light rail).
- Generators did not kick-in because the water overwhelmed the area.
- Harrison and Jackson Streets always had flooding.
- Flooding worse because of the increased construction. Building on the water is part of the problem.

Aftermath conditions:

- For two weeks: without electricity; smell of gasoline; "mysterious green ooze" in the water; smell of sewage; and standing water.

- Fish in the water.
- Didn't pump out the water, had to wait for it to recede.
- Kids were running through the water.
- NY police and military assisted during weeks after the storm.
- Hospital was flooded and closed.
- Residents were able to boil water using gas stoves (manually lit).
- Community came together to help each other out and share resources.

Evacuation:

- Toward the end of the storm, residents were advised to evacuate building, but not before. They had the buses beforehand, but it was not clear where people were going to be taken. Buses left before the storm.
- First evacuees were ground floor apartments.
- National Guard came a few days after with boats to get people out.
- This group decided to stay in their apartments – did not expect it to be "that bad."
- City provided buses to Wallace Elementary School, but they flood too. Felt more comfortable in own homes and the buildings are very strong.
- Would not want to go through this experience again. Life stood still for two weeks.
- What would you do if another Sandy type of storm came?
    - Initially, most people indicated they would likely stay in the event of another storm, except for one person whose husband has a pacemaker.
    - Upon revisiting the question, several more people said they would go to family in Bellville, Union City and Secaucus, which do not flood.
    - One participant indicated that for Irene his family had to split up and stay with different grandparents.

Impact on mobility:

- After the storm, could not get to work. Eventually took down the NJ TRANSIT fence behind the light rail stop and then people could walk to Franklin/Palisade Ave to go to work in Jersey City.
- One participant could not reach mother, who was stranded in another building in a wheelchair. Daughter had to push policy/emergency workers to get her out.
- A few participants lost their cars during Sandy.

Other observations:

- Harrison and Jackson Streets always had flooding, but now that there is new development in the area it seems that people are paying more attention to the problem.
- Flooding worse because of the increased construction. Building on the waterfront is perceived to be part of the problem.
- Historically, downtown did not flood, but now it is starting to flood when there is a heavy rain.

Equity considerations:

- Now that there is new development in the area it seems that people are paying more attention to the problem.
- Housing Authority residents were forgotten in the aftermath. City Hall ignored them.
- HHA areas were the last to be emptied and were given fewer supplies. This did include the residents of the new condo developments.
- Eventually food trucks and donations did arrive.

IV. Experiences with chronic flooding in Hoboken

Participants were asked to shift their focus from Sandy recollections to their experiences with everyday flooding in Hoboken.

Extent of flooding:

- A heavy rain will cause flooding up to and over the curb, often into the middle of the street.
- Living in Hoboken for 62 years and have seen floods for 62 years.
- Floods quickly on Harrison Street – will have to walk through water to get home in a heavy rain.
- Have to go out of the way to reach delis, etc. because of regular flooding. Laundromat, super food and liquor store gets flooded every year.
- Heavy rain, water from Wash Street and water from hills runs off into this area.
- From Harrison to Jackson is a mess after a flood.

Damage due to regular flooding:

- Foundation of some HHA buildings falling apart after Sandy.
- Construction of new condos on empty lots and old factories – new residents now getting lawyers because of the frequent flooding.
- Wise to put something on the roofs of these new buildings to absorb water.
- Black "gunk" left behind after a storm; condos pay someone to wash it off the sidewalks, but not the HHA buildings and other residences.

Sewage:

- Since 2006, there have seen people cleaning out the sewer drains and pipes, but water still pushes through and backs up into the streets.
    - The facilitator explained what a combined sewer system is and noted that Hoboken is served by a combined sewer system. Participants were not aware of the problem but recognized the impacts (e.g., smell, contaminants in water, etc.)
- Participants acknowledged the heavy sewer smell during storms, noting that toilet paper is often seen floating in the street.

Mobility issues:

- Residents do not typically evacuate due to regular flooding.
- One participant reported he was not able to get to work several times. Another reported she could not get to a job interview because of flooding.

- Kids often have trouble getting to school, and if they do go, they play in the water and arrive at school soaking wet and smelly.

Health impacts:

- Some reported feeling sick due to strong smell. Like a toilet bowl and in the summer it is terrible.
- 4th and Jackson – sewer smell is very strong; "sewage heaven"; also Harrison.
- In summer, after a flood there are a lot of mosquitos and flies. Repellants do not work. Conditions seem worse than in previous years.
- Street sweepers after a flood raise dust and put kids with asthma at risk.
- Often there are rashes – person that works at Boys and Girls Club corroborated this.
- Some parents limit the time kids play in the park because of the residue left behind after a strong rain.
- Injuries experienced during floods:
    - One person fell over a manhole cover when it came loose.
    - Another person fell into a storm drain as a child.
- Concerned about contaminants in the flood waters, including the impacts of the "green gunk" post-Sandy. Grass doesn't grow in these areas.

Coping strategies:

- Leave shoes in hallway to avoid bringing in dust/dirt.
- Rubber boots – everyone has them. Sometimes the flood goes over the top of the boots.
- There was some concerned about odor in the running water and as a result they don't use it to brush their teeth. It was suggested that the odor might be due to reservoir levels.

Wildlife:

- Increase in the number of wildlife seen post-flood. One theory is that they were scattered into "upper areas" after Sandy and are coming down.
    - Rabbits – have not seen in many years and they have re-emerged.
    - Skunks – in particular on Jackson Street.
    - Squirrels – in particular on Harrison Street, very aggressive.

V. Green Infrastructure Benefits and Risks

The facilitator provided an overview of green infrastructure best management practices and the City's stormwater management plan update that is underway. He walked participants through a handout called "What is Green Infrastructure?" with visuals to illustrate the concepts and also talked through a packet called "City of Hoboken Proposed Stormwater Management Plan Amendments Health Impact Assessment," which included a collection of photographs illustrating the range of different green infrastructure best management practices being considered as part of the Hoboken Storm Water Management Plan update.

Positive responses

- Permeable pavement is definitely needed on the west side of Hoboken.
- Some support the BASF proposal because of the incorporation of parking, which is in high demand.
- It was suggested that the plan will lessen the blow, but there was acknowledgement that the flood will still happen.
- One participant suggested starting with swales on outer edge of Hoboken.

Concerns about implementation

- There was concern about installing giant tanks/cisterns to collect rainwater because it might attract mosquitoes, flies and gnats, which are already a problem. Participants mentioned a previous proposal to install storage along western edge of city near HHA property.
- It was suggested that green infrastructure is not being installed in much of the new condo development, which is a missed opportunity.
    - One participant noted that there is a rain garden installed at 7th and Jackson.
- Concerned about the cost of maintaining the green infrastructure, especially since the city can't stay on top of pot holes.
- There was skepticism about the BASF project helping the HHA neighborhoods.
- Concern about storage tanks because of vandalism, mosquitoes, flies, gnats. Already have a lot of these.

Equity concerns

- Participants asked if the green infrastructure like rain gardens, stormwater tree pits and infiltration planters being considered will be installed at any of the housing authority properties.
    - The facilitator suggested pervious pavement might be an option for some of the areas.
- Does this study include the housing authority residents/properties?
    - The facilitator replied that this is one of the reasons for the focus group. Findings from this meeting and the HIA will be shared with the city council and planning board.
- BASF is good for the east side, but the west side has to worry about flooding from all directions.
- Seems like the city only cares about 9th St by the ShopRite.
- City has installed new pipes across the city, but not in the HHA areas. Worried they may be funneling water into their neighborhood.
- Participants encouraged city to have an open forum where residents can come voice opinions, with visuals and an opportunity to comment.

General questions

- Can existing buildings be retrofitted for green roofs, etc.?
    - The facilitator replied that it depends on the buildings' structural engineering.
- If all this done in Hoboken, and none of surrounding towns participate, what is the point?

VI. Adjournment

The facilitator thanked participants for their time and valuable input. He asked them to fill out forms in order to receive cash incentive payments.

Senior Residents Focus Group

Meeting Notes

Date/Time/Location:
Tuesday, April 28, 2015
10:30 AM to 1 PM
HOPES CAP, Rue School
301 Garden Street, Hoboken

Facilitator: Jon Carnegie, Rutgers University
Staff support: Teri Jover, New Jersey Future; Ryan Whytlaw, Rutgers University

Participants:
Six (6) individuals participated as part of this focus group.

I. Introduction

The focus group facilitator introduced himself and the project staff and provided an overview of the HIA project, emphasizing that the analysis will focus on chronic flooding and how it relates to health and the city's proposed stormwater management plan. He explained what focus groups are and how they work, including a few meeting ground rules.

II. Statement of Confidentiality

Participants were instructed regarding the need for them to provide consent to participate in the focus group. The facilitator highlighted that participation is voluntary and confidential. He also acknowledged that talking about past flooding experiences can bring up stressful memories and offered referrals for mental-health counseling or other storm-recovery services. Participants were then asked to review and sign the informed consent form and received a hand-out with information on how to access mental-health and other services if needed.

III. Experiences During Hurricane Sandy

Participants were asked to describe their experiences during Hurricane Sandy. Among the comments:

History of flooding:

- Prior to Sandy, streets/neighborhoods had little to no history of flooding. One participant reported no cases of flooding in 58 years.
- There were reports of storm sewers backing up into streets, but not flooding of homes.
- One participant who lives in a housing authority residence reported that the new pumps are helping with chronic flooding, but there is still stagnant water after heavy rain.
- Hoboken is a "hole" where water runs downhill from Union City and into the projects.

Sandy flooding/damages:

- Cars were flooded and destroyed (parked in the church parking lot).
- Street level apartment of home flooded up to the top kitchen cabinets, which were not damaged.

- Five feet of flood waters surrounded apartment building (housing authority).
- Clinton/4th to Willow/6th was completely flooded.
- After the storm there was furniture and all sorts of belongings on the street, damaged by flood water. All items that were flooded had to be destroyed because of sewer contamination.
- The senior housing building went 10 days without electricity. No power for medical equipment, no elevator, etc. Supplies were provided regularly.
- Sand was found throughout the home.

Evacuation:

- Several participants related a reluctance/unwillingness to evacuate:
    - Evacuation to Holmdel during Hurricane Irene proved unnecessary as there was no flooding in her neighborhood. This made evacuation for Sandy seem less urgent.
    - Did not evacuate apartment building even after rescue boats arrived. Eventually was helped by the National Guard after the storm and then stayed at son's home in Hoboken.
    -
- Several participants did evacuate during storm:
    - Evacuated to daughter's home on Garden Street during Sandy.
    - Mayor called one participant and encouraged evacuation; moved to daughter's home in Hoboken to wait out storm.

Mobility issues:

- There were no subways available for three months after the storm.

Health observations:

- There was an oil scent pervasive after the storm.
- Mold grew in houses. Construction debris stored in crawl space caused mold damage.
- Nervousness/anxiety was rampant among residents. One participant reported her friend taking Xanax to help with the mental strain.

Other observations:

- The city is fixing the corners on Jackson Street.
- Pump station on Observer Highway not in the right place.
- How are new buildings impacting the sewer system?
- Sandy could happen again; is Hoboken ready?

IV. Experiences with chronic flooding in Hoboken

Participants were asked to shift their focus from Sandy recollections to their experiences with everyday flooding in Hoboken.

- Jackson Street is affected by chronic flooding, particularly near 4th and at the ShopRite.
- There are stagnant water spots at 2nd and Harrison St and the stagnant water smells.

- The water comes down to Hoboken from Union City.
- The larger buildings that are being built are making flooding problems worse.
- When the ShopRite area floods, grocery shopping is difficult. People have to go to the A&P or Jersey City, which can be very expensive.
- In addition to Shop Rite, local shopping center with grocery store gets flooded regularly.
- Corners need to be dealt with because the storm sewers back up a lot, maybe they need cleaning. There is always water at the corner, making it hard to walk.
- Storm drain repairs have helped with chronic flooding.
- Before the boom in new residential development, Hoboken was a big family where everyone knew everyone else.

V. Green Infrastructure Benefits and Risks

The facilitator provided an overview of green infrastructure best management practices and the City's stormwater management plan update that is underway. He walked participants through a handout called "What is Green Infrastructure?" with visuals to illustrate the concepts and also talked through a packet called "City of Hoboken Proposed Stormwater Management Plan Amendments Health Impact Assessment," which included a collection of photographs illustrating the range of different green infrastructure best management practices being considered as part of the Hoboken Storm Water Management Plan update.

Positive responses:

- Less concrete, more gardens a good thing as it looks pretty.
- Permeable pavement good because it takes water away.

Thoughts about implementation:

- Trees on Jackson St. are dying as-is. Facilitator indicated need for special design of pit to allow for water to permeate.
- New condos have some rain barrels to help manage stormwater.
- There is regularly stagnant water near the housing authority buildings and the city is not addressing it; will they be able to maintain new green infrastructure that might bring with it some stagnant water?
- Permeable pavers that allow grass to grow might take more to maintain and could be slippery. It would look nicer though.
- Is the BASF site that is proposed for storm water storage contaminated?
- What about putting storm water storage sites throughout the town to collect water?
- What are they doing about run-off from Jersey City and Union City?

Other observations:

- Could they dig a hole into the mountain to give a place for the water to go? Facilitator mentioned a proposal to design an underground parking garage to serve as storm water storage during heavy rain as well as plans to install infrastructure to absorb water before it enters Hoboken.

- Jackson St/Harrison St. used to be a marshy area.
- City does not fix things on Harrison St.; they just patch them up.

VI. Adjournment

The facilitator thanked participants for their time and valuable input. He asked them to fill out forms in order to receive cash incentive payments.

Appendix 6; Attachment A

"What is Green Infrastructure" Handout