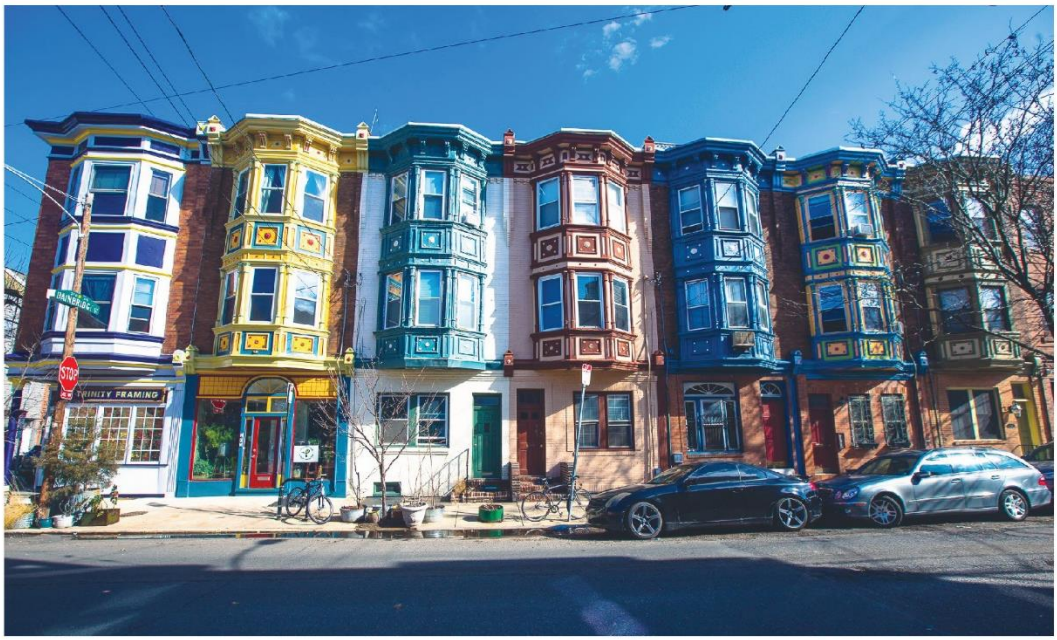
City of Philadelphia

2022 All-Hazard Mitigation Plan



City of Philadelphia
2022 All Hazard Mitigation Plan Update

FEMA 2nd Submission: May 6, 2022

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Table of Contents

Table of Figures

Table of Tables

Executive Summary

Executive Summary

The City of Philadelphia 2022 All-Hazard Mitigation Plan is an aspirational plan to mitigate, or reduce risk to, natural and human-caused hazards with the goal of improving the safety and resiliency of our City. **Hazard mitigation** is a sustained action taken to reduce or eliminate impacts of natural or human-made hazards including preventing loss of life and damage to property.

The 2022 plan update was led by the Philadelphia Office of Emergency Management (OEM) with the strong support of a Hazard Mitigation Steering Committee. The Steering Committee includes leaders from departments across the City with roles in hazard mitigation and specialties related to implementing the plan:

- City Planning Commission
- Commerce Department
- Department of Public Property
- Fire Department
- Licenses & Inspections
- Mayor's Office for People with Disabilities
- Mayor's Office of Policy
- Mayor's Office of Recovery and Grants
- Office of Emergency Management
- Office of Sustainability
- Office of Transportation, Infrastructure and Sustainability

There were additional opportunities for stakeholder engagement through working groups, stakeholder workshops and other plan-related meetings and updates. Overall, more than 190 representatives from more than 80 agencies, departments, and organizations participated in this plan update. Philadelphia OEM spread the word about this plan update and gathered public feedback through surveys, flyers, radio updates, and through several social media platforms. Robust engagement led to the priorities identified in the plan, hazard selection, and an updated mitigation strategy.

Three priorities were identified for the plan update. These themes were woven throughout the plan:

Equity

- Diversified methods of outreach to reach new people and stakeholders
- An analysis to identify populations placed at greater risk to these hazards using social vulnerability indexes and qualitative local knowledge.
- Added equity as a criterion for prioritizing mitigation actions.

Climate Change

- Examined flood risk beyond identification of the floodplain by including maps and Hazus loss estimates for a 1% annual chance flood, 0.2% annual chance flood, storm surge, and sea level rise.
- Included additional information on how climate change will impact the intensity and frequency of future disasters.

Integration

- Updated future temperature and precipitation projections based off of the *Growing Stronger: Toward a Climate-Ready Philadelphia* report which informed the Flood, Flash Flood, and Ice Jam and the Extreme Temperature profiles.
- Expanded outreach to new stakeholders and added new partners, plans, and actions to the capability assessment and mitigation strategy.

One key aspect of the 2022 All-Hazard Mitigation Plan update was updating the plan format and the hazards to match the *Pennsylvania Hazard Mitigation Plan Standard Operating Guide.* This guide aligns hazard mitigation plans across the Commonwealth allowing counties to share information and compare information about risk. Based on public and stakeholder input, the 2022 All-Hazard Mitigation Plan profiles the following hazards for Philadelphia:

Outreach and engagement, conducting a risk assessment, and defining City capabilities are all important steps in the planning process used to inform the development of the mitigation strategy. The mitigation strategy looks forward at what project, plans, and policies Philadelphia wants to complete to reduce risk to hazards. The Steering Committee and stakeholders informed an updated set of goals for the plan. These goals integrate priorities such as improving equity in implementation, planning ahead for increased risk from climate change, and integrating hazard mitigation into programs and plans across departments. The 2022 goals follow:

- **Goal 1:** Protect all life and reduce risks that exacerbate inequities in health safety.
- **Goal 2:** Build the resilience of community assets, including property, infrastructure, and cultural resources.
- **Goal 3:** Foster an economy that promotes mitigation and reduces impacts from hazards.
- **Goal 4:** Restore and enhance the natural ecology.
- **Goal 5:** Create awareness and demand for mitigation and adaptation as a standard of practice.

The 2022 All-Hazard Mitigation Plan will feature an online, executive summary which can be viewed on Philadelphia OEM's website.

1 Introduction

1 Introduction

1.1 Background

Philadelphia is a diverse city of neighborhoods, home to over 1.6 million people, numerous historical landmarks, colleges, universities, cultural treasures, and thriving businesses. Emergencies and disasters can have an extreme impact on what makes the City of Brotherly Love so great, which is why it is important to proactivity address hazard risk through mitigation. **Hazard mitigation** is a sustained action taken to reduce or eliminate impacts of natural, human-made, or technological hazards including preventing loss of life and damage to property. Mitigation actions can be taken in advance of a disaster and are essential to breaking the disaster cycle of preparedness, response, and recovery. Mitigation efforts conducted pre-disaster reduce future costs related to response and recovery efforts. In fact, a study conducted by the National Institute of Building Science in 2018 found that for every $1 spent on mitigation, $6 is saved in future response and recovery efforts. Mitigation actions can also be taken post-disaster to help a community build back stronger and more resilient for future disasters.

Figure 1-1. FEMA Mitigation Graphic

Philadelphia has experienced numerous disasters, large-scale incidents, and emergencies in the last five years, including the COVID-19 Pandemic, wide-scale civil disturbance in June 2020, Tropical Storm Isaias in 2020, and the remnants of Tropical Storm Ida in 2021. Experts predict that climate change will continue to increase the frequency and intensity of natural disasters across the United States, further stressing the importance of finding ways to reduce Philadelphia's risk before the next disaster strikes.

Mitigation is best accomplished when based on a long-term plan developed before a disaster. The City and County of Philadelphia (hereinafter referred to as Philadelphia or "the City") adopted its first **Hazard Mitigation Plan** (hereinafter referred to as the HMP) in 2012 and an updated plan in 2017. Philadelphia developed this 2022 HMP to assess current risks posed by natural and human-made hazards, and to document an updated, city-wide mitigation strategy for reducing risk that reflects the City's current priorities. The Office of Emergency Management (OEM) led the update of the 2022 HMP in accordance with the requirements of the Disaster Mitigation Act of 2000 (DMA 2020) in cooperation with other City, state, and federal agencies and departments, as well as private agency representatives and members of the public.

Disasters disproportionately impact populations across Philadelphia due to a variety of factors, including but not limited to environmental exposure, inherent factors such as age and health, as well as economic and social factors. Philadelphia is dedicated to an equitable, accessible, and inclusive planning and implementation process, with a mitigation strategy focused on strengthening the resilience of communities most at risk.

1.2 Purpose

The Philadelphia HMP represents the City's approach to mitigate impacts of natural and human-caused disasters and threats. The purpose of the 2022 HMP is to:

- Identify natural and human-made hazards and threats that pose the greatest risk to Philadelphia,
- Analyze and identify geographic areas and populations most at risk for experiencing impacts from these hazards and threats,
- Document and implement a coordinated, city-wide strategy and cost-effective measures for reducing risk to current and future hazard risk that aligns with current City priorities,
- Identify eligible projects for the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance (HMA) grant programs,
- Foster collaboration and communication amongst city, state, federal, private sector, and community partners for ongoing implementation of the mitigation plan,
- Comply with all federal and state requirements related to local mitigation planning,
- Qualify for federal pre-disaster and post-disaster mitigation funding, and
- Promote a more prepared and resilient Philadelphia before, during, and after disasters.

1.3 Scope

As a condition of receiving federal disaster mitigation funds, Section 322 of the DMA 2000 requires that local governments have a mitigation plan which is updated every 5 years. The Philadelphia 2022 HMP complies with all requirements set forth by the FEMA and the Pennsylvania Emergency Management Agency (PEMA) for the City to be eligible for funding and technical assistance from state and federal hazard mitigation programs including:

- **Building Resilient Infrastructure & Communities (BRIC):** A pre-disaster mitigation grant program offered by FEMA annually. The goal of this non-disaster grant is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on federal funding in future disasters. The program funds both structural and non-structural projects, with a focus on large projects that promote capacity- and capability-building, innovation, and partnerships. There is a 25%local, non-federal cost match required for this grant.
- **Flood Mitigation Assistance (FMA):** A pre-disaster mitigation grant program offered by FEMA annually. The goal of this non-disaster grant is to reduce flood risk to National Flood Insurance Program (NFIP) insured properties. The program funds both structural and non-structural projects. There is a 25% local, non-federal cost match required for this grant.
- **Hazard Mitigation Grant Program (HMGP):** This funding is only available after presidentially declared disasters. The purpose of HMGP is to help communities implement hazard mitigation measures following a Presidential Major Disaster Declaration in the areas of the state designated by the Governor. The key purpose of this grant program is to enact mitigation measures that reduce the risk of loss of life and property from future disasters. The 25%non-federal cost match is often covered by the Commonwealth.

Philadelphia's HMP will be updated on a continuous basis to address both natural and human-made hazards determined to be of significant risk to Philadelphia. Updates will take place following significant disasters, after an annual review each year, and/or when other plan updates impact the HMP.

1.4 Authority and References

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq.
- National Flood Insurance Reform Act of 1994, 42 U.S.C. 4101

Authority for this plan originates from the following Commonwealth of Pennsylvania sources:

- Pennsylvania Emergency Management Services Code. Title 35, Pa C.S. Section 101
- Pennsylvania Municipalities Planning Code of 1968, Act 247 as reenacted and amended by Act 170 of 1988
- Pennsylvania Stormwater Management Act of October 4, 1978. P.L. 864, No. 167

The following FEMA reference documents and guides was references when preparing this document:

- *Local Mitigation Plan Review Guide*, October 2011
- *Local Mitigation Planning Handbook*, March 2013
- *Mitigation Ideas*, January 2013
- *Hazard Mitigation Assistance Mitigation Action Portfolio*, 2020
- *Building Community Resilience with Nature Based Solutions,* June 2021
- FEMA's *Guides to Expanding Mitigation*, 2020-2021
    - *Making the Connection to People with Disabilities*, 2021
    - *Making the Connection to Wildlife,* 2021
    - *Connecting Mitigation and Codes and Standards*, 2021
    - *Connecting Mitigation and the Whole Community*, 2021
    - *Connecting Mitigation and Communications Systems*, 2021
    - *Connecting Mitigation and Equity,* 2020
    - *Connecting Mitigation and Electric Power*, 2020
    - *Connecting Mitigation and Municipal Financing,* 2020
    - *Connecting Mitigation and Transportation,* 2020
    - *Connecting Mitigation and Public Health,* 2020
    - *Connecting Mitigation and Arts and Culture,* 2020
- *Hazard Mitigation Assistance Guidance*, February 2015
- *Integrating Hazard Mitigation Into Local Planning*, March 2013
- *Plan Integration: Linking Local Planning Efforts*, July 2015
- *Integrating Hazard Mitigation into the Local Comprehensive Plan*, July 2017
- *Resilience and Climate Change Adaptation* Job Aide, 2018

The following PEMA guides and reference documents were used prepare this document:

- *Pennsylvania Hazard Mitigation Plan Standard Operating Guide* (PA SOG), 2020
- *Flood Plain Management Regulations,* July 2010
- *County Hazard Mitigation Plans Lessons Learned Document*
- Plan Integration Guide, July 2014

The following guidance document produced by the National Fire Protection Association (NFPA) assisted in the creation of standard list of hazards in the PA SOG followed in this plan:

- NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs. 2007.

In addition, planners referenced numerous data sources to assist with hazard profiles, formulation of the risk assessments, and mitigation project development. Please see the Appendix A: Bibliography for more details.

2 Community Profile

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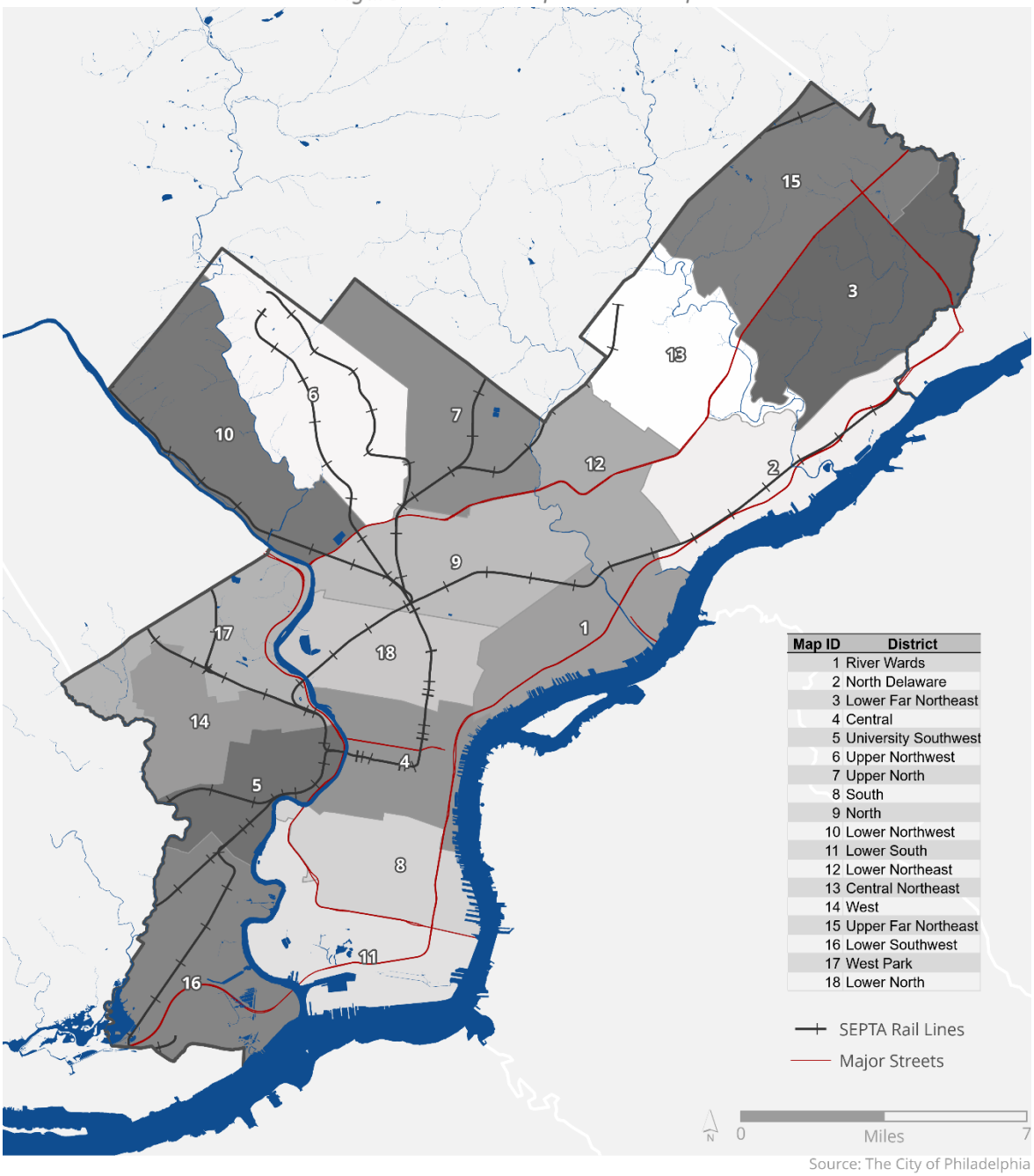
2.1 Geography and Environment

Figure 2-1. Philadelphia Base Map



Source: The City of Philadelphia

2.1.1 Geography

Philadelphia initially encompassed the area between South and Vine Streets, ending at the Delaware and Schuylkill Rivers (Independence Hall Association, n.d.). In 1854, citizens voted to pass a bill that consolidated settlements that sprang up outside the city's borders (such as Northern Liberties, Spring Garden, and Moyamensing) into what would become the county, and City, of Philadelphia.

Today, the City encompasses 134.1 square miles of land in the southeastern region of Pennsylvania. The City is bordered by Bucks County to its north, Montgomery County to its west, Delaware County to its south, and the state of New Jersey to its east (the Delaware River separates the City of Philadelphia from the State of New Jersey). Philadelphia is the largest city in Pennsylvania. The City of Philadelphia is coterminous to Philadelphia County, meaning the City and County of Philadelphia share the same boundaries. The U.S. Census Bureau places Philadelphia at the urban center of a four-state "Greater Philadelphia" region, otherwise known as the Delaware Valley, which is comprised of the 11 counties within the Metropolitan Statistical Areas (MSA) of Philadelphia-Camden-Wilmington. The Delaware Valley is home to approximately six million people and is the country's sixth-largest metropolitan area.

2.1.2 Hydrology and Hydrography

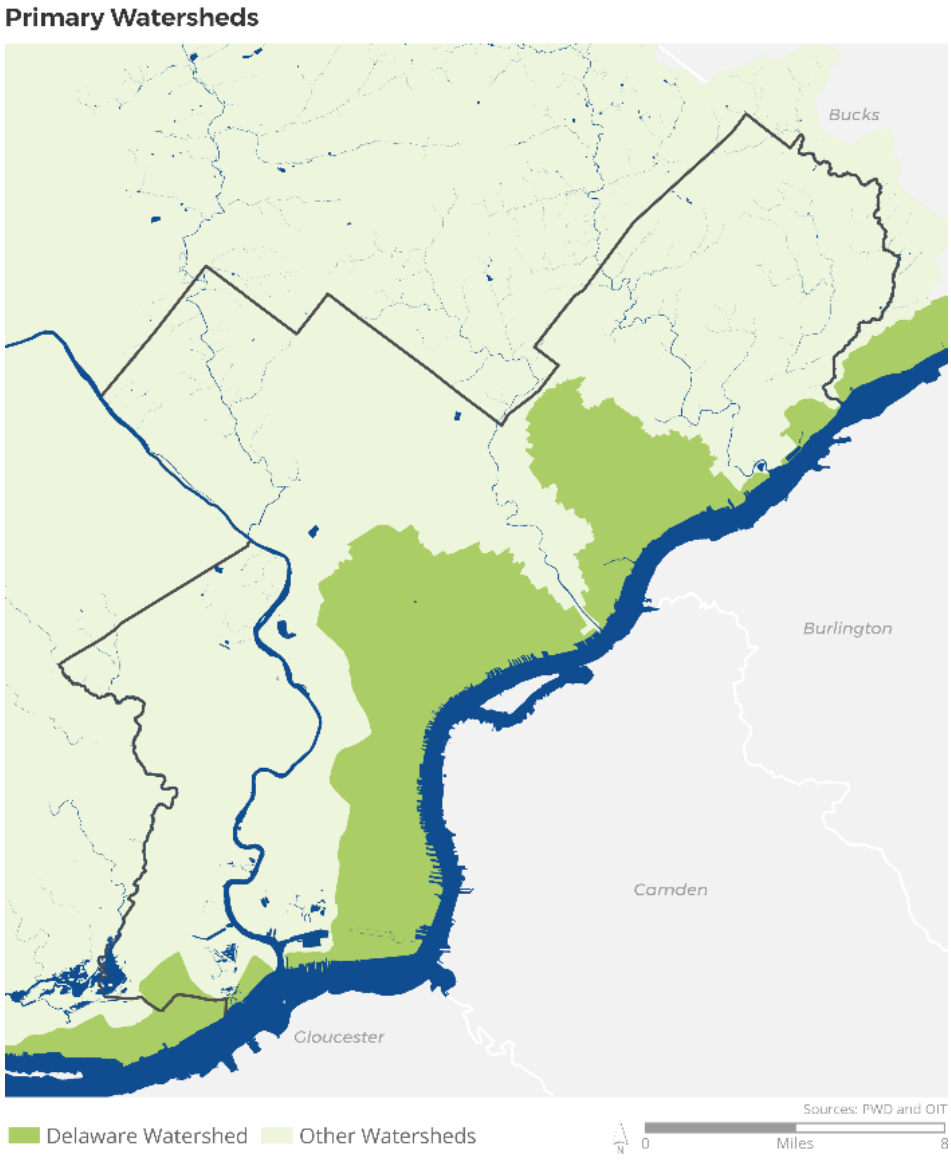
Numerous creeks, rivers, and waterways pass through the City of Philadelphia, including the Delaware River, Schuylkill River, Wissahickon Creek, Pennypack Creek, Frankford Creek, Poquessing Creek, and Cobbs Creek. All the major bodies of water within Philadelphia are part of seven primary and secondary watersheds. Within Philadelphia's watersheds, 54% of the surfaces are impervious, which is why many areas of the city are prone to flash flooding.

2.1.2.1 Primary Watersheds

Delaware Watershed

The Delaware River watershed encompasses areas of four states, 42 counties, and all or parts of 838 municipalities in the Mid-Atlantic region. Philadelphia constitutes approximately 40 square miles of the Delaware River Watershed, which drains 13,000 square miles overall. The watershed contains 23,700 linear miles of streams, 21 of which are located within Philadelphia. An estimated 7.7 million people reside within the watershed, about 500,000 of which live in Philadelphia. The land use composition for this watershed is estimated at roughly 55% forest, 26% agriculture, and 15% developed. The developed area within Philadelphia is estimated to be 72% impervious surface and highly susceptible to flash flooding (Philadelphia Water Department (PWD), n.d.-b).

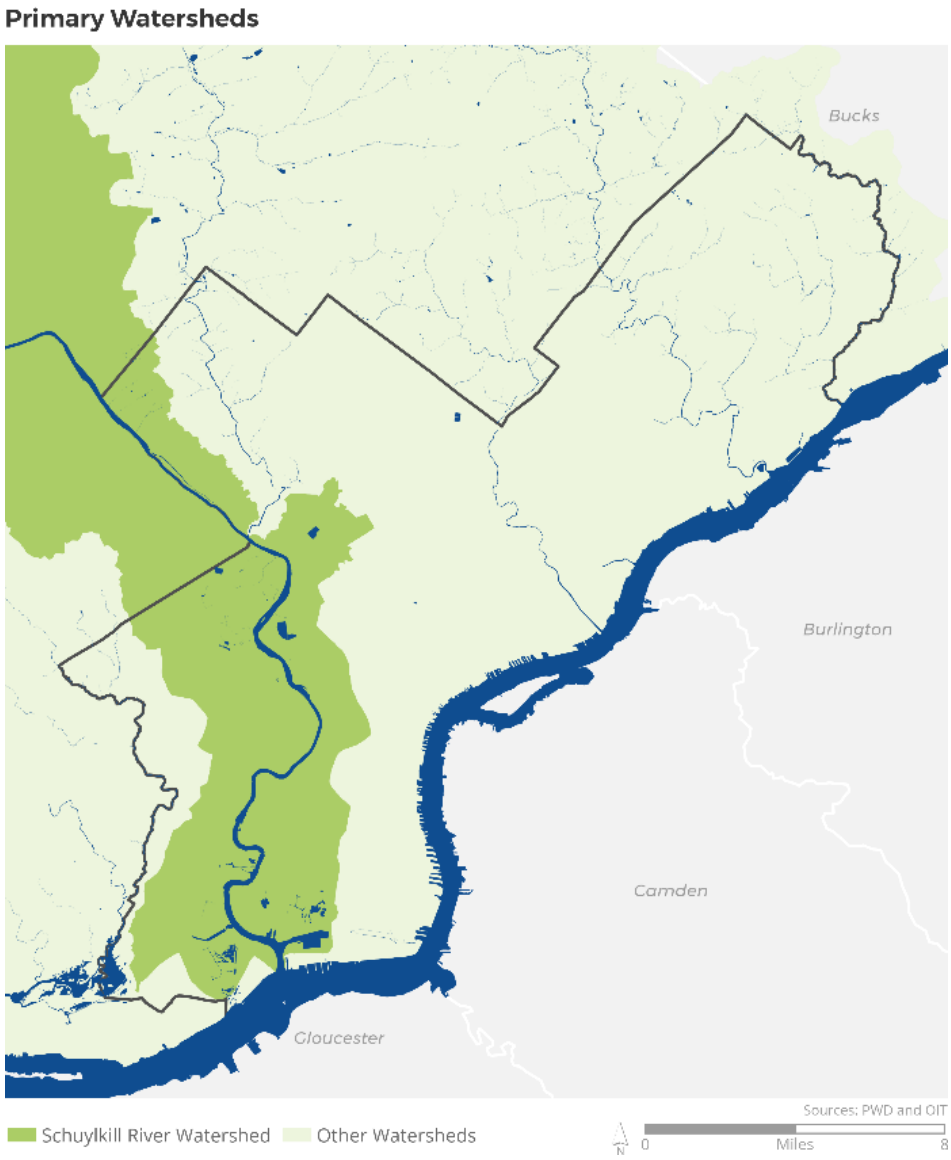
Figure 2-2. Delaware Watershed (PWD)



Schuylkill River Watershed

The Schuylkill River Watershed drains approximately 2,000 square miles and encompasses around 130 linear miles of streams. One-quarter of the watershed is designated as high quality or exceptional waters and serves as a natural border between the City of Philadelphia and Lower Merion Township. The Schuylkill River flows through Fairmount Park, originally established to preserve the water quality in the Schuylkill for Philadelphia's drinking water supply. The river is the largest tributary to the Delaware River. The watershed encompasses 11 counties including Philadelphia. Approximately 1.5 million residents live in the Schuylkill River Watershed. Approximately 10% of the area in the Schuylkill River Watershed in Philadelphia is impervious surfaces and highly susceptible to flash flooding (PWD, n.d.-e).

Figure 2-3. Schuylkill River Watershed (PWD).

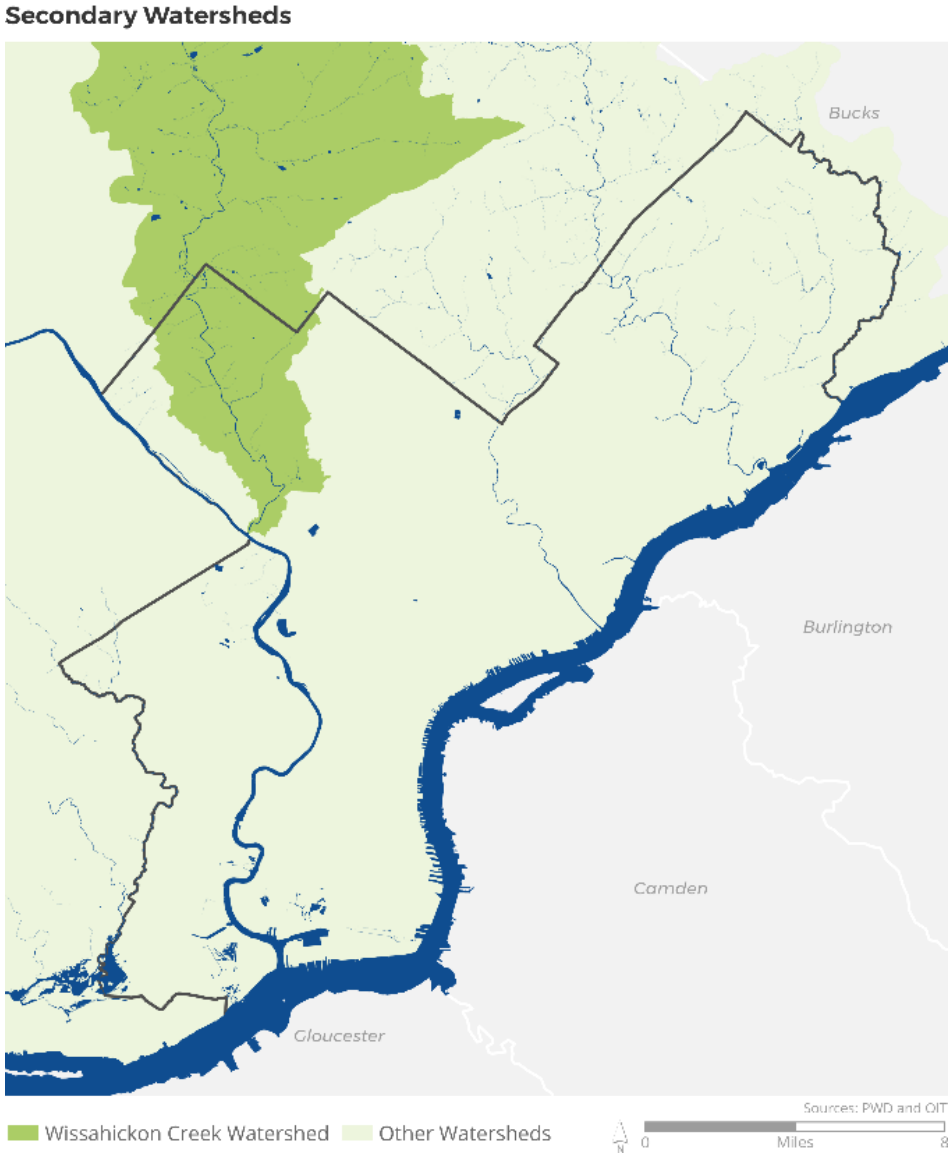


2.1.2.2 Secondary Watersheds

Wissahickon Creek Watershed

The Wissahickon Creek Watershed drains approximately 64 square miles and contains around 134 linear miles of streams. Headwater tributaries begin in Montgomery County, flowing into the Schuylkill River in Manayunk. Altogether, 160,000 residents live within the Wissahickon Creek Watershed, including those from the areas of Montgomery and Philadelphia Counties. About 24% of the Wissahickon Creek Watershed is impervious, making those areas subject to higher risks for flash floods. The suburban portion of the watershed has developed rapidly over the last decade causing strain on the water resources, mostly from increased storm water runoff and discharge of treated wastewater (PWD, n.d.-g).

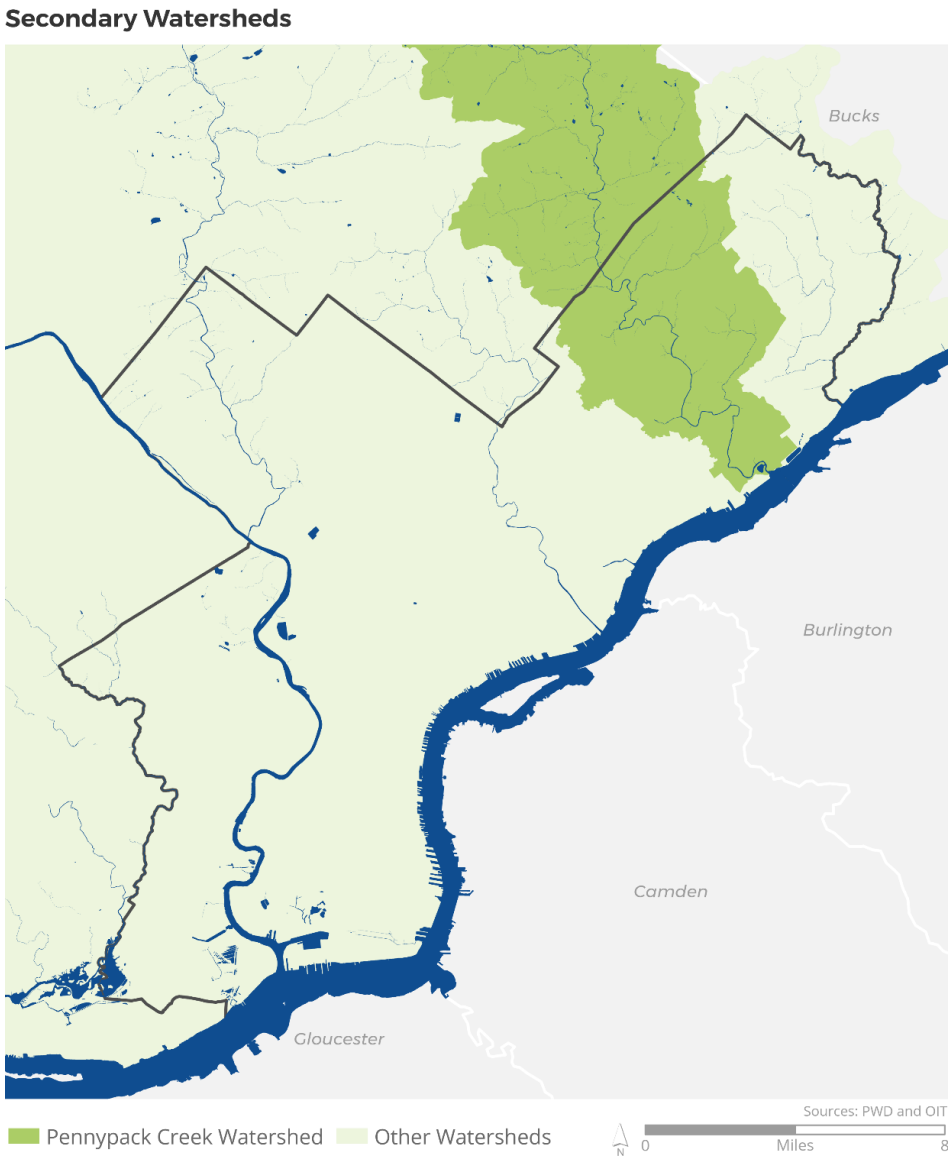
Figure 2-4. Wissahickon Creek Watershed (PWD)



Pennypack Creek Watershed

Pennypack Creek rises from headwater springs and wetlands in the suburbs of Horsham, Warminster, and Upper Southampton, and drops into the winding greenbelt of Philadelphia's Pennypack Park before discharging into the Delaware River. The watershed drains approximately 56 square miles, encompassing portions of Montgomery, Philadelphia, and Bucks Counties. Pennypack Creek Watershed includes approximately 230,000 total residents. Roughly 33% of the watershed within the City limits is impervious, and therefore may be prone to flash floods (PWD, n.d.-c).

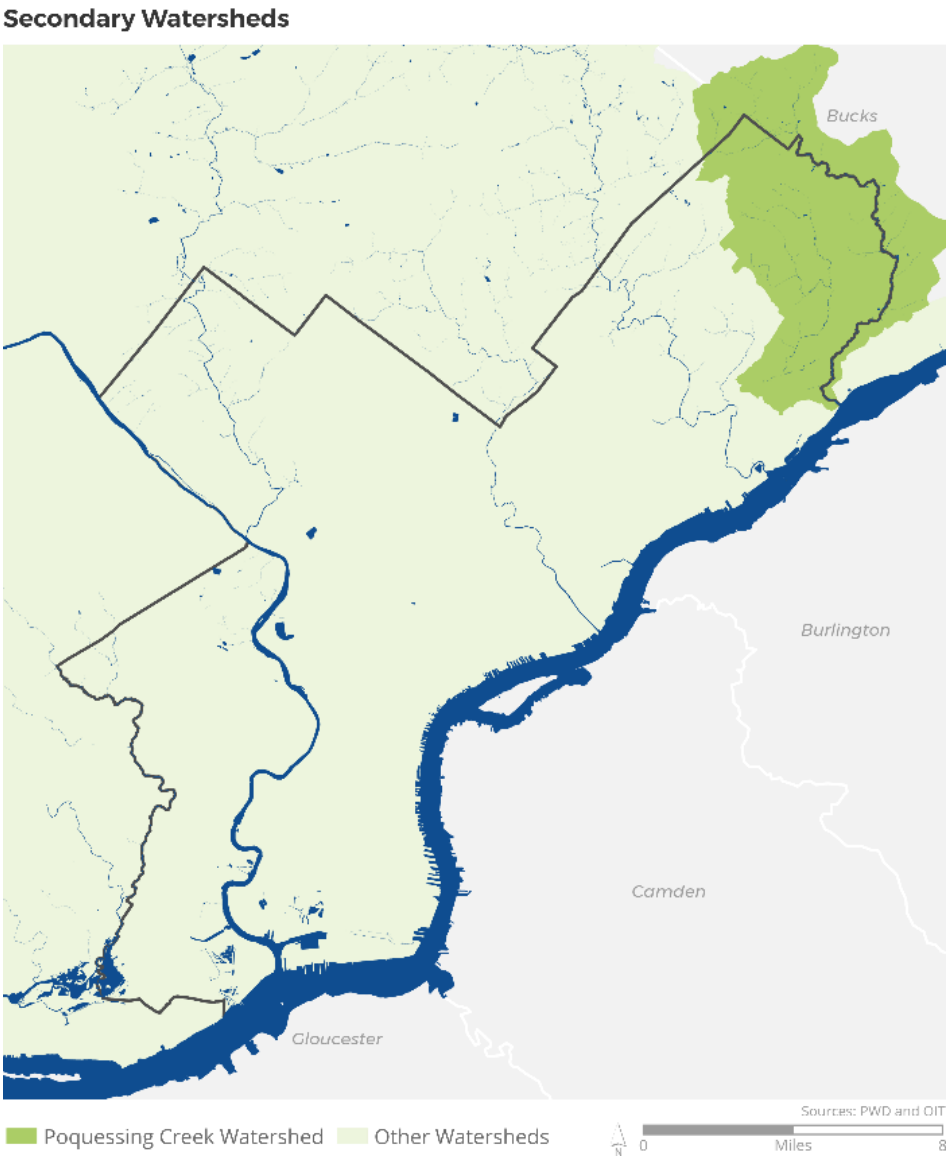
Figure 2-5. Pennypack Creek Watershed (PWD, n.d.)



Poquessing Creek Watershed

The Poquessing Creek Watershed forms from tributary streams in Lower Moreland and Lower Southampton Townships. These waters join the main stem of Poquessing creek, carving the border between Bensalem Township and Philadelphia before flowing into the Delaware River. Byberry Creek is a major contributing stream, draining backyards of Northeast Philadelphia before joining the Poquessing just above Frankford Avenue. The watershed encompasses about 22 square miles of drainage area in the areas of Philadelphia, Bucks, and Montgomery counties. Poquessing contains 45 linear miles of streams and is home to 105,000 residents. The watershed has 38% impervious cover within the City's borders, increasing the area's risk of flash flooding (PWD, n.d-d).

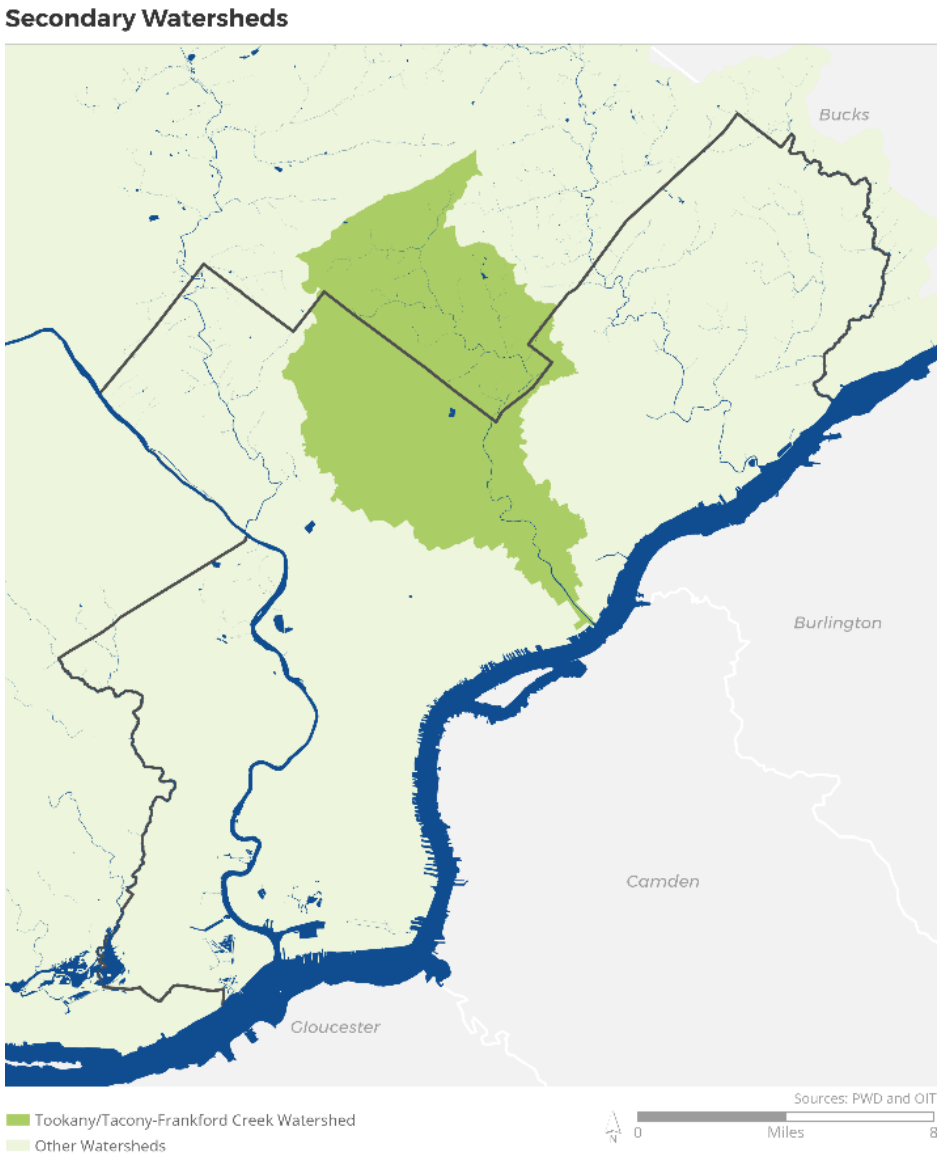
Figure 2-6. Poquessing Creek Watershed (PWD).



Tookany/Tacony/Frankford Watershed

The Tookany/Tacony/Frankford Watershed drains approximately 33 square miles of parts of Philadelphia and Montgomery Counties, with all or parts of five municipalities, including Abington, Cheltenham, Jenkintown, Rockledge, and Springfield. Approximately 360,000 individuals reside within the Tookany/Tacony/Frankford Watershed, with 285,405 living in Philadelphia. Within the watershed and the City's borders, 48% of the area is covered by impervious cover, making almost half of the watershed prone to flash flooding (PWD, n.d.-f).

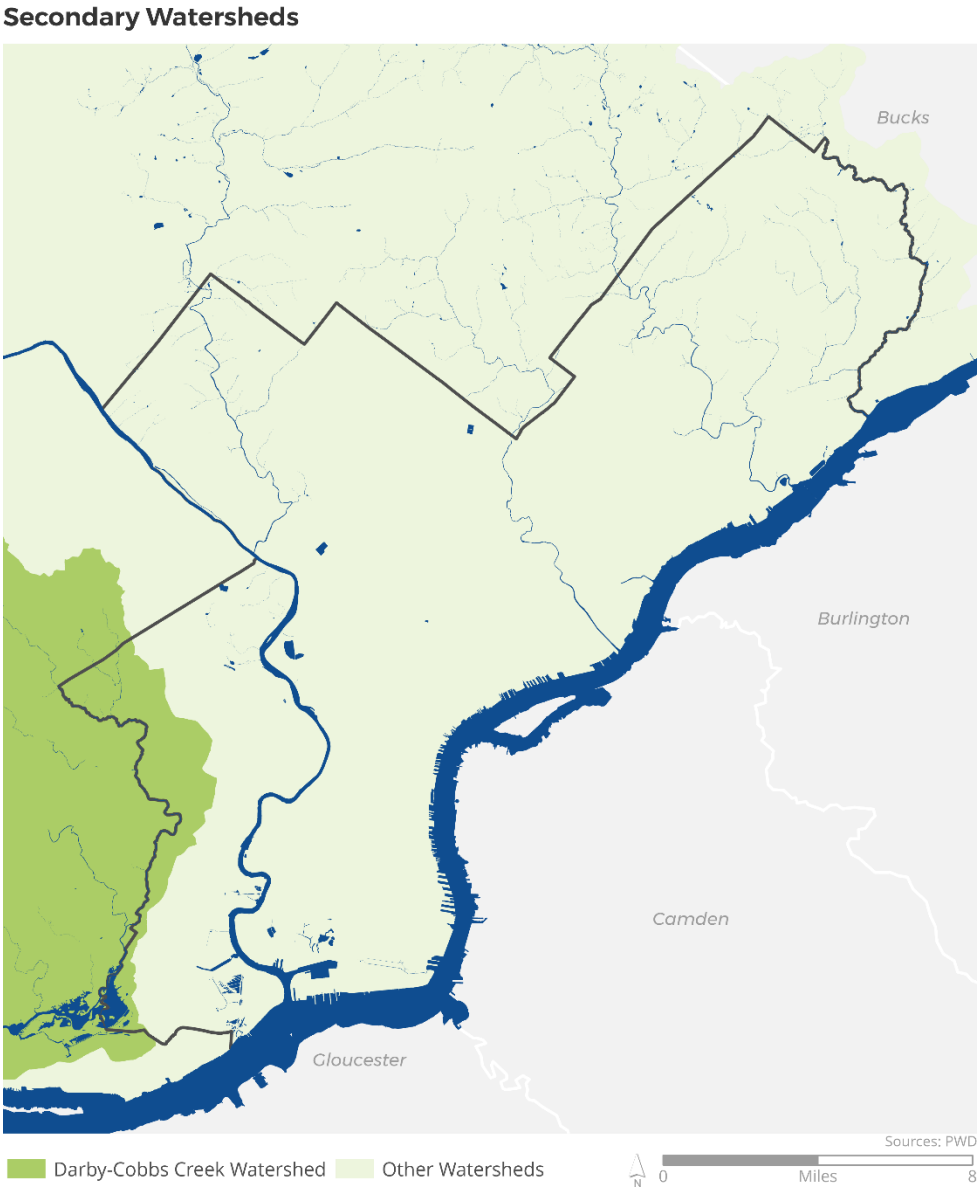
Figure 2-7. Tookany/Tacony/Frankford Watershed (PWD)



Darby-Cobbs Watershed

The Darby-Cobbs Watershed drains approximately 77 square miles, including parts of Chester, Delaware, Montgomery, and Philadelphia counties, with the Cobbs Creek subwatershed contributing approximately 22 square miles. The Darby-Cobbs Watershed is home to approximately 460,000 residents, half of which live within the subwatershed. Darby-Cobbs watershed contains roughly 135 linear miles of streams, about 33 miles of which are in the Cobbs Creek subwatershed. An estimated 45% of the surfaces located within the watershed in Philadelphia are impervious (PWD, n.d.-a).

Figure 2-8. Darby-Cobbs Creek Watershed



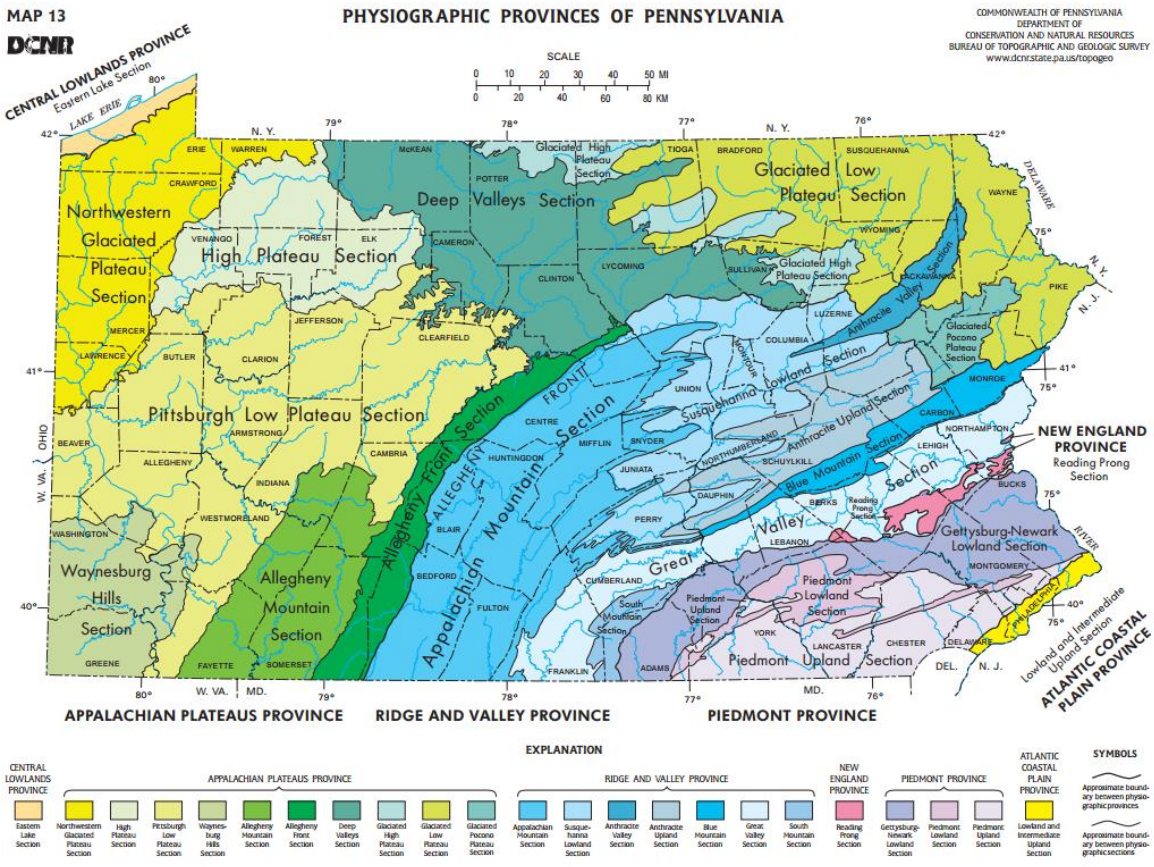
2.1.3 Topography and Geology

On average, Philadelphia is 39 feet above sea level (*Philadelphia Topographic Contours*, n.d.). Philadelphia's lowest point is 10 feet below sea level, and the highest point occurs at 445 feet above sea level (Pennsylvania Department of Conservation and Natural Resources, n.d.).

According to the Commonwealth of Pennsylvania Department of Conservation and Natural Resources Bureau of Topographic and Geologic Survey, Philadelphia straddles two physiographic provinces. A **physiographic province** is an area of land that is composed of a particular type(s) of rock. Each province is distinguishable by its physical landforms, unique rock formations, and groundwater characteristics. Philadelphia spans the Atlantic Coastal Plain and the Piedmont Upland Section (otherwise known as the Southern Piedmont Province). **Figure 2-9** depicts the physiographic provinces of Pennsylvania and delineates the two physiographic provinces found within Philadelphia.

The Atlantic Coastal Plain is a narrow strip of sandy, low-lying land immediately adjacent to the Delaware River in southeastern Philadelphia. This province is low-lying, flat, and sandy. The Southern Piedmont province located in the Northwest portion of the city contains schist, metagraywacke, amphibolite, and associated ultramafic rocks of the Wissahickon Formation overlain by unconsolidated Cretaceous and tertiary sediments. This province is characterized by broad, rounded to flat-topped hills and shallow valleys (*Physiographic Provinces of Pennsylvania*, n.d.).

Figure 2-9. Pennsylvania Physiographic Provinces Map (DCNR, n.d.)



2.2 Community Facts

Philadelphia is home to over 1.6 million people and ranks as the six most-populous city in the United States (U.S. Census Bureau, 2020). The City is located at the confluence of the Delaware and Schuylkill Rivers and has a diverse population that is slowly growing. With numerous universities and colleges, the City is an international education destination. The Philadelphia region has a gross domestic product (GDP) of $401 billion which ranks as the 9th largest metropolitan GDP in the United States (Bureau of Economic Analysis, 2020). In 2015, Philadelphia became the first U.S. World Heritage City. Philadelphia offers many historical destinations and is home to 68 National Historic Landmarks (National Park Service, n.d.). Philadelphia's cultural strengths, along with increasing development, position Philadelphia for growth in residents, businesses, and industry.

Key Facts

Population:1.6 million people

Population Density: 11,775.23 /mi^2

Ranking: 6th largest city in the US

Gross Domestic Product: 9th largest metropolitan GDP in the United States

Land: 134.1 square miles of land

2.2.1 History

Native American tribes were the first inhabitants of the Philadelphia region. The earliest people, called Paleo-Indians, settled in the vicinity of Philadelphia over 10,000 years ago. When the Swedish settlers arrived in the Delaware Valley in 1638, they referred to the area as Lenapehocking or the "Land of the Lenape" after the members of the Lenni-Lenape tribe that inhabited the region. The English later renamed the river surrounding the area and the tribe, "Delaware" after Lord del la Warr, the governor of the Jamestown colony. William Penn came to the region in 1682, dreaming to build a city on the land

Figure 2-10. Free Library of Philadelphia, retrieved 2015

between the Schuylkill and Delaware Rivers. Penn made numerous treaties with the Delaware Indians compensating them for the acquisition of the land (*Lenni-Lenape (Delaware) Indians' History, Culture and Food*, n.d.). The future city was named Philadelphia from the Greek words *philos* and *adelphos*. *Philos* means "loving" and *adelphos* means brother, making Philadelphia the City of Brotherly Love (Harper, n.d.).

William Penn's early city plan with gridded streets interspersed with plazas still defines Philadelphia. Long, straight streets running east-west and north-south were surveyed over the landscape creating a grid of the land between the Delaware and Schuylkill Rivers. The grid was an efficient way of selling real estate and thereby growing the population of Philadelphia. Philadelphia grew rapidly during the first few decades of the city's existence, expanding from a few hundred inhabitants in 1683 to over 2,000 in 1700 (Weigler, n.d.). Immigration of Germans and Scots-Irish, coupled with growth of the port turned Philadelphia into a major city by the 1750s. During the 1770s, Philadelphia grew into an important colonial city, hosting the First and Second Continental Congresses and the Constitutional Convention. Following the Revolutionary War, Philadelphia was selected to be the temporary capital of the United States. On December 6, 1790, the U.S. Capital officially moved from New York City to Philadelphia. The capital remained in Philadelphia until 1800 when it permanently settled in Washington, D.C.

*Figure 2-11. Photo of historic Philadelphia (*Philadelphia*, n.d.).*

Philadelphia was at the heart of the boom in manufacturing in the late 18th and 19th century. Manufacturing plants, foundries, coal and iron mines were built in the City to support textile, leather, and paper-related industries. From 1800 to 1897, Philadelphia was the leading manufacturing city in the

United States. In response, immigrants - mostly from Germany and Ireland - streamed into Philadelphia, increasing the population from 41,220 in 1800 to 565,529 by 1860. Immigrants from eastern and southern Europe, China, Latin America and the Caribbean contributed to the growing diversity of the City. By World War I, new jobs led to an increasing African American population from the South. This movement North, known as the Great Migration, caused Philadelphia's black population to nearly double in size. The city's growth continued until the early 1950s. As in many Northeast cities, decades-long de-industrialization resulted in closed factories, population loss, vacant land, and urban decay. By 2010, demographic shifts towards cities and an economic resurgence of urban living began to stabilize and reverse previous decades of population decline (Philadelphia's population increased by 0.6% between 2000 to 2010).

2.2.2 Economic Characteristics

Philadelphia is in the geographical and economic center of the fourth largest Metropolitan Statistical Area (MSA) on the East Coast, the Philadelphia-Camden-Wilmington MSA (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020). A **Metropolitan Statistical Area** (MSA) is an area defined by the U.S. Office of Management and Budget (OMB) that is linked by significant social and economic interactions and has at least one urbanized area with a minimum population of 50,000 people.

Gross Domestic Product (GDP) is an estimate of the value of the goods and services produced in an area and can be used to compare the size and growth of a region's economy. The GDP for the Philadelphia-Camden-Wilmington MSA as of December 2019 was approximately $401 Billion Dollars (Bureau of Economic Analysis, 2020). This is the 9th largest metropolitan GDP in the United States.

Table 2-1. GDP for Philadelphia MSA 2017-2019

2017	2018	2019
$385,818,977	$392,231,712	$401,231,952

A healthy economy promotes job growth, high employment rates, and more income, all which give residents and the City the ability to prepare for and quickly recover from disasters when they occur (U.S. Economic Development Administration, n.d.).

2.2.2.0 Industries

Economic diversification, the degree to which economic activity is spread across sectors, is one measure of a region's economic resilience (U.S. Economic Development Administration, n.d.). Philadelphia's economy is made up of a diverse set of industries, with strengths in insurance, law, finance, health, education, utilities, and the arts.

Like many urban areas in the East and Midwest of the United States, Philadelphia's economy has undergone a major transition in recent decades. Approximately half a century ago, manufacturing dominated the economy, providing almost half of Philadelphia's jobs. As manufacturing employment declined, knowledge-based industries gained prominence with life sciences, information technology, professional services and chemicals ranking among Philadelphia's top industries. More recently, sectors such as education and health services, professional and business services, financial activities, research, and information technology have emerged strongly as principal drivers of the economy.

The Bureau of Labor Statistics data shows that in August 2020, the education, health services, government, professional and business services, trade, transportation, and utilities sectors collectively represented 77% of all employment in the City. Educational and healthcare services continue to be the leading industry in Philadelphia, making up approximately 33% of all employment in the City. Since 2017, the leisure and hospitality industry has seen a decrease in employment by 4% likely due to the impact of the COVID-19 pandemic on tourism (U.S. Bureau of Labor and Statistics, 2020). **Figure 2-12** below displays the breakdown of employment by industry in Philadelphia. **Table 2-2.** depicts the breakdown of Philadelphia's employment by industry in both 2017 and in 2020.

Figure 2-12. Philadelphia Employment by Industry (US Bureau of Labor Statistics, 2020).

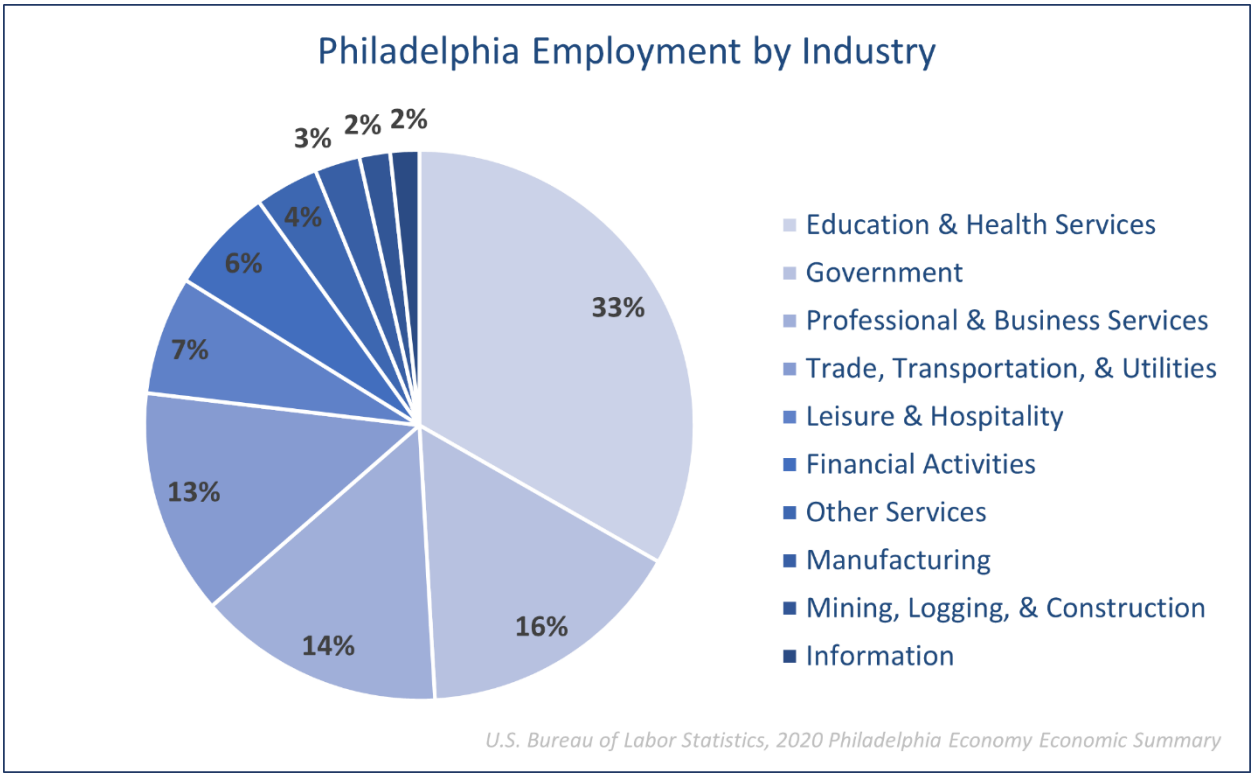


Table 2-2. Individuals Employed by Industry in 2017 and 2020.

Industry	Individuals Employed August 2017[1]		Individuals Employed August 2020[2]	
Education and Health Services	221,500	31%	226,300	33%
Government	99,400	14%	107,800	16%
Professional and business services	97,900	14%	98,700	14%
Trade, transportation, and utilities	93,400	13%	90,300	13%
Leisure and hospitality	77,500	11%	47,400	7%
Financial activities	44,100	6%	42,500	6%
Other services	28,400	4%	25500	4%

[1] Source: (U.S. Bureau of Labor and Statistics, 2017)
[2] Source: (U.S. Bureau of Labor and Statistics, 2020)

Industry	Individuals Employed August 2017[1]		Individuals Employed August 2020[2]	
Manufacturing	19,600	3%	18,100	3%
Mining, logging, and construction	12,800	2%	12,300	2%
Information	11,700	2%	11,600	2%

There are two Fortune-500 companies and three Fortune-1000 companies headquartered in Philadelphia (Fortune Media IP, 2020). These companies are listed in **Table 2-3**.

Table 2-3. Fortune 500 and Fortune 100 companies in Philadelphia (Fortune Media IP, 2020)

Company Headquartered	Industry	Rank
Comcast	Telecommunications	28
Aramark	Hospitality	200
FMC	Chemicals	578
Urban Outfitters	Apparel	644
Carpenter Technology	Manufacturing	897

In addition to the Fortune-1000 companies located in Philadelphia, there are thousands of businesses located within the City's borders. See **Table 2-4** below for a list of the largest private employers based in Philadelphia as of 2019 (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020).

Table 2-4. Largest Private Employers Based in Philadelphia, Ranked by Number of Local Employees 2019 (2020)

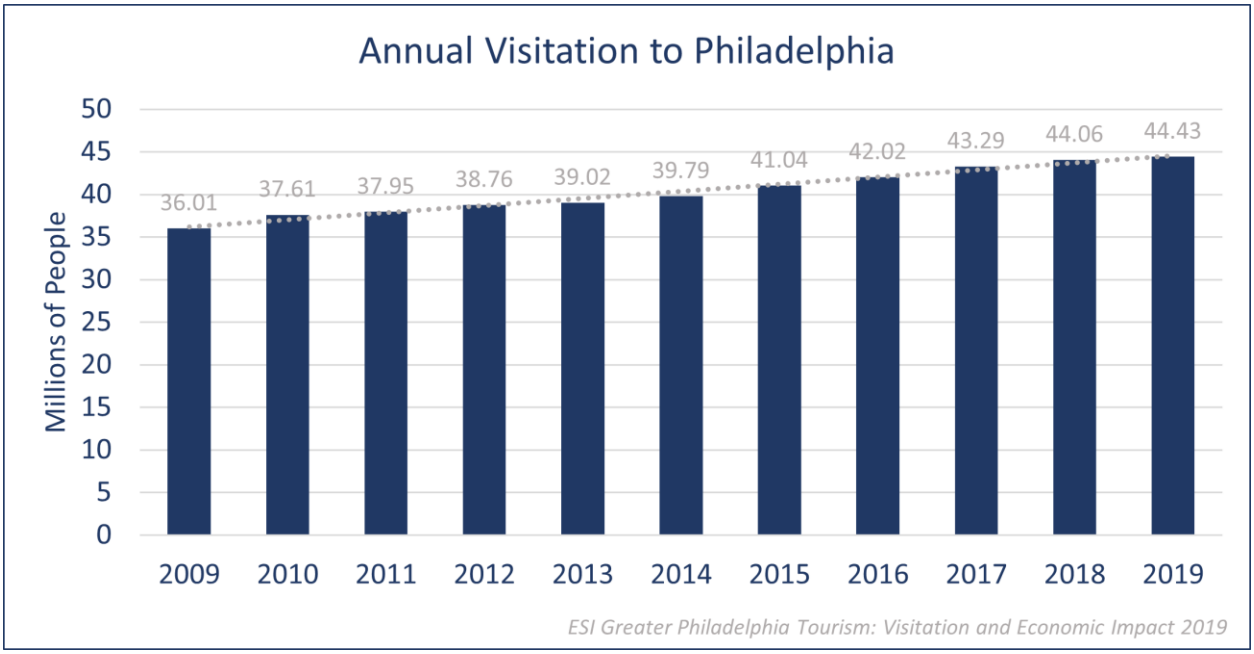
Employer	# Local Employees
University of Pennsylvania	40,697
Thomas Jefferson University and Jefferson Health	30,000
Comcast Corporation	12,349
Drexel University	12,124
Temple University	9,808
Einstein Healthcare Network	8,645
Wells Fargo Bank	6,328
Independence Health Group	6,116
Accenture	2,730
PwC	1,900
Deloitte LLP	1,750
Community College of Philadelphia	1,700
SugarHouse Casino	1,520
Cardone Industries	1,400
Ernst & Young LLP	1,378
Saint Joseph's University	1,374
Day & Zimmeran	1,243
KPMG	1,181
CareersUSA	1,175
Jacobs	1,094

Since the 2017 plan update, two major employers in Philadelphia closed including Philadelphia Energy Solutions which employed approximately 1,000 people and Hahnemann University Hospital which employed 2,500 employees. Both closed in 2019.

2.2.2.1 Tourism

In September 2020, the City of Philadelphia and Visit Philadelphia announced that a record 46 million people visited the five-county Greater Philadelphia region in 2019. This was the 10th consecutive year of growth in tourism and contributed to $7.64 billion in visitor spending and supported over 105,460 jobs (City of Philadelphia Office of the Mayor, 2020). Between 2009 and 2019, Philadelphia experienced a 38% growth in overnight visitation and 15% growth in daytime visitation (Consult Solutions Inc., 2020). **Figure 2-13** depicts this growth in visitor volume

Figure 2-13. Annual Visitation to Philadelphia (2020)



Philadelphia is a popular location for international travelers to visit. In 2018, The Philadelphia Convention and Visitors Bureau (PHLCVB) ranked Philadelphia as the 16th most visited city in the U.S. by overseas travelers, with more than 648,000 visitors from overseas in 2017. International visitation increased by 18% in Philadelphia between 2007 and 2019 (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020).

In addition to tourists visiting the City for our numerous historical landmarks and museums, the City also hosts annual events that draw people to the region, such as the July 4th celebration and the Thanksgiving Day parade. Several recent, high-profile events such as the World Meeting of Families and papal visit in 2015, the Democratic National Convention in 2016, and the NFL Draft in 2017 have created a spotlight on tourism in Philadelphia.

Tourists will continue to dynamically affect Philadelphia's population over the next five years with the FIFA World Cup and large events celebrating the 250th anniversary of the birth of our nation planned for

2026. As a transient population, tourists may have transportation, language, and accessibility needs during a disaster not captured in city-specific Census data.

The COVID-19 pandemic is projected to have a large impact on Philadelphia's tourism industry. Visit Philly reported in December 2020 that there were approximately 52,000 jobs lost in the tourism and travel industry between January 2020 and December 2020, a 27% decrease. Philadelphia also experienced a 74% decline in hotel room reservations, an 80% decline in overseas visitors, and a projected $5.8 billion loss in economic impact between 2019 and 2020 (Visit Philadelphia, 2020). Tourism Economics predicts it will take until 2023-2024 for Philadelphia's tourism industry to fully recover from the effects of the pandemic.

2.2.3 Colleges and Universities

Philadelphia has many colleges, universities, continuing education institutions, and technical schools within its borders. According to Campus Philly's most recent data, student enrollment in Philadelphia colleges and universities exceeded 278,945 students in 2017 (Campus Philly, 2020). College and university students make up close to 9% of Philadelphia's overall residency population (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020).

Educational institutions support a stable local economy and generate an educated workforce for the City's various professional industries. Similar to tourists, students attending colleges and universities from outside the City of Philadelphia contribute to a fluctuating City population. Students that commute, or only live within the City for a portion of the year may not be as familiar with the City or city services available to them in times of disaster.

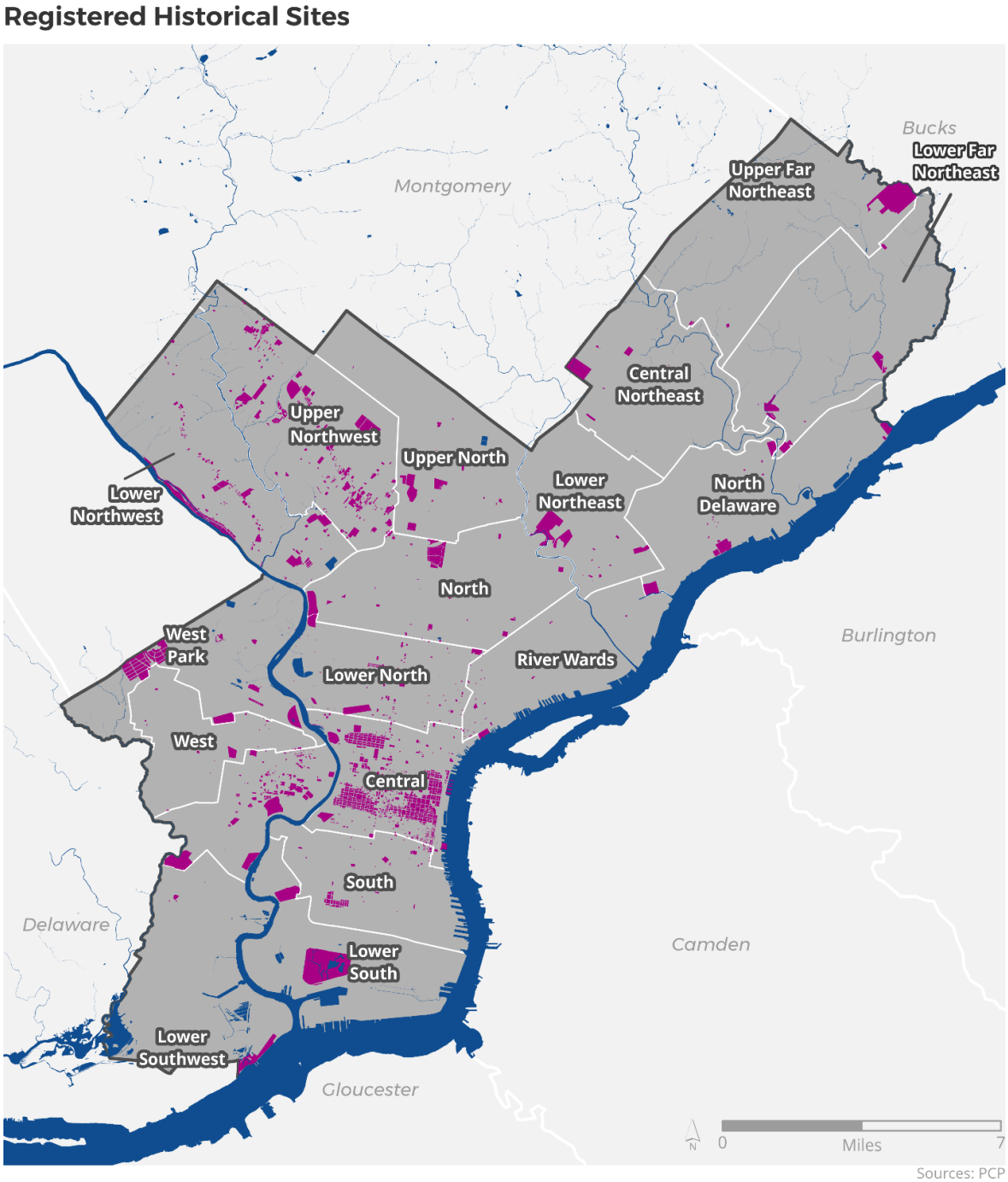
Colleges and Universities in Philadelphia include:

- Art Institute of Philadelphia
- Chestnut Hill College
- Community College of Philadelphia
- The Curtis Institute of Music
- Delaware Valley Academy of Medical and Dental Assistants
- Devry University, Center City
- Drexel University
- Harrison Career Institute
- Holy Family University
- Hussain School of Art
- La Salle University
- Lincoln Technical Institute
- Moore College of Art and Design
- Orleans Technical Institute
- Pennsylvania Institute of Technology
- Pennsylvania Academy of the Fine Arts
- Peirce College
- Philadelphia University
- The Restaurant School at Walnut Hill College
- Saint Joseph's University
- Star Technical Institute
- Strayer University, Center City Campus
- Talmudical Yeshiva of Philadelphia
- Temple University
- Thomas Jefferson University
- Thompson Institute
- University of the Arts
- University of Pennsylvania
- University of the Sciences in Philadelphia

2.2.4 Historic & Cultural Significance

Philadelphia is one of the oldest cities in the nation and has numerous historically significant sites. These include the Betsy Ross House, Independence Hall, the Liberty Bell, and the Constitution Center, with additional sites throughout the city. **Figure 2-14** shows the distribution and concentration of historical sites listed in the Philadelphia Register of Historic Places.

Figure 2-14. Historical Sites and Districts Registered with the City of Philadelphia



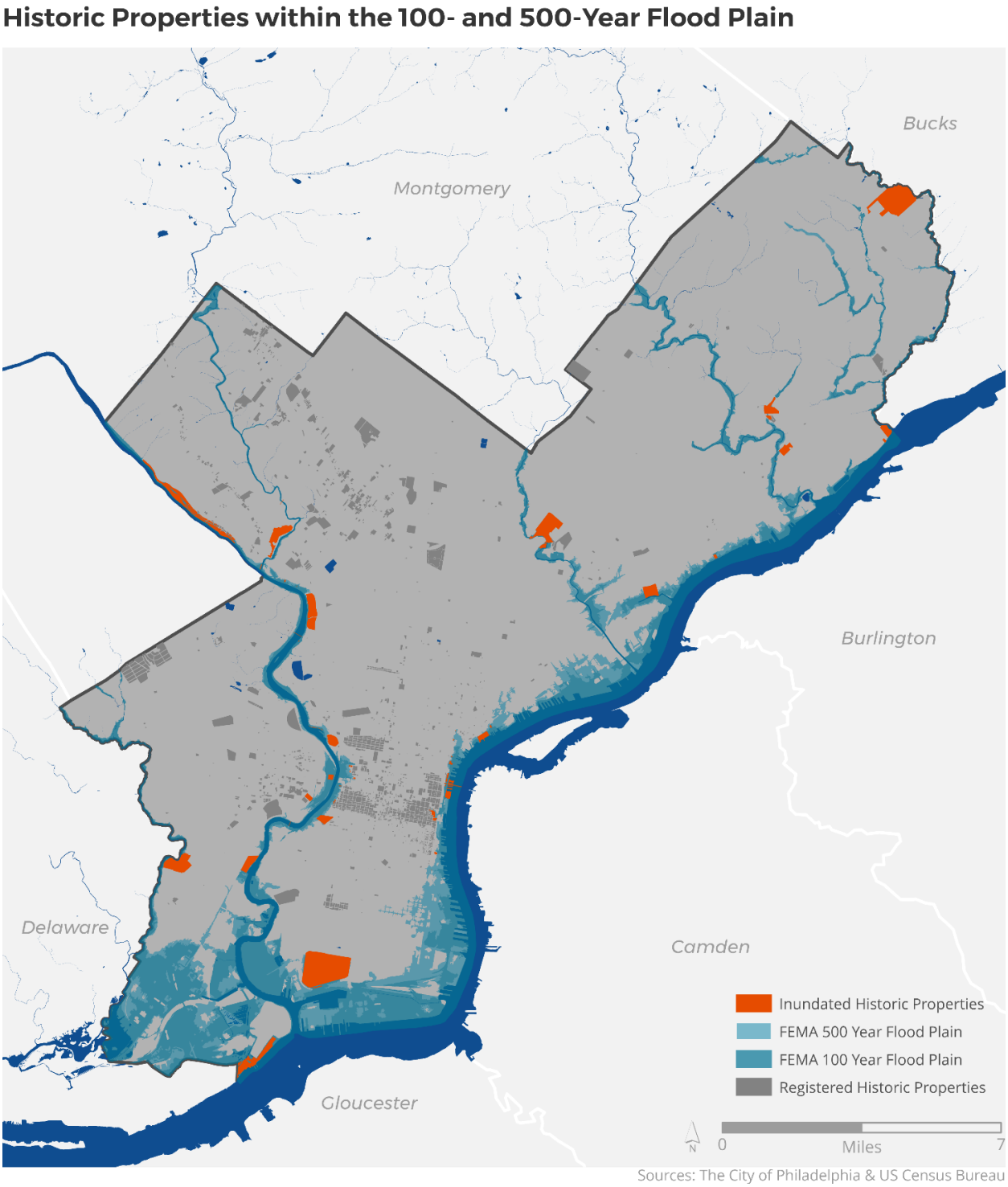
In 2016, The Pennsylvania State Historic Preservation Office (PA SHPO) conducted a study to gather up-to-date information on historic buildings listed in the National register of Historic Places (NRHP) and the Philadelphia Register of Historic Places (PRHP) located in flood prone areas. This study, conducted by AECOM between January and March 2016, found the following:

- A total of **568 designated historic structures** in flood inundation areas throughout the City
- Approximately **289 structures** in the 100-year flood hazard area
- Approximately **272 structures** within the 500-year flood hazard area
- **160 structures** vulnerable to projected sea level rise in the future (Pennsylvania Historical and Museum Commission, 2016)

The map on the next page displays the concentration of historic structures in flood prone areas of Philadelphia. The highest concentration of historic, flood-prone structures is located along the Schuylkill River and near the Philadelphia Naval Shipyard.

Phase II of this study, conducted by the US Army Corps of Engineers (USACE) and completed in April 2018, consisted of a nonstructured assessment of 25 identified structures in Phase I of this study. Nonstructural flood mitigation and adaptive measures were recommended for each of the 25 structures (USACE, 2018). Phase II of this study only offers potential flood mitigation techniques but does not determine the feasibility of each recommended action. Findings from this study, and identified gaps in data and information, were referenced when developing the mitigation strategy of the 2022 Hazard Mitigation Plan.

Figure 2-15. Map of Historic Properties within the 100- and 500-Year Floodplain.



2.2.4.0 Cultural Facilities

Philadelphia has one of the greatest collections of cultural institutions in the world. The table below displays some of Philadelphia's most visited museums, stadiums, iconic sites, zoos, theaters, and concert halls.

Table 2-5. Cultural Facilities in Philadelphia

Museums	
Philadelphia Museum of Art	Polish American Cultural Center Museum
The Franklin Institute	Historical Society of Pennsylvania
Academy of Natural Sciences	National Liberty Museum
Please Touch Museum	Fabric Workshop and Museum
Penn Museum	Civil War Library and Museum
Rodin Museum	Wagner Free Institute of Science
National Museum of American Jewish History	Mummers Museum
Mutter Museum	Franklin Court
African American Museum	Fireman's Hall
Independence Seaport Museum	USS Becuna
Simeone Foundation Museum	Woodmere Art Museum
Rosenbach Museum and Library	
Historic and Cultural Sites	
Independence Hall	Bishop White House
Masonic Temple	Second Bank of the U.S.
Independence National Historical Visitors Center	Cathedral Basilica of SS. Peter and Paul
Eastern State Penitentiary	Pennsylvania Convention Center
National Constitution Center	Gloria dei Church
City Hall	Boathouse Row and Schuylkill River rowing course
U.S. Mint	Love Park
Liberty Bell Center	Rittenhouse Square
Todd House	Washington Square
Christ Church	Reading Terminal Market
Independence Mall	Italian Market
Congress Hall	Betsy Ross House
Historic Germantown	
Theaters/Concert Halls	
Kimmel Center for the Performing Arts	Painted Bride Art Center
Arden Theatre Company	Academy of Music
Wilma Theater	Curtis Institute of Music
Walnut Street Theatre	Mann Center for the Performing Arts
The Dell Music Center	
Stadiums/Arenas	
Citizens Bank Park	Palestra
Lincoln Financial Field	Liacouras Center
Wells Fargo Center	Tom Gola Arena
Franklin Field	Hagan Arena
Zoos/Nature Centers	
Philadelphia Zoo	Shofuso Japanese House and Garden
Morris Arboretum	Bartram's Garden
Fairmount Park	John Heinz Wildlife Refuge

2.3 Population and Demographics

The *Population and Demographics* section contains information on the Philadelphia's population, population density, racial composition, age breakdown, income, housing, education, and how each of these factors impacts vulnerability to hazards and hazard planning. Data in this section is pulled from the 2019 5-year U.S. Census data estimates from the American Community Survey (ACS), except where noted.

2.3.1 Population & Population Density

The City of Philadelphia is the sixth most populous city in the United States, and the most populous county in the Commonwealth of Pennsylvania with an estimated population of 1,603,797 as of 2020 (US Census Bureau, 2020). This population count increased by 23,733 residents since the 2017 plan. The City's population continues to grow and has increased approximately 3.8% between 2010 and 2019 (The Center for Rural Pennsylvania, n.d.). The graph below displays population estimates in Philadelphia by age in 2019.

Figure 2-16. Philadelphia's Population Estimates by Age in 2019 (US Census Bureau, 2019b, Table PEPANNRES)

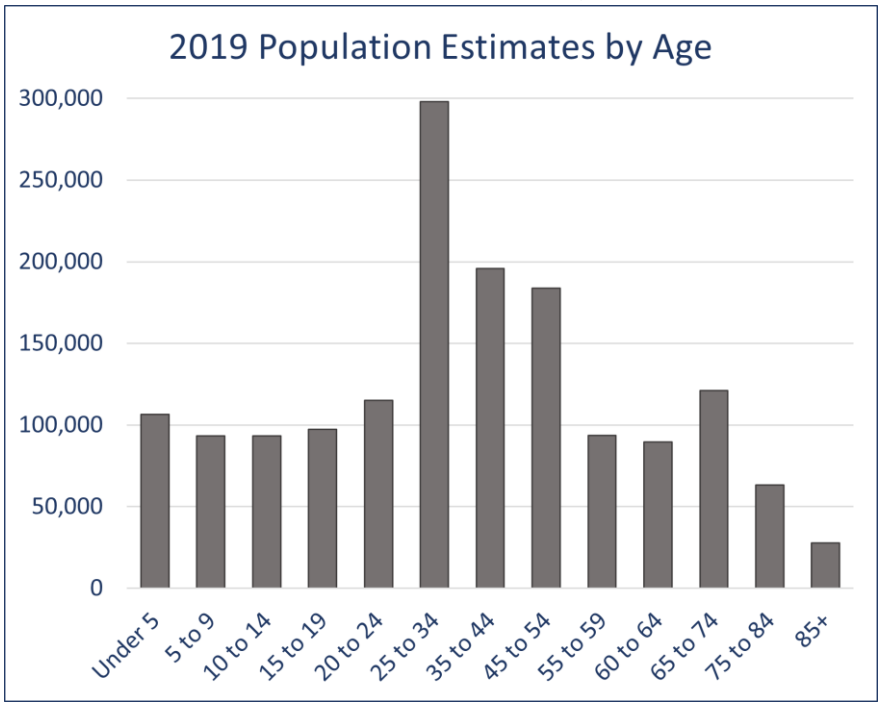
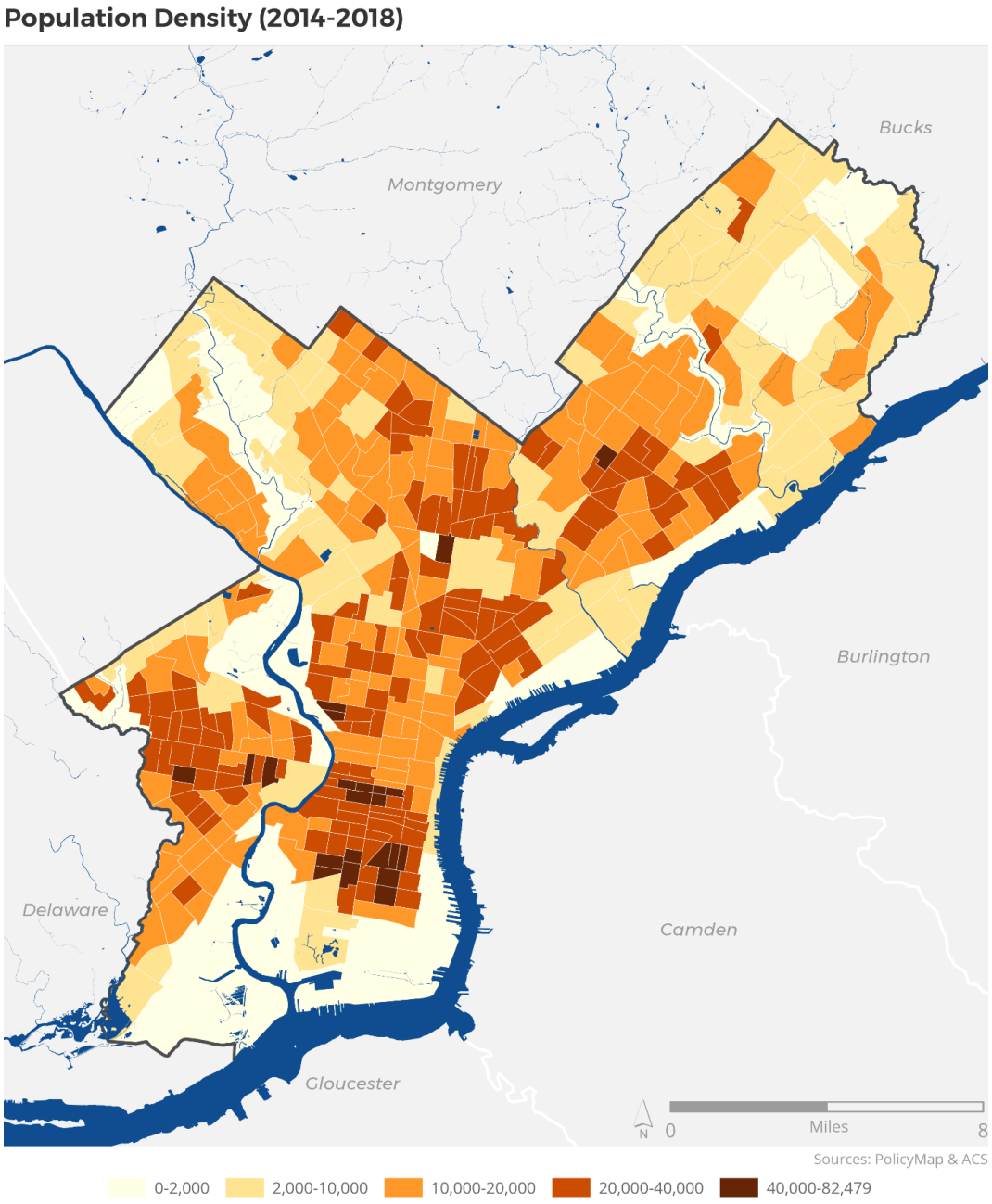


Figure 2-17. Map of Philadelphia's Population Density



According to the American Community Study (ACS) 2019 5-year estimate, the population density of Philadelphia is approximately 11,775.23 /mi^2. As shown in the map above, the areas of the city with the highest density are in Center City, South Philadelphia, and West Philadelphia. Philadelphia's larger population size and higher population density means that we are likely to experience greater losses from the hazards identified in this plan than surrounding rural counties due to the greater number of people and extent of infrastructure at risk (PEMA, 2019).

Approximately 240,373 people commute into Philadelphia for work, while 168,979 leave the city for employment elsewhere (The PEW Charitable Trusts, 2019). This leads to a 71,394 net gain in daytime population, increasing the total population of Philadelphia to approximately 1,655,458 during daytime working hours. **Table 2-6** details the inbound and outbound population change by county.

Table 2-6. Average Daily Inbound and Outbound Population by County (The Pew Charitable Trusts, 2019)

County	Inbound to Philadelphia	Outbound from Philadelphia	Net Population Gain during work hours
Bucks County, PA	34,777	32,708	2,069
Burlington County, NJ	17,473	7,637	9,836
Camden County, NJ	28,170	10,279	17,891
Chester County, PA	16,438	12,481	3,957
Delaware County, PA	57,555	27,913	29,642
Gloucester County, NJ	14,308	3,133	11,175
Montgomery County, PA	64,887	70,910	-6,203
New Castle County, DE	6,765	3,918	2,847
Total	**240,373**	**168,979**	**71,394**

Transient populations are often more at-risk during disasters because they are less familiar with the City and its hazards. The high number of commuters into the City highlights the importance and necessity of workplace preparedness and emergency response training for employees.

COVID-19 significantly changed workplace dynamics in Philadelphia and across the nation. Approximately 5.1% of workers ages 16 and older reported working from home in 2019 (US Census Bureau, 2019d, Table DP05). Based on responses to the U.S. Census Bureau's Household Pulse Survey between January 20, 2021 and February 1, 2021, approximately 38.6% of adults in the United States reported living in households where at least one adult substituted some or all in-person work for telework because of the pandemic[3].

[3] The U.S. Census Bureau's Household Pulse Survey is an experimental survey designed to quickly collect and distribute information on how people's lives have been impacted by COVID-19 in the United States.

2.3.2 Age Breakdown

Figure 2-18. 2019 Percentage of Population by Age Range

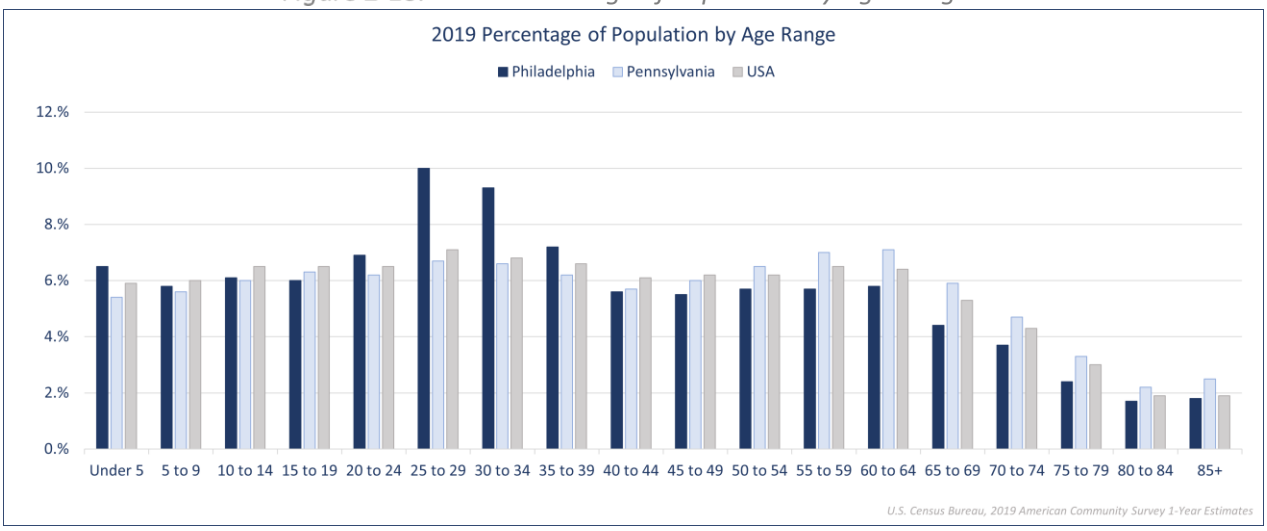
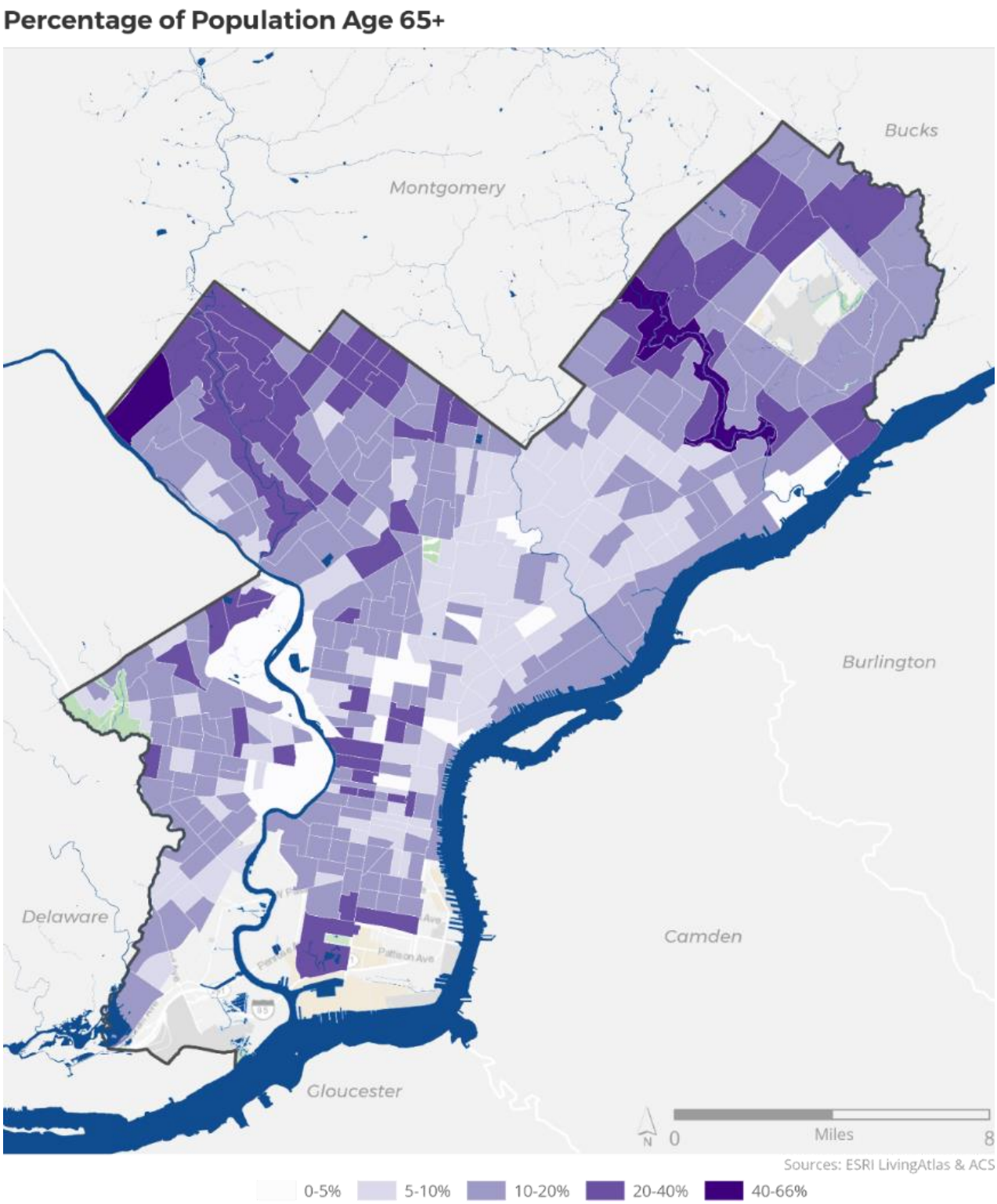


Figure 2-18 above displays the breakdown of Philadelphia's population by age in comparison to the State and Nation (US Census Bureau, 2019a, Table 20101). Although a large portion of Philadelphia's population is made up of residents between the ages 25 and 34, close to 20% of the population is under the age of 5 or over the age of 66 (2019a). These age groups are disproportionately impacted by the hazards identified in this plan and often require additional support to adequately respond and recover from disaster. For example, individuals under the age of 5 may not be able to quickly respond and remain safe in a disaster without the support of an adult. Some individuals over the age of 65 do not regulate temperature as efficiently as others, making them more prone to heat-related illness during high heat events. These are important considerations when planning projects that reduce risk to hazards in Philadelphia. For more detailed information on how age can impact hazard risk, please see the hazard profiles in **4 Risk Assessment**.

Figure 2-19 on the next page displays the percentage of the population over the age of 65 by geographic location. Northwest Philadelphia and Northeast Philadelphia have the highest concentration of residents over the age of 65.

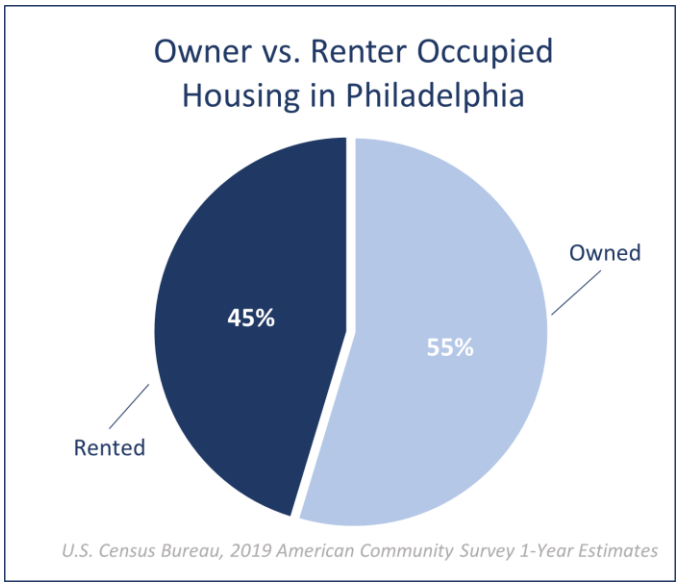
Figure 2-19.Geographic distribution of Philadelphia's Population, Age 65 years and older



2.3.3 Housing and Home Ownership

There are approximately 691,653 housing units in the city. About 90% are occupied (US Census Bureau, 2019m, Table S0101). As illustrated in **Figure 2-20**, 55% are owner occupied and 45% are renter occupied (2019m). Of the owner-occupied homes in Philadelphia, 41.1% own their homes and do not have a mortgage or loan on the house (2019m).

Figure 2-20. Percentage of owner vs. renter occupied housing units in Philadelphia (US Census Bureau, 2019m)



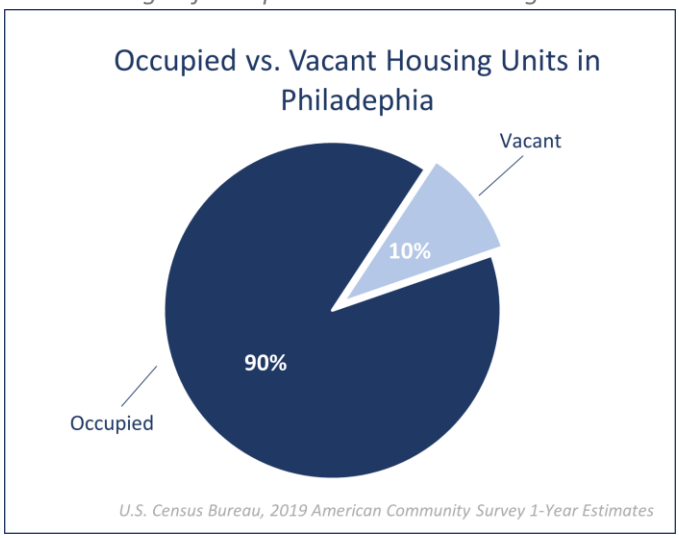
This division implies a difference in insurance coverage which impacts long-term recovery from disasters. Renters insurance coverage exists mainly to cover the occupants' belongings, not the housing itself. Additionally, homeowners that do not have a mortgage are not required to have homeowner's insurance. This can present challenges with repairing houses and reoccupying homes after a disaster.

Vacant homes without insurance can also impact risk and long-term recovery. Unoccupied or vacant homes pose a greater risk for both fires and collapse than occupied homes (Shai, 2006). Vacant properties that are also uninsured or under-insured greatly increases the likelihood of a longer recovery time. **Figure 2-21** shows a breakdown of vacant vs. occupied homes in Philadelphia.

Within Philadelphia, 3,633 households (0.6%) lack complete plumbing facilities[4]. Housing units without sufficient plumbing pose additional challenges in emergency situations where sheltering-in-place, or staying in your home throughout the emergency, is required. About 7,562 households (1.2%) have no telephone (home and/or cell phones) service available, 10.3% of homes do not have a computer, and 16.8% of homes do not have internet broadband service (computer or phone) (US Census Bureau, 2019m, Table S0101). Those households without a phone, computer, and/or internet may be harder to reach with emergency notifications in times of disaster and crisis, and should be accounted for when designing alert and warning systems and outreach

[4] Complete plumbing facilities include: Hot and cold running water; a flush toilet; a bathtub or shower.

Figure 2-21. Percentage of occupied vs. vacant housing units in Philadelphia.



2.3.3.0 Housing Costs and Housing Cost Burden

Philadelphia's housing stock is among the oldest of any city in the country. The numerous vacant and ill-maintained homes in the city increases our risk for urban fire. However, the City's recent growth in population has spurred new construction and investment into housing in many neighborhoods. While the total housing stock increased by 0.7% from 2010-2016, rent also increased by 10.9% between 2013 and 2018. Housing values have tripled since 1993, a growth rate that is more than 50% greater than the rest of the county (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020). Higher cost burdens can contribute to increased poverty rates and increased poverty rates directly impact a community's ability to withstand and recover from disaster.

2.3.3.1 Individuals Experiencing Homelessness

Individuals experiencing homelessness are at greater risk for many of the hazards identified in this plan. Natural hazards such as extreme temperatures and severe weather leave unsheltered individuals exposed to the elements and without adequate resources to shelter-in-place, access food, and access healthcare when needed (U.S. Department of Housing and Urban Development, 2014).

According to the Philadelphia Office of Homeless Services (OHS), as of 2020 there were approximately 5,634 persons in Philadelphia experiencing homelessness (Philadelphia Office of Homeless Services, 2020). This number represents a "point-in-time count" of people who are literally homeless as defined by the U.S. Department of Housing and Urban Development[5]. This was a 4% decrease in the number of people experiencing homelessness since 2019. Between July 2019 and June 2020, the OHS served 19,988 unique persons, indicating that the need for support extends beyond the 5,634 persons with no place to shelter.

The COVID-19 Pandemic highlighted the increased risk of those experiencing homelessness. People experiencing homelessness are known to have a higher risk of exposure to infectious diseases and often

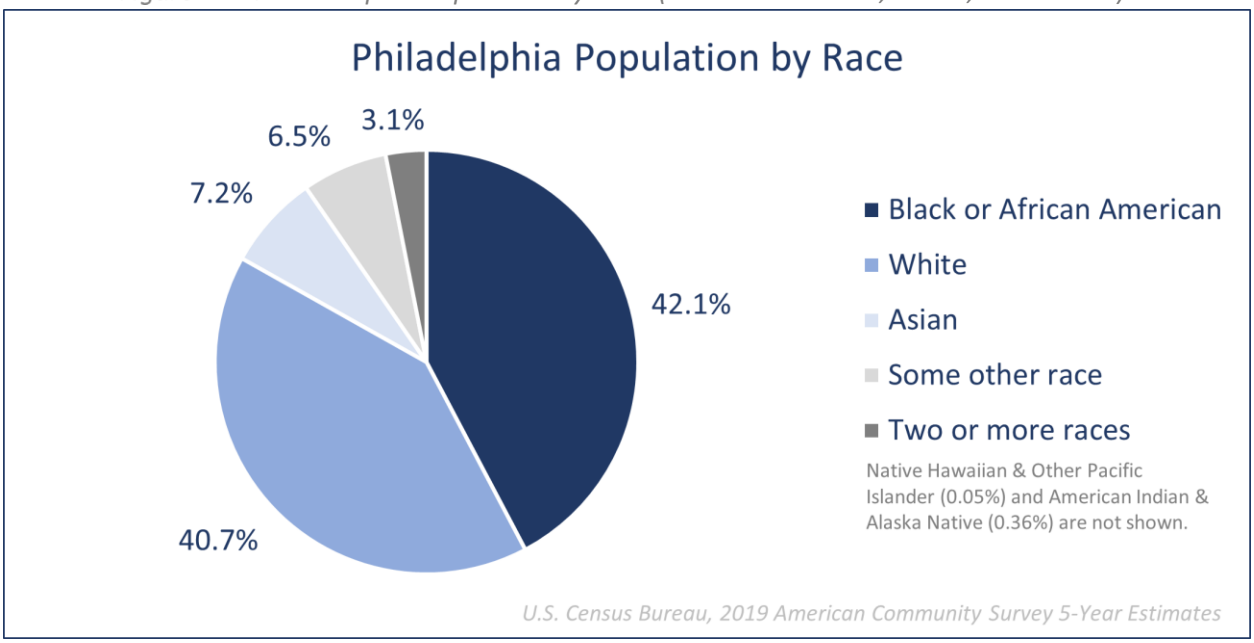
[5] Individuals defined by the U.S. Department of Housing and Urban Development (HUD) as "literally Homeless" include individuals who lack a fix, regular, and adequate nighttime residences.

lack adequate access to resources, healthcare, and treatment needed to prevent and treat infectious diseases (HUD, n.d.).

2.3.4 Race, Ethnicity and Language

Philadelphia is an ethnically and culturally diverse city, with 42.1% of the population identifying as Black or African American, 40.7% identifying as White, 7.2% identifying as Asian, 6.5% identifying as another race, and 3.1% identifying as two or more races (US Census Bureau, 2019d, Table DP05).

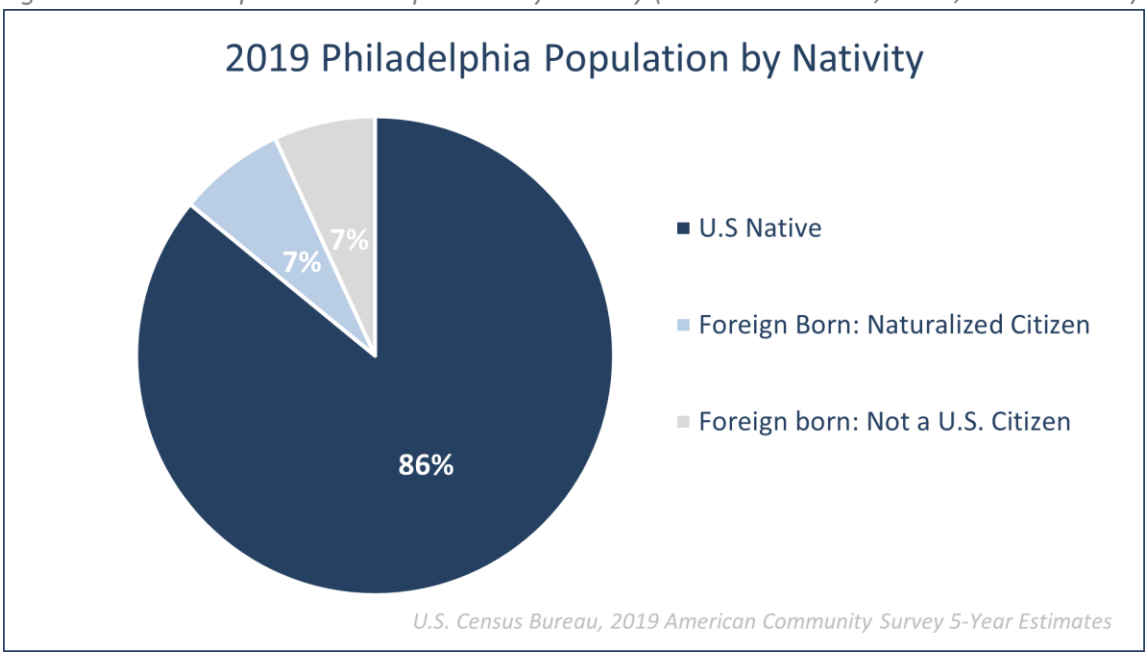
Figure 2-22. Philadelphia Population by Race (US Census Bureau, 2019d, Table DP05).



2.3.4.0 Nativity and Language

According to the most recent data, 14% of the people living in Philadelphia are foreign born, and 50% of those individuals are naturalized citizens. Approximately 86.0% of Philadelphia residents are U.S. born (US Census Bureau, 2019i, Table B05002). **Figure 2-23** depicts the population breakdown of Philadelphia by nativity.

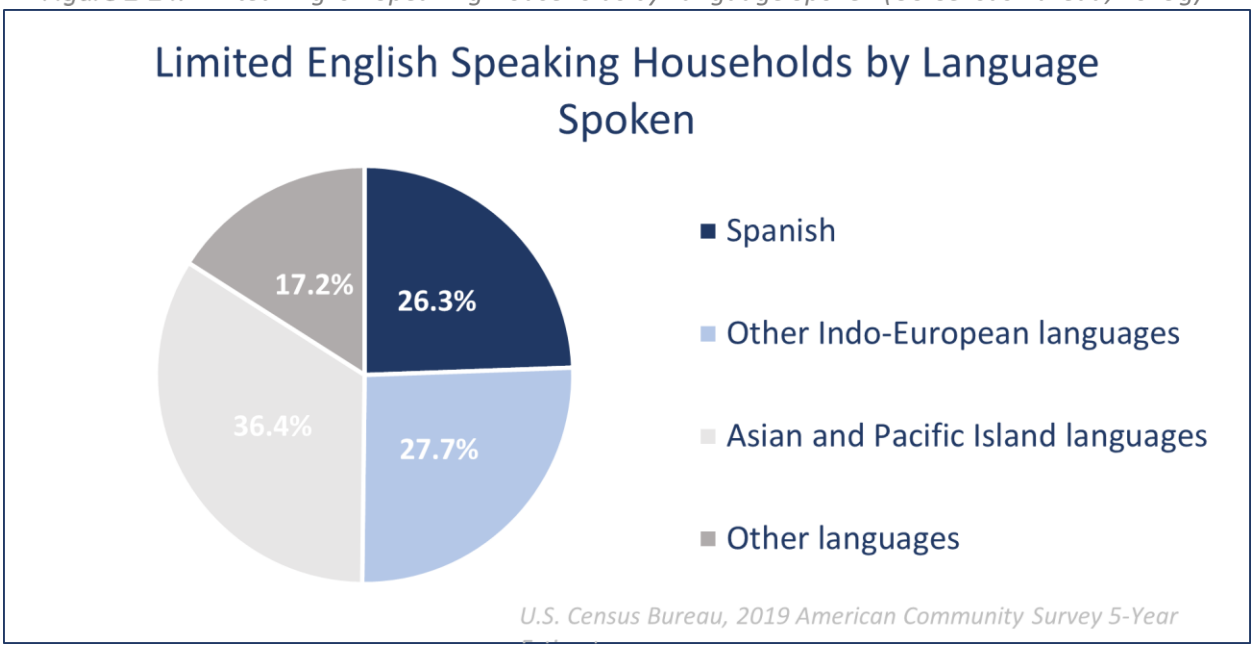
Figure 2-23. Philadelphia's 2019 Population by Nativity (US Census Bureau, 2019i, Table B05002).



As of 2019, 24.1% of people in Philadelphia over the age of 5 primarily speak a language other than English in their home. Approximately 6.8% of households in Philadelphia are characterized as limited English speaking (U.S. Census Bureau, 2019g). **Figure 2-24** displays those households in Philadelphia who self-identify as less than proficient in English.

When distributing information on hazard risk and preparedness measures, materials should be translated into multiple languages. Emergency responders should also be equipped with tools and resources that allow them to communicate with non-English speaking residents on scene.

Figure 2-24. Limited English-Speaking Households by Language Spoken (US Census Bureau, 2019g).



2.3.5 Education

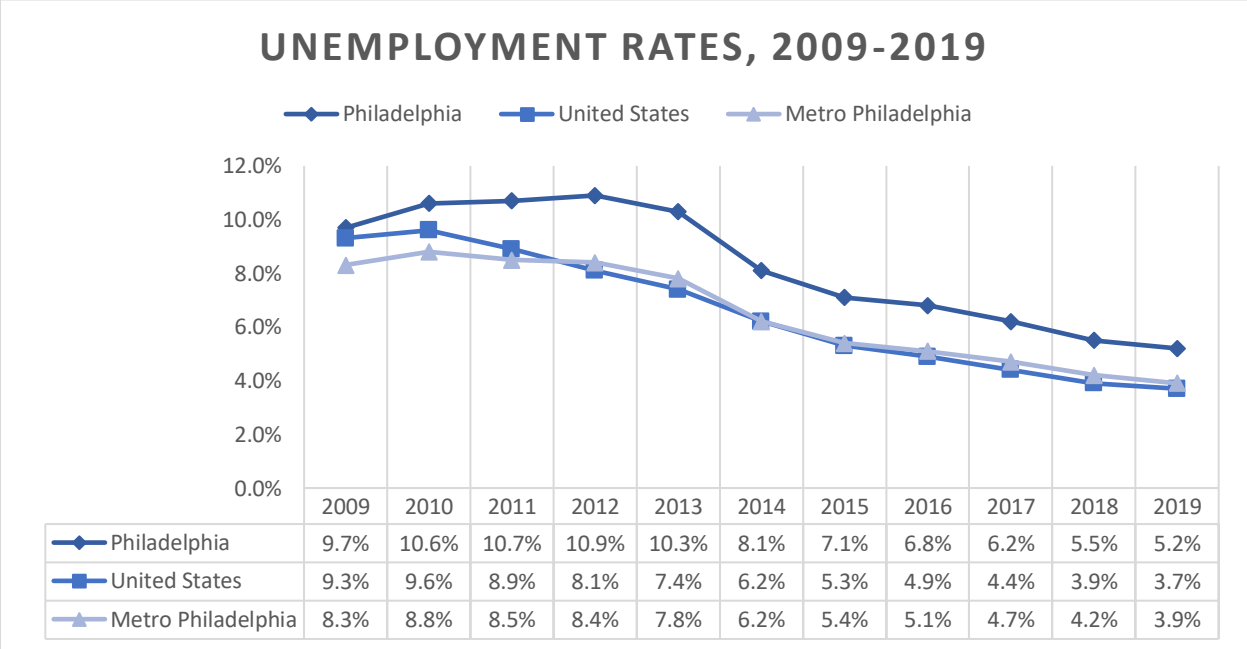
Approximately 84.7% of people 25 years and over in Philadelphia have graduated high school, and 29.7% received a bachelor's degree or higher (U.S. Census Bureau, 2019f, Table S1501). About 401,265 students ages 3 years and over are enrolled in school, with 27,774 enrolled in nursery school or pre-school, 237,759 enrolled in elementary through high school, and 135,732 enrolled in college/graduate school (US Census Bureau, 2019k, Table S1401).

Despite the large percentage of individuals over the age of 25 that have graduated high school, it's important to note that 19% of all high school graduates in the United States cannot read and 13% of adults in Pennsylvania lack basic literacy skills (U.S. Census Bureau, 2019f, Table S1501). This should be accounted for when planning for the delivery of emergency messaging to the community during disasters.

2.3.6 Income & Employment

Prior to the COVID-19 pandemic, unemployment rates in Philadelphia had decreased since 2012, with historically low rates in 2019 at 5.2% (The PEW Charitable Trusts, 2019). However, compared to the surrounding metropolitan region, peer cities, and the nation, a 5.2% unemployment rate was high. Philadelphia is ranked fourth in the nation for high unemployment among other US cities of comparable size. A current surge in crime and growing concerns over public safety are threatening the steady increase in jobs and population that Philadelphia has experienced over the last several years (2019.)

Figure 2-25. Philadelphia's Unemployment Rates from 2009-2019 (The PEW Charitable Trusts, 2019).

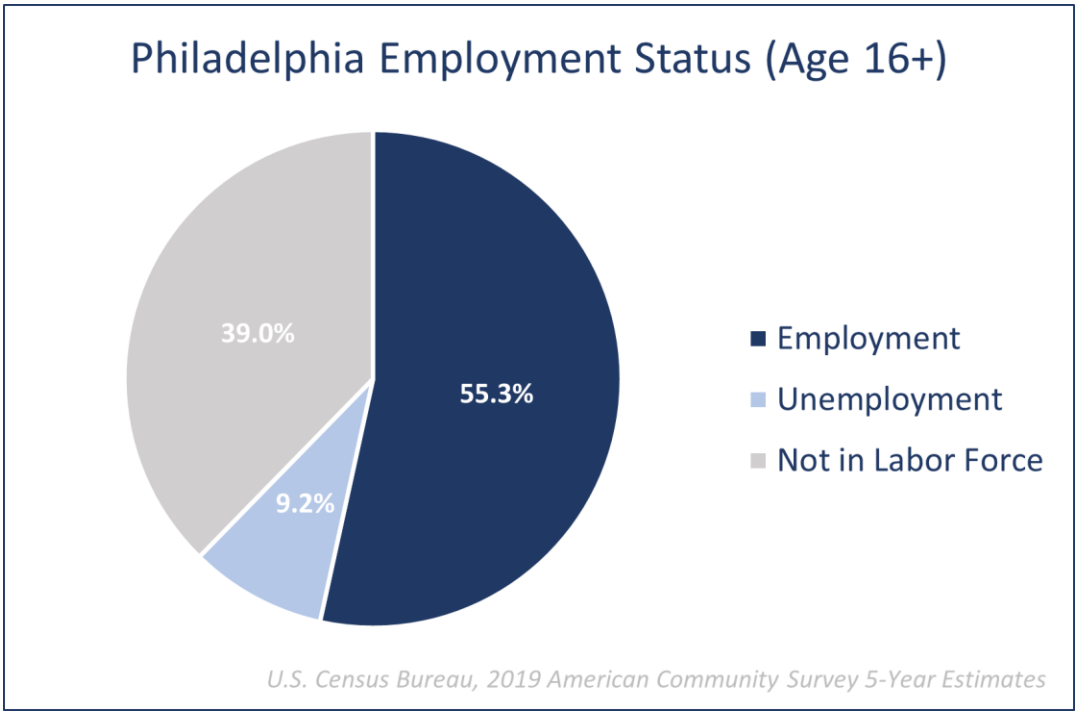


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Philadelphia	9.7%	10.6%	10.7%	10.9%	10.3%	8.1%	7.1%	6.8%	6.2%	5.5%	5.2%
United States	9.3%	9.6%	8.9%	8.1%	7.4%	6.2%	5.3%	4.9%	4.4%	3.9%	3.7%
Metro Philadelphia	8.3%	8.8%	8.5%	8.4%	7.8%	6.2%	5.4%	5.1%	4.7%	4.2%	3.9%

In 2019, the job market in Philadelphia rose by 2.4% with an average of 741,200 jobs available, a historical high for Philadelphia (The City of Philadelphia, Commerce Department, 2020). During 2019, two large employers in Philadelphia - Hahnemann University Hospital and the Philadelphia Energy Solutions (PES) refinery - closed.

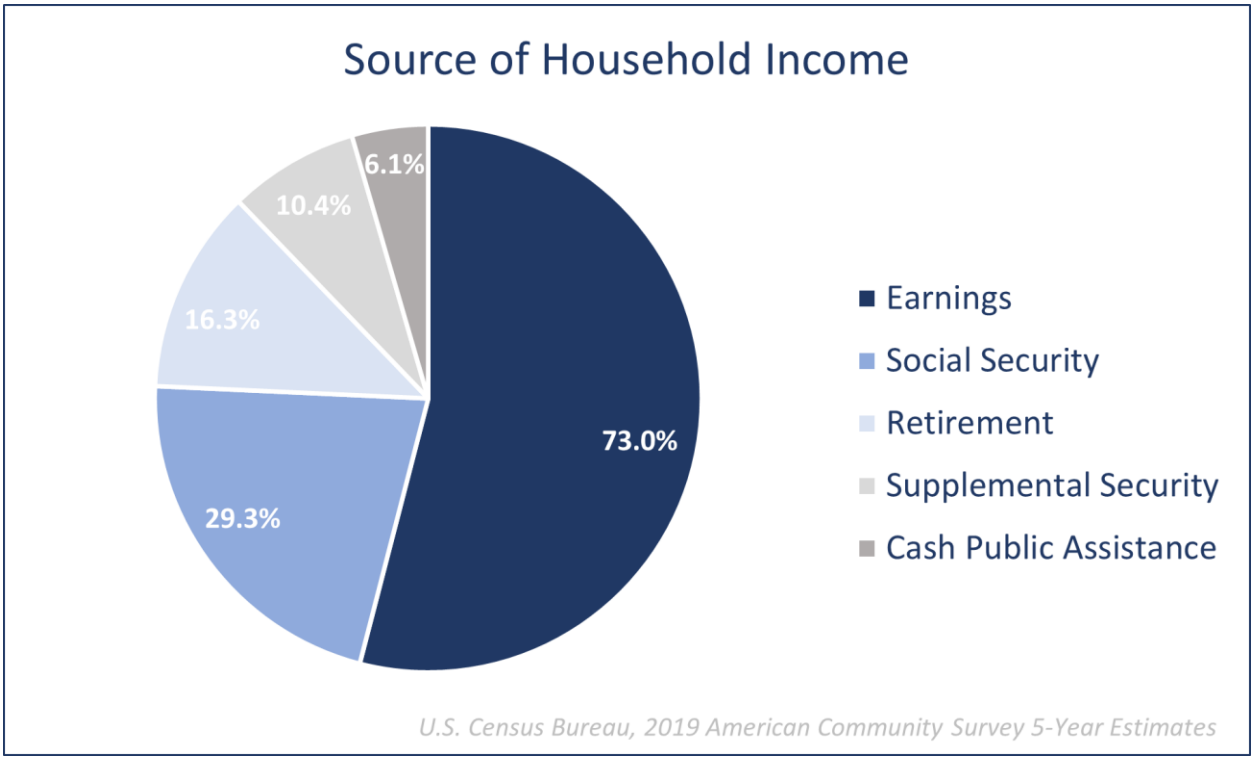
The median income of Philadelphia households is $45,972, an increase of $5,780 from the median income reported in the 2017 Hazard Mitigation Plan (HMP). Of individuals 16 years and older, 55.3% of Philadelphians are employed, while 9.2% of the civilian labor force is unemployed (US Census Bureau, 2019h, Table S1903). Thirty-nine percent of Philadelphians are not in the labor force. The graph below depicts the breakdown of the employment status of Philadelphia residents.

Figure 2-26. Philadelphia Employment Status (Age 16+) (US Census Bureau, 2019h, Table S1903).



Seventy-three percent of Philadelphia households receive their income through earnings, 29.3% receive Social Security, and 16.3% receive retirement income other than Social Security (US Census Bureau, 2019l, Table DP03). In addition, 10.4% of Philadelphians received Supplemental Security Income and 6.1% received public assistance income, with a mean cash public assistance income of $2,448 (2019l). Some households received income from more than one source. **Figure 2-27** displays this breakdown.

Figure 2-27. Source of Household Income in Philadelphia (US Census Bureau, 2019l, Table DP03).

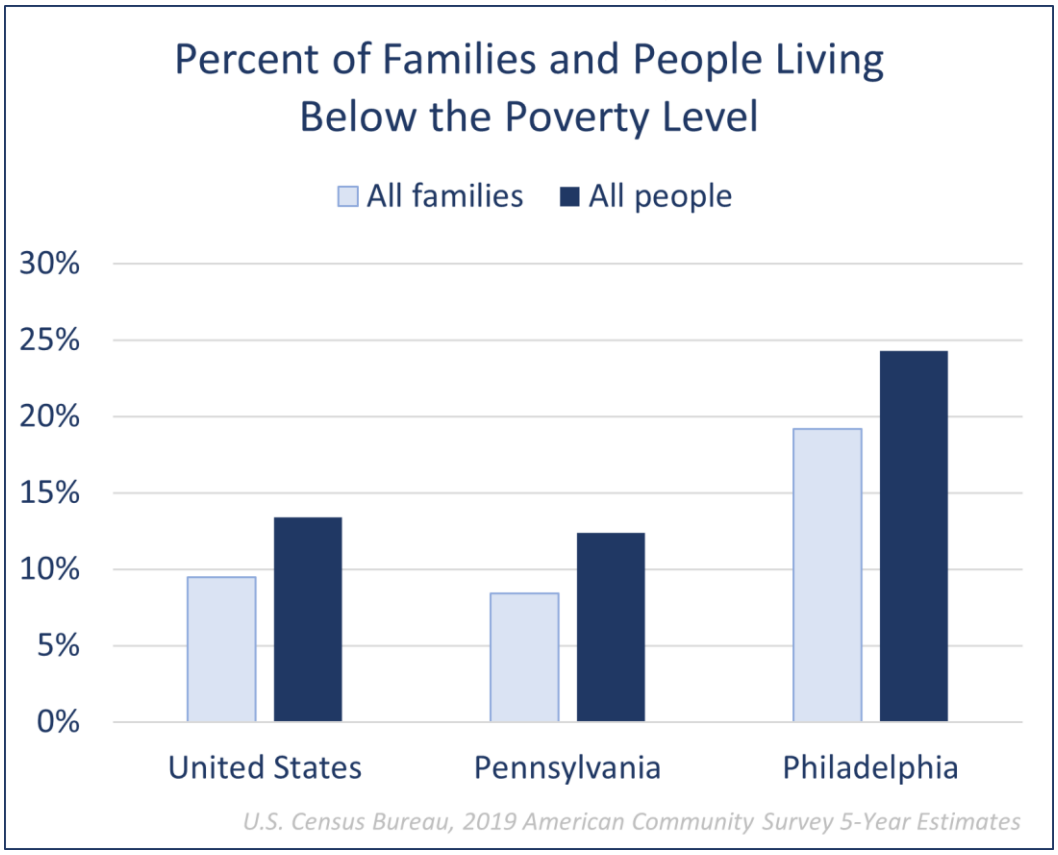


Initial analysis indicates that unemployment spiked to 17.7% in June 2020 due to the COVID-19 pandemic, which was much higher than the national unemployment rate of 11.1% at the time (The City of Philadelphia Commerce Department, 2020). More than 208,000 Philadelphians filed claims for Unemployment Compensations (UC) between March 15 and August 1, 2020 (2020). The full effects of the COVID-19 pandemic on Philadelphia's economy and employment have not yet been determined.

2.3.6.0 Poverty and Participation in Government Programs

Almost a quarter of Philadelphians live below the poverty line (24.3% as of 2019). Philadelphia has the highest poverty rate out of the top 10 most populous U.S. Cities (The PEW Charitable Trusts, 2019). The national poverty rate in 2019 was 13.4% (US Census Bureau, 2019j, Table S1701). **Figure 2-28** displays the higher poverty rate that exists in Philadelphia compared to the state and nation.

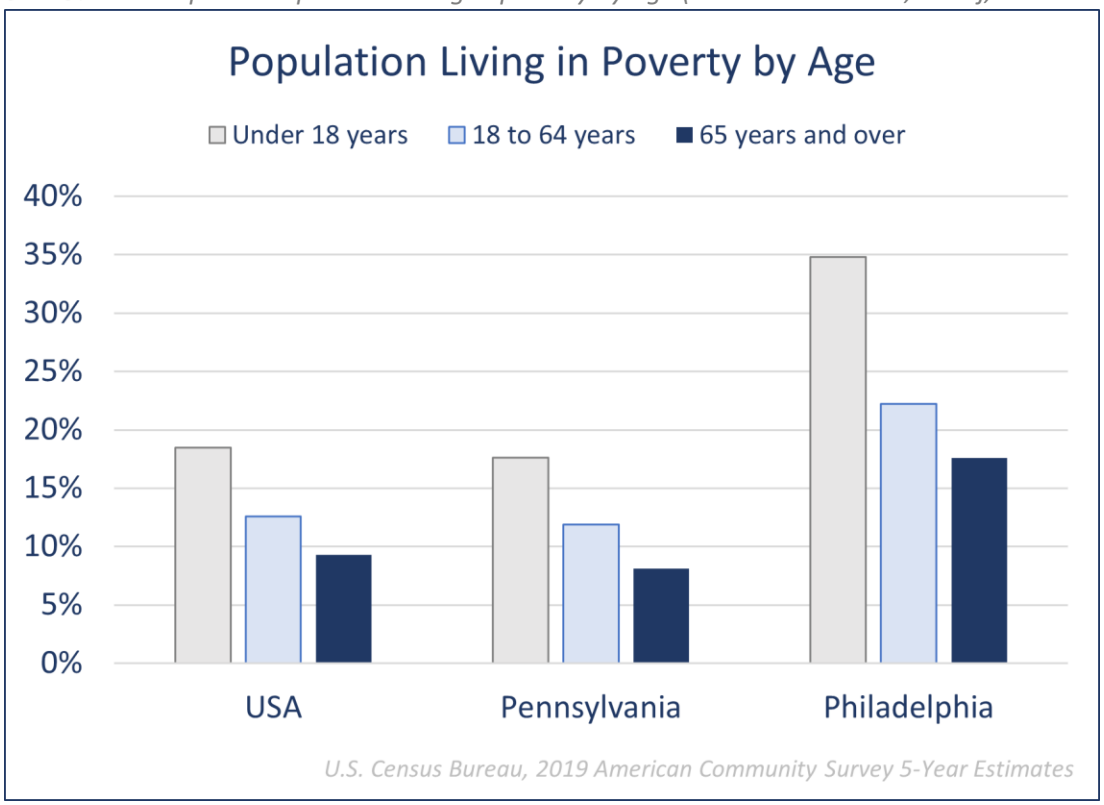
Figure 2-28. Percent of Families and People Living below the Poverty Level (US Census Bureau, 2019j, Table S1701).



Individuals living below the federal poverty line are inherently more at risk of experiencing debilitating impacts from the natural and human-caused hazards and threats identified in this plan because they may not have the financial means to adequately prepare, respond and recover. For example, FEMA recommends that families and individuals keep a small cash reserve in case of disaster. For those that struggle to put food on the table, this can be a difficult, or even impossible, feat. Insurance – such as home insurance or flood insurance - is another positive indicator of faster recovery from disasters. However, many living in poverty may not have the resources to prioritize insurance.

According to the 2019 ACS 5-year study, 34.8% of children under age 18 were living in poverty, a decrease of 1.5% since the 2017 Hazard Mitigation Plan. In the older population, 17.6% of people 65 years old and over were living in poverty, an increase of 0.3% from the last iteration of the Hazard Mitigation Plan.

Figure 2-29. Philadelphia's Population living in poverty by age (US Census Bureau, 2019j, Table S1701).



2.3.7 Individuals with AFN and Disabilities

According to FEMA, individuals with **access and functional needs (AFN)** may need additional assistance due to a temporary or permanent condition that limits their ability to respond in an emergency or disaster. Individuals with access and functional needs include, but are not limited to, individuals with disabilities, seniors, populations having limited English proficiency, limited access to transportation and/or limited access to financial resource to prepare for, respond to and recover from a disaster or emergency (FEMA, 2021).

The U.S. Census Bureau defines **disability** as "a long-lasting sensory, physical, mental, or emotional condition or conditions that make it difficult for a person to do functional or participatory activities such as seeing, hearing, walking, climbing stairs, and learning" (US Census Bureau, 2019e, Table S1810). There are six types of disabilities identified in the most recent version of the ACS: hearing, vision, cognitive, ambulatory, self-care, and independent living disability. **Figure 2-30** details the percentage of Philadelphia residents who reported having one or more disabilities in Philadelphia, Pennsylvania, and the United States.

Figure 2-30. Percentage of Philadelphia's population with a disability compared to the state and nation (US Census Bureau, 2019e, Table S1810).

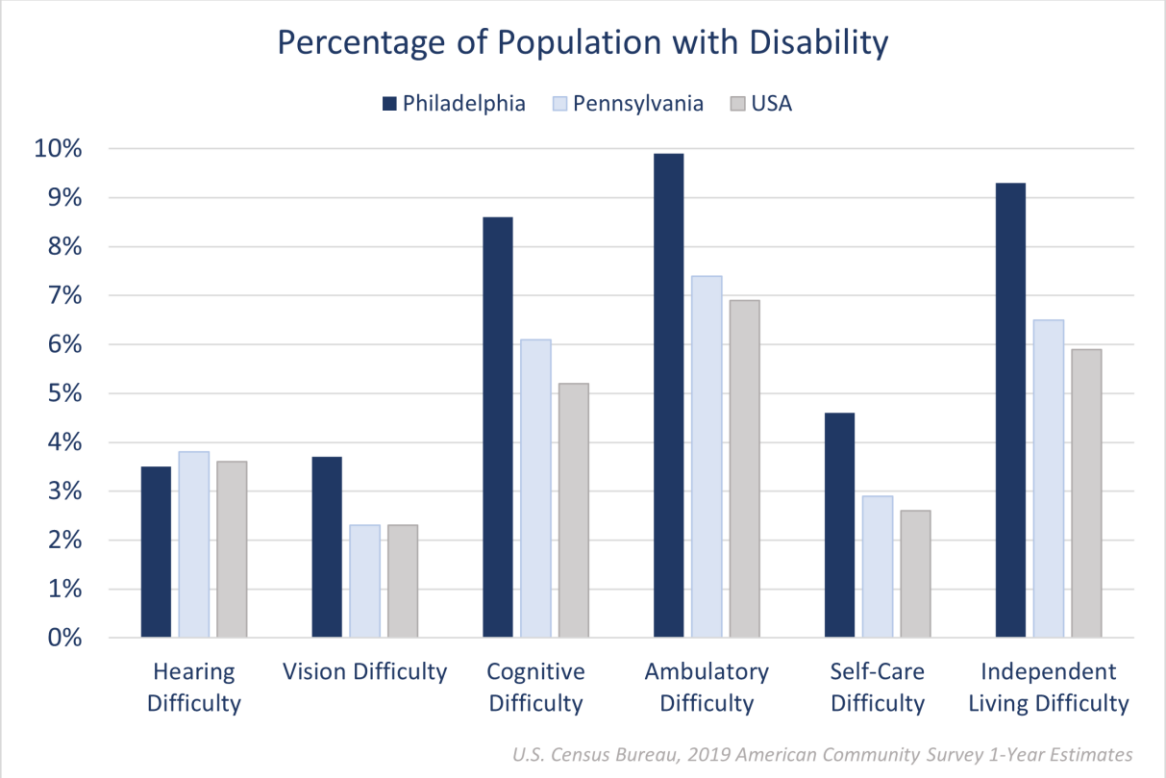
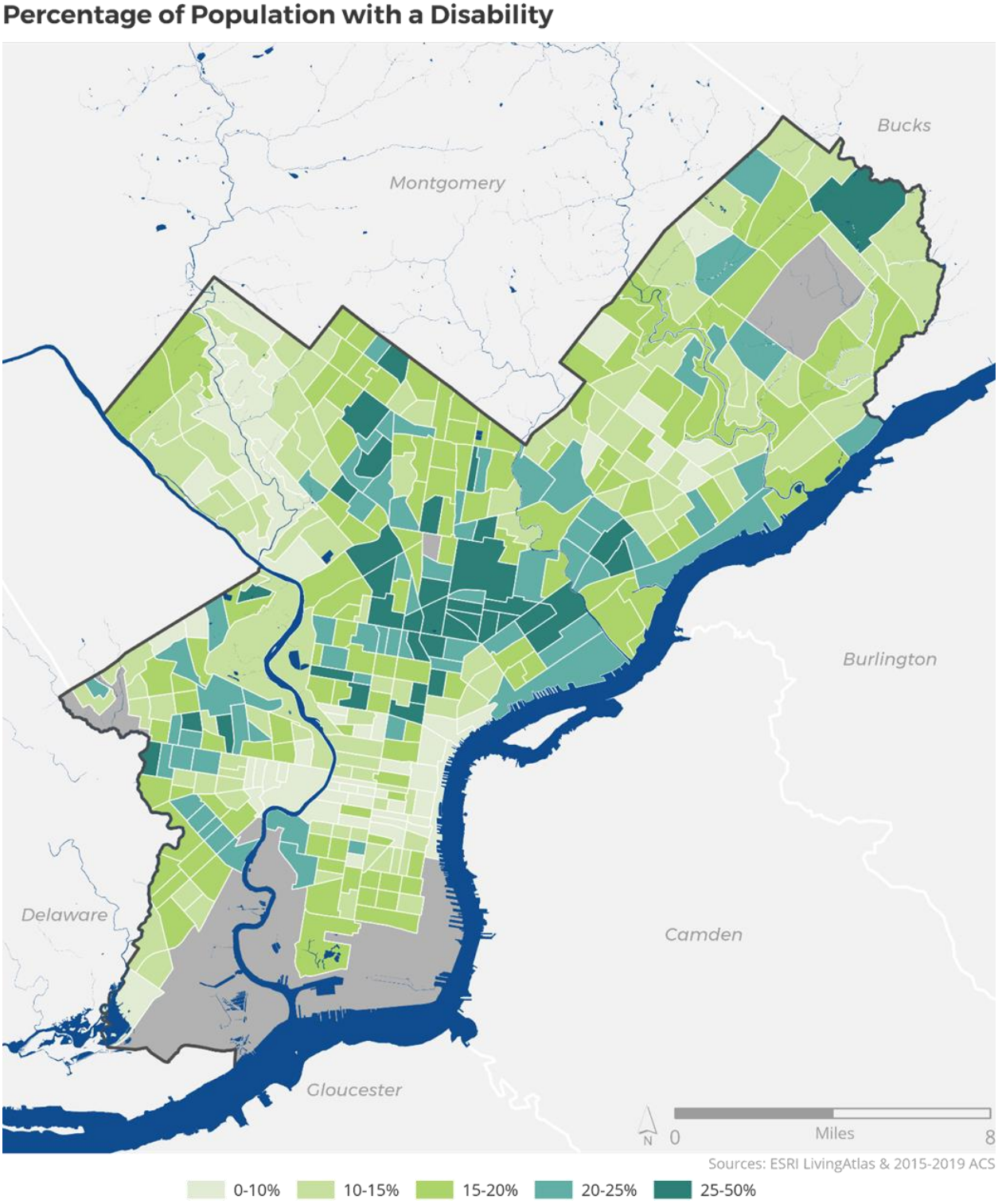


Figure 2-31 on the next page displays the distribution of individuals with disabilities across Philadelphia.

In Philadelphia, roughly 16% of residents have a disability. However, the Mayor's Office for People with Disabilities believes that disability data is more than numbers. It tells the story of our city and its people. The map of disability characteristics in Philadelphia linked below was created by the Mayor's Office for People with Disabilities in partnership with the Managing Director's Office and Philly Counts to support departments, residents and the community to learn more about the disability representation in our City. Additional accommodations may be necessary for individuals with disabilities and access and functional needs during the response and recovery phases of a disaster. Accommodations will vary by individual. This map can also be used as a tool when planning for projects that reduce risk. Learn more about the map here: [Guide to a map of disability characteristics in Philadelphia | Mayor's Office for People with Disabilities | City of Philadelphia]

Figure 2-31. Geographic distribution of individuals with a disability in Philadelphia.



2.3.8 Social Vulnerability

Social vulnerability is the susceptibility of an individual or social group to the negative impacts of natural hazards and disasters due to characteristics that influence one's ability to prepare, respond, cope, or recover from a disaster (FEMA, 2020). These factors include, but are not limited to, financial circumstances, health, age, functional status, the ability to communicate effectively, presence of chronic or terminal illness, or an access and functional need (AFN) (2020). Historic, discriminatory policies such as redlining have also placed communities of color and low-income communities at more risk for experiencing impacts from disasters.

According to FEMA's *Guide to Expanding Mitigation: Making the Connection to Equity (2020)*, populations who may be disproportionately impacted by disaster include:

- Underserved communities with a low socioeconomic status
- People of color
- Tribal and first nation communities
- Women
- Members of the LGBTQ+ community
- Individuals experiencing homelessness or displacement
- Populations over the age of 65 or under the age of 5
- Populations with limited English proficiency
- Service workers and migrant laborers
- Populations with limited cognitive or physical abilities
- Institutionalized populations, such as those in prisons and nursing homes, or individuals going through reentry
- Renters

Please see **4 Risk Assessment** for more details on populations placed at risk for each hazard.

FEMA's National Risk Index incorporates the Social Vulnerability Index (SoVI) published by the University of South Carolina's Hazards and Vulnerability Research Institute (HCRI) into its overall hazard risk calculation for each county and census track. This social vulnerability score represents the relative level of vulnerability of a location in comparison to other communities across the nation. Philadelphia received an overall social vulnerability rating of "very high," indicating higher vulnerability in comparison to other communities across the nation and the State (2020).

Social vulnerability can be considered and analyzed in a variety of ways. The Center of Disease Control (CDC) Social Vulnerability Index is a database to help emergency response planners and public health officials identify and map communities that will most likely need support before, during, and after a hazardous event. The CDC Social Vulnerability Index uses U.S. Census data to examine social vulnerability at the census tract level for 15 social factors, including poverty, lack of vehicle access, and crowded housing.

Figure 2-32 on the next page shows the social vulnerability index score for each census tract in Philadelphia from FEMA and **Figure 2-33** from the CDC. The census tracts with a high index score may require additional support preparing for, responding to, or recovering from hazards. Areas with highest

social vulnerability include North Philadelphia and West Philadelphia. This analysis supports the vulnerability analysis in **4 Risk Assessment** and prioritization of mitigation actions in **6 Mitigation Strategy**.

Figure 2-32.Social vulnerability in Philadelphia based on FEMA's Risk Index (2020).

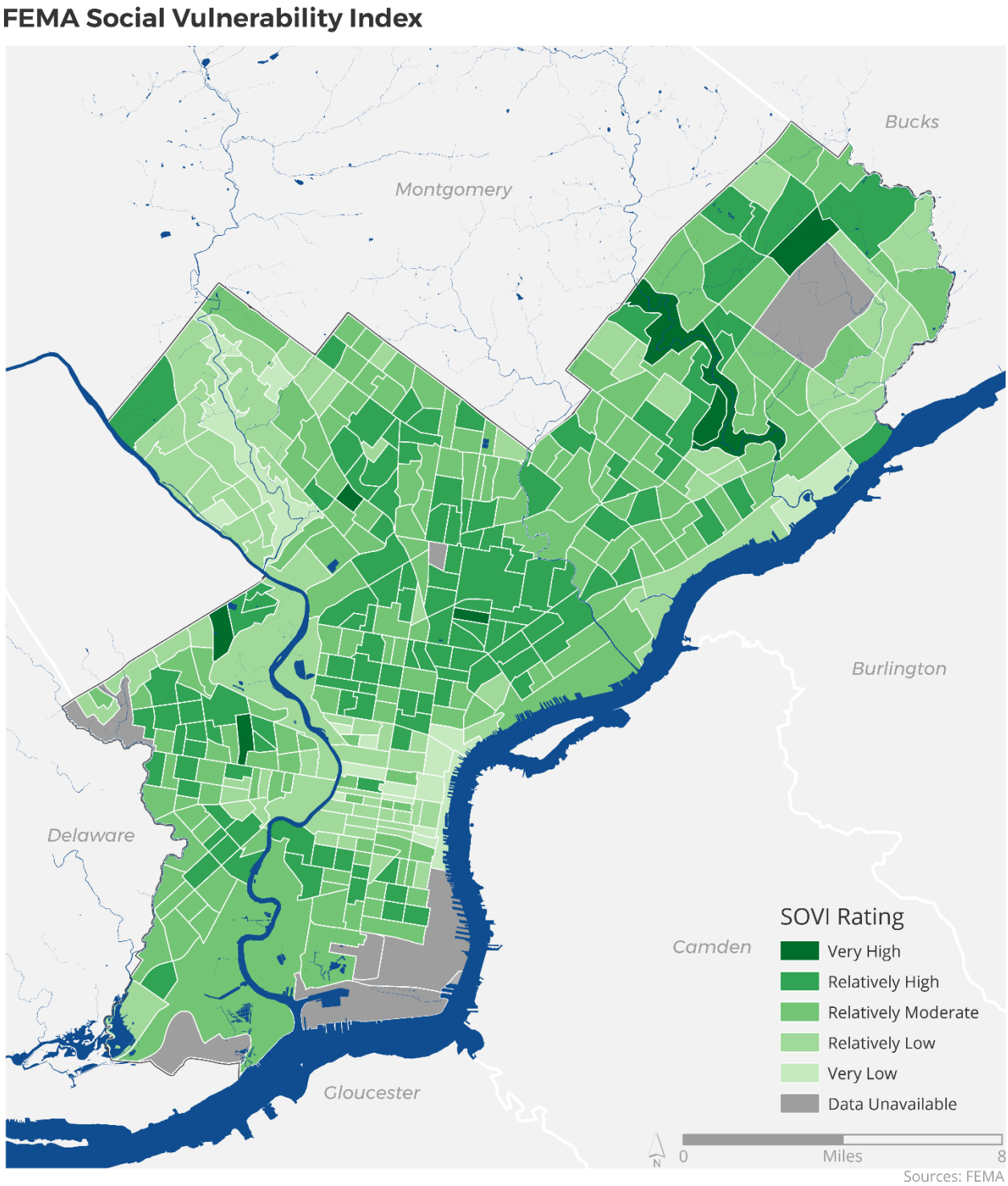
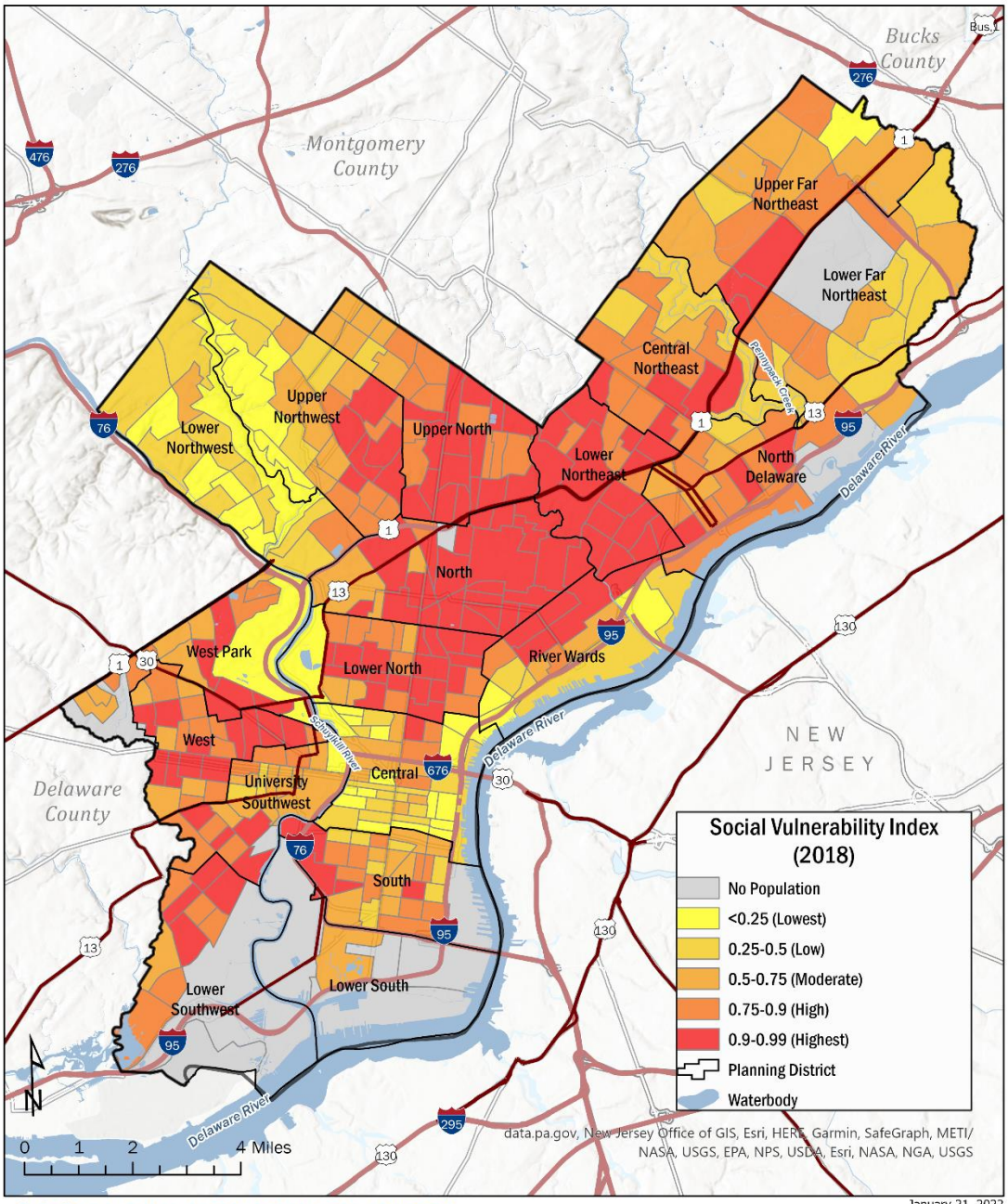


Figure 2-33.Social vulnerability in Philadelphia based on CDC's Risk Index (2018).



SOCIAL VULNERABILITY INDEX
(CDC, 2018)
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

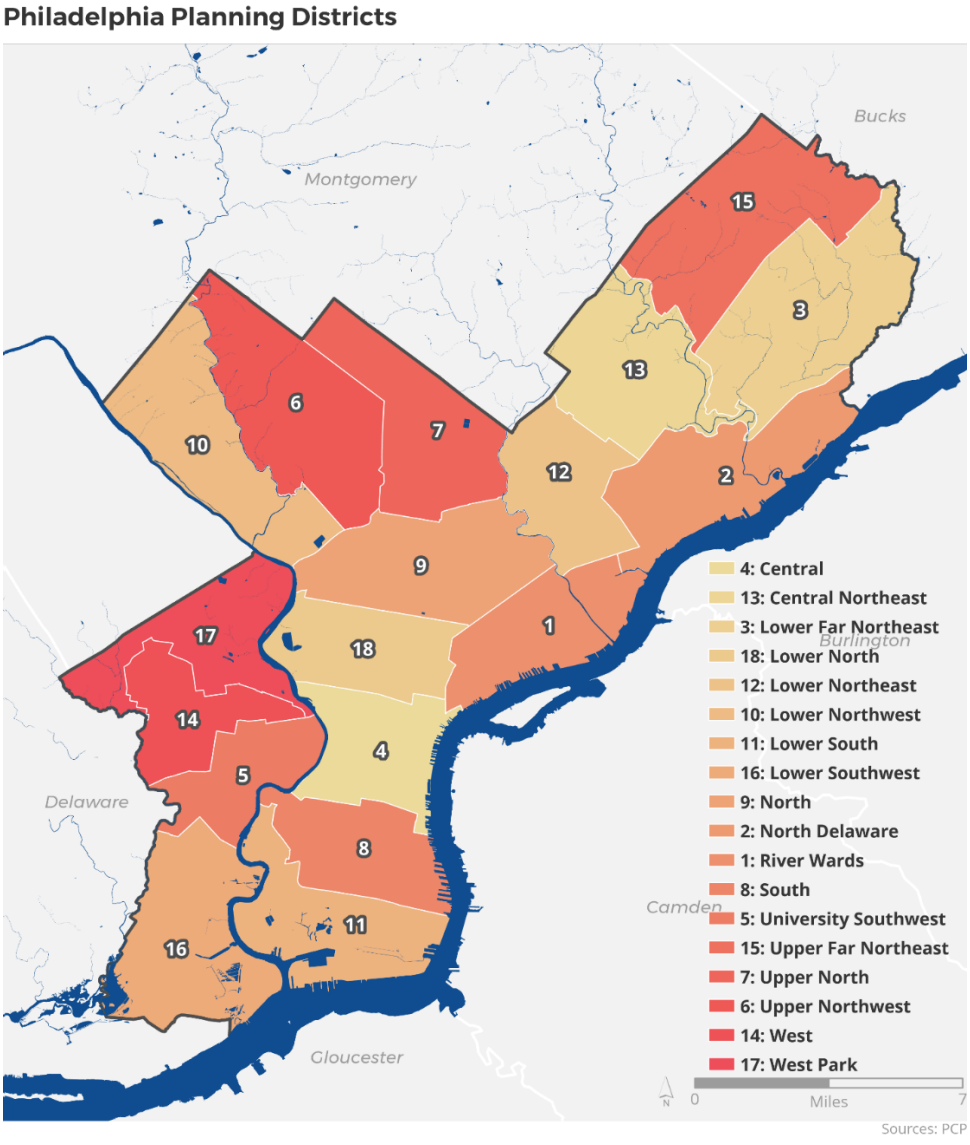
2.4 Land Use, Development, and Growth Trends

2.4.1 Land Use

2.4.1.1 Districting

The Philadelphia City Planning Commission (PCPC) divided Philadelphia neighborhoods into 18 planning districts, as shown in the map below. The City's current comprehensive plan, *Philadelphia 2035* is broken out into plans for each of these planning districts. These districts overlap with 21 police districts, 13 fire battalion districts, and 48 zip codes within the city.

Figure 2-34. Philadelphia planning districts as designated in the Philadelphia 2035 plan.



2.4.1.2 Past Land Use

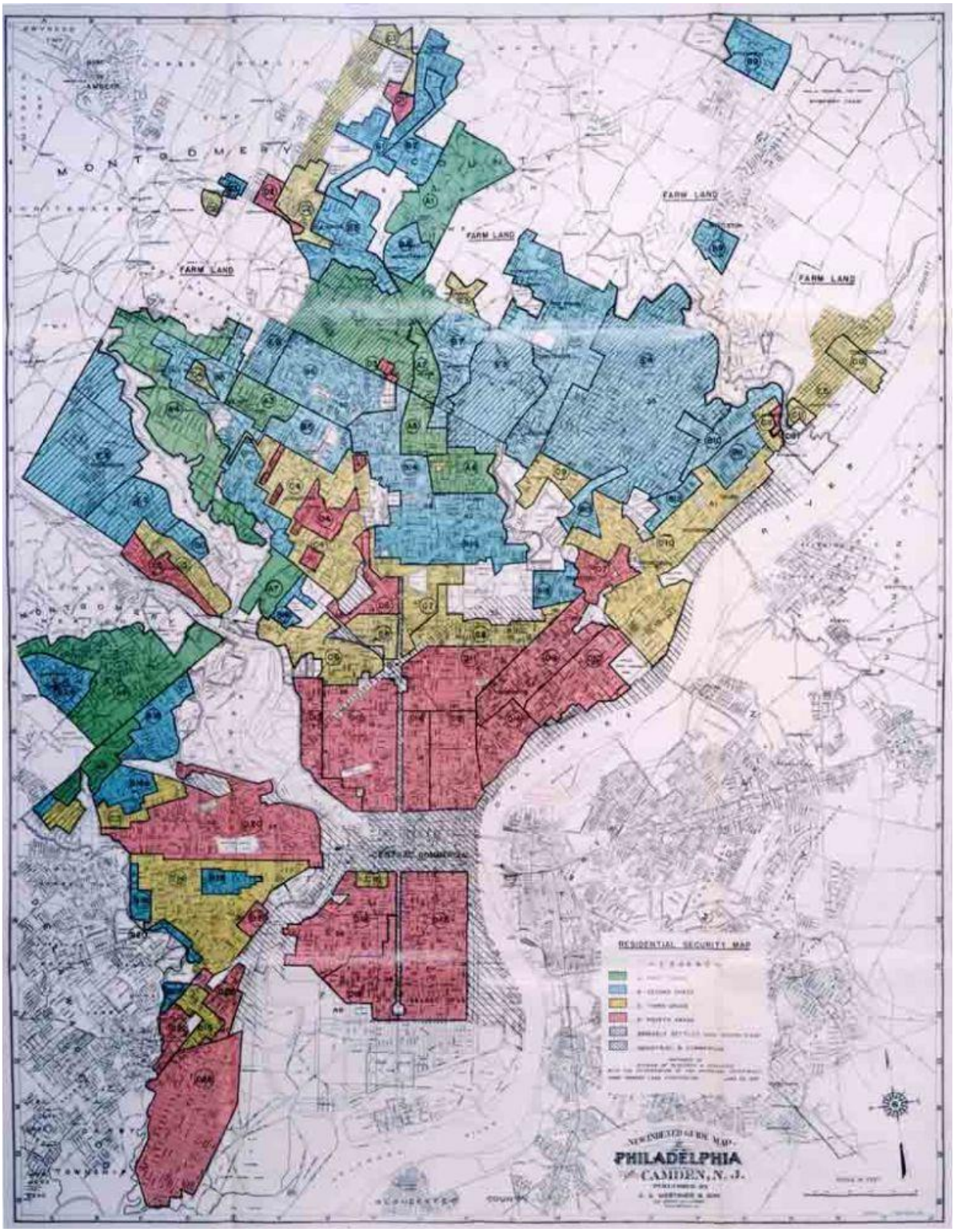
Past land use in Philadelphia was heavily influenced by industrial growth in Philadelphia before WWII, when industrial areas developed along the riverfronts of the Schuylkill and Delaware River and the freight rail lines through older sections of the city. Industrial output peaked in the 1950s and then declined, leading to abandoned and underutilized industrial areas. Many of these areas, referred to as Industrial Legacy Areas in the *Philadelphia2035* Comprehensive Plan, are seen as opportunities for modern industrial or other land uses in Philadelphia in the years to come. It is important to note that many of these areas overlap with FEMA designated flood zones, which should be a key consideration when planning for future development in these areas.

Redlining in the early 20th century contributed to significant racial segregation in Philadelphia. **Redlining** is the discriminatory historical practice of discouraging investment in neighborhoods designated financial risky due to the presence of racial and ethnic minorities. Discriminatory federal mortgage programs and appraisal maps created barriers for African Americans and other minority populations to own homes (City of Philadelphia, Office of the Controller, 2020).

Studies show redlining and other discriminatory policies have lasting impacts on hazard vulnerability today, leaving geographic areas within Philadelphia at higher risk to hazards such as heat, flooding, and gun violence (Hoffman et al., 2020). *Mapping the Impact of Structural Racism in Philadelphia,* a 2020 exploration into the present impacts of historical redlining undertaken by the City of Philadelphia Controller's Office, showed that most historically redlined neighborhoods are also areas where there is a higher poverty rate. Additionally, historically redlined neighborhoods are more likely to experience a higher level of violence and homicides (City of Philadelphia, Office of the Controller, 2020). Philadelphia recognizes the impact these discriminatory policies have on Philadelphians today and is committed to grounding the Hazard Mitigation Planning process in equity, with a focus on populations and geographic areas disproportionately impacted by disaster.

Figure 2-35 on the next page displays classifications of different neighborhoods by the Homeowners' Loan Corporation (HOLC) in the 1930's. Areas in red were deemed "hazardous" due to the presence of racial and ethnic minorities in the neighborhood (*Homeowners' Loan Corporation (HOLC) Neighborhood Redlining Grade*, n.d.).

Figure 2-35.Map of areas relined by HOLC in the 1930s (Homeowners' Loan Corporation (HOLC) Neighborhood Redlining Grade, n.d.)

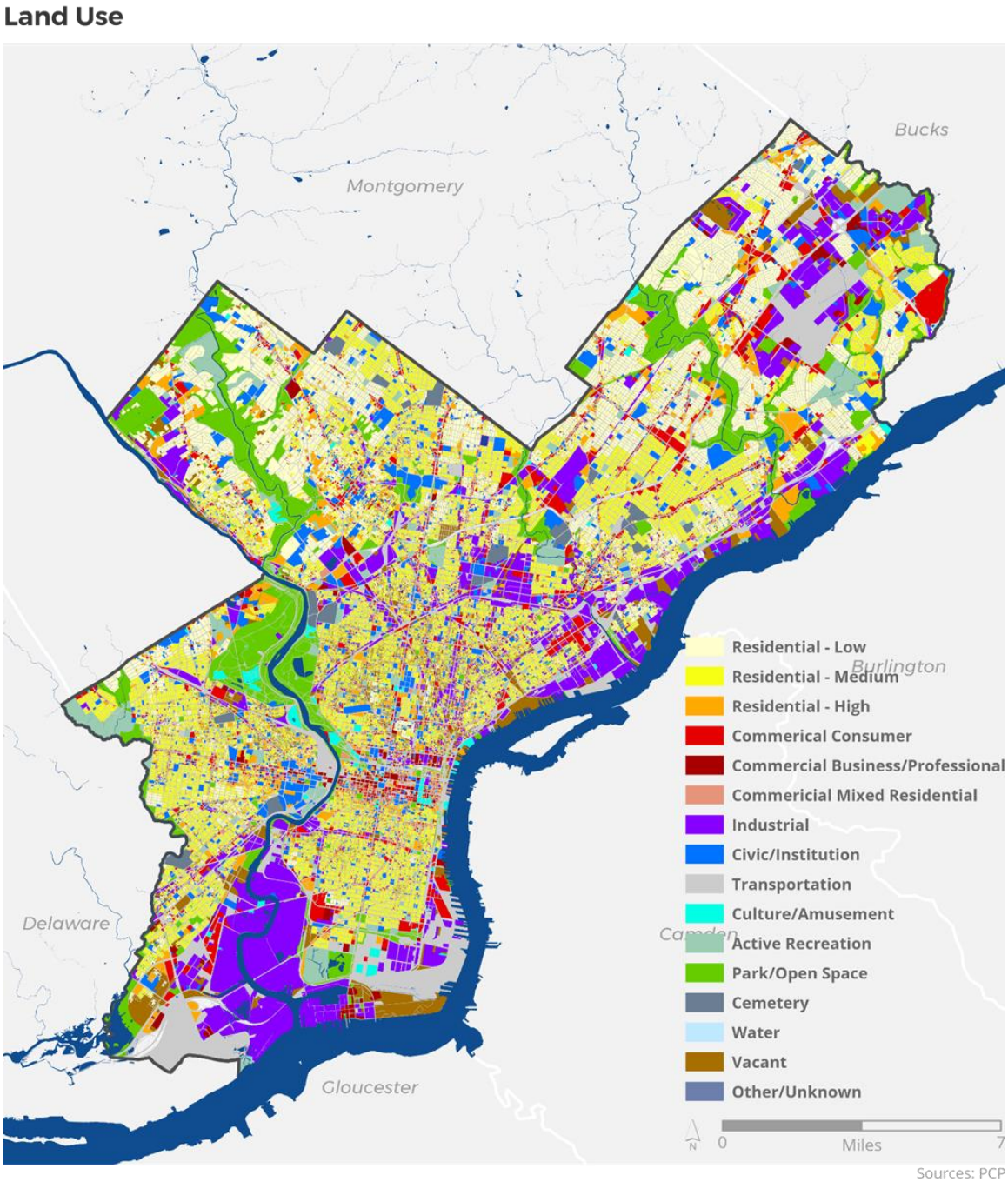


2.4.1.3 Current Land Use

Philadelphia has a diverse and growing population and an expanding commercial and industrial sector. Between 1970 and 2010, vacant land decreased in the neighborhoods bordering surrounding counties. Vacant land decreased in the Center City and University City region in the early part of the 21st Century as the area experienced redevelopment.

As seen in the figure below, land usage is diverse across the city. Outside of industrial uses and open space, land uses are mixed throughout the city and varies greatly block-to-block within the city.

Figure 2-36. Land Use in Philadelphia



2.4.1.4 Green Space

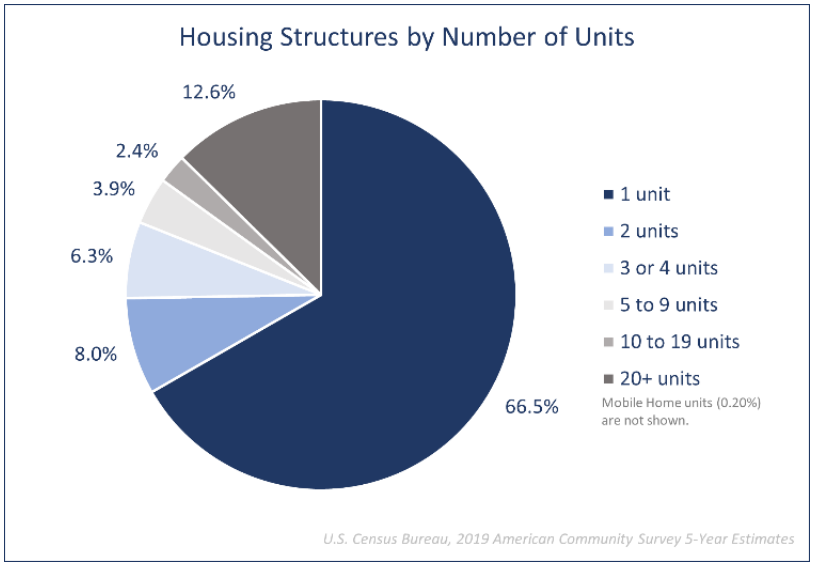
Philadelphia's Parks and Recreation (PPR) oversees over 300 neighborhood parks, recreation centers and playgroups, 166 miles of trails and 40 historic sites, 60 community gardens, farms, and orchards, 3 environmental education centers, numerous recreational fields, and pools, and 5 golf courses (Philadelphia Parks and Recreation, 2018). All contribute to our City's green open space.

Green space is land that is partly or completely covered with grass, trees, shrubs, or other vegetation. Green space includes parks, community gardens, and cemeteries. Philadelphia has one of the oldest and largest metropolitan park systems in the United States. Fairmount Park was originally created in the 1850s with the purpose of preserving a clean water supply for the City and preserving green space. Philadelphia was one of the first big cities to acquire land ideal for industrial development and convert it for public recreational space (Philadelphia Parks and Recreation, n.d.). As a result, flood prone land surrounding the Fairmount Park section of the Schuylkill River and Wissahickon Creek are still park land and open space to this day.

2.4.1.5 Housing

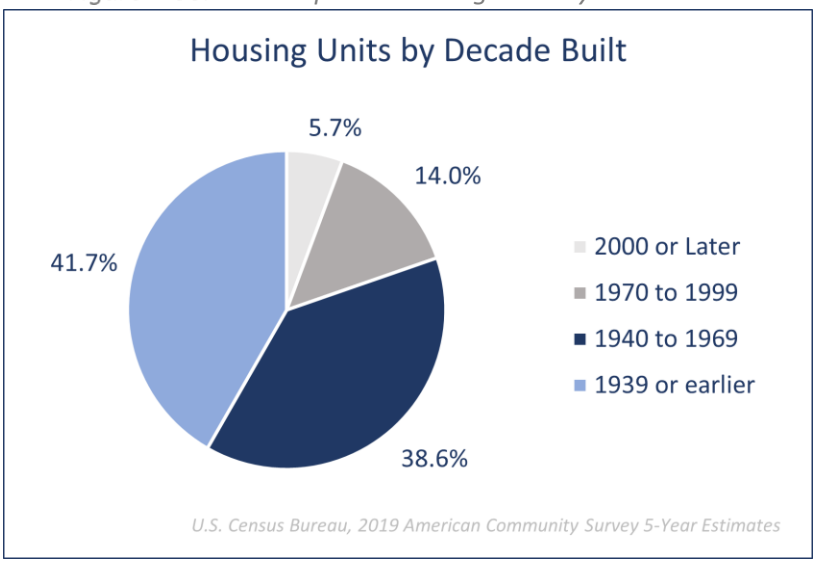
Philadelphia's housing units are largely single unit attached homes, commonly referred to as "row homes." This style of housing contributes to the population density and distribution in the city. **Figure 2-37** shows the varied types of housing structures built in Philadelphia.

Figure 2-37. Philadelphia's Housing Structure by Number of Units



Philadelphia housing units are largely aging structures, with most units built prior to 1939. These features, along with high vacancy rates in specific neighborhoods, cause greater risk of fire to housing units (Shai, 2006). **Figure 2-38** shows the housing units by the decade built.

Figure 2-38. Philadelphia's Housing Units by Decade Built



2.4.2 Infrastructure

2.4.2.1 Streets, Highways and Bridges

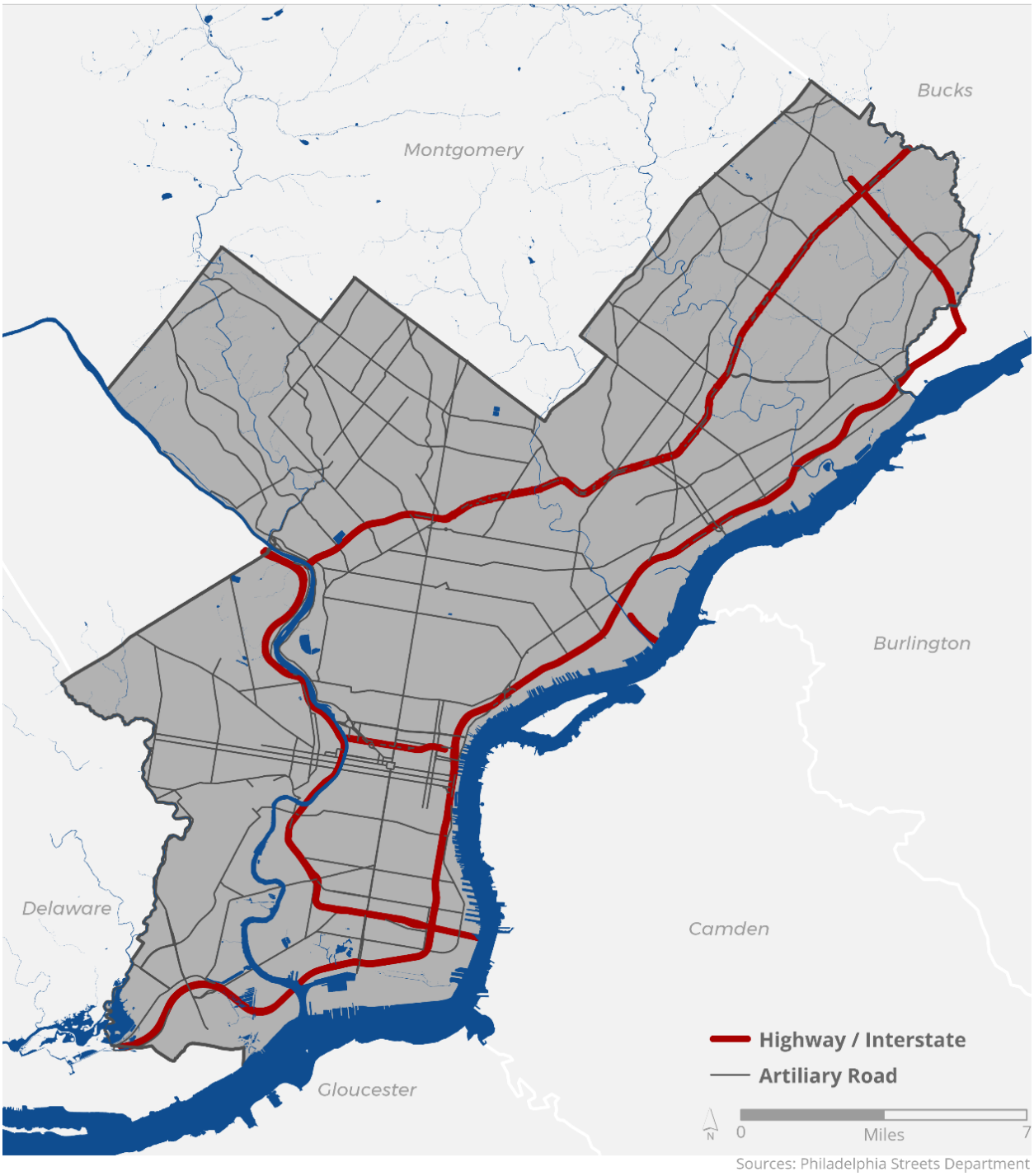
The Philadelphia Streets Department (Streets), the Philadelphia Department of Parks and Recreation, and the Pennsylvania Department of Transportation (PENNDOT) manage roadway travel in Philadelphia. The streets system in Philadelphia totals 2,575 miles: 2,180 miles of city streets, 35 miles of Fairmount Park roads, and 360 miles of state highways. The Streets Department is responsible for the construction and maintenance of 320 bridges in the city (Philadelphia Streets Department, n.d.).

Many major highways and roadways serve Philadelphia. Interstate 95 (I-95) is an interstate highway which runs from Miami, Florida to Houlton, Maine. The highway provides northern and southern access to the United States' eastern seaboard. In Philadelphia, the route is commonly referred to as the Delaware Expressway. It runs for approximately 19.89 miles along the eastern boundary of Philadelphia, parallel to the Delaware River. An estimated 169,000 motorists utilize the highway daily within Philadelphia. Interstate 76 (I-76) is an interstate highway running 435 miles from Akron, Ohio to Camden, New Jersey. The stretch of I-76 close to Philadelphia is more commonly known as the Schuylkill Expressway. The Schuylkill Expressway is 25 miles in length, extending from the Pennsylvania Turnpike at Valley Forge, through Center City Philadelphia, to the Walt Whitman Bridge. The highway runs 10.33 miles through Philadelphia and is located along the southwest side of the Schuylkill River.

Interstate 676 (I-676), or the Vine Street Expressway, also serves as an essential part of Philadelphia's highway system. Completed in 1991, I-676 runs seven miles between I-76 and I-95, crossing the Ben Franklin Bridge into Camden, New Jersey. U.S.-1 (also known as the Roosevelt Expressway/Roosevelt Boulevard) runs from Florida to Maine along the east coast. Construction crews completed the portion in Philadelphia in 1961 after three years of construction. In Philadelphia, U.S.-1 is an 18.43 mile stretch of road, connecting northeast Philadelphia with Center City.

Figure 2-39. Major Roadways in Philadelphia (Philadelphia Streets Department)

Major Roadways



Sources: Philadelphia Streets Department

2.4.2.2 Public Transportation

Philadelphia has three major public transportation lines running through the city that conduct hundreds of millions of trips annually. Twenty-five percent of Philadelphian's commute to work (US Census Bureau, 2019c, Table S0801). Public transit providers in Philadelphia include:

- Southeastern Pennsylvania Transportation Authority (SEPTA)
- Amtrak
- Port Authority Transit Corporation (PATCO)
- New Jersey Transit

Public transit systems provide transportation beyond the borders of Philadelphia, extending to surrounding counties and across state borders. The details and description of the major public transit providers are listed below.

SEPTA

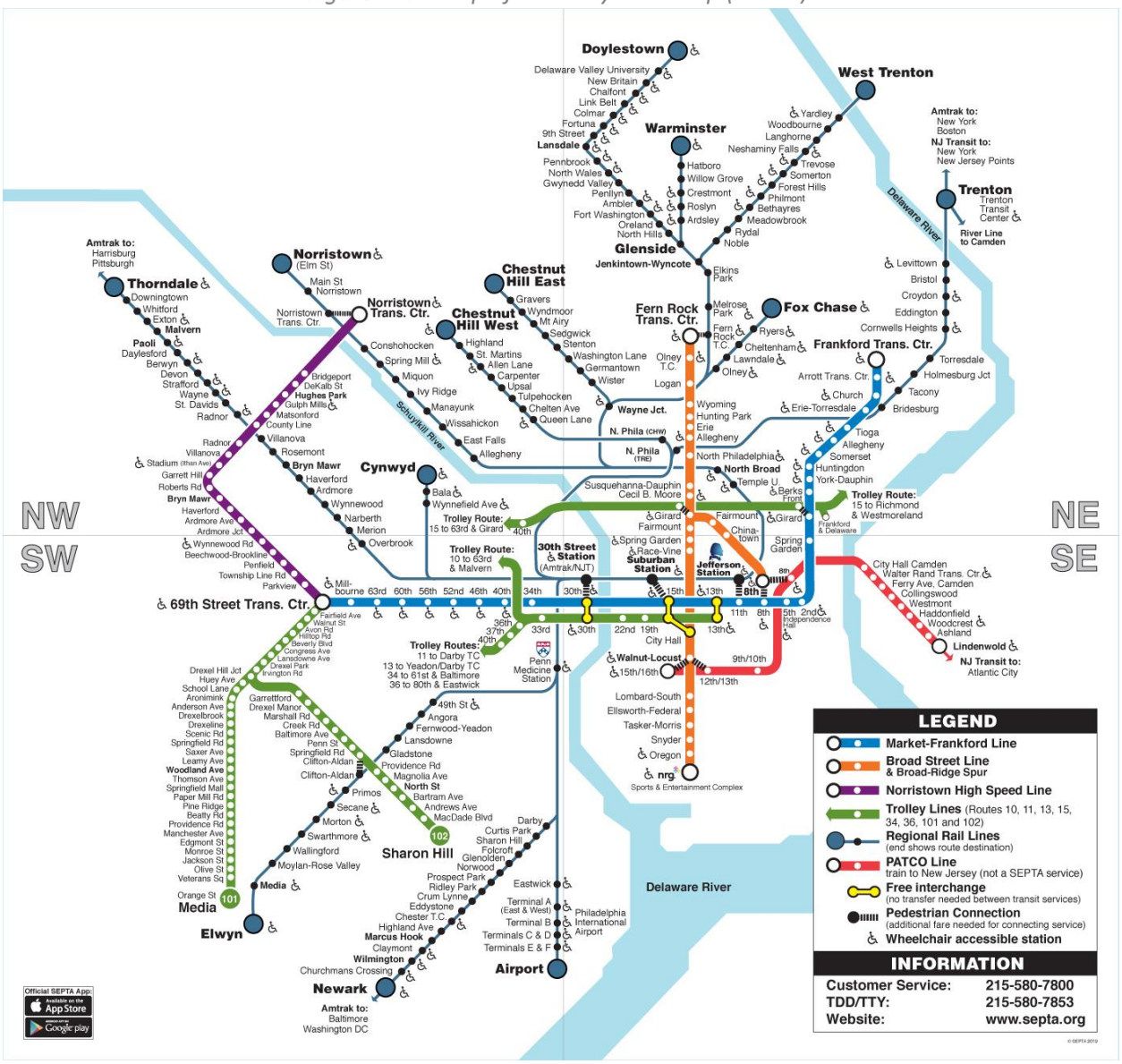
Philadelphia's primary public transit provider is the Southeastern Pennsylvania Transportation Authority (SEPTA). SEPTA is the nation's 6th largest transit system and operates public buses, trolleys, trackless trolleys, Broad Street Subway, and Market-Frankford Elevated subway. In addition, SEPTA operates regional rail lines and regional bus services throughout Philadelphia, Bucks, Montgomery, Chester, Delaware counties, as well as service to and from parts of southern New Jersey (SEPTA, 2020).

At the end of the 2020, SEPTA's buses, subways, trolleys, and trains had approximately 220 million trips, down from the recorded 330 million reported in the 2017 Hazard Mitigation Plan. Passenger trips in FY2020 were significantly lower than in 2019 due to COVID-19 (2020).

The system map on the following page illustrates the regional rail, subways, elevated rail, and trolley lines throughout the greater Philadelphia area associated with SEPTA operations.

Figure 2-40. Photo of SEPTA Regional Rail Service Line (SEPTA, n.d.).

Figure 2-41. Map of SEPTA system Map (SEPTA).



PATCO

More than 38,000 people ride the PATCO high-speed line every day. PATCO runs a single line with 13 stations from 15th to 16th St. station in Center City to Lindenwold, New Jersey. To meet increasing demand, PATCO has teamed up with NJ Transit, SEPTA and AMTRAK on several projects meant to expand and improve public transportation in the Philadelphia region. In recent years, PATCO also completed several efforts to improve accessibility for riders with disabilities (PATCO, 2018).

Figure 2-42. Map of PATCO stops (PATCO, n.d)

NJ Transit

Covering a service area of 5,325 square miles, NJ Transit is the nation's third largest provider of bus, rail, and light rail transit, linking major points in New Jersey, New York, and Philadelphia. The agency operates a fleet of 2,221 buses, 1,231 trains and 93 light rail vehicles (NJ Transit, n.d.). In Philadelphia, NJ Transit provides a train line service from Philadelphia to Atlantic City, New Jersey.

Figure 2-43. Map of NJ Transit Train Line Service (NJ Transit, n.d.)

Amtrak

Amtrak is the major semi-national railroad company that serves Philadelphia at 30th Street Station. In FY2020, Philadelphia's 30th Street Station was the 3rd busiest station for Amtrak in the United States with ridership equaling 2,261,194 passengers (Amtrak, 2020).

RiverLink Ferry System

The Delaware River Waterfront Corporation (DRWC) operates the RiverLink Ferry System, which provides seasonal cross-river transportation between the Camden and Philadelphia Waterfronts on the Delaware River (Delaware River Waterfront Corporation, 2017).

2.4.2.3 Airports

Philadelphia is the home of two airports: Philadelphia International Airport (PHL) and Northeast Philadelphia Airport (PNE). Both are owned by the City of Philadelphia and operated by the Division of Aviation. PHL operates under the jurisdiction of the 77th Philadelphia Police Department (PPD) district, a police district solely responsible for PHL. PNE operates under the 8th PPD district.

Philadelphia International Airport

Philadelphia International Airport is the only major airport serving Philadelphia. In a typical year, 30 airlines offer approximately 500 daily departures to approximately 32.24 million passengers annually. This is an increase in the 30.74 million passengers reported in the 2017 HMP (Philadelphia International Airport, 2021a). Although ridership decreased to about 11,865,006 people in 2020 due to the COVID-19 Pandemic, PHL set a record for passenger volume of 33 million passengers in 2019, making it the 20th busiest airport in the United States (Philadelphia International Airport, 2021b).

PHL has a $16.8 billion economic impact on the region and accounts for 106,000 full-time jobs, making it one of the largest economic engines in Pennsylvania.

Located in a FEMA designated floodplain, The Philadelphia International Airport conducted a Climate Vulnerability Assessment (CVA) in 2019 to better understand and prepare for impacts from climate change. This assessment identified and assessed key vulnerabilities based on climate trends and projects for the City of Philadelphia. It also developed a set of key recommendations and next steps for the airport, including the development an airport-specific Climate Adaption and Resiliency Plan (CARP) which is underway today (Figueroa Emanuelli, 2020). Implementation of this plan is included as a mitigation action in the 2022 HMP. The Airport is also updating their Master Plan in 2021 and 2022, which will guide future development of the airport moving forward.

Table 2-7. PHL Rankings for 2019 (Philadelphia International Airport, 2020)

Philadelphia International Airport (PHL) Rankings for 2019
Among U.S. Airports
20th Busiest Airport for passengers
19th Busiest in Airport for aircraft operations
15th busiest for cargo tonnage

Philadelphia Northeast Airport

Philadelphia Northeast Airport is located on 1,150 acres of land in the northeast part of the City. It is the sixth busiest airport in Pennsylvania and provides “on-call” support to U.S. Customs, Immigrations and United States Department of Agriculture (Philadelphia International Airport, 2021c). The airport does not provide commercial service. In 2020, PNE managed approximately 68,059 airport flight operations.

In general, the number of annual flight operations managed by PNE has decreased since 2005 (Philadelphia International Airport, 2020).

2.4.2.4 Freight

The production and distribution of goods is an important part of the Philadelphia region's economy. The primary freight-intensive industries in the region include extraction, production, and distribution, all which contribute 675,000 jobs or 22% of regional employment. The region's transportation infrastructure plays a large role in distribution of freight and influences the resilience of the region's supply chain (Delaware Valley Regional Planning Commission, 2021b).

Port of Philadelphia

The Port of Philadelphia is both the fastest growing and the largest refrigerated port in the United States. The Philadelphia Regional Port Authority (PRPA) reported approximately 6.3 million metric tons of cargo moved through the Port in 2016, a 2.7% increase from 2015. The Port is a top-ranked port in the United States for meat imports, and imports a significant amount of fruit, cocoas, forest products and steel (*The City of Philadelphia, PA General Obligation Refunding Bonds*, 2020). The port is currently undergoing an update to their Master Plan.

Rail

Philadelphia has served as a hub for major railroad transportation, including both freight, and passenger rail, since the early 19th Century. Freight cars transport a variety of goods throughout the region, supplying local businesses with the equipment and raw materials required for industrial processing plants and heavy equipment work.

Norfolk Southern, Canadian Pacific (CP) Rail, and CSX serve Philadelphia's port, making it one of the few U.S. ports served by three class-one railroads. Philadelphia's core rail lines carry some of the highest volume in the nation. For example, the former Pennsylvania Railroad main line—now Norfolk Southern—connects Philadelphia, Harrisburg and Pittsburgh and extends to Chicago. This line carries more than 120 million gross tons (MGT) annually. Other very high-traffic rail lines include the I-95 corridor in southeastern Pennsylvania. This line contains the CSX mainline and parallels I-95 at Chester north through Philadelphia to the New Jersey/Pennsylvania border at Yardley, PA.

Another important core line is Amtrak's Northeast Corridor, which passes through Philadelphia. Some freight is moved on this predominantly passenger rail corridor (American Society of Civil Engineers (ASCE), 2010). Although Conrail no longer handles commercial matters for customers, they continue to play a critical role in serving shippers and receivers as an agent for their owners. Conrail operates about 372 miles of track in the Philadelphia/southern New Jersey area (Conrail, n.d.).

Air

Philadelphia International Airport (PHL) has 6 active cargo facilities. Increased demand for online goods during the COVID-19 pandemic led to an 6.5% increase in total cargo tonnage in 2020. There was approximately 40,340 tons of mail and 573,499 tons of freight, totaling 613,839 tons of total cargo transported by PHL in FY2020. This is up from the 404,050 tons of cargo and 28,702 tons of mail reported in the 2017 plan (Philadelphia International Airport, 2020).

2.4.2.5 Hospitals and Healthcare Facilities

Philadelphia is one of the United States' leading major metropolitan areas in healthcare. The City is home to 29 hospitals dedicated to high-quality patient care and service

Table 2-8. Table of Hospitals and Healthcare Facilities in Philadelphia.

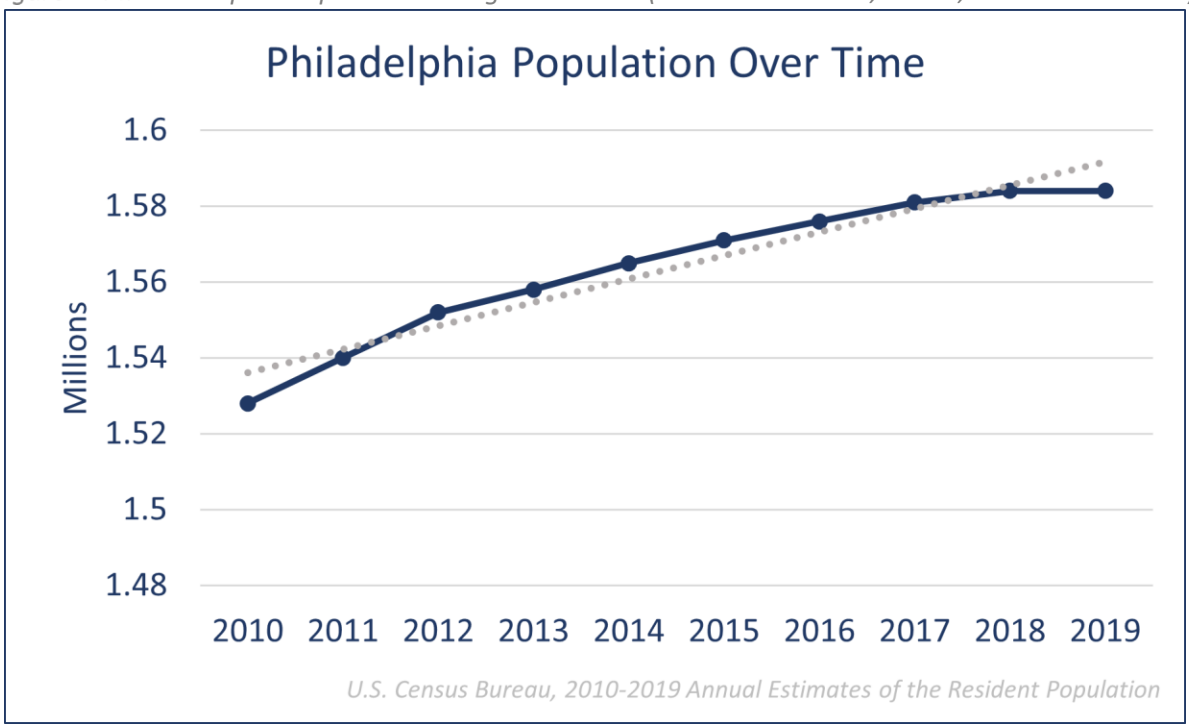
Hospital Name	Emergency Department	Trauma Center	Burn Center	Pediatric
Angela Jane Pavilion Rehabilitation Hospital				
Aria Health – Frankford Campus	X			
Jefferson Torresdale	X	Level 2		
Chestnut Hill Hospital	X			
Children's Hospital of Philadelphia	X	Level 1		X
Einstein Medical Center	X	Level 1		
Fox Chase Cancer Center				
Germantown Community Health Services				
Girard Medical Center				
Hahnemann University Hospital – CLOSED	X	Level 1		
Hospital of the University of Pennsylvania	X			
Jeanes Hospital	X			
Kindred Hospital of Philadelphia				
Magee Rehabilitation Hospital				
Mercy Philadelphia Hospital	X			
Methodist Hospital	X			
Moss Rehab				
Nazareth Hospital	X			
Penn Medicine at Rittenhouse				
Penn Presbyterian Medical Center	X	Level 1		
Pennsylvania Hospital	X			
Roxborough Memorial Hospital	X			
Shriner's Hospital for Children – Philadelphia				X
St. Christopher's Hospital for Children	X	Level 1	X	X
Temple University Hospital	X	Level 1	X	
Temple University Hospital – Episcopal Campus	X			
Thomas Jefferson University Hospital	X	Level 1	X	
Philadelphia VA Medical Center	X			

2.4.3 Population Changes and Future Development

2.4.3.1 Population Change

Philadelphia experienced steady growth between 1860 and 1950, except for a brief lull in 1930, which was in part due to the Great Depression. The City's population peaked in the 1950s and has been steadily declining. However, since 2010, Philadelphia has slowly gained population. According to the recently released 2020 Census data, Philadelphia's population is currently over 1.6 million people.

Figure 2-44. Philadelphia Population Change Over Time (US Census Bureau, 2019b, Table PEPANNRES)



According to the Delaware Valley Regional Planning Commission (DVPRC), the region's population is expected to grow at a moderate pace, increasing by 440,000 people, or 7.6 percent, by 2050 (2021a).

2.4.3.2 Future Land Use and Development

As part of the creation and implementation of the Phila2035 comprehensive planning process, The Philadelphia City Planning Commission (PCPC) worked with communities and stakeholders to develop district plans with recommendations on future land use, development opportunities, urban design scenarios, and proposed zoning. PCPC adopted these plans on a district-by-district basis.

With anticipated, 62continued growth in population, households, and employment between now and 2050, Philadelphia will see a high-level of development activity, a need for new infrastructure, and a potential decrease in the amount of open space available in Philadelphia and the surrounding counties (DVRPC, 2021a)

For more information on future land use and development, please see **4.4.4 Future Development and Vulnerability**.

2.5 Data Sources and Limitations

The City of Philadelphia is a data rich location for GIS analysis and a thorough risk assessment. The City has an excellent resource, OpenDataPhilly and Philadelphia OEM maintains access to robust sets of data for analysis before, during, and after disaster events. City data was used and described through the risk assessment. Two special City data sources came from City of Philadelphia Office of Property Assessment (OPA) and the Philadelphia Water Department (PWD). Their data enabled the consultant team to utilize local data for analysis of buildings and sea level rise (SLR) in Hazus. OPA provided a building data layer

that was utilized in Hazus to greatly improve loss estimation. PWD shared a flood depth raster depicting 4 feet of sea level rise in Philadelphia; this data was utilized in Hazus for the sea level rise scenario. It was decided that the HMP would use 4 ft. of SLR aligning with the scenarios in the *Growing Stronger* report which includes 2 ft. for mid-century, 4 ft. for the end-of-century and 6 ft. for the end-of-century, high emissions scenario. In full, Hazus was utilized with OPA building to analyze potential losses from earthquakes, floods, sea level rise, and hurricanes.

The risk assessment examines numerous different national data sources, which are cited throughout the section and included in Appendix A: Bibliography. The risk assessment references data sources including:

- National Hurricane Center (NOAA)
- National Climatic Data Center (NOAA)
- Federal Bureau of Investigation
- PennDOT Bridge Information
- National Earthquake Data Center
- Global Terrorism Database
- USGS
- NOWData (NOAA)
- Department of Homeland Security
- FEMA Region III
- City agencies, such as the Planning Commission, The Philadelphia Water Department, and the Department of Licenses and Inspections.

Three data limitations were identified during the HMP update including older effective flood maps, COVID-19 data limitations, and US Census data availability. The Philadelphia Flood Insurance Rate Map (FIRM) is an older floodplain map. FIRM information is available on the FEMA Flood Map Service Center. Most of the City is on FIRM panels effective January 17, 2007. The southern portion of the tidal Delaware is part of a coastal study effective November 18, 2015. It would be helpful to have a more recent update and full Flood Risk Products available for the whole City. The concern related to having older effective maps was addressed by examining flooding in a variety of ways. In addition to mapping the 1% and 0.2% annual chance flood, the risk assessment includes a National Oceanic and Atmospheric Administration (NOAA) storm surge map, and PWD SLR map. **Table 4-18.** and PWD's SLR Map build on the best available SLR data from NOAA when the plan was developed which is the 2017 projections for the Philadelphia local scenario. The 2022 projection came out as the plan was being finalized. The 2022 scenarios show slightly lower increases in SLR, so it is actually less risky to plan using the 2017 scenarios.

COVID-19 is expected to have a lasting impact on Philadelphia and the surrounding region. The full extent of impacts on our environmental characteristics, social characteristics, and the built environment is still to be determined. As data on these impacts is collected, they will be included in annual reviews and incorporated into the risk assessment and pandemic hazard profile for the next HMP.

Due to the timing and schedule of this plan update, the Community Profile was primarily updated in Spring 2021, prior to the release of the 2020 Census Data. With the delay of the 2020 Census Data release due to the COVID-19 Pandemic, 2019 ACS Data was the most recent, accurate data available at the time the plan was updated. The recently released 2020 Census Data will be used to support the first annual review of this plan and next plan update.

3 Planning Process

3 Planning Process

3.1 Update Process and Participation Summary

3.1.1 Summary of Updates

Philadelphia's first HMP was adopted in 2012. The plan was then updated and adopted by City Council 5 years later in May 2017. In November 2019, Philadelphia OEM hired a permanent Hazard Planning Coordinator to oversee the development and coordination of Philadelphia's third HMP and to focus on implementation of the plan in between plan updates. An annual review and kickoff were conducted in February 2020, and a second kickoff to re-engage partners after the City's initial response to COVID-19 was held in February 2021.

Figure 3-1. Photo of the February 2020 Annual Review and Kickoff event at the DVRPC.

The 2022 planning process was led by Philadelphia OEM with support from WSP, Inc. and the Hazard Mitigation Plan Steering Committee. Stakeholders were engaged throughout the planning process starting with a kickoff in February 2020, four all-stakeholders workshops, two mitigation brainstorming sessions, six focus group sessions, twelve steering committee meetings, and numerous public events, one-on-one meetings, and workgroup meetings.

Philadelphia's 2022 HMP was updated following the process outlined by the *Pennsylvania Hazard Mitigation Plan Standard Operating Guide* (PA SOG) and FEMA's Local Mitigation Plan Review Guide (2011). Top priorities for this plan included:

- **Climate Change**: Incorporating new climate change projections and impacts into Philadelphia's risk assessment and mitigation strategy to create a forward-looking plan.
- **Equity**: Equity is the just and fair inclusion of the whole community. OEM placed a heavy emphasis on expanding stakeholder and community participation through a more equitable and inclusive planning process. Mitigation actions were also identified and prioritized through an equity lens.
- **Increasing stakeholder engagement**: Enhancing the HMP stakeholder outreach strategy to increase awareness and participation from city partners, regional partners, private-sector partners, community partners, state partners, and federal partners.
- **Plan integration**: Integrating hazard mitigation objectives into plans developed across the city to ensure implementation of the mitigation strategy.
- **Plan implementation**: Standing workgroups and a Steering Committee will continue to support implementation of high priority projects identified in the Mitigation Strategy in between updates.

Below is a table summarizing changes to the format and content of each section of Philadelphia's 2017 Plan. The format of the plan was updated to align with requirements outlined in the PA SOG.

Table 3-1. Summary of Updates

Section	Changes made
Executive Summary	• An online, executive summary designed to be accessible by members of the public was created for the 2022 plan and will be available on Philadelphia OEM's website at www.phila.gov/ready
1. Introduction	• Information was reviewed and updated to reflect current authorities and current City priorities
2. Planning Process	• Chapter reformatted and organized to match PA SOG requirements • Expanded stakeholder outreach to include additional regional partners, private-sector, and community partners, representatives from hospitals, universities, non-profits, community organizations, homeowners' associations, and businesses • Improved planning process documentation • An enhanced public engagement strategy designed to be equitable and to reach a larger portion of Philadelphia's population • All sub-sections of this chapter were updated to reflect the new planning process for the 2022 plan • *Section 3.5: Multi-jurisdictional participation* was excluded from this plan because the City/County of Philadelphia does not have municipalities.
3. Community Profile	• Chapter reformatted and organized to match the PA SOG requirements • All maps, tables, and graphics were updated using the best available data at the time of the update • All population and demographic statistics were updated based on the 2019, 5-year ACS data • Expanded discussion on equity and social vulnerability • Additional graphics, maps, charts, and visuals were reformatted and added to make the data more accessible to members of the public • Section on climate from the 2017 was moved to *Chapter 4: Risk & Vulnerability Assessment*
4. Risk & Vulnerability Assessment	• Chapter reformatted and organized to match the PA SOG requirements • All hazards included in the 2017 plan are included in the 2022 plan

Section	Changes made
	• Stakeholder and public outreach conducted to determine which new hazards to include in the plan • The following hazards were added based on stakeholder and public feedback: Civil Disturbance, Cyber Terrorism, Opioid Addiction Response, Pandemic & Infectious Disease, Terrorism, Subsidence/Sinkholes, and War and Criminal Activity which includes Active Assailant and Gun Violence. • The hazard "Hazardous Materials Train Derailment" was re-named "Hazardous Materials Release" • The 2017 Improvised Explosive Device (IED) Profile was focused on terrorism, so the profile was expanded to a Terrorism profile to match PA SOG • Updated hazard history and hazard risk information using new data from the past five (5) years, including local data on disasters that have occurred • Updated dam failure hazard profile and risk assessment to meet new HHPD requirements (Regulation HHPD2) • Enhanced risk assessment through advanced Hazus modeling[6] • New descriptions of how land use and development impacts hazard risk in each planning district of Philadelphia
5. Capability Assessment	• Chapter reformatted and organized to match the PA SOG requirements • A Capability Assessment Survey was distributed to all plan stakeholders • Additional feedback on new capabilities and gaps in capabilities was gathered and documented through a Capability Assessment workshop
6. Mitigation Strategy	• Chapter reformatted and organized to match the PA SOG requirements • Goals and objectives were evaluated by plan stakeholders in a Mitigation Strategy Workshop and updated to reflect new City priorities and capabilities • All mitigation actions in the 2017 were updated to reflect changes in status and progress • Removed the 2017 plan distinction between 'Existing' and 'Potential' actions which led to a lot of duplication • Re-focused Mitigation Strategy on mitigation actions, electing to remove a lot of response focused actions • New mitigation actions were identified by plan stakeholders in a Mitigation Strategy Workshop, through Philadelphia Mitigation Action Forms, and through one-on-one stakeholder outreach
7. Plan Implementation	• Chapter reformatted and organized to match the PA SOG requirements • An annual plan review schedule was added along with addition guidance around continued plan implementation procedures and the role of The Steering Committee.
8. Plan Adoption	• Plan adoption letter will be added to the plan once received
9. Appendices	• Appendices reformatted and organized to match PEMA's Standard Operating Guide requirements

[6] Hazus is a GIS-based software used to estimate physical damage, economic loss, and social impacts from natural hazards such as earthquakes, floods and hurricane winds.

3.2 The Planning Team

Philadelphia OEM was the primary City lead for the 2022 Hazard Mitigation Plan. In 2019, OEM was awarded funding through FEMA's Pre-Disaster Mitigation (PDM) Grant Program to assist with the 2022 Hazard Mitigation Plan. WSP, Inc was hired to support the following:

- Development of the online, executive summary,
- Updating the Capability Assessment,
- Updating the Mitigation Strategy,
- Updating the Risk and Vulnerability Assessment including advanced Hazus and GIS analysis,
- Providing technical assistance integrating equity and new climate change data throughout the plan, and
- Support with reviewing, compiling, and finalizing the final plan for submission to PEMA and FEMA.

3.2.1 Steering Committee

A Steering Committee made up of subject matter experts was formed to guide the development of the 2022 plan. The Steering Committee met monthly from December 2020 – January 2021 to oversee the update process, guide the development of City mitigation goals and objectives, and to assist with prioritization of mitigation actions. The Steering Committee also serves as the decision-making body for mitigation action selection and prioritization, and project selection for mitigation grant opportunities, such as FEMA's BRIC, FMA, and HMGP grant programs.

Table 3-2. Steering Committee Members

Member	Title	Organization
Emma Giardina	Hazard Planning Coordinator	Philadelphia OEM
Carolyn Caton	Deputy Director for Planning	Philadelphia OEM
Joshua Lippert[7]	Floodplain Manager	Licenses & Inspections
Saleem Chapman	Chief Resilience Officer	Office of Sustainability
Liz Lankenau	Director, Infrastructure Program Coordination	Office of Transportation, Infrastructure and Sustainability
Richard Quodomine	Senior Lead GIS Analyst	Department of Public Property
Lt. Michael Kirby	Lieutenant, Planning	Philadelphia Fire Department
Ashley Del Bianco	Chief Grants Officer	Mayor's Office of Recovery and Grants
Nazaarah Sabree	Senior Director of Business Services	Commerce Department
John Haak	City Planner	Philadelphia City Planning Commission
Ryan Ford	Homeland Security Program Manager	Philadelphia OEM
Orlando Almonte	Policy and Research Manager	Mayor's Office of Policy
Amy Nieves	Director	Mayor's Office for People with Disabilities

Moving forward, the Steering Committee will remain in-tact after the 2022 plan is complete to provide guidance on plan implementation and the annual review process. This will ensure the HMP remains a living document in between 5-year updates.

See **3.3 Meetings and Documentation** for more details on Steering Committee Meetings.

[7] Josh Lippert left City service at the beginning of November 2021. The newly hired floodplain manager will be invited to participate in the Steering Committee once hired.

3.2.2 Participants

Philadelphia OEM began engaging partners in February 2020 at the plan kickoff and annual review workshop. An emphasis was placed on expanding the number of stakeholders involved in the planning process, including regional partners, private-sector partners, universities and academic institutions, and the community. The 2-year timeframe for this plan update allowed for extensive and targeted one-on-one outreach to educate and engage stakeholders. Over 85 different agencies and organizations were directly or indirectly involved in the two-year planning process, an increase in 57 entities since the 2017 plan update.

Stakeholders were engaged through one-on-one meetings and presentations, a series of stakeholder planning workshops, and focus group meetings. Invitations for meetings and workshops were sent to a wide variety of different agencies and organizations to promote involvement from as many different entities as possible. Participants represented a range of different levels of experience and areas of expertise.

Participants were also able to track on progress and upcoming meetings via an online portal created on Microsoft SharePoint.

Table 3-3. Participants in the 2022 HMP Planning Process

Participant	Position	Agency or Organization
Nazaarah Sabree	Senior Director of Business Services	Commerce
Stacy Irving	Senior Advisor	Delaware Valley Intelligence Center (DVIC)
James Clarkin	City Planner II	Department of Aviation
Edwin Gbomita	Project Architect	Department of Public Property
Joe Misko	Building Services Manager	Department of Public Property
Richard Quodomine	Senior Lead GIS Analyst	Department of Public Property
Terra Luke	GIS Analyst	Department of Public Property
Steve Hartner	Deputy Commissioner	Department of Public Property
Aparna Palantino	Deputy Commissioner for Capitol Infrastructure	Managing Director's Office
Angie Dixon	Director of Fundraising	Managing Director's Office - Rebuild
Amy Nieves	Executive Director	Mayor’s Office for People with Disabilities, Philadelphia
Orlando Almonte	Policy & Research Manager	Mayor's Office of Policy
Malik Bandy	Community Engagement and Community Coordinator	MDO - Office of Criminal Justice
Aviva Tevah	Director, Philadelphia Reentry Coalition	MDO - Philadelphia Reentry Coalition
Anthony Procik	Citywide Civic Engagement Manager	Office of Community Engagement and Volunteer Service
Nefertiri Sickout	Deputy Diversity and Inclusion Officer	Office of Diversity, Equity & Inclusion
Adrienne Ewing	ADA Coordinator	Office of Diversity, Equity and Inclusion
Alyssa Fico	Senior Lead GIS Analyst	Office of Emergency Management

Participant	Position	Agency or Organization
Dave Natale	Health and Human Services Program Manager	Office of Emergency Management
Emma Giardina	Hazard Planning Coordinator	Office of Emergency Management
Jeffrey Kolakowski	Public Information Program Manager	Office of Emergency Management
Allison Miller	Communications Specialist	Office of Emergency Management
Joshua Nussbaum	Community Resilience Coordinator	Office of Emergency Management
Olivia Gillison	Community Preparedness Program Manager	Office of Emergency Management
Nicola Mammes	Regional Preparedness Program Manager	Office of Emergency Management
Paige Kaspar	Infrastructure Planning Coordinator	Office of Emergency Management
Ryan Ford	Homeland Security Program Manager	Office of Emergency Management
Sarah Bailey	Mass Care Coordinator	Office of Emergency Management
Zorina Morton	Infrastructure Planning Coordinator	Office of Emergency Management
Anthony O'Hare	Health & Safety specialist	Office of Risk Management
Kendal Banks	Director of Safety & Loss Prevention	Office of Risk Management
Linwood Murray	Manager	Office of Risk Management
Erica Atwood	Senior Director	Office of Policy and Strategic Initiatives for Criminal Justice & Public Safety
Dominic McGraw	Senior Efficiency & Projects Manager	Office of Sustainability
Matina Granieri	Place-based Initiatives Manager	Office of Sustainability
Saleem Chapman	Chief Resilience Officer	Office of Sustainability
Cheyenne Flores	Climate Resilience Specialist	Office of Sustainability
Mark Wheeler	Chief Information Officer	OIT
Aaron Ritz	Transportation Planner	OTIS
Dora Chi	Program Coordinator	OTIS
Elizabeth Lankenau	Director, Infrastructure Program Coordination	OTIS
Patricia Ellis-Dinatale	Transportation Planner	OTIS
Rob Armstrong	Trails & Transportation Manager	OTIS
Manny Anastasiadis	Traffic Operations Manager	PennDOT
Matthew Elliott		PennDOT
Sarah Chiu	District Planner	Philadelphia City Planning Commission
Ayse Unver	District Planner	Philadelphia City Planning Commission
David Kanthor	Transportation Planner	Philadelphia City Planning Commission
Donna Carney	Citizens Planning Institute Director	Philadelphia City Planning Commission
Jametta Johnson	Senior Planner	Philadelphia City Planning Commission
John Haak	City Planner	Philadelphia City Planning Commission
Kacie Liss	City Planner II - Urban Design Division	Philadelphia City Planning Commission
Laura Dipasquale	Historic Preservation Planner	Philadelphia City Planning Commission

Participant	Position	Agency or Organization
Laura Spina	Community Planning Director	Philadelphia City Planning Commission
Meredith Keller	Historic Preservation Planner	Philadelphia City Planning Commission
Meredith Trego	Manager of Development Services	Philadelphia City Planning Commission
Martine DeCamp	Deputy Director of City Planning	Philadelphia City Planning Commission
Ian Hegarty	City Planner	Philadelphia City Planning Commission
Alexandra Skula	Public Health Preparedness Analyst	Philadelphia Department of Public Health
Liam Dougherty	AFN Coordinator	Philadelphia Department of Public Health
Molly Mattes	Public Health Preparedness Coordinator	Philadelphia Department of Public Health
Capt. Devon Richio	Planning	Philadelphia Fire Department
Chief Carl Randolph	Special Operations Command Unit, HMAU	Philadelphia Fire Department
DC Craig Murphy	Deputy Commissioner of Planning & Risk Reduction	Philadelphia Fire Department
FF Christopher Lukens	Planning	Philadelphia Fire Department
Lt. Michael Kirby	Planning	Philadelphia Fire Department
Chief Gus Bauman	BC Fire Prevention Division	Philadelphia Fire Department
Chief Chris Baldini	Fire Paramedic Services Chief	Philadelphia Fire- EMS
Cole Norgaarden		Philadelphia Housing Authority
Karanja Slaughter	Special Project Coordinator	Philadelphia Housing Development Corporation (PHDC)
John Glass	Airport Operations Superintendent	Philadelphia International Airport
Angel Rodriguez	Executive Director	Philadelphia Land Bank
Keli McLoyd	Deputy Director	Philadelphia Opioid Response Unit
Noelle Foizen	Director	Philadelphia Opioid Response Unit
Joshua Bell	Operations & Landscape Management	Philadelphia Parks and Recreation
Roger Tenant	Park Manager 2	Philadelphia Parks and Recreation
Stephanie Craighead	Director of Planning, Preservation and Policy	Philadelphia Parks and Recreation
Tom Witmer		Philadelphia Parks and Recreation
C/I Deborah Francis	Commander for PPD Homeland Security Bureau	Philadelphia Police Department
CAPT. Thomas McLean	Counterterrorism Operations	Philadelphia Police Department
Captain Luca	SWAT	Philadelphia Police Department
Captain LaSalle	Counter Terrorism Operations	Philadelphia Police Department
Inspector Singletary	Special Ops/ Homeland Security	Philadelphia Police Department
John Grasso	PPD GIS	Philadelphia Police Department
Kevin Thomas	PPD GIS	Philadelphia Police Department
LT Fitzpatrick	Bomb Disposal Unit	Philadelphia Police Department
LT Gress	Counter Terrorism Operations	Philadelphia Police Department
Lt John Gorman	PPD Traffic	Philadelphia Police Department

Participant	Position	Agency or Organization
Michael Cram	Chief Inspector / Homeland Security Bureau	Philadelphia Police Department
Michael McCarrick	Intelligence Bureau	Philadelphia Police Department
Sgt. Marthe Monasse	Admin Sergeant for PPD Homeland Security Bureau	Philadelphia Police Department
Sgt. Sal Fede	Office of 1st Deputy Commissioner - Field Ops	Philadelphia Police Department
Abby Sullivan	Environmental Scientist - Climate Change Adaptation Program	Philadelphia Water Department
Alex Vencius	Graduate Civil Engineer	Philadelphia Water Department
Bill Dobbins	Water Engineering	Philadelphia Water Department
Erik Haniman	Environmental Engineer	Philadelphia Water Department
Glen Abrams		Philadelphia Water Department
Julia Rockwell	Climate Change Adaptation Program Manager	Philadelphia Water Department
Kelly Anderson	Watershed Protection Program Manager	Philadelphia Water Department
Kimberly Flood		Philadelphia Water Department
Marc Cammarata		Philadelphia Water Department
Mustafa Haweejah	Graduate Civil Engineer	Philadelphia Water Department
Nicole Charlton	Emergency Manager	Philadelphia Water Department
Patrick Perhosky	Engineering Supervisor	Philadelphia Water Department
Susan Patterson	Engineering Specialist	Philadelphia Water Department
Lt. Andrew Napoli	Lieutenant	PPD – Marine Unit
Terrence Clark	Deputy Commissioner for Operations and Emergency Services	Prisons
Kira Strong	Interim Executive Director	Rebuild - MDO
Anthony O'Hare	Health & Safety specialist	risk, City of Philadelphia
Alex Bernstein	Consultant	Sage Services
Diane Mercer	Fire Safety Operations Officer	School District of Philadelphia
John Mulligan	Fire Marshall	School District of Philadelphia
Kyle Brown	City Planner II	Streets Department
Patrick Clark	Transportation Planner & Grants Coordinator	Streets Department
Richard Montanez	Deputy Commissioner for Transportation	Streets Department
Scott McGrath	City Planner	Streets Department
Steve Lorenz	Chief Highway Engineer	Streets Department
Josh Lippert	Floodplain Manager	L&I
Ashley Del Bianco	Chief Grants Officer	Mayor's Office of Grants
Carolyn Caton	Deputy Director of Planning	Office of Emergency Management
Barry Scott	Deputy Finance Director	Office of Risk Management
Murray Linwood	Health and Safety Manager	Office of Risk Management

Participant	Position	Agency or Organization
Jessica Caum	Public Health Preparedness Program Manager	Philadelphia Department of Public Health
Randolph Merced	Director, Safety and Security	Community College of Philadelphia
David Hollinger	Director, Fire and Emergency Services	Drexel University
Margaret Owens	Emergency Preparedness Specialist	Temple University
Sarah Powell	Director of Emergency Management	Temple University
Michael Lapotask	Emergency Management Coordinator	University of the Sciences
Tricia London	Emergency Management Liaison, Office of School Safety	School District of Philadelphia
Daniel Gonzalez		UPenn
Eugene Janda	Chief, Fire and Emergency Services	UPenn
Matthew Poissant		UPenn
Mari Radford	Region 3 Community Planning Lead	FEMA
Matthew McCollough	Mitigation, Pennsylvania	FEMA Region III
Glena Tredinnick		US Coast Guard
Jerry Conrad		US Coast Guard
Lt. Plank	Emergency Management Specialist	US Coast Guard
Paul Fawcett	USCG Logistics Chief	US Coast Guard
Cecelia Thompson		ARC Philadelphia
Shane Janick		ARC Philadelphia
Bria Wimberly	Environmental Organizer	Audobon PA
Allison Schapker	Capital Projects Director	Fairmount Park Conservancy
Ruffian Tittmann	Executive Director	Friends of Wissahickon
Rodney Whitmore	Independent Living Specialist	Liberty Resources, Inc
Elizabeth Johnson	Urban Conservation Strategy Lead	The Nature Conservancy
Kristin Baja	Program Director, Climate Resilience	Urban Sustainability Directors Network (USDN)
Joe Goldschmidt	Property Mgt, Navy Yard	CBRE
Poe Leggette	Property Mgt, Navy Yard	CBRE
Lawrence Gerardi	Emergency Preparedness Fellow	CHOP
Rodney Whitmore		Liberty Resources
Jose Aguirre	External Affairs Manager	PECO
Delores Holley		PHCD
Mark Lee	Manager Corporate Preparedness	Philadelphia Gas Works
Morgan Fletcher	Business Continuity Planning Specialist	Philadelphia Gas Works
Charles Graham	Chief Supervisor	SEPTA
Dennis Stefanski		SEPTA
Thomas Stammerjohann	Distribution-Metering Manager	Vicinity Energy

Participant	Position	Agency or Organization
Zoe Linder Baptie		Wharton Risk Center
Elena Fisher	Capital Development Group	Philadelphia International Airport
Raymond Scheinfeld	Capital Development Group	Philadelphia International Airport
Kelsey Edelen	Project Manager	PIDC
Monica Trudeau	Senior Project Manager, Infrastructure Projects	PIDC
Rudy Terry		PIDC
Thomas Dalfo		PIDC
Troy Mandy	Director, Real Estate Services	PIDC
Brian McDonough	Regional Emergency Manager	Amtrak
Emily Costello	Real Estate Asset Manager	Amtrak
Kara Angotti	Senior Sustainability Manager	Amtrak
Bill Turner	Deputy Director for Emergency Management	Chester County Department of Emergency Services
Gabby Ratliff	Emergency Planning Coordinator	Chester County Department of Emergency Services
Kelly Tinsman	Emergency Planning Coordinator	Chester County Department of Emergency Services
Sara Senkow	Emergency Management Specialist, AFN Coordinator	Delaware County Emergency Services
Charles Cunningham	Director, Homeland Security and Emergency Management	Delaware River Port Authority
Harold Neil	Project Manager, Homeland Security and Emergency Management	Delaware River Port Authority
Amy Verbofsky		Delaware Valley Regional Planning Commission
Robert Graff	Manager, Energy and Climate Change Initiatives	Delaware Valley Regional Planning Commission
Jason Wilson	Deputy Director of Emergency Management	Montgomery County Dept of Public Safety
Ellis Foley	Environmental Planner	Montgomery County Division of Public Safety
Douglas Trahey	Emergency Preparedness and Response Coordinator	Department of Human Services
Ceena Jenkins	Disaster Disability Specialist	Department of Human Services
Jessica Miller	AFN Administrator	PA Department of Health
Cory Kegerise	Community Preservation Coordinator	PA Historic Preservation Office, Eastern Region
Bill Bradfield	NFIP Coordinator	PEMA
Tom Hughes	Director, Emergency Management Mitigation, Insurance and Resilient Communities Office	PEMA
Ernie Szabo	State Hazard Mitigation Officer	PEMA - HQ
Matthew Elliott		PENNDOT

Participant	Position	Agency or Organization
Susan Myerov	Watershed Program Director	Pennsylvania Environmental Council
John Gardosik	Disaster Planning Project Manager	Pennsylvania State Historic Preservation Office
David Montvydas	Chief Engineer	SEPTA
Dennis Stefanski	Program Manager – Special Projects	SEPTA
Jason Miller	Chief, Flood Plain Management	USACE

3.3 Meetings and Documentation

Philadelphia's 2022 HMP required extensive outreach to subject matter experts, city agencies, state partners, federal partners, private sector partners, nonprofits, businesses, and the public to gather feedback and generate buy-in. Stakeholders and the public were engaged through:

- Stakeholder Planning Workshops,
- Steering Committee meetings,
- Focus groups and workgroup meetings,
- Trainings,
- Presentations offered to existing workgroups and committees,
- One-on-one meetings, and
- Public workshops and events.

Due to the COVID-19 pandemic, all outreach was conducted virtually after our kickoff event in February 2020. For meeting agendas, notes, sign-in sheets, presentation slides, and distributed handouts, please see Appendix C.

3.3.1 Stakeholder Planning Workshops

Figure 3-2. Stakeholders participating in the USDN's Game of Extremes during the kickoff meeting on 2/19/2020.

Between February 2020 and December 2021, stakeholders were invited to participate in a series of workshops focused on the overall planning strategy, the capability assessment, and the mitigation strategy. Participants represented a wide array of organizations, expertise, experience levels, and backgrounds. Community leaders were invited to join this kickoff meeting. For more information on stakeholder participants, see **3.4 Public & Stakeholder Participation**.

Table 3-4. Dates, Locations, and Descriptions of Stakeholder Planning Workshops

Workshop	Meeting Date	Meeting Location	Description
2020 Annual Review and Kickoff	February 19, 2020	DVRPC 190 N Independence Mall W Philadelphia, PA	Philadelphia OEM, in partnership with the Delaware Valley Regional Planning Commission, PEMA, and FEMA, hosted an annual plan review and 2022 Plan Kickoff event in February 2020. OEM sought input on the planning process from subject matter experts in attendance and discussed Philadelphia's mitigation priorities and accomplishments since 2017 through a series of group discussions. Attendees also participated in an interactive activity led by the Urban Sustainability Director's Network, called "The Game of Extremes". This exercise explores the intersection of climate change and hazard risk reduction. Over 75 representatives from 48 different agencies were present. For more details on this workshop and the 2020 Annual Review process, please see the memo available publicly on OEM's website.

Workshop	Meeting Date	Meeting Location	Description
2021 Annual Review and HMP Planning Workshop	February 23, 2021	Virtual, Microsoft Teams	The purpose of this meeting was to provide updates on the 2022 Hazard Mitigation Plan, introduce focus groups and workgroups, and outline next steps in the planning process. In this virtual meeting, participants were asked to reflect on the events of 2020 and how they changed the City's mitigation goals and objectives moving forward. At this time, Philadelphia was still in the middle of a global pandemic which taxed our local City government, businesses, and the healthcare system. Philadelphia experienced a Derecho event in May 2020 a confirmed report of a tornado in the Northeast, and flooding in August 2020 after Tropical Storm Isaias. Philadelphia also experienced mass demonstrations and civil disturbance in early June of 2020. Participants were asked to discuss how these events changed their perspective on hazard mitigation. Miami-Dade Fire Rescue presented on their hazard mitigation plan and recently funded mitigation projects. Feedback was documented in meeting notes and used to design the planning process for the 2022 update.
Capability Assessment Planning Workshop	October 4, 2021	Virtual, Microsoft Teams	In this workshop, goals and objectives of the capability assessment were reviewed. Attendees participated in an interactive activity using MURAL where they identified hazards that were most concerning to their organizations, vulnerabilities of their organization, and strengths of their organization. Concluded with a review of next steps and reminder to complete capability assessment worksheet.
Mitigation Strategy Brainstorm Workshops *(Optional)*	October 18, 2021: NBS October 21, 2021: Housing & Infrastructure	Virtual, Microsoft Teams	In these optional brainstorming sessions, WSP, Inc shared examples of existing mitigation actions from the 2017 plan and examples of new mitigation actions. The workshops focused on brainstorming new mitigation actions and allowing participants to ask questions about potential mitigation actions they were considering for the 2022 plan. October 18th focused on Nature Based Solutions (NBS) and October 21st on Housing & Infrastructure Solutions.
Mitigation Strategy Workshop	November 19, 2021	Virtual, Microsoft Teams	In this workshop, participants provided feedback on newly revised, citywide mitigation goals and objectives. Next, attendees participated in a group discussion to identify new, high priority mitigation actions for their organization and the City. Ideas were captured visually via a MURAL board.
Final Draft Review Workshop	January 31, 2021	Virtual, Zoom	In this meeting, Philadelphia OEM reviewed the City's updated plan for mitigating or reducing risk to natural and human-made hazards. There was an opportunity for questions, answers, and feedback from the audience. This meeting was open to all planning partners, the public, and the media. Following this meeting, the plan was published on OEM's website for a 30-day review public review and comment period. Printed copies of the plan were available at several Free Library locations around the City.

3.3.2 Steering Committee Meetings

The Steering Committee met regularly between October 2020 and February 2021 to guide the planning process. After the plan is updated, the Steering Committee will remain in-tact but will meet less frequently to focus on implementation of the plan and annual reviews. For more information on each of these meetings along with a list of participants, agendas, and meeting notes, please see Appendix C: Meetings and Other Participation Documentation.

Table 3-5. Date, Location, and Descriptions of Steering Committee Meetings

Meeting Date	Meeting Location	Description
October 1, 2020	Virtual Microsoft Teams	Reviewed planning process and timeline for 2022 HMP. Discussed goals and objectives of the Steering Committee. Gathered feedback on the public engagement strategy.
December 1, 2020	Virtual Microsoft Teams	Reviewed progress made on plan update and discussed the purpose of the capability assessment and plan integration.
January 5, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update and discussed feedback on the Hazard Mitigation Planning Grant RFP.
February 4, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update and finalized focus groups and workgroups.
March 4, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. The Office of Diversity, Equity and Inclusion conducted a presentation on the City's Racial Equity Strategy and how this connects to Hazard Mitigation Planning.
April 7, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. Group reflected on the presentation from the Office of Diversity, Equity and Inclusion in March and discussed next steps for increasing inclusion and incorporating more equitable approaches in the planning process.
June 21, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. Discussed ongoing mitigation work in the City. Finalized and agreed upon HMP Amendment process and the role of the Steering Committee in project selections for BRIC/FMA FY 2021.
August 4, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. Introduced WSP, T&M, and Lion Advisors to the Steering Committee. Reviewed steps in the Risk and Vulnerability Assessment process. Distributed risk assessment data collection handout. Discussed overarching climate change and equity goals for the plan. Reviewed list of potential natural and human-made hazards for the HMP.
September 14, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. Discussed Ida impacts and how this influences 2022 plan update. Reviewed BRIC and FMA proposals and voted on projects that could move forward in the state application process. Reviewed capability assessment workshop and survey.
December 13, 2021	Virtual Microsoft Teams	Reviewed progress made on the plan update. Finalized mitigation goals and objectives, and mitigation action selections.
January 7, 2021	Virtual Microsoft Teams	Steering Committee reviewed final list of mitigation actions, prioritized projects, and chose the top 10 City projects for implementation within the next 5 years.

3.3.3 Focus Group & Workgroup Meetings, Spring /Summer 2021

The following focus groups met once in Spring/Summer 2020 to assist with development and design of the plan. Focus groups shared relevant data, information, and expertise to inform the plan update and planning process. For more information on each of these focus group sessions along with a list of participants, agendas, and meeting notes, please see Appendix C: Meetings and Other Participation Documentation.

Table 3-6. Date, Location, and Descriptions of Focus Group Meetings

Public Safety Focus Group		
Meeting Date	**Meeting Location**	**Description**
October 1, 2020	Virtual Microsoft Teams	Gathered to review the planning process, collect general input, and key data sources to support the risk and vulnerability assessment.
Educational Institutions Focus Group		
Meeting Date	**Meeting Location**	**Description**
April 1, 2021	Virtual Microsoft Teams	Gathered to review the planning process, collect general input from the perspective of educational institutions, and to identify key data sources to support the risk and vulnerability assessment.
Historic and Cultural Resources Focus Group		
Meeting Date	**Meeting Location**	**Description**
April 12, 2021	Virtual Microsoft Teams	Gathered to review the planning process, collect general input on mitigation of historic and cultural resources, and to identify key data sources to support the risk and vulnerability assessment.
Flood Focus Group		
Meeting Date	**Meeting Location**	**Description**
April 19, 2021	Virtual Microsoft Teams	Gathered to review the planning process, collect general input on flooding in Philadelphia and the 2017 flood hazard profile, and to identify key data sources to support the risk and vulnerability assessment.
Infrastructure Focus Group		
Meeting Date	**Meeting Location**	**Description**
April 22, 2021	Microsoft Teams	Gathered to review the planning process, collect general input from the perspective of the infrastructure community, and to identify key data sources to support the risk and vulnerability assessment.
Individuals with Disabilities and Access & Functional Needs Focus Group		
Meeting Date	**Meeting Location**	**Description**
June 24, 2021	Microsoft Teams	Gathered to review the planning process, collect input on inclusion of individuals with disabilities and access & functional needs in the planning process, and identify to key data sources to support the risk and vulnerability assessment.

Standing workgroups were formed to provide ongoing feedback on specific portions of the plan update and plan implementation. The following workgroups met more than once throughout the planning process and will likely remain intact after the 2022 plan is complete to continue providing guidance on plan implementation.

Table 3-7. Date, Location, and Descriptions of Workgroup Meetings

Grants Workgroup		
Meeting Date	**Meeting Location**	**Description**
March 12, 2021	Microsoft Teams	Group reviewed lessons learned from the FY2020 BRIC/FMA grant cycle including timeline, outreach, and project prioritization. The group discussed other potential mitigation funding and partnership opportunities. Finally, the group began planning for a Spring Mitigation Grants Workshop.
March 31, 2021	Microsoft Teams	OEM reviewed FEMA's mitigation grants opportunities. The group continued planning for a Spring Mitigation Grants workgroup meeting.
April 13, 2021	Microsoft Teams	The group reviewed an agenda for the Spring Mitigation Grants Workshop and discussed potential projects and key contacts.
June 8, 2021	Microsoft Teams	The group reflected on the Grants Workshop hosted in May and discussed next steps in the FY2021 BRIC and FMA application process.
Land Use Workgroup		
Meeting Date	**Meeting Location**	**Description**
July 1, 2021	Microsoft Teams	The group discussed and agreed upon goals and objectives of the workgroup. OEM reviewed the HMP requirements related to hazard risk and past, current, and future land use. The group brainstormed data to support the plan update. Finally, the group discussed potential land use mitigation strategies, including land acquisitions.
July 29, 2021	Microsoft Teams	The group discussed the possibility of a feasibility study to determine the best land use, flood mitigation strategy for Philadelphia. Discussion included the following topics: scope of work, ownership and coordination of the work, potential funding sources, leadership support, and outreach to other entities.
August 12, 2021	Microsoft Teams	The group discussed progress made in land use coordination in the Lower Southwest District, and next steps for a feasibility study on land use mitigation strategies in Philadelphia.
November 18, 221	Microsoft Teams	OEM reviewed new post-disaster funding opportunities available to move work forward. OOS reviewed ongoing work being conducted in the Lower Southwest Planning District. The group discussed top land-use mitigation strategies to include in the 2022 plan.

3.3.4 Other Meetings & Presentations

3.3.4.1 G-318 Hazard Mitigation Plan Training and Technical Assistance

To align with the City's 2022 HMP update, FEMA Region 3 and PEMA offered the **G-318: Local Mitigation Planning Workshop Series** to Philadelphia hazard mitigation planning partners. G-318 covers the fundamentals of mitigation planning in a series of four, 2-hour modules that align with each step of the hazard mitigation planning process: organizing the planning process, conducting a risk assessment, developing a mitigation strategy, and plan adoption & implementation. Steering Committee members and key planning partners were invited to participate in the workshop series alongside Philadelphia OEM.

Figure 3-3. FEMA's Technical Assistance Modules and Topics (Chart provided by FEMA).

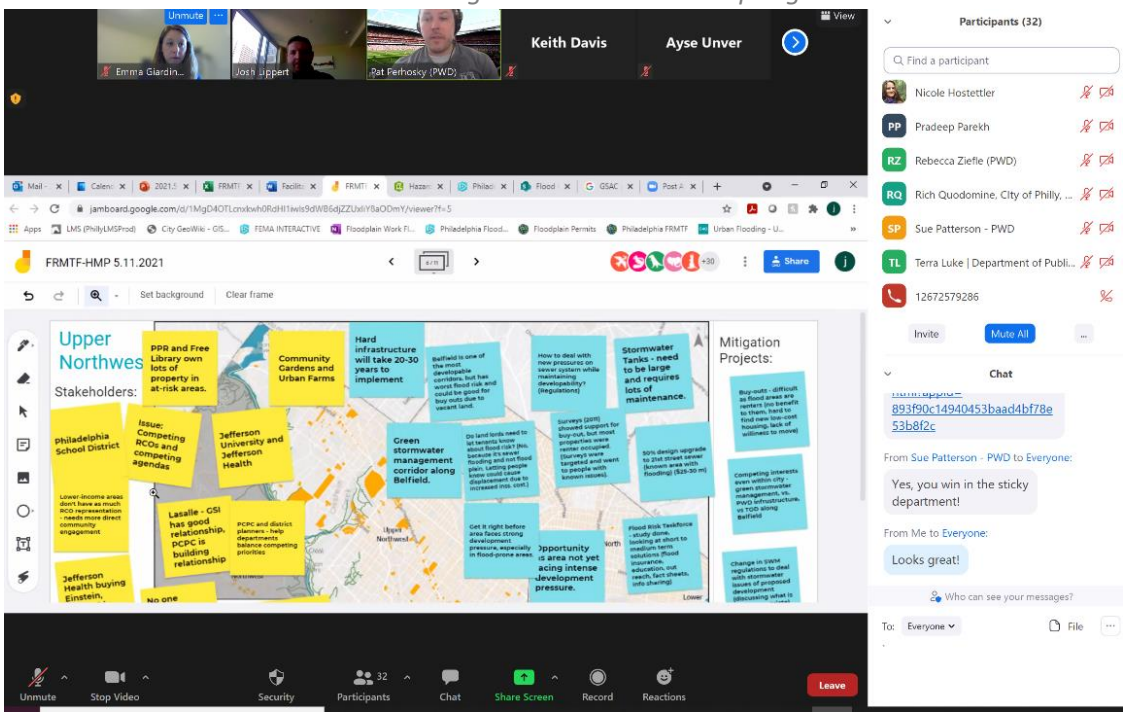
Table 3-8. Dates, Locations and Topics Discussed at each Training Module.

Topics Discussed	Date	Location
Module 1: The Planning Process	September 24, 2020	WebEx
Module 2: Conduct a Risk Assessment	January 12, 2021	WebEx
Module 3: Develop a Mitigation Strategy	May 5, 2021	WebEx
Module 4: Adopt, Maintain, and Implement the Plan	October 7, 2021	Microsoft Teams

3.3.4.2 Existing Workgroups and Committees

Several City commissions, advisory groups, and steering committees consisting of representatives from a variety of different agencies and organizations were also engaged throughout the plan update. By leveraging pre-existing groups to gather feedback, we limited unnecessary outreach to partners already meeting around similar topics. This was important after the initial response to the COVID-19 pandemic, when many partners were limited on staff capacity and time.

Figure 3-4. Picture of virtual Hazard Mitigation Planning Workshop with the City's Flood Risk Management Task Force in Spring 2021.



Groups included the City's Equitable Engagement Collaborative, Racial Equity Workgroup, Flood Risk Management Task Force, Philadelphia's Historic Preservation Committee, and the Committee of Highway Supervisors.

Table 3-9. Other pre-existing workgroups, steering committees, & advisory groups that were engaged

Group	Date	Location	Description of Group and Topics Covered
Philadelphia Navy Yard Smart Grid Meeting	December 18, 2019	The Navy Yard 4960 S 12th Street Philadelphia, PA	Philadelphia OEM provided this group with background on the HMP and hazard risk in Philadelphia. Participants were given the opportunity to ask questions and provide input on their role in the plan update.
City Equitable Engagement Collaborative	October 28, 2020	Microsoft Teams	The City's Equitable Engagement Collaborative (ECC) is a group of subject matter experts in the city that meet weekly to discuss and collaborate on equitable public outreach strategies. The purpose of this meeting was to inform partners about the update of the 2022 HMP, identify areas for collaboration with partner agencies, and gather feedback on an equitable approach to public engagement and project prioritization in the HMP.
Committee of Highway Supervisors	March 10, 2021	Microsoft Teams	This group consists of a variety of partners in the transportation sector. OEM reviewed the hazard mitigation planning process and gathered feedback from the group on their role and potential mitigation projects.

Group	Date	Location	Description of Group and Topics Covered
Philadelphia City Planning Committee (PCPC) District Planner Meeting	March 12, 2021	Microsoft Teams	This group meets monthly and consists of all the PCPC's district planners. In this meeting, OEM reviewed the hazard mitigation planning process and the importance of plan integration with the City's Comprehensive Plan. The group provided feedback on the planning process and opportunities for collaboration.
City Racial Equity Workgroup	April 30, 2021	Microsoft Teams	This group consists of variety of representatives from city agencies, focused on racial equity initiatives across the City. OEM reviewed the 2022 HMP engagement strategy and led a discussion on equitable approaches to public engagement and project prioritization in the planning process.
Flood Risk Management Task Force (FRMTF)	May 11, 2021	Microsoft Teams	The FRMTF is a group of city subject matter experts convened to develop a coordinated approach to flood risk management across local government. In this meeting, participants were split into groups to look at a flood risk and flood mitigation strategies by planning district. Key stakeholders and mitigation project ideas for each planning district were recorded in a Google Jamboard for use in the Hazard Mitigation Plan.
Historic Preservation Policy Team	September 29, 2021 and January 26, 2022	Microsoft Teams	OEM reviewed the hazard mitigation planning process and the importance of incorporating historical and cultural institutions in the planning process. Feedback on potential mitigation strategies post Tropical Storm Ida were discussed.
Local Emergency Planning Committee (LEPC)	January 27, 2022	Zoom	OEM reviewed the hazard mitigation planning process and reviewed portions pertaining to hazardous materials release for review and feedback.
Planning Commission	February 17, 2022	Zoom	OEM reviewed the key features of the 2022 draft to the City's Planning Commission at their monthly, public facing meeting.

3.3.4.3 Mitigation Grants Workshops

To promote plan implementation, Philadelphia OEM in coordination with the Mayor's Office of Recovery and Grants and the Hazard Mitigation Plan Grants and Funding Workgroup planned and implemented two Mitigation Grants Workshops between 2020 and 2021. Both workshops featured presentations from PEMA on the BRIC and FMA application process and state priorities.

Date	Location	Description
October 13, 2021	Microsoft Teams	PEMA presented on the FY 2020 BRIC and FMA Application process along with state priorities. Philadelphia OEM reviewed the City application process for BRIC and FMA. Participants were given time to ask PEMA and FEMA questions related to these grants.
May 19, 2021	Microsoft Teams	PEMA presented on the FY2021 BRIC and FMA Application process. Philadelphia Water Department presented on lessons learned from the FY2020 BRIC/FMA application process. Philadelphia OEM discussed implementation of the HMP and led a discussion on potential mitigation projects for FY2021 BRIC and FMA.

3.3.4.4 One-on-one Meetings

In between focus group meetings, stakeholder planning workshops, and various other presentations and planning meetings, Philadelphia OEM hosted one-on-one meetings with stakeholders to educate them on the planning process, generate buy-in, discuss mitigation priorities, and to gather feedback on the plans specific to their organization. Organizations that participated in virtual, one-on-one meetings included:

- The Urban Sustainability Director's Network: February 20, 2020
- The Philadelphia Planning Commission: October 14, 2020 and December 21, 2021
- The Philadelphia Department of Public Health: October 26, 2020 and December 2, 2021
- The Office of Community Engagement and Volunteer Services: October 21, 2021
- PA Volunteer Organizations Active in Disaster (VOAD): November 30, 2020
- The Philadelphia Industrial Development Corporation: December 2, 2020 and December 7, 2020
- The Commerce Department: January 13, 2021
- The Office of Diversity, Equity and Inclusion: January 20, 2021
- The Philadelphia Housing Authority: March 5, 2021
- Manayunk Development Corporation: March 30, 2021
- American Rivers: April 1, 2021
- The United States Coast Guard, Sector Delaware Bay: April 5, 2021
- The Delaware Valley Regional Planning Commission: April 8, 2021
- Philadelphia Water Department: May 36, 2021 and December 8, 2021
- Temple University: July 26, 2021
- Office of Transportation, Infrastructure, and Sustainability (OTIS): November 12, 2021
- Office of Sustainability: Monthly between January 2021 and December 2021
- Philadelphia's Opioid Response Unit: December 2, 2021
- The Office of Criminal Justice & Public Safety: December 14, 2021
- Philadelphia International Airport: December 14, 2021
- Philadelphia Police Department: January 21, 2022

3.3.4.5 Regional Coordination

In addition to inviting partners from surrounding counties and partners representing regional entities to all stakeholder workshops and meetings, Philadelphia OEM also participated in a Regional Hazard Mitigation Planning Workgroup convened on November 4th, 2021 by Montgomery County Planning Commission. In this meeting, participants discussed roadblocks and challenges with hazard mitigation planning and shared best practices. There was interest from the group to reconvene regularly to continue regional coordination around mitigation planning. The next meeting is tentatively planned for Spring 2022. To support the efforts of this group, Philadelphia OEM convened a meeting in December 2021 between Montgomery County and the Delaware Valley Regional Planning Commission (DVRPC) to discuss next steps. Philadelphia OEM will remain actively engaged.

3.3.5 Public Meetings and Outreach

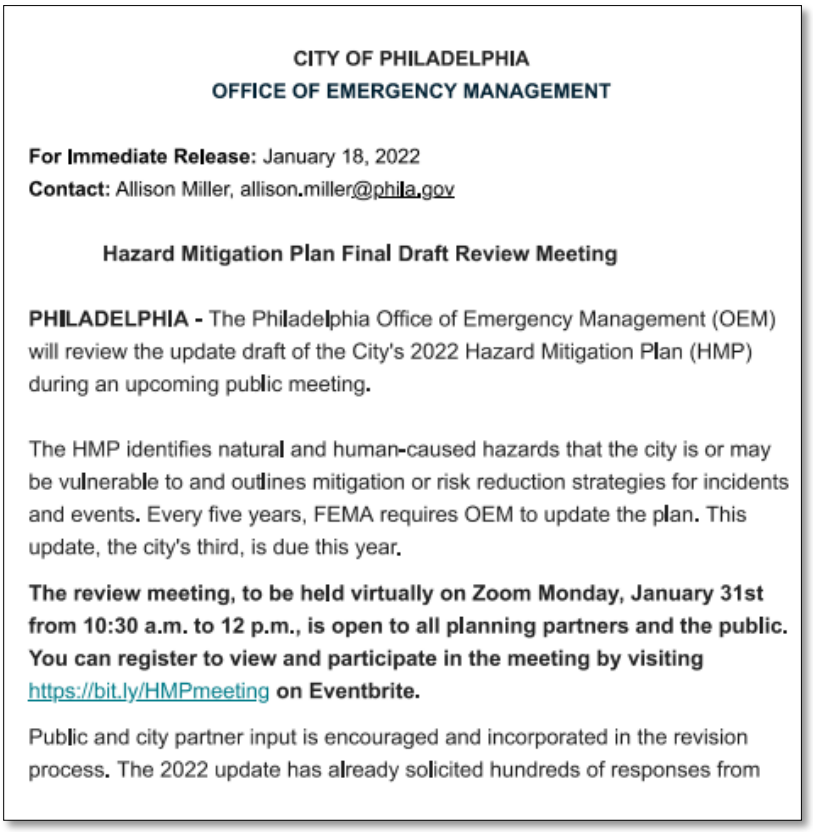
3.3.5.1 Hazard Mitigation Public Meetings

OEM hosted 6 HMP public workshops that provided opportunities for residents to interact and provide feedback on the plan, identify strengths and assets in their community, identify mitigation

opportunities, and provide feedback on the City's mitigation goals. Public feedback from workshops directly informed the planning process, development of citywide mitigation goals, and prioritization of mitigation projects.

Public workshops were advertised via social media, blog posts, newsletters, radio, news outlets, and through individual outreach to community leaders and City partners. A public notice for the Draft Review Workshop was posted over 7 days prior to the event, in addition to being shared via social media and with local news media outlets. OEM leveraged pre-existing relationships with community leaders through OEM's READY programming and worked alongside other City partners to advertise the workshops and gain more participation from residents. An emphasis was placed on reaching out to community organizations and City Commissions with direct ties to populations who are underrepresented in government processes and are who are more at risk to hazards due to exposure, health factors, or historical inequities[8]. A social media toolkit with pre-scripted posts advertising public workshops and the public survey was distributed so that partners could help spread the word. Flyers advertising the first workshop were also available at Philadelphia's Community Vaccination Site at the Philadelphia Convention Center, which saw over 6000 people from the City of Philadelphia each day.

Figure 3-5. Final Plan Review Public Notice (Available in full in Annex C)



CITY OF PHILADELPHIA
OFFICE OF EMERGENCY MANAGEMENT

For Immediate Release: January 18, 2022
Contact: Allison Miller, allison.miller@phila.gov

Hazard Mitigation Plan Final Draft Review Meeting

PHILADELPHIA - The Philadelphia Office of Emergency Management (OEM) will review the update draft of the City's 2022 Hazard Mitigation Plan (HMP) during an upcoming public meeting.

The HMP identifies natural and human-caused hazards that the city is or may be vulnerable to and outlines mitigation or risk reduction strategies for incidents and events. Every five years, FEMA requires OEM to update the plan. This update, the city's third, is due this year.

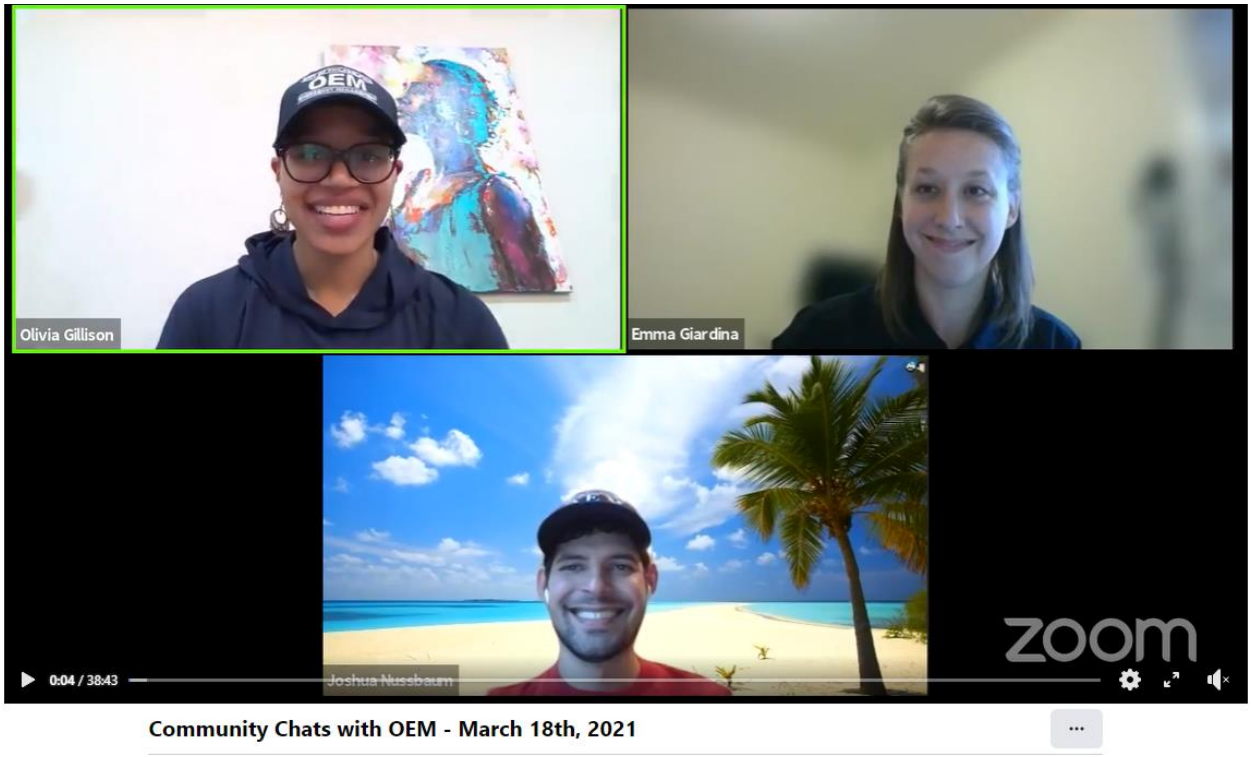
The review meeting, to be held virtually on Zoom Monday, January 31st from 10:30 a.m. to 12 p.m., is open to all planning partners and the public. You can register to view and participate in the meeting by visiting https://bit.ly/HMPmeeting **on Eventbrite.**

Public and city partner input is encouraged and incorporated in the revision process. The 2022 update has already solicited hundreds of responses from

[8] For more information on populations in Philadelphia that are more vulnerable to impacts from disaster, please see **2 Community Profile** and specifically **2.3.8 Social Vulnerability.**

Philadelphia OEM partnered with pre-existing community organizations such as the Philadelphia Block Captain's, the Citizen's Planning Institute (described in **3.3.5.2 Citizen's Planning Institute**), AKA-DST Sorority, and the OWN Community Organization for workshops in the Spring and Summer of 2020. By partnering with pre-existing community organizations for workshops tailored specifically to the public audience, Philadelphia OEM documented significantly more public participation than during our 2017 plan update. Workshops were advertised and offered to any community organization in Philadelphia that expressed interest. For more information on public participation, please see **3.4 Public & Stakeholder Participation**.

Figure 3-6. Community Chat hosted on Zoom and Facebook on March 18th, 2021



To maximize the safety of participants during the COVID-19 Pandemic, all public workshops were hosted on Zoom and live streamed on OEM's Facebook page. Several public presentations continue to be available for viewing and comment on OEM's Facebook Page. This allows for more participation from residents who may not have been available for the live presentation. For more information on public participation, please see **3.4 Public & Stakeholder Participation**. Copies of public presentations and sign-in sheets can be found in Appendix C: Meeting and Other Participation Documentation.

Table 3-10. OEM Public Hazard Mitigation Plan Workshops

Date	Type	Topics Covered	Location	Facebook views	Number of people (live)
3/18/2021, 6pm-7pm	Community Kickoff and Risk & Vulnerability Assessment Review	The purpose of this online community chat was to raise awareness about the purpose of the plan and the importance of public feedback. Gathered feedback on hazards of concern for the risk and	Zoom, Facebook live	336	27

Date	Type	Topics Covered	Location	Facebook views	Number of people (live)
		vulnerability assessment and community assets that were most important to community members through an interactive platform, Google Jamboard. Link to view workshop			
6/1/2021	HMP Workshop with AKA-DST Sorority	Raise awareness about the purpose of the plan and the importance of public feedback. Gathered feedback on hazards of concern for the risk and vulnerability assessment and community assets that were most important to community members through an interactive platform, Google Jamboard.	Zoom	N/A	31
4/15/2021	HMP Workshop with Block Captain's Meeting	Raise awareness about the purpose of the plan and the importance of public feedback. Gathered feedback on hazards of concern for the risk and vulnerability assessment and community assets that were most important to community members through an interactive platform, Google Jamboard.	Zoom	N/A	20
5/19/2021	HMP Workshop with Citizen's Planning Institute	See detailed Description in **3.3.5.2 Citizen's Planning Institute**.	Zoom	N/A	22
6/2/2021	HMP Workshop with OWN Community Meeting	Raise awareness about the purpose of the plan and the importance of public feedback. Gathered feedback on hazards of concern for the risk and vulnerability assessment and community assets that were most important to community members through an interactive platform, Google Jamboard.	Zoom	N/A	25
1/31/2022	Final Draft Review and Feedback Workshop (All Plan Stakeholders and the Public)	In this meeting, Philadelphia OEM review the City's updated plan for mitigating or reducing risk to natural and human-made hazards. There was an opportunity for questions, answers, and feedback from the audience. This meeting was open to all planning partners, the public, and the media. Following this workshop, the plan was published on OEM's website for a 30-day review public	Zoom	N/A	117

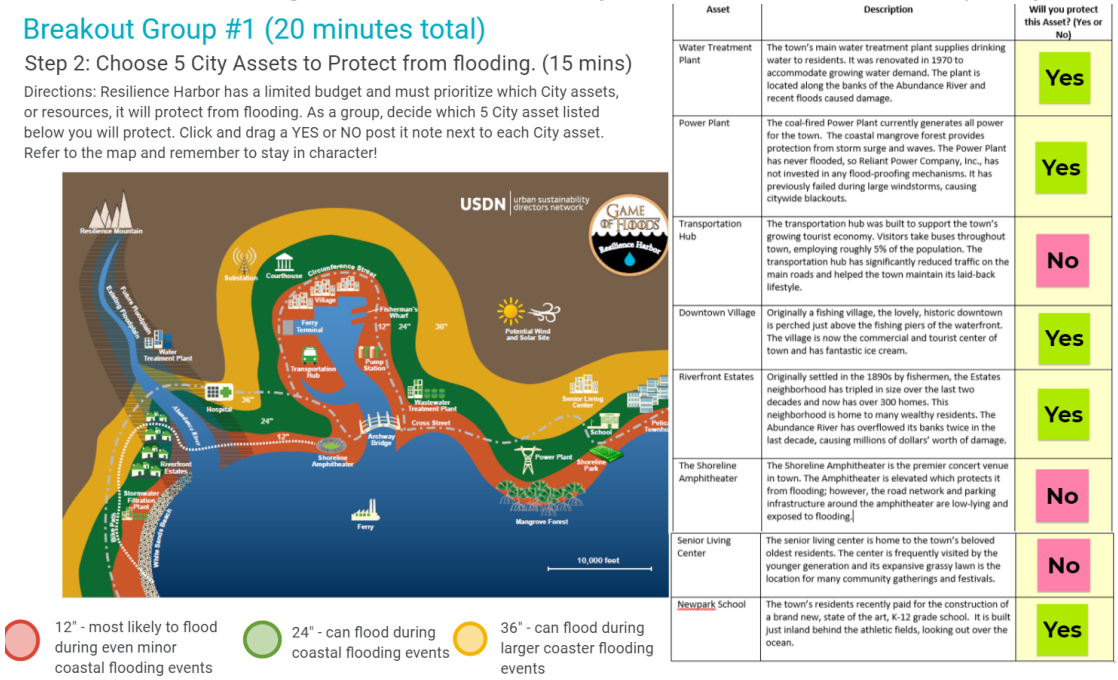
Date	Type	Topics Covered	Location	Facebook views	Number of people (live)
		review and comment period. Printed copies of the plan were available at several Free Library locations around the City.			
TOTAL:				336	242

3.3.5.2 Citizen's Planning Institute

The Citizen's Planning Institute (CIP) is the education and outreach arm of the Philadelphia City Planning Commission (PCPC), made up of a diverse group of thirty residents all interested in city planning. CPI leads cohorts of about thirty residents each year through eight-weeks of courses on a variety of different planning-related topics. Philadelphia OEM was invited to join their May 19th, 2021 workshop to discuss the hazard mitigation planning process.

In teams, participants used a game-based exercise to learn about how to protect community assets from hazards. Participants learned how to reduce risk in their own neighborhood and how to help neighbors bounce back after disaster. Feedback from the class directly informed the update of the HMP for 2022. Approximately **22 participants** representing **15 different planning districts** joined.

Figure 3-7. Participants played an interactive, game-based activity based off the USDN's Game of Extremes. Google Jamboard was used to facilitate the discussion and capture feedback.



3.3.5.3 READYPhiladephia Workshops

Throughout the year, Philadelphia OEM's Community Engagement program offers READYPhiladelphia emergency preparedness workshops for residents, businesses, and community organizations. In additional to hazard mitigation specific outreach and events, OEM also discussed the HMP in every virtual and in-person workshop hosted in 2021.

Philadelphia OEM hosts bi-monthly *Community Chats* on the first Tuesday of every month at 11:00am and the third Thursday of every month at 6:00pm. In these Community Chats, OEM's Community Engagement Program provides valuable emergency preparedness tips and tricks, updates on major, ongoing emergency responses and disasters, and updates on OEM's planning work. Throughout 2021, OEM provided updates on the HMP and advertised the Hazard Mitigation Public Survey. Chats are offered in the morning and evening, allowing members of the public with different schedules to join and advertised heavily across City social media accounts and during in-person preparedness workshops. Recordings for Philadelphia OEM's community chats can be found on OEM's Facebook page.

READYHome is a basic, emergency preparedness workshop offered to community organizations, school groups, and civic organizations. Throughout 2021, the HMP and public survey were added to the standard READYHome presentation to help spread the word. A copy of this READYHome presentation can be found in Appendix C: Meeting and Other Participation Documentation.

Table 3-11. Dates, locations, and attendance for OEM's 2021 Community Chats and READYHome Presentations.

Date	Type	Location	Facebook views	Number of people (live)
2/10/2021	Community Chat	Zoom, Facebook live	390	4
3/2/2021	Community Chat	Zoom, Facebook live	316	2
3/11/2021	READYHome – CHOP Headstart Program	WebEx	N/A	13
4/15/2021	Community Chat	Zoom, Facebook Live	208	2
4/22/2021	READYHome – Headstart Program	Zoom	N/A	20
5/4/2021	Community Chat	Zoom	119	5
5/5/2021	READYHome – Community Connectors	Zoom	N/A	6
5/10/2021	READYHome – Northern Living Senior Center	Zoom	Recorded and shared with unknown number of residents	0
5/12/2021	READYHome – Headstart Program	Zoom	N/A	25
5/26/2021	READYHome – CHOP Headstart	Zoom	N/A	4
6/1/2021	Community Chat	zoom, Facebook live	161	0
6/17/2021	Community Chat	Zoom, Facebook live	155	0
7/6/2021	Community Chat	zoom, Facebook live	123	5
7/15/2021	Community chat	zoom, Facebook live	232	2
8/3/2021	Community chat	zoom, Facebook live	205	3
8/19/2021	Community Chat	zoom, Facebook live	199	0

Date	Type	Location	Facebook views	Number of people (live)
9/7/2021	Community Chat	zoom, Facebook live	237	3
9/16/2021	Community Chat	Zoom, Facebook live	126	5
10/4/2021	READYHome – AKA & DST Sorority	Zoom	N/A	52
10/5/2021	Community chat	Zoom, Facebook live	185	2
10/21/2021	Community Chat	Zoom, Facebook Live	167	4
11/2/2021	Community Chat	Zoom, Facebook Live	175	4
11/18/2021	Community Chat	Zoom, Facebook Live	386	5
11/18/2021	Franklin Institute	Zoom	N/A	40
2/1/2022	Community chat	Facebook Live	384	10
TOTAL:			**3764**	**216**

3.3.5.4 Mitigation Station Table Events

Figure 3-8. Mitigation Station Event Hosted in Love Park, Center City.

To reach populations that may not have access to online platforms like Zoom and Facebook, OEM planned pop-up table events called *Mitigation Stations at* strategic locations around the City. At the *Mitigation Stations*, residents had the opportunity to fill out the HMP Public Survey in-person, ask questions about the plan update to OEM staff members, and they also received important emergency

preparedness information and resources. *Mitigation Station* events were heavily advertised via social media and through one-on-one outreach to community leaders and organizations in the area.

Table 3-12. Mitigation Station Events

Date	Location	Number of people
3/26/2021	Vaccination Site at The Children's Playhouse 2501 S Marshall Street	50
6/11/2021	Love Park Center City, Philadelphia	25
6/19/2021	Eastwick United Juneteenth Event	100
8/4/2021	Burholme Park 401 Cottman Ave	20
8/5/2021	Francis House Senior Center 4460 Fairmount Ave	33
TOTAL:		**228 people reached**

3.4 Public & Stakeholder Participation

3.4.1 Outreach Tools

3.4.1.1 Newsletter

To keep plan stakeholders engaged in the planning process in between planning workshops and meetings, Philadelphia OEM started distributing monthly newsletters in March 2021 to update partners on the status of the plan update, upcoming trainings and meetings, and mitigation funding opportunities. Approximately **174 stakeholders** are on the newsletter distribution list. Philadelphia OEM will keep stakeholders engaged after the plan update by continuing to distribute this newsletter on a quarterly basis.

3.4.1.2 Social Media

Philadelphia OEM advertised the plan update, public survey, and public workshops through social media channels such as Twitter, Facebook, and NextDoor. To reach a larger following, OEM created a social media toolkit with pre-scripted messages in both Spanish and English which was distributed to partner agencies to help spread the word.

Table 3-13. Sampling of agencies or organizations that posted about the HMP on their social media accounts

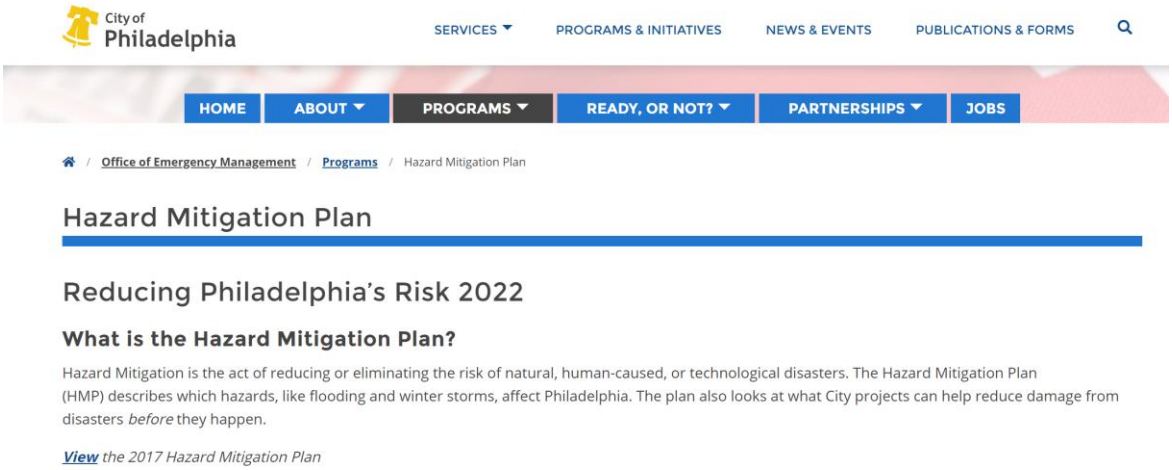
Agency or Organization	Twitter Handle	Social Media Followers
City of Philadelphia	@PhilaGov	327.7K
KYW News Radio	@KYWNewsradio	61.7K
Office of Emergency Management	@PhilaOEM	34.5K
Philadelphia Fire Department	@PhillyFireDept	33.2K
Philadelphia Department of Public Health	@PHLPublicHealth	30.9K
Parks and Recreation	@PhilaParkandRec	30.2K
Office of Sustainability	@GreenworksPhila	8,401

Agency or Organization	Twitter Handle	Social Media Followers
PDPH Get Healthy Philadelphia	@GetHealthyPHL	5,538
Department of Planning and Development	@PHLPlanDevelop	6, 918
Office of Civic Engagement and Volunteer Service	@PHLserves	3,838
Office of Immigrant Affairs	@PhillyOIA	3,652
Temple University Small Business Development Center (SBDC)	@TU_SBDC	1,702

Figure 3-9. Spanish HMP Twitter advertisement by Philadelphia Office of Immigrant Affairs.

3.4.1.3 *Website*

Figure 3-10.Screenshot of the City of Philadelphia's Hazard Mitigation Plan website.



The City of Philadelphia's Hazard Mitigation Plan Webpage was updated to include information on the 2022 Hazard Mitigation Plan, BRIC & FMA funding opportunities, and a description of how the public and planning partners could get involved and submit feedback on the plan update. Plain language on the website was used to make sure that the information is accessible to all members of the public. The 2022 Plan will be posted on the HMP website for review and feedback.

3.4.1.4 *Radio and News*

On Saturday, November 14th, 2020, Fire Commissioner Thiel's "Let's Talk Safety" WURD Radio show featured presentations from the Philadelphia Fire Department on Cooking Safety during Thanksgiving and from Philadelphia OEM's Hazard Mitigation Planner, Emma Giardina on the 2022 update of the Hazard Mitigation Plan. WURD Radio is the only African-American owned and operated talk radio station in Pennsylvania, and one of a few in the country. WURD takes a multimedia approach – on-air, online and in the community – WURD is widely recognized as the pulse of the African-American community locally, regionally and nationally.

Figure 3-11.Snapshot of WURD Radio's live post of the radio show on 11/14/2020.

The November 14th radio show was broadcast live via radio and through Facebook Live. By Monday, November 16th, Facebook counted 133 views and 2 likes. This radio show, as well as OEM's Hazard Mitigation Blog Post, was widely advertised via the Philadelphia Fire Department's Twitter and Facebook accounts in the days leading up to the show. A recording of this show can be viewed HERE.

Emma Giardina, Philadelphia OEM's Hazard Planning Coordinator also spoke with John McDevitt of KYW Radio station about the update of Philadelphia's HMP and the release of the public survey on February 11, 2021. Clips from the interview were featured on KWY Radio News Station the evening of February 11, 2021 and the next afternoon. An article was also featured on their website and can viewed using the link below.

KYW Newsradio is a News radio station based in Philadelphia. Close to 1.5 million listeners tune into KW each week for local, national, and international news, weather, sports and traffic.

Finally, Philadelphia OEM was a guest on WURD radio again on January 26, 2022 to discuss the 2022 Plan update, public draft review workshop, and opportunities for the public to provide feedback on the plan.

3.4.1.5 Public Survey

On January 27, 2021, Philadelphia OEM released a public survey to gather information on general emergency preparedness and community concerns. The survey was created and advertised in both

English and Spanish. Members of the public without digital access, or who required the survey in a different language, were able to call Philly311 for support filling out the survey. The 2022 public survey was built from the 2017 survey but included additional questions around hazards of concerns and hazard preparedness. Optional questions capturing the demographics of survey respondents helped OEM to assess whether the survey was being distributed equitably and reaching populations representative of Philadelphia's diverse population. This survey was open until December 13th, 2021 and feedback received from the survey directly informed the update of the plan.

In total, 397 unique survey responses were received (307 completed surveys), a slight decrease from the 441 survey responses received during the 2017 planning process. Based on a comparison of the completed survey demographic questions and U.S. Census Data, these survey results alone are not representative of Philadelphia's diverse community. The skewed results of this survey align with historical trends of survey non-response among communities that are either harder for government to reach, less able to commit time to respond to a survey, or less likely to trust the government to represent their interests. These challenges are likely exacerbated because of challenges with survey distribution and lack of in-person outreach during the COVID-19 Pandemic. These results indicate that a greater focus is needed on partnering with communities who are underrepresented during the next plan update. See **7 Plan Maintenance** for more details on future plan updates.

For more detailed information on public survey results, please see **3.4.2 Stakeholder Participation.**

3.4.1.6 Blog Post

Philadelphia OEM posted a blog post *Hazard Mitigation Planning: Why it Matters to You* which provides background information on what the HMP is, and how the community can get involved. This blog post served as an additional resource to help raise awareness with the public about this plan.

Between October 28th when the blog was created and November 17th, 2020, the link to the blog was clicked 116 times, averaging 5 clicks a day over 20 days.

3.4.2 Stakeholder Participation

The Hazard Mitigation is used to generate public discussion and awareness of the city's greatest threats and hazards and is also used as an informational tool and resource by city, state and federal partner agencies that plan for and implement hazard mitigation projects. Engaging and obtaining feedback from all stakeholders, including the public, throughout the update process strengthens the value of the plan and validates the city's commitment to mitigation strategies that address the needs of the whole community.

Philadelphia OEM began engaging partners in the planning process starting in February 2020 with the plan kickoff and annual review workshop. An emphasis was placed on expanding the number of stakeholders involved in the planning process, with a focus on engaging more regional partners, private-sector partners, universities and academic institutions, and the community. This 2-year timeframe allowed for extensive and targeted one-on-one outreach to educate and engage stakeholders in the planning process. Over **85 different agencies and organizations** were engaged at some point during this two-year process, an **increase in 57 entities** since the 2017 plan update.

Table 3-14. Participation in the Planning Process by Sector

Sectors for Engagement	Count of agencies/organizations by Sector	
	2017	2022
City or Quasi-City Agencies	15	36
State Agencies	4	7
Federal Agencies	3	2
Regional Partners	0	10
Utilities	3	3
Transportation Agencies	2	6
Educational Institutions	0	7
Non-profits	0	6
Hospital & Healthcare Partners	0	2
Other Private-Sector Partners	1	6
TOTAL	**28**	**85**

Stakeholders were engaged through one-on-one meetings and presentations, a series of planning workshops, and workgroup meetings. Invitations for meetings and workshops were sent to a wide variety of different agencies and organizations to promote involvement from as many different entities as possible. For partners that were unable to attend stakeholder workshops, one-on-one meetings were offered. Worksheets and surveys were distributed to partners to allow for feedback in a variety of different ways. Worksheets and surveys included:

- **Risk Assessment Data Collection Survey**: This survey collected information on local data sources to inform the Risk and Vulnerability Assessment for hazards in the plan.
- **Capability Assessment Survey**: This survey collected information on capability strengths and gaps in Philadelphia to inform the Capability Assessment Chapter of the plan.
- **Mitigation Action Form**: The Mitigation Action form was used to collect key details on new mitigation actions from stakeholders to include in the Mitigation Strategy.

For more information on meetings, workshops, and copies of surveys and worksheets distributed, please see **3.3 Meetings and Documentation**.

Table 3-15. Summary of agencies and organizations participating in the planning process

Agency or Organization	Category	Meeting or Workgroup Participation	2019 Annual Review	2020 Kickoff	Capability Assessment Workshop	Mitigation Brainstorm #1 (Optional)	Mitigation Brainstorm #2 (Optional)	Mitigation Strategy Workshop	Draft Review Workshop
			2/19/20	2/23/21	10/4/21	10/18/21	10/21/21	11/19/21	1/31/22
Commerce Department	City	x		x					
Delaware Valley Intelligence Center (DVIC)	City	x							
Department of Public Property	City	x	x	x	x	x	x	x	x
Free Library of Philadelphia	City		x						
L&I	City	x	x	x		x			

Agency or Organization	Category	Meeting or Workgroup Participation	2019 Annual Review	2020 Kickoff	Capability Assessment Workshop	Mitigation Brainstorm #1 (Optional)	Mitigation Brainstorm #2 (Optional)	Mitigation Strategy Workshop	Draft Review Workshop
			2/19/20	2/23/21	10/4/21	10/18/21	10/21/21	11/19/21	1/31/22
Managing Director's Office	City			x	x				
Managing Director's Office - Rebuild	City	x							
Mayor's Office of Civic Engagement & Volunteer Service	City	x		x					
Mayor's Office of Policy	City	x						x	x
Mayor's Office for People with Disabilities	City	x			x			x	x
Mayor's Office of Recovery & Grants	City	x		x		x	x		
MDO - Office of Criminal Justice	City	x							
MDO – Office of Special Events	City								x
MDO – Opioid Response Unit	City	x						x	x
MDO - Philadelphia Reentry Coalition	City	x							
Office of Criminal Justice and Public Safety	City	x							x
Office of Diversity, Equity & Inclusion	City	x			x				
Office of Emergency Management	City	x	x	x	x	x	x	x	x
Office of Risk Management	City	x	x	x					
Office of Sustainability	City	x	x	x		x	x	x	x
OIT	City				x				
OTIS	City	x		x	x	x	x	x	x
Philadelphia City Planning Commission	City	x	x	x	x	x	x		x
Philadelphia Department of Planning and Development	City	x	x						
Philadelphia Department of Public Health	City	x	x	x	x	x	x	x	x
Philadelphia Fire Department	City	x	x	x	x		x	x	x
Philadelphia Historical Commission	City	x						x	
Philadelphia Housing Authority	City	x		x	x				x

Agency or Organization	Category	Meeting or Workgroup Participation	2019 Annual Review	2020 Kickoff	Capability Assessment Workshop	Mitigation Brainstorm #1 (Optional)	Mitigation Brainstorm #2 (Optional)	Mitigation Strategy Workshop	Draft Review Workshop
			2/19/20	2/23/21	10/4/21	10/18/21	10/21/21	11/19/21	1/31/22
Philadelphia Housing Development Corporation (PHDC)	City	x					x		
Philadelphia International Airport	City	x							
Philadelphia Land Bank	City	x							
Philadelphia Opioid Response Unit	City	x							
Philadelphia Parks and Recreation	City	x	x			x	x	x	x
Philadelphia Police Department	City	x		x	x	x		x	x
Philadelphia Water Department	City	x	x	x	x	x	x	x	x
Streets Department	City	x	x	x				x	x
Community College of Philadelphia	Education	x							
Drexel University	Education	x	x	x					x
Temple University	Education	x	x	x					
University of the Sciences	Education	x		x					
UPenn	Education	x		x					
Wharton Risk Center	Education	x							x
The School District of Philadelphia	Education		x	x	x				
FEMA Region III	Federal		x	x					x
US Coast Guard - Sector Delaware Bay	Federal	x	x						x
USACE	Federal	x							
CHOP	Hospital			x				x	
Philadelphia Healthcare Management Cooperation (PHMC) (previously HAP)	Hospital		x						
American Red Cross	Non-Profit								x
Audubon PA	Non-Profit		x						
Fairmount Park Conservancy	Non-Profit		x				x		
Friends of Wissahickon	Non-Profit			x					
The Nature Conservancy	Non-Profit	x			x	x		x	x
Urban Sustainability Directors Network (USDN)	Non-Profit	x	x	x					

Agency or Organization	Category	Meeting or Workgroup Participation	2019 Annual Review	2020 Kickoff	Capability Assessment Workshop	Mitigation Brainstorm #1 (Optional)	Mitigation Brainstorm #2 (Optional)	Mitigation Strategy Workshop	Draft Review Workshop
			2/19/20	2/23/21	10/4/21	10/18/21	10/21/21	11/19/21	1/31/22
ARC Philadelphia	Private	x			x	x	x	x	x
CBRE	Private	x		x					
Liberty Resources, Inc	Private	x			x	x			
Manayunk Development Corporation	Private	x							
Philadelphia Industrial Development Corporation (Navy Yard)	Private	x	x	x	x	x		x	x
Temple Small Business District	Private	x							
Bucks County Planning Commission	Regional								x
Camden County Office of Sustainability	Regional		x						
Chester County Department of Emergency Services	Regional		x	x					x
Delaware County Emergency Management	Regional						x	x	x
Delaware County Planning Commission	Regional		x						
Delaware Valley Regional Planning Commission	Regional		x	x					x
Gloucester County Planning	Regional		x						
Mercer County OEM	Regional		x						
Montgomery County Division of Public Safety	Regional		x						
Montgomery County Planning Division	Regional							x	
Eastern Region, PA Historic Preservation Office	State	x	x	x					
PA Department of Human Services	State	x			x	x	x	x	x
PA Department of Health	State	x			x			x	
PennDOT	State	x	x	x	x				
Pennsylvania DEP	State		x						
PEMA	State	x	x	x					x
Pennsylvania Environmental Council	State		x						
Amtrak	Transportation	x	x						x

Agency or Organization	Category	Meeting or Workgroup Participation	2019 Annual Review	2020 Kickoff	Capability Assessment Workshop	Mitigation Brainstorm #1 (Optional)	Mitigation Brainstorm #2 (Optional)	Mitigation Strategy Workshop	Draft Review Workshop
			2/19/20	2/23/21	10/4/21	10/18/21	10/21/21	11/19/21	1/31/22
Amtrak Police	Transportation		x						
Delaware River Port Authority	Transportation	x	x		x				
PennDOT	Transportation	x	x						
Philadelphia International Airport	Transportation	x	x	x			x	x	x
SEPTA	Transportation	x	x		x	x	x	x	x
PECO	Utilities	x	x						
Philadelphia Gas Works	Utilities	x	x	x					x
Vicinity Energy	Utilities	x		x					

3.4.3 Public Participation

Philadelphia is a city of neighborhoods, and our goal for the 2022 HMP was to engage meaningfully with each part of the City during this process. By presenting information in a way that was accessible, the community was able to provide us with input on hazards that most concerned them. Our public engagement strategy helped us listen to and learn from a diverse representation of residents and businesses, creating a plan that reflects the goals and objectives of the community.

The Public Engagement Strategy for the 2022 Plan included:

- **5** public HMP workshops designed to capture feedback from members of the public with lived experiences
- **5** *Mitigation Station* pop-up table events at different locations around the City and at different times of the day
- Outreach via **3** public radio shows
- One-on-one outreach to community organizations, community leaders, and City Agencies and Commissions with direct ties to populations who are underrepresented in government processes and are who are more at risk to hazards due to exposure, health factors, or historical inequities
- An updated HMP landing page on the City website, featuring additional information on the planning process in a public-friendly, accessible format
- An updated public survey receiving 397 responses and that included optional demographic questions to determine if the survey was reaching a section of the public representative of Philadelphia's diverse community
- Public survey and social media posts available in both Spanish and English
- A social media toolkit with pre-scripted messages in two languages, which was distributed to various partners to help spread the word about the plan update and the public survey

- A partnership with the Planning Commission's Citizen's Planning Institute (CPI), reaching **22** participants in **15** planning districts
- The addition of an online, executive summary designed to continually provide the public with opportunities to engage in the hazard mitigation planning process beyond the 2022 update

The table below shows a comparison of public outreach events and public participation during the 2017 plan vs the 2022 plan update. Despite challenges due to the COVID-19 Pandemic, OEM still succeeded in offering more varied opportunities for engagement with the plan.

Table 3-16. Comparison of Public Outreach and Participation Results during the 2017 Plan update and 2022 Plan update

Metric	2017 Plan	2022 Plan
# of Community Workshops	3	6
# of Table Events	0	5
# of Radio Shows	0	3
# of Public Survey Responses	441	397
# of community members engaged via workshops and table events	Unknown	686

In total, 397 unique public survey responses (307 complete responses) were received from residents and business owners, a decrease from the 441 survey responses received during the 2017 planning process. Based on a comparison of the completed survey demographic questions and U.S. Census Data, these survey results alone are not representative of Philadelphia's diverse community. The skewed results of this survey align with historical trends of survey non-response among communities that are either harder for government to reach, less able to commit time to respond to a survey, or less likely to trust the government to represent their interests. These challenges are likely exacerbated because of challenges with survey distribution and lack of in-person outreach during the COVID-19 Pandemic.

For future updates, there will be a continued focus placed on partnering with community organizations and community leaders throughout Philadelphia to gather survey results from populations underrepresented in the 2022 public survey process. If COVID-19 conditions safely allow us to, there will also be an increased number of in-person opportunities for residents to respond to the survey.

Please note, these survey results were not the only means for collecting community feedback throughout this planning process. A variety of options for participation in the planning process were available including one-on-one workshops for community organizations upon request, pop-up table events, and direct outreach to community leaders and organizations.

For more detailed information on public survey results, please see Appendix C.

3.4.4 Stakeholder Feedback

Feedback was gathered from all plan stakeholders, including the public, in a variety of different ways including through the public survey, virtual workshops, and meetings throughout the plan update. During the 30-day public review and comment period, questions, comments, and feedback was gathered during the Draft Review Workshop, via OEM's email, and through a Survey posted on OEM's website. A printed copy of the draft plan was available at 3 Free Library of Philadelphia locations. Feedback received during the 30-day review period was documented and incorporated into the 2022

Plan prior to final submission to the Pennsylvania Emergency Management Agency (PEMA) and the Federal Emergency Management Agency (FEMA). For more detailed information on feedback and comments received during the 30-day public review and comment period, please see **Appendix C.**

4 Risk Assessment

4 Risk Assessment

According to the FEMA's *Local Mitigation Planning Handbook*, "The planning team conducts a risk assessment to determine the potential impacts of hazards to the people, economy, and built and natural environments of the community." Philadelphia's risk assessment is organized into four sections:

- **Section 4.1** outlines the risk assessment and hazard identification process.
- **Section 4.2** identifies both natural and human-caused hazards of concern for further profiling and evaluation.
- **Section 4.3** profiles hazards identified in Section 4.1, defining the hazard, describing the hazard's range of magnitude, environmental impact, past occurrences, and future occurrences.
- **Section 4.4** overviews the methodology and risk factors for profiled hazards.

4.1 Update Process Summary

The risk assessment process used for Philadelphia's 2022 HMP is consistent with the process and steps presented in the FEMA's *Local Mitigation Planning Handbook* which breaks the process into four unique steps:

1. Describe hazards,
2. Identify community assets,
3. Analyze risk, and
4. Summarize vulnerability.

The 2022 Hazard Mitigation Plan expanded on the hazards included in the 2017 Hazard Mitigation Plan. In addition to the hazards discussed in the 2017 HMP, the 2022 HMP included hazard profiles for pandemic and infectious disease; subsidence, sinkhole; civil disturbance; cyber terrorism; opioid addiction response; terrorism; and war and criminal activity which covers active assailant and gun violence in this HMP. Hazard profiles on flash floods and ice jams have been added to the hazard profile for flooding. Also, existing hazard profiles were revised to match the categories in the *Pennsylvania Hazard Mitigation Plan Standard Operating Guide* (PA SOG) Standard list of hazards. Infrastructure failure was revised into building and structure collapse and dam failure profiles. Hazardous train derailment was revised to hazardous materials release. The existing IED profile was focused on terrorism and was revised into a terrorism profile. Then urban conflagration was revised to urban fire and explosion.

There are additional hazards in the PA SOG that the City of Philadelphia did not profile. These hazards are not prevalent in Philadelphia, low risk, and not a focus for inter-agency mitigation efforts. This list will be re-visited in future annual reviews and HMP updates: coastal erosion, expansive soils, hailstorm, invasive species, landslide, lightning strike, radon exposure, wildfire, disorientation, drowning, environmental hazards other than hazardous materials release, levee failure, mass food/animal feed contamination, nuclear incidents, transportation accidents, utility interruption, and war and criminal activity.

The 2022 update utilized Hazus to analyze potential losses for Earthquake, Flood, Sea Level Rise, and Hurricane. Data from the City of Philadelphia Office of Property Assessment (OPA) and the Philadelphia

Water Department (PWD) was utilized to improve the accuracy of analysis. **Hazus** is a nationally standardized risk modeling methodology provided by FEMA as a free GIS-based software. The software includes an inventory of databases that can be used to estimate losses for earthquakes, floods, hurricanes, and tsunamis. The existing inventory was improved to complete Level 2 analysis with the best available data from the City. Hazus quantifies physical, economic, and social impacts as follows:

- Physical damage to buildings including critical facilities and infrastructure.
- Economic loss including lost jobs, business interruptions, and the cost of recovery from the disaster.
- Social impacts including people displaced and people requiring shelter.

People react and respond to disaster mitigation based on different information. Hazus provides a way to quantify disaster loss and impacts in a way that will drive some people to actions and expands the tools available to inform risk in this HMP.

4.2 Hazard Identification

For this update, the Steering Committee considered the full range of hazards that could impact Philadelphia and then ranked the hazards that presented the greatest concern. The process incorporated a review of the 2017 City of Philadelphia All-Hazard Mitigation Plan, and consideration of local, state, and federal information on the frequency, magnitude, and costs associated with hazards that have impacted or could impact Philadelphia. The Committee also considered relevant qualitative or anecdotal information regarding hazards, and the perceived vulnerability of assets within Philadelphia. Public survey results were also considered as part of process for selecting hazards.

A key source of historical information on hazards that have impacted Philadelphia is FEMA's data on Presidential Major Disaster Declarations. Typically requested by governors, Presidential Major Disaster Declarations open sources of Federal funding and assistance in the form of grants or loans to state and local governments, as well as to impacted individuals and businesses. Since 1955, Philadelphia has received 18 Presidential Major Disaster Declarations, providing aid for a variety of natural hazards including floods, snowstorms, and the COVID-19 Pandemic. A list of these declarations is shown in **Table 4-1.** This list does not include Presidential Emergency Declarations or disasters defined by other Federal agencies outside of FEMA.

Table 4-1. Table of Presidential Major Disaster Declarations

Declaration #	Declaration Date	Event Period	Event Name
4618	September 10, 2021	August-September 2021	Remnants of Hurricane Ida
4506	March 30, 2020	January 2020-Ongoing	COVID-19 Pandemic
4267	March 23, 2016	January 2016	Severe Winter Storm and Snowstorm
4099	January 10, 2013	October-November 2012	Hurricane Sandy
4030	September 12, 2011	September-October 2011	Tropical Storm Lee
4025	September 3, 2011	August 2011	Hurricane Irene
1898	April 16, 2010	February 2010	Severe Winter Storms and Snowstorms
1649	June 30, 2006	June-July 2006	Severe Storms, Flooding, and Mudslides
1557	September 19, 2004	September-October 2004	Tropical Depression Ivan
1538	August 6, 2004	July-August 2004	Severe Storms and Flooding
1294	September 18, 1999	September 1999	Hurricane Floyd

Declaration #	Declaration Date	Event Period	Event Name
1219	June 8, 1998	May-June 1998	Severe Storms, Tornadoes, and Flooding
1093	January 21, 1996	January-February 1996	Severe Storms and Flooding
1085	January 13, 1996	January 1996	Blizzard of 1996
1015	March 10, 1994	January 1994	Severe Winter Storms
340	June 23, 1972	June 1972	Hurricane Agnes
312	September 18, 1971	September 1971	Floods
240	August 18 ,1965	August 1965	Drought

Based on the review and assessment of historical events described above, this plan update will focus on the natural and human-made hazards described in **Table 4-2.**

Table 4-2. Hazard Descriptions

Hazard Name	Hazard Description
Drought 	Drought is defined as a deficiency of precipitation experienced over an extended period of time, usually a season or more. Droughts increase the risk of other hazards, like wildfires, flash floods, and landslides or debris flows. This hazard is of particular concern in Pennsylvania due to the prevalence of farms and other water-dependent industries, water dependent recreation uses, and residents who depend on wells for drinking water.
Earthquake 	An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area.
Extreme Temperature 	Extreme heat often results in the highest number of annual deaths of all weather-related hazards. In most of the United States, extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. (Ready.gov, 2018). Extremely cold air comes every winter in at least part of the country and affects millions of people across the United States. The arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite and hypothermia in a matter of minutes.
Flood, Flash Flood, Ice Jam 	Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all natural hazards in Pennsylvania. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams.

Hazard Name	Hazard Description
Hurricane, Tropical Storm, Nor'easter 	Hurricanes, tropical storms, and nor'easters are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counterclockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. Potential threats from hurricanes include powerful winds, heavy rainfall, storm surges, coastal and inland flooding, rip currents, tornadoes, and landslides. The Atlantic hurricane season runs from June 1 to November 30.
Pandemic and Infectious Disease 	A pandemic is a global outbreak of disease that occurs when a new virus emerges in the human population, spreading easily in a sustained manner, and causing serious illness. An epidemic describes a smaller-scale infectious outbreak, within a region or population, that emerges at a disproportional rate. Infectious disease outbreaks may be widely dispersed geographically, impact large numbers of the population, and could arrive in waves lasting several months at a time.
Subsidence, Sinkhole 	Land subsidence is a gradual settling or sudden sinking of the ground surface due to the movement of subsurface materials. A sinkhole is a subsidence feature resulting from the sinking of surficial material into a pre-existing subsurface void. Subsidence and sinkholes are geologic hazards that can impact roadways and buildings and disrupt utility services. Subsidence and sinkholes are most common in areas underlain by limestone and can be exacerbated by human activities such as water, natural gas, and oil extraction.
Tornado, Windstorm 	A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. About 1,250 tornadoes hit the U.S. each year, with about 16 hitting Pennsylvania. Damaging winds exceeding 50-60 miles per hour can occur during tornadoes, severe thunderstorms, winter storms, or coastal storms. These winds can have severe impacts on buildings, pulling off the roof covering, roof deck, or wall siding and pushing or pulling off the windows.
Winter Storm 	A winter storm is a storm in which the main types of precipitation are snow, sleet, or freezing rain. A winter storm can range from a moderate snowfall or ice event over a period of a few hours to blizzard conditions with wind-driven snow that lasts for several days. Most deaths from winter storms are not directly related to the storm itself, but result from traffic accidents on icy roads, medical emergencies while shoveling snow, or hypothermia from prolonged exposure to cold.

Hazard Name	Hazard Description
Building and Structure Collapse 	Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards.
Civil Disturbance 	A civil disturbance is defined by FEMA as a civil unrest activity (such as a demonstration, riot, or strike) that disrupts a community and requires intervention to maintain public safety.
Cyber Terrorism 	Cyber terrorism refers to acts of terrorism committed using computers, networks, and the Internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism…is generally understood to mean unlawful attacks and threats of attack against computers, networks, and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear."
Dam Failure 	Dam failure is the uncontrolled release of water (and any associated wastes) from a dam. This hazard often results from a combination of natural and human causes, and can follow other hazards such as hurricanes, earthquakes, and landslides. The consequences of dam failures can include property and environmental damage and loss of life.
Hazardous Materials Release 	Hazardous material releases can contaminate air, water, and soils and have the potential to cause injury or death. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events.

Hazard Name	Hazard Description
Opioid Addiction Response 	Opioid addiction occurs when an individual becomes physically dependent on opioids, which include opiates and narcotics. Opioids are a synthetic substance found in certain prescription pain medications: morphine, codeine, methadone, oxycodone, hydrocodone, fentanyl, and hydromorphone, and street drugs like heroine. Opioids block the body's ability to feel pain and can create a sense of euphoria. Individuals often build a tolerance to opioid drugs, which leads them to take more of the medication than originally prescribed.
Terrorism 	Terrorism is use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear and radiological weapons. Cyber-attacks have become an increasingly pressing concern.
Urban Fire and Explosion 	Urban fire and explosion hazards include vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. This hazard occurs in denser, more urbanized areas statewide and most often occurs in residential structures. Nationally, fires cause over 3,000 deaths and approximately 16,000 injuries each year.
War and Criminal Activity 	War and criminal activity hazards are intentional acts of violence, damage to property, and other criminal activities. This category specifically includes the following hazards: • War, Enemy Attack; foreign attack on territory of the United States. • Disinformation, Sabotage; intentionally spread inaccurate information, for example; interfering or impairing an operator's management or control of an organization. • Criminal Activity; lawlessness, acts committed for which punishment is imposed upon conviction after due process. • Physical or Information Security Breach; contravening security and confidentiality laws and procedures; burglary, unreasonable search and seizure, for example. • Workplace, School Violence; some environments are more likely than others to experience violence including occupations involving contact with the public. • Harassment; a pattern of conduct that causes substantial emotional distress with no legal purpose. • Discrimination; widespread treatment based on class, category, or prejudice rather than merit, applies extensively to civil and labor law.

Source: *Pennsylvania Hazard Mitigation Plan Standard Operating Guide* (PA SOG), 2020

4.3 Hazard Profiles

Natural Hazards

4.3.1 Drought

Drought is defined as a deficiency of precipitation experienced over an extended period of time, usually a season or more. Droughts increase the risk of other hazards, like wildfires, flash floods, and landslides or debris flows. This hazard is of particular concern in Pennsylvania due to the prevalence of farms and other water-dependent industries, water-dependent recreation uses, and residents who depend on wells for drinking water (PEMA, 2020).

4.3.1.1 Location and Extent

As regional climatic events, droughts can affect many counties to varying degrees throughout the region. In rural counties surrounding Philadelphia, for example, droughts affect agriculture and water supply. In Philadelphia, droughts primarily affect water supply for water use activities, such as pool filling and landscaping. The Philadelphia Water Department (PWD) in coordination with Delaware River Basin Commission (DRBC) closely monitor drinking water levels and quality during times of drought. The actions of DRBC, neighboring states, and federally and privately owned reservoirs work together to prevent severe declines in the rivers that Philadelphia and other municipalities use for drinking water supplies. The agricultural land in Philadelphia is not immune to the effects of a drought. However, as of 2017, only about 284 acres of land (0.33% of land use) in Philadelphia are designated for agricultural purposes (PennState, 2017). For future plan updates, Philadelphia OEM will engage with the Philadelphia Food Policy Advisory Council to incorporate the results of the Philadelphia Urban Agricultural Plan and include a more complete analysis of agricultural land.

There are five types of droughts: meteorological, hydrological, agricultural, socioeconomic, and ecological. These drought types are further described in **Table 4-3.** The two types of drought of greatest concern to Philadelphia are hydrological drought and socioeconomic drought.

Table 4-3. Types of Droughts

Drought Type	Description
Meteorological	A drought when dry weather patterns dominate a region.
Hydrological	A drought that typically follows prolonged meteorological droughts and occurs when water supplies become measurably lower in streams, reservoirs and ground water levels.
Agricultural	A drought when a lack of water and moisture in the soil adversely affects agricultural crops.
Socioeconomic	A drought when the supply and demand of certain goods and services, such as drinking water, food, and energy, are threatened or reduced by drought conditions.
Ecological	A drought that creates multiple stresses across ecosystems.

Source: National Drought Mitigation Center (NDMC)

4.3.1.2 Range of Magnitude

To the natural environmental, droughts can cause impacts to aquatic resources, loss or destruction of wildlife habitats, increased chance of wildfires, and damage to soil quality and a higher occurrence of erosion. To developed areas, droughts can affect the quality of emergency services, impact regional food supplies, lower milk production, and lessen the amount of water distribution to the public. High temperatures, sustained winds, and low relative humidity may exacerbate the severity of a drought.

The Pennsylvania Emergency Management Agency (PEMA), with direct support from the Pennsylvania Department of Environmental Protection (PADEP), monitors Pennsylvania's water resources during droughts with the Palmer Drought Severity Index (PSDI). The PSDI uses temperature and precipitation data to calculate water supply and demand. The numerical value assigned under the PSDI reflects this data, with zero being normal, a negative number implying drought conditions, and a positive number implying moist conditions. PDSI details are shown in **Table 4-4.**

Table 4-4. Palmer Drought Severity Index

Palmer Drought Severity Index	
Extreme Drought	-4.0 or less
Severe Drought	-3.0 to -3.9
Moderate Drought	-2.0 to -2.9
Near Normal	-1.9 to +1.9
Unusually Moist Spell	+2.0 to +2.9
Very Moist Spell	+3.0 to +3.9
Extremely Moist	+4.0 and above

Source: NOAA & NIDIS, National Current Conditions, https://www.drought.gov/current-conditions

PADEP and PEMA qualify drought using the drought phase conditions watch, warning, and emergency. Agencies use these indicators to identify, on a county basis, the overall water supply conditions. While some of the indicators can help identify meteorological, agricultural, and other types of droughts, the primary objective is to identify and manage hydrological droughts.

A **drought watch** alerts government agencies, public water suppliers, water users, and the public of the potential for future drought-related problems. The watch triggers increased monitoring, awareness, and preparation for response if conditions worsen. The issuing agency may request voluntary water conservation to manage water in the affected areas. Due to varying conditions, individual water suppliers or municipalities may ask for more stringent conservation actions. The Palmer Drought Severity Index (PDSI) classifies a drought watch as a "moderate" drought.

A **drought warning** involves a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures. The objective of voluntary water conservation measures during a drought warning is to reduce overall water uses by 10-15% in the affected areas. Due to varying conditions, individual water suppliers or municipalities may request more stringent conservation actions. The PDSI classifies a drought warning as a "severe" drought.

A **drought emergency** is a phase of concerted management operations to marshal all available resources to respond to actual emergency conditions. Operations aim to avoid depletion of water sources, to assure at least minimum water supplies to protect public health and safety, and to support essential and high priority water uses. Mandatory restrictions on nonessential water uses (as defined in the Pennsylvania Code, Chapter 119), may be ordered by the Governor. The objective of water use restrictions is to reduce consumptive water use in the affected area by 15%. The PDSI classifies a drought emergency as an "extreme" drought. The worst-case scenario for Philadelphia would be an extreme drought.

4.3.1.3 Past Occurrence

Declared drought status for Philadelphia County from 1980 to 2021 includes 14 drought watches, 23 total drought warnings, and 10 drought emergencies. The following table captures the 10 worst drought

instances in Philadelphia's recent history, with PSDI values where available. Drought conditions led to one Presidential and five Gubernatorial Declarations.

Table 4-5. Top Ten Drought Occurrences in Philadelphia

Month and Year	PSDI Monthly Value Ranges (where available)
January 2002 to September 2002	-10.18 to -7.38
December 1998 to May 1999	-6.64 to -5.16
July 1999	-5.80
November 2001 to December 2001	-5.72 to -4.19
December 1965 to August 1965	5.58 to -4.06
March 1992 to July 1992	5.15 to -4.42
March 1969 to May 1969	-4.74 to -4.38
October 1964 to December 1964	-4.55 to -3.37
December 1965 to January 1966	-4.49 to -4.42
June 1966 to August 1966	-4.19 to -3.56

Sources: Pennsylvania

4.3.1.4 Future Occurrence

It is difficult to forecast the severity and frequency of future drought events in Philadelphia. Occasional drought is a normal occurrence in virtually every climate in the United States. However, climate change may increase the risk of extreme drought, even if it remains relatively rare. Historical data shows a slight downward trend in PSDI over the past seven decades, quantifying the potential increase in drought risk for the future.

4.3.1.5 Vulnerability Assessment

The impact of a drought depends on its severity, duration, and spatial extent, but also on regional drought management policies that prevent salinity intrusion of the Baxter Water Treatment Plant. The Baxter Water Treatment plant is the largest drinking water intake in Philadelphia and supplies about 60% of the City with water. The most critical drought management policy is the Flexible Flow Management Plan (FFMP). The FFMP is a set of reservoir operating rules and water withdrawal regulations authorized by unanimous consent of the five parties to the 1954 Supreme Court Decree that control reservoir releases and drought management policies within the Delaware River Basin; New York City, New York, Pennsylvania, New Jersey, and Delaware. The FFMP is a temporary modification to the 1954 Supreme Court Decree, which was a legal settlement that dictated formal allocation of out-of-basin water diversions to New York City, New Jersey and equitable apportionment reservoir releases to Pennsylvania, New Jersey and Delaware. There have been multiple versions of the FFMP since 2006, which incrementally changed NYC reservoir releases to better support trout fisheries and reduce flooding and extreme streamflow fluctuation in the areas immediately downstream of the dams.

Policies contained within the FFMP detail how reservoir releases are made during severe drought conditions to reduce salinity in the vicinity of the Baxter intake. As salt moves up the estuary the streamflow objectives at Montague and Trenton are increased to manage salinity. The Montague objective is met with NYC reservoir water and the Trenton objective is met with Army Corps reservoir water. The current FFMP, the 2017 FFMP, is different from prior iterations in that it is a multi-year policy and requires studies to be conducted and assessed by the Decree Parties during the policy window. Changes to the salinity repulsion policies are a primary focus of the 2017 FFMP. PWD's policy position is that comparable protection of the Philadelphia drinking water supply, for any FFMP alternatives, is a

policy that leads to no ocean salt at the PWD Baxter Water Treatment Plant intake. A policy contributing to ocean salt at the PWD Baxter Water Treatment Plant intake for one day is considered a significant adverse impact.

The salinity repulsion policies within the FFMP are critical to protecting the PWD drinking water supply from becoming too salty to drink during severe drought conditions. PWD is currently working on a comprehensive analysis of the relationship between flow, salinity intrusion, water quality at Baxter, and sea level rise utilizing a three-dimensional salinity model and a reservoir optimization model. The PWD analysis will be provided to the Decree Parties to inform policy deliberations prior to negotiating a new FFMP in 2023.

PWD continues to monitor the latest climate change science, which currently indicates a high level of uncertainty on the severity and frequency of future droughts for our region.

4.3.2 Earthquake

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area (PEMA, 2020).

4.3.2.1 Location and Extent

The impact of earthquakes can extend up to hundreds of thousands of square miles and cause fatal loss, injury, substantial property damage, and disrupt social and economic functions (PEMA, 2018). Most earthquake damage is caused by the failure and collapse of structures due to ground shaking, which depends upon amplitude and duration of the earthquake (PEMA, 2018).

Most earthquakes originate at faults (PEMA, 2018). Philadelphia is located on the North American plate and is far from the plate boundary, which is 2,000 miles east in the Atlantic Ocean. The closest fault line to Philadelphia is the Ramapo Fault, which is part of a system of northeast-striking, southeast-dipping faults. These faults run from southeastern New York to eastern Pennsylvania. The Ramapo Fault and its series were active at different points during the evolution of the Appalachian Mountains, approximately 200 million years ago (Columbia University, 2012).

The best predictor of the distribution of earthquakes is the distribution of past earthquakes (PEMA, 2019). Earthquake events in Pennsylvania typically do not impact areas greater than 100 km from the epicenter, and earthquake epicenters in Philadelphia are not common. Due to zones of weakness or deep fault lines within the North American plate, earthquakes are a possible hazard within Philadelphia.

4.3.2.2 Range of Magnitude

More severe earthquakes can result in subsidence, soil liquefactions, and landslides. Lesser earthquakes may not be felt at all. The severity of an earthquake depends on the amount of energy released at the epicenter, the distance from the epicenter, and the underlying soil type. The United States Geological Survey (USGS) relies on specific measurement tools to account for magnitude and intensity, and to describe the overall severity of an earthquake.

The Richter scale, an open-ended logarithmic scale, measures the magnitude of earthquakes (the amount of energy released at the source of the earthquake). Since it is logarithmic, each higher number on the Richter scale represents a tenfold increase in the magnitude of the tremors, and a thirtyfold increase in the energy released. A 2.0 quake is barely noticeable while an 8.0 quake can cause serious damage across a large area. Earthquake effects by Richter Magnitude are in **Table 4-6.**

Table 4-6. Richter scale magnitudes and associated earthquake size effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally felt but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive up to about 100 km from epicenter.
7.0-7.9	Major earthquake, can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred km across.

The Richter Scale does not give an indication of the intensity or damage of an earthquake, although it can be inferred that higher magnitudes cause more damage. The impact of an earthquake is measured in intensity. The Modified Mercalli Intensity (MMI) scale measures earthquake intensity, see **Table 4-7.**

Table 4-7. Modified Mercalli Intensity Scale with associated impacts

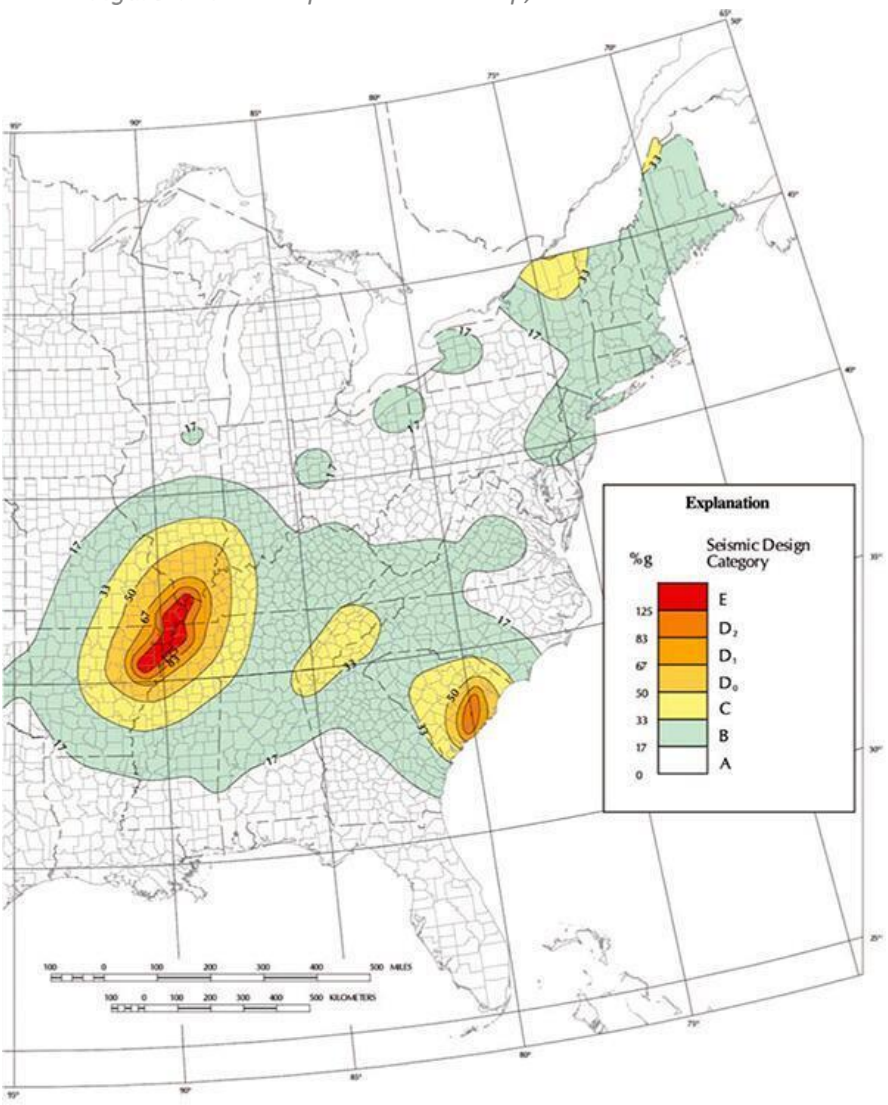
Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	**Instrumental**	Usually detected only on seismographs.	< 4.2
II	**Feeble**	Felt only by a few persons at rest, especially on upper floors of buildings.	
III	**Slight**	Felt quite noticeably indoors, especially on upper floors. Most people don't recognize it as an earthquake (i.e. a truck rumbling).	
IV	**Moderate**	Can be felt by people walking; dishes, windows, and doors are disturbed.	
V	**Slightly Strong**	Sleepers are awoken; unstable objects are overturned.	< 4.8
VI	**Strong**	Trees sway; suspended objects swing; objects fall off shelves; damage is slight.	< 5.4
VII	**Very Strong**	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built or badly designed structures; some chimneys are broken.	<6.1
VIII	**Destructive**	Damage is slight in specially designed structures; considerable in ordinary, substantial buildings. Moving cars become uncontrollable; masonry fractures, poorly constructed buildings damaged.	<6.9
IX	**Ruinous**	Some houses collapse, ground cracks, pipes break open; damage is considerable in specially designed structures; buildings are shifted off foundations.	
X	**Disastrous**	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with foundations. Ground cracks profusely; liquefaction and landslides widespread.	<7.3

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed.	<8.1
XII	Catastrophic	Total destruction; trees fall; lines of sight and level are distorted; ground rises and falls in waves; objects are thrown upward into the air.	>8.1

The USGS further evaluates the intensity of earthquakes through Peak Ground Acceleration (PGA) and Spectral Acceleration (SA). PGA expresses the severity of an earthquake and measures how hard the earth shakes or accelerates in a given geographic area.

Figure 4-1 depicts seismic design categories, which reflect the likelihood of experiencing earthquake shaking intensities. Philadelphia is in Category B, meaning it could experience shaking of moderate intensity that is felt by all. Heavy furniture may move, some instances of fallen plaster could occur, but damage would be slight (FEMA, 2020).

Figure 4-1. Earthquake Hazard Map, Eastern United States



The worst-case scenario for the City would be an earthquake measuring moderate on the MMI scale affecting the region. Everyone would be able to feel the quake. Damage to buildings would occur, such as broken windows and cracks in the masonry for poorly constructed homes. Household items would shift around, breaking or causing damages or injuries. Emergency services would be used immediately, with the 9-1-1 call center being overwhelmed by concerned citizens.

4.3.2.3 Past Occurrence

Based on seismic records, thousands of earthquakes have occurred in Pennsylvania over the past few centuries. Many earthquakes are so slight that they go largely unnoticed by the general population. The tables below list the top ten earthquakes that have occurred in or around Southeast Pennsylvania. The United States Geological Survey keeps an active and up-to-date record of earthquakes around the nation. The following tables below provide the top ten earthquakes my magnitude and intensity in or around Southern Pennsylvania (PA DCNR, 2003).

Table 4-8. Top Ten Earthquakes by Magnitude within 100 km of Philadelphia

Date	Location, County, State	Magnitude	Intensity
1/16/1994	Sinking Spring, Berks, PA	4.6	V
9/1/1895	Mountainville, Hunterdon, NJ	4.5	VI
9/15/1961	Bethlehem, Lehigh, PA	4.3	V
4/23/1984	Marticville, Lancaster, PA	4.2	VI
11/20/1800	Landisville, Lancaster, PA	4.1	V
10/9/1871	Deepwater, Salem, NJ	4.1	VII
1/16/1994	Sinking Spring, Berks, PA	4.0	V
2/5/1834	Quarryville, Lancaster, PA	4.0	V
8/23/1938	Cream Ridge, Monmouth, NJ	3.9	V
2/28/1973	Penns Grove, Salem, NJ	3.8	V-VI

Table 4-9. Top Ten Earthquakes by Intensity within 100 km of Philadelphia

Date	Location, County, State	Magnitude	Intensity
10/9/1871	Deepwater, Salem, NJ	4.1	VII
4/23/1984	Marticville, Lancaster, PA	4.2	VI
2/10/1977	Wilmington, New Castle, DE	2.6	VI
3/11/1975	Wilmington, New Castle, DE	2.0	VI
5/31/1908	Allentown, Lehigh, PA	3.1	VI
1/7/1954	Mount Pleasant, Berks, PA	3.2	VI
9/1/1895	Mountainville, Hunterdon, NJ	4.5	VI
3/23/1957	White House, Hunterdon, NJ	3.5	VI
10/6/1978	East Petersburg, Lancaster, PA	3.0	VI
2/28/1973	Penns Grove, Salem, NJ	3.8	V-VI

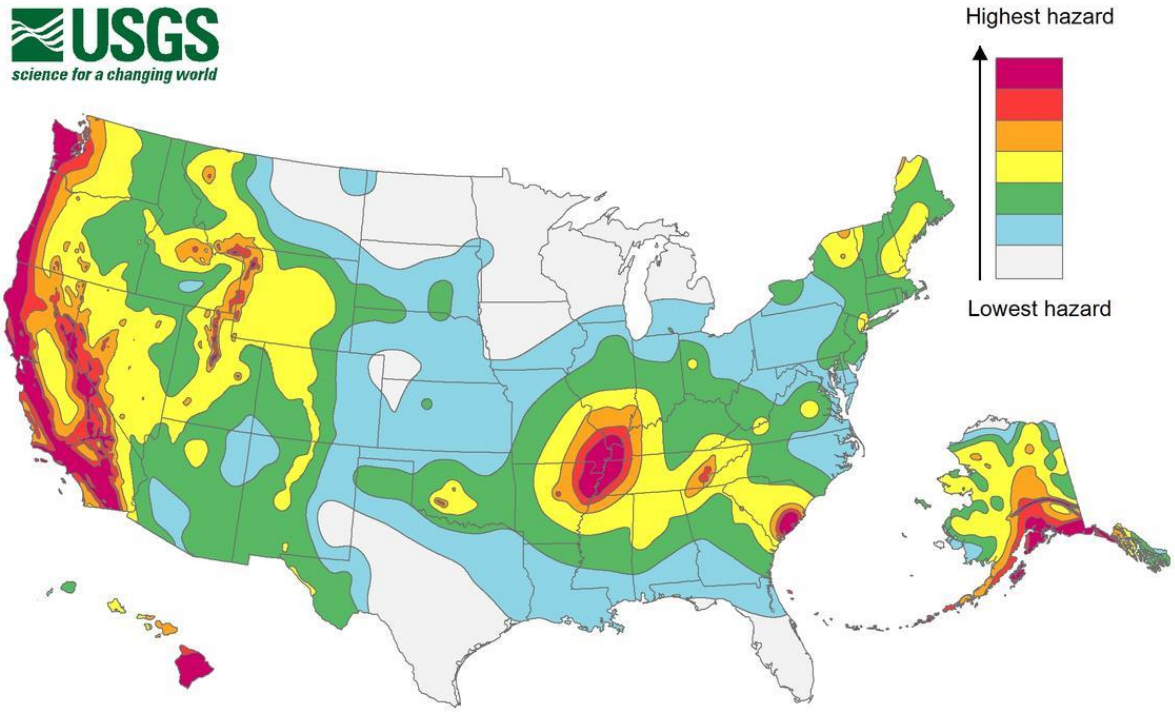
Very few earthquakes with intensities of VI or higher have been centered within 100 km of Philadelphia. The most widely felt earthquake known to be centered within 100 km of Philadelphia occurred in the Lancaster area on April 23, 1984 (PEMA, 2018). More recently, an earthquake on January 16, 1994 measured 4.6 on the Richter Scale and caused damage exceeding two million dollars in Sinking Spring, near Reading, PA (PEMA, 2018).

4.3.2.4 Future Occurrence

The best available guides to the magnitude and frequency of seismic hazards are the probabilistic ground motion maps produced by USGS. The latest available maps are the 2018 USGS National Seismic Hazard Maps.

Figure 4-2 shows relative seismic hazard zones in the U.S. as determined by the USGS National Seismic Hazard Mapping Project (USGS, 2018). The map of hazard zones is based on peak ground acceleration (PGA) for the US with a recurrence interval of 2,500 years (2% probability of exceedance in 50 years). PGA is expressed as a percentage of the force of gravity, or %g. Damage to buildings of poor construction generally begin at a PGA of 10% g. Pennsylvania is in the green zone, which is indicated as a lower-level hazard. The green corresponds to a 0.2-0.28 0.2-second spectral response acceleration (g) (Shumway, 2020).

Figure 4-2. Long-term National Seismic Hazard Map, 2018



Source: USGS, 2018

4.3.2.5 Vulnerability Assessment

Overlooking the low probability, if a strong earthquake with an epicenter located in downtown Philadelphia were to occur, it would cause extensive critical services disruptions, financial losses, and casualties. The following table lists earthquake-induced direct or indirect impacts that would affect Philadelphia's economy, environment, and residents.

Table 4-10. Earthquake Impacts

Economic	Environmental	Community/Population
• Damage/destruction of infrastructure • Disruption of transportation systems • Disruption of communication systems • Disruption of utility systems • Disruption of marketing systems • Loss of business • Loss of industrial output • Higher insurance premiums • Increased fire hazard • Loss to tourism industry • Reduction of economic development	• Induced flooding • Landslides/Mudslides • Poor water quality • Damage to vegetation • Breakage in sewage or toxic material containments • Breakage of gas mains • Breakage of water mains • Soil liquefaction • Increased fire hazard	• Loss of life, livelihoods, property • Loss of housing • Decrease in quality of • life • Breakdown of social order • Disease • Lack of basic necessities • Increased fire hazard • Loss in aesthetic values • Increased poverty

The impacts of a large-scale earthquake in Philadelphia would disproportionately effect Philadelphia's socially vulnerable populations. While absolute losses are more likely to occur among wealthier groups or property and business owners in dense Center City, the relative impact of an earthquake on low-income households' economic stability and resilience would be far greater in the long term. Socially vulnerable households are less likely to have strong financial safety nets or insurance to recover from disasters such as earthquakes. Additionally, housing is often the principal economic asset of lower-income urban households which a large-scale earthquake might damage irreparably (UNDRR).

Beyond an earthquake's threat to the economic stability of Philadelphia's most vulnerable populations, the housing stock in Philadelphia is old, depreciated, and concentrated in low-income neighborhoods (LISC). Many of Philadelphia's rowhomes were constructed as worker housing and not intended to last for more than 100 years (Kramer, 2018). The median age of Philadelphia's housing stock is 93 years old; 41% of houses are more than 100 years old (LISC). Low-income households also often struggle with deferred maintenance on home repairs, which creates more critical and expensive problems over time (LISC). Altogether, Philadelphia's socially vulnerable populations are more likely to live in poorly maintained structures that were not designed to withstand an earthquake. **Figure 4-25** and **Figure 4-27** (in **4.3.10 Building and Structure Collapse** hazard profile) illustrates that the two areas of highest social vulnerability, North and West Philadelphia (see **2.3.8 Social Vulnerability**) have high concentrations of structures built before 1939 and structures in danger of imminent collapse.

The following table summarizes earthquake losses for Philadelphia predicted by a Hazus analysis run in January 2022. Hazus is FEMA's national standardized risk modeling software. The table also includes analyses from the Pennsylvania 2017 HMP, 2013 PEMA HMP, and 2012 Philadelphia HMP for comparison. As shown in the divergence in the 2012 Philadelphia HMP model and the 2013 PEMA HMP Model, the Hazus-MH modeling used in the 2012 plan resulted in much lower damages than both the 2017 and 2013 models. The 2022 and 2017 Philadelphia modeling produced numbers much closer to

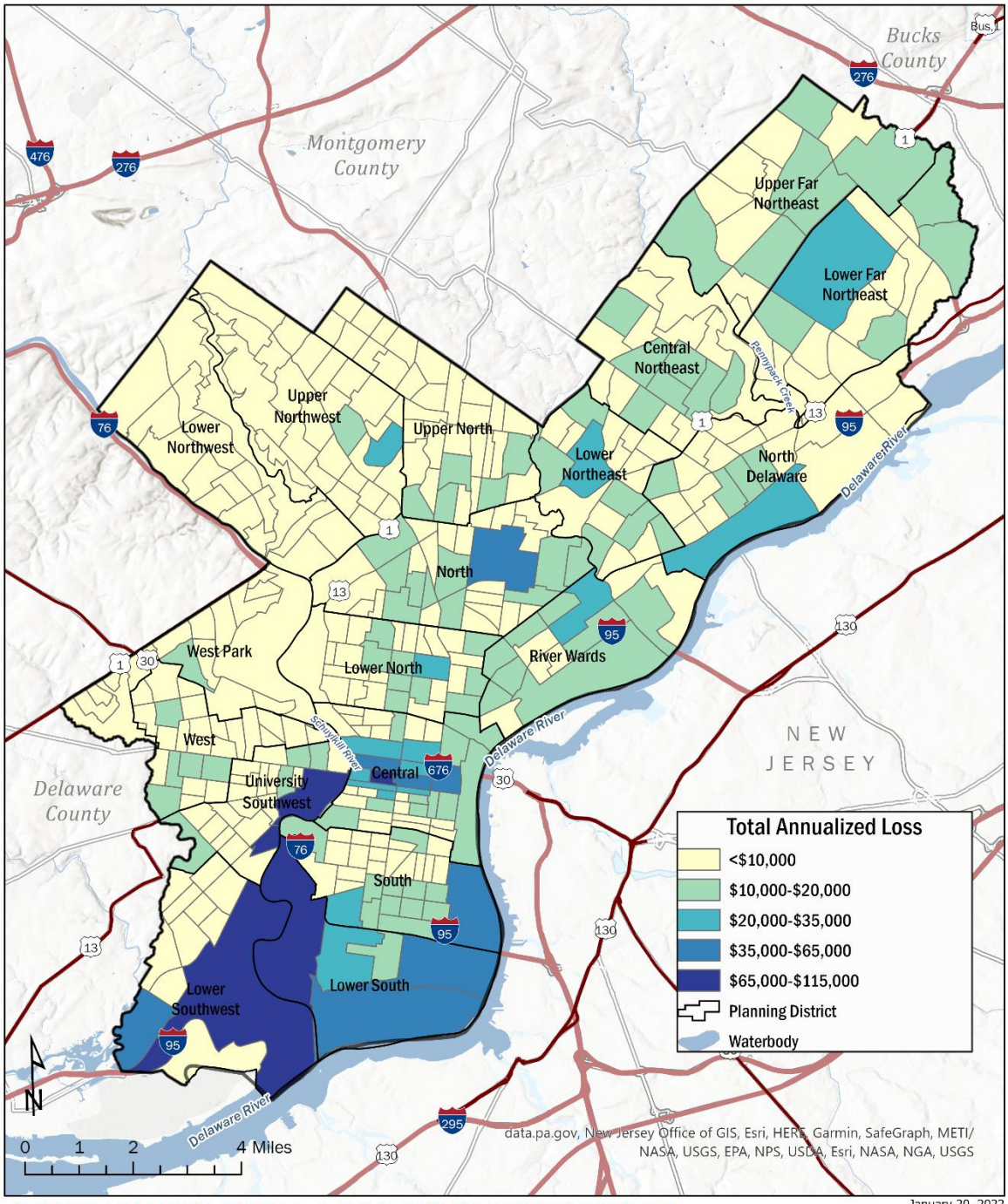
those of the 2013 PEMA model, potentially due to more accurate data used for modeling and updated Hazus-MH software.

Table 4-11. Hazus Results for Earthquake Impacts

	2022 Philadelphia HMP Model	2017 Philadelphia HMP Model	2013 PEMA HMP Model	2012 Philadelphia HMP Model
Buildings at Least Moderately Damaged	130,757	120,147	157,484	37,980
Buildings Damaged Beyond Repair	9,856	9,908	7,428	873
Economic Losses for Buildings – Including Capital and Income Losses	$41.6 billion	$23.4 billion	$20.5 billion	$6.32 billion
Shelter Requirement	19,004	18,861	9,695	2,237
Injury Estimates (2AM)	7,116	1,548	25	1,375
Casualty Estimates (2AM)	357	372	1	41

Figure 4-3 shows the distribution of potential total economic losses for the Hazus scenario. According to the Hazus model, the densely populated area of Center City Philadelphia would incur large economic losses, as well as the areas along the Schuylkill River in the University Southwest, Southwest, and Lower South. Annualized losses from Hazus measure the value of damages or losses expected each year due to earthquakes. The annualized losses quantify value of earthquake damages to buildings, critical facilities, business interruption, and reconstruction costs.

Figure 4-3. Earthquake Total Loss by Census Tract, Hazus 5.1 Annualized Results



EARTHQUAKE TOTAL LOSS BY CENSUS TRACT
(HAZUS 5.1 ANNUALIZED RESULTS)
CITY OF PHILADELPHIA

January 20, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

4.3.3 Extreme Temperature

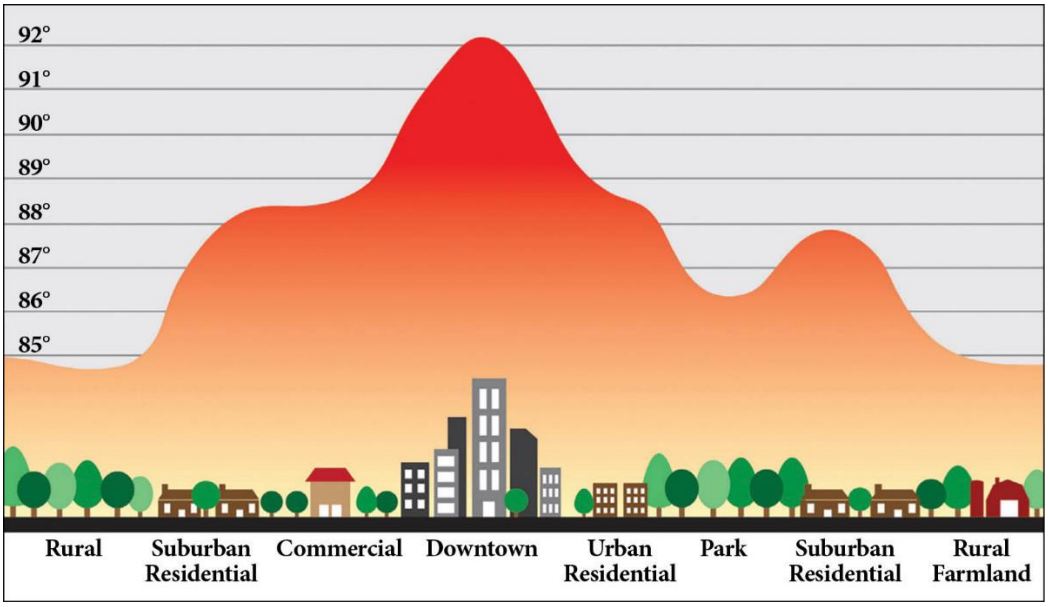
Extreme heat often results in the highest number of annual deaths of all weather-related hazards. In most of the United States, extreme heat is defined as a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees. (Ready.gov, 2018). Extremely cold air comes every winter in at least part of the country and affects millions of people across the United States. The arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite and hypothermia in a matter of minutes (PEMA, 2020).

4.3.3.1 Location and Extent

A **heat wave** is a type of extreme event that the National Weather Service defines as a period of two or more days of hot and humid weather. For most of the United States, temperatures during a heat wave reach at least 90 degrees (Ready.gov, 2018). The term 'heat wave' is often used informally by the media and general public and may apply to routine weather variations and to extraordinary spells of heat, which may occur only once a century.

Located in the northern reaches of the humid subtropical zone (Köppen climate classification), Philadelphia experiences warm to hot summers and mild winters. Extreme temperature events typically affect all neighborhoods within Philadelphia, but certain neighborhoods experience higher than usual temperatures during the summer due to the **urban heat island effect**. Philadelphia has less green space than surrounding suburban areas and more paved surfaces which absorb heat faster and release heat slower than green space. This phenomenon develops over time as buildings, roads, and other infrastructure replace open land and vegetation. Dry, impervious surfaces like asphalt may continue to release heat hours after the sun is down. Other urban by-products, such as exhaust fumes, burning furnaces, heating units, and smokestacks also contribute to heat retention and entrapment and reduce air quality during hot weather.

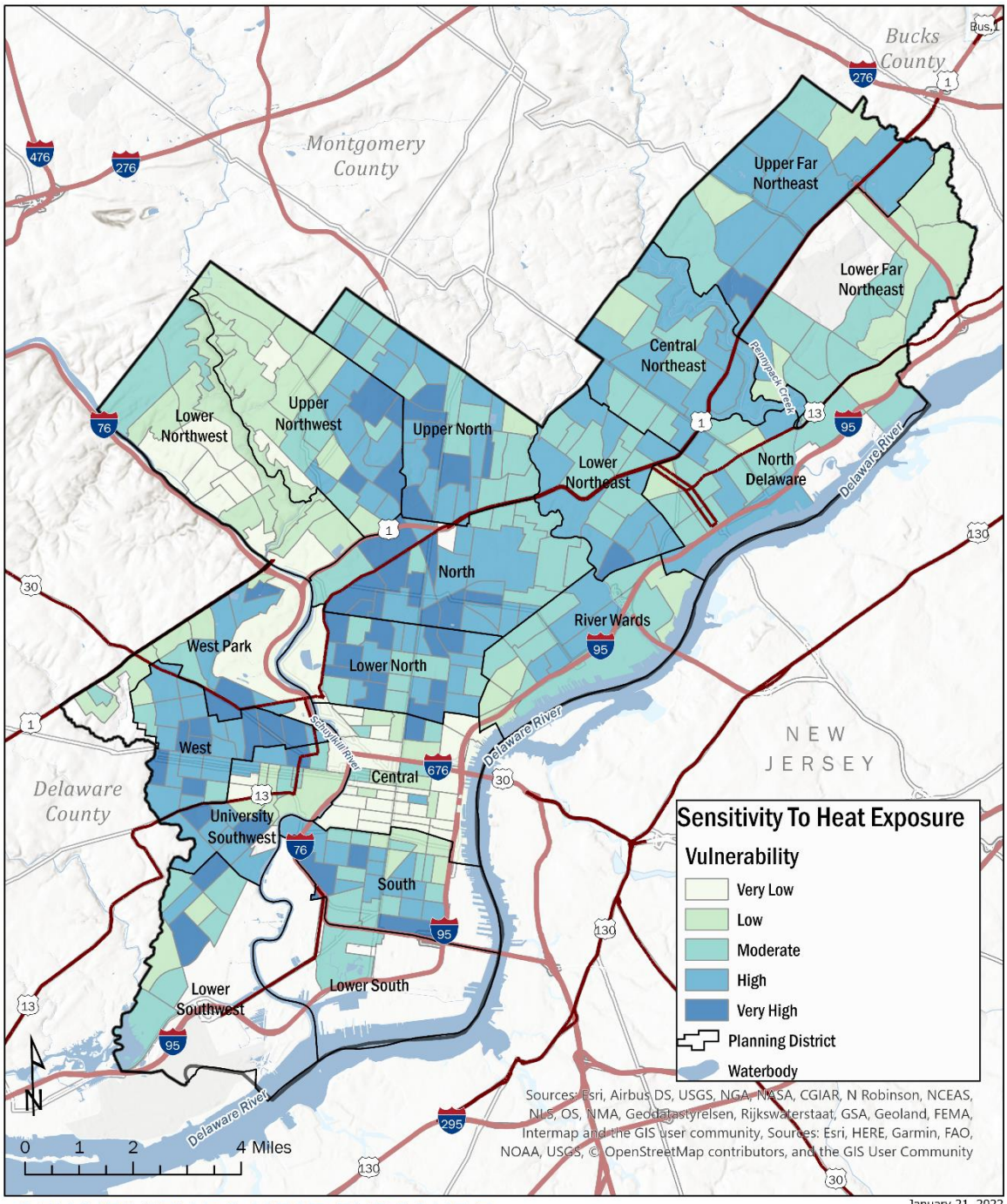
Table 4-12. The Urban Heat Island Effect in Urban Environments



Source: Bay Area Monitor, 2017

The strength of the heat island effect also varies across the city and is based on factors in the built environment like number of street trees, proximity to highways or industry, and the presence of green space like parkland. This means that while the entire city is subject to higher heat compared to outlying parts of the region, some neighborhoods are even more vulnerable than others. According to Philadelphia's Heat Vulnerability Index (HVI), the most vulnerable neighborhoods can be up to 22 degrees hotter than the least vulnerable (City of Philadelphia, 2019). As shown by the map below, these neighborhoods are most concentrated in the North, West, and South overlapping with areas that have low-income populations. Individuals living in these areas have a higher risk of heat-related illnesses and death.

Figure 4-4. Philadelphia's Heat Vulnerability Index (HVI), 2019



SENSITIVITY TO HEAT EXPOSURE
BY CENSUS TRACT
CITY OF PHILADELPHIA

January 21, 2022

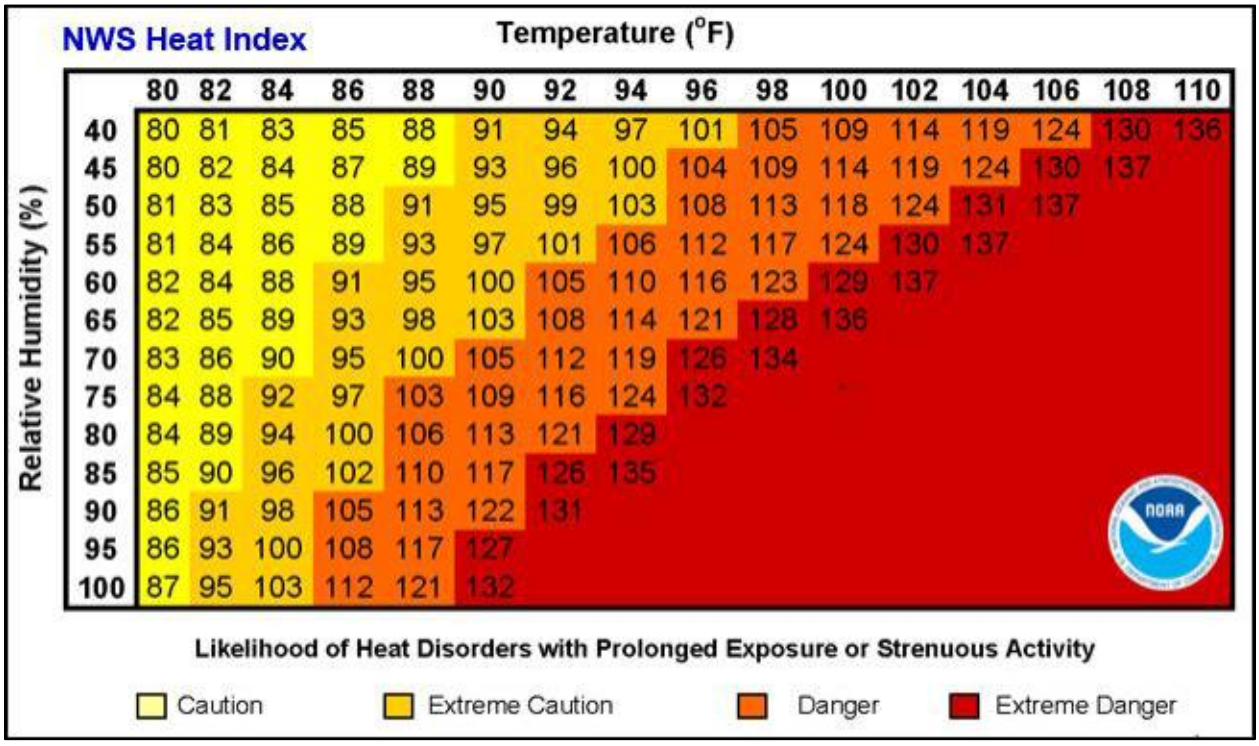
Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

While winters in Philadelphia are generally mild, with average high temperatures hovering just above 40 degrees in January, artic air masses from Canada can bring frigid temperatures to the region for extended periods. The polar vortex—a large pocket of low pressure and very cold air normally located above the polar region (NWS, n.d.) —can move into the Philadelphia region when it is pushed farther south by a powerful high-pressure system in the Eastern or Western Pacific. The polar vortex can sometimes deliver below-zero temperatures for several days until it moves back above the pole.

4.3.3.2 Range of Magnitude

Extreme heat is measured through the Heat Index. As identified by the National Weather Service (NWS) and NOAA, the **Heat Index** is the temperature the body feels when heat and humidity combine. Higher humidity levels plus higher temperatures can combine to make individuals feel a perceived temperature that is higher than the ambient air temperature. The figure below identifies the Heat Index that corresponds to the actual air temperature and relative humidity. When conditions warrant, NWS issues heat-related weather warnings, including excessive heat outlooks, excessive heat watches, excessive heat advisories, and excessive heat warnings. The City of Philadelphia's Office of Homeless Services (OHS) can also declare a **Code Red** when heat is a health concern for people who are experiencing homelessness. A Code Red declaration activates a variety of additional resources including an OHS Street Outreach team.

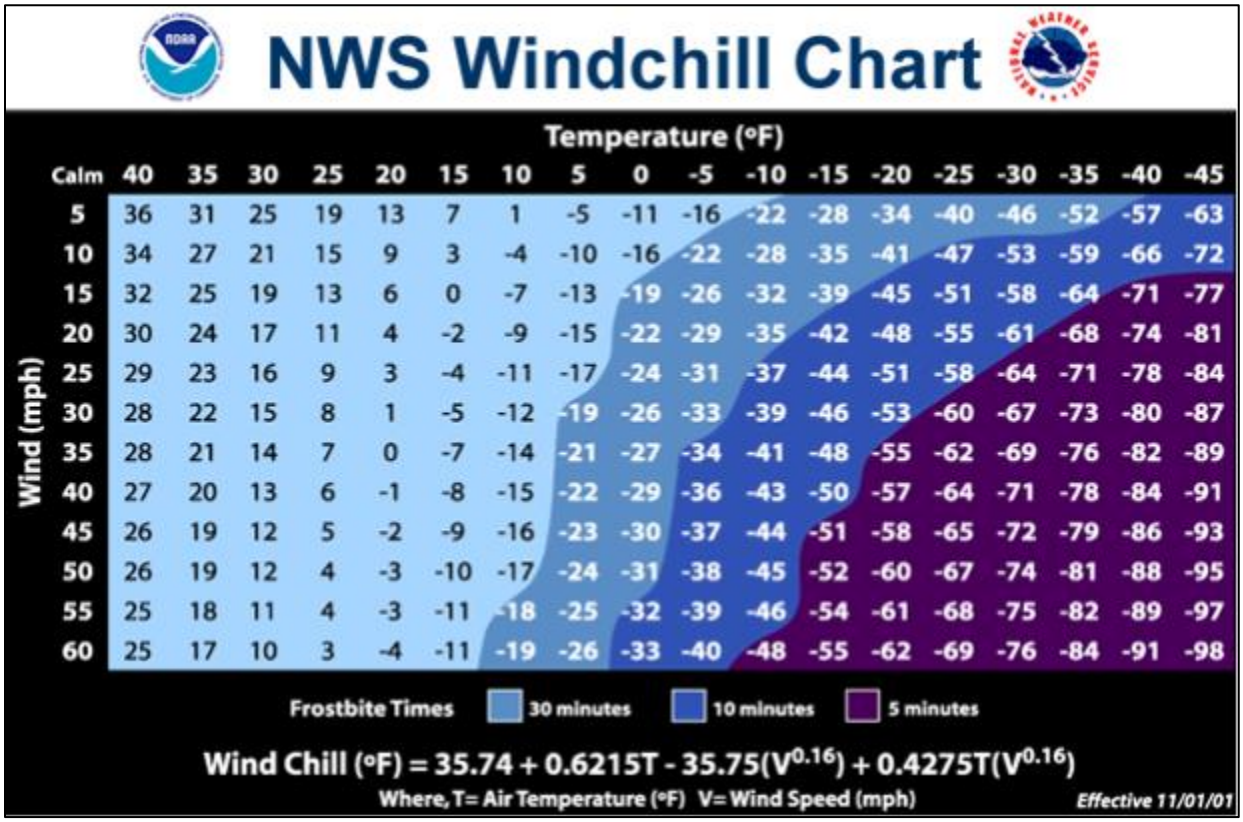
Figure 4-5. NWS Heat Index Chart



The **Wind Chill Temperature Index** for extreme cold measures the severity or magnitude of extreme temperatures. NWS developed the wind chill chart below depicting apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. When conditions warrant, NWS issues wind chill watches, advisories, and warnings. The City of Philadelphia issues a **Code Blue** during extremely cold conditions, usually when temperatures feel near or below 20 degrees Fahrenheit.

This activates a variety of resources to keep people who are experiencing homelessness safe, including 24-hour outreach and increased bed availability within the emergency housing network.

Figure 4-6. NWS Windchill Chart



Extreme temperatures have a wide range of impacts on public health, the environment, and infrastructure. Common cold-related health conditions include frostbite, hypothermia, and exacerbation of pre-existing health conditions. Additionally, the risk of carbon monoxide poisoning increases in the winter because windows and doors are kept shut, keeping potentially harmful gases from heating systems and fuel-burning appliances trapped inside. Fires and associated injuries and deaths are also a risk when space heaters and ovens are improperly used to add supplemental warmth to a home that may not have a properly functioning heating system. Heat-related health conditions include muscle cramps, heat exhaustion, and heat stroke or sunstroke. Prolonged exposure to both extreme heat and extreme cold can lead to death. Adults over the age of 65, young children under the age of 4, those with pre-existing health conditions, and those experiencing homelessness are more at risk of experiencing these effects.

Plants and wildlife are also at risk of impacts from extreme temperatures because they can cause disruptions to normal growing seasons and other natural cycles such as migration. Both temperature extremes can negatively affect livestock, pets, and other domestic animals, particularly if they spend extended periods outdoors or if they do not receive adequate hydration during hot weather. Extreme or prolonged cold during winter can keep water from thawing and disrupt the ecology of the affected waterway while extreme or prolonged heat can trigger a drought or cause increased algae growth that can kill fish by depleting oxygen levels in the water. Toxic blue-green algae, or cyanobacteria, can also

bloom during hot weather (EPA, 2021b). Cyanobacteria blooms lead to some of the same impacts as other algae, but also release toxins that are dangerous to humans, pets, and other animals when they contact or drink contaminated water (CDC, n.d.).

Extreme heat can cause buckling of highways, resulting in detours that can significantly affect traffic patterns and cause gridlock. Water usage increases during high heat events which may lead to water shortages. Increased power usage for air conditioning may cause power outages or brownouts. Extreme cold can cause freezing or bursting pipes and lead to flooded or iced-over locations. Power outages may also occur in cold conditions, which can lead to the inability to safely heat homes. Cold weather can cause aging critical infrastructure and systems such as electrical, water and wastewater, and gas systems to fracture and fail. More than half of Philadelphia's water main breaks occur during the coldest months of the year (PWD, 2015). Outcomes where critical infrastructure is severely damaged or taken out-of-service for an extended period would be considered worst-case scenarios for Philadelphia.

4.3.3.3 Past Occurrence

Summer, from June to August, is hot and humid with daily temperatures typically reaching 30 °C (86 °F). On average, the temperature reaches 90°F between 25 and 30 days each year. Heat waves have caused temperatures to reach 36/38 °C (97/100 °F). The highest temperature ever recorded in Philadelphia is 106 °F, on August 7, 1918. In more recent times, record-high temperatures occurred in July 2010 (103°F), July 2011 (103°F), and July 2012 (101°F) (Pennsylvania State, 2021).

From December to February, Philadelphia averages just above freezing (0 °C or 32 °F) but can experience cold spells with temperatures as low as -10/-15 °C (5/14 °F). In late 2013 and early 2014 and 2016, Philadelphia experienced the effects of a polar vortex that allowed temperatures to drop into the single digits for three consecutive days. The coldest days ever recorded in Philadelphia include when the temperature dropped to -11 °F in February 1934, to -7 °F in January 1982, and to -7 °F in January 1984 (Climates to Travel, n.d.). The temperature has not dropped below 0 °F in Philadelphia for a 24-hour period since January 1994 when it reached -5 °F.

4.3.3.4 Future Occurrence

Currently, several extreme cold and hot temperature events occur each year in Philadelphia. Warming trends related to climate change will affect temperature trends in the future, making cold temperature events less likely to occur and hot temperature events more common. Climate warming trends vary by the model used, but all predict an overall increase in temperature. However, emerging research proposes that climate change--particularly extreme warming in the Arctic and the loss of Arctic sea ice—could play a role in mid-latitude weather patterns, including potentially increasing the severity and persistence of extreme weather events, including extreme cold events in the winter months. While average annual and seasonal temperature trends are increasing, our region will still experience extreme cold events, even if they are less frequent. Some research suggests that climate change could make those infrequent cold events more severe and last for longer durations, though additional observation and research is needed. Summer temperature projections suggest that Philadelphia may experience 17 to 52 days above 95°F, and 2 to 16 days above 100°F. These warming trends were projected by the Mayor's Office of Sustainability during a 2015 analysis that tracked annual temperature trends for Philadelphia from 1948 to 2014 (ICF International, 2015).

Using downscaled climate data to update the Mayor's Office of Sustainability projections, projects temperatures in Philadelphia for 2040-2059 and for 2080-2099 are shown in **Table 4-13.**). Daily temperature projections were processed across 4 grid cells over Philadelphia for a moderate future warming scenario (RCP4.5) and the high future warming scenario (RCP8.5) across two sets of climate models. Philadelphia is projected to experience hotter summer temperatures with a dramatic increase in the number of hot days by the end of the century. Summer temperatures are projected to be more than 5°F to 6°F higher in mid-century (2040-2059) compared to the 1950-1999 average, and more than 6°F to almost 12°F hotter by the end of century (2080-2099).

Table 4-13. Historical and projected temperature indicators for Philadelphia

	Observed (1950-1999)	Projections for 2040-2059	Projections for 2080-2099
Average summer temperatures	84.5°F	89.7 - 90.5°F	90.7 - 96.4°F
Average number of days above 95°F	3	22 - 26.4	27.8 - 66.7
Average number of days above 100°F	0	5 - 7.5	6.7 - 30.6
Hottest 7-day average temperature	92°F	97.1 - 97.9°F	97.4 - 102.4°F

As shown in **Figure 4-7** and **Figure 4-8**, the average number of days above 95°F increases from 3 days in 1950-2000 to more than 3 weeks under the lower scenario and almost 4 weeks under the higher scenario by mid-century. By the end of the century, the lower scenario projects almost a full month of days above 95°F and the higher scenario suggests more than 2 months of days above 95°F. There is also a notable increase in the number of days above 100°F, from between 5 to 7 days by mid-century to between 7 to 30 days towards the end of the century.

Figure 4-7. Projected average number of days per year above 95 °F in 2040-2059 and 2080-2099

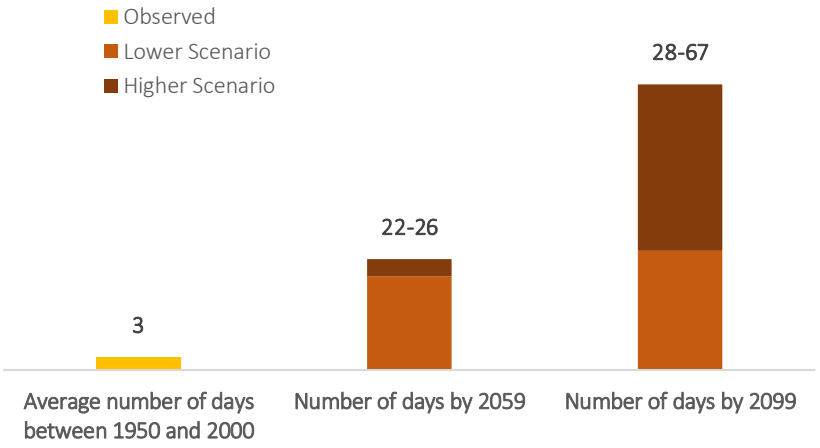
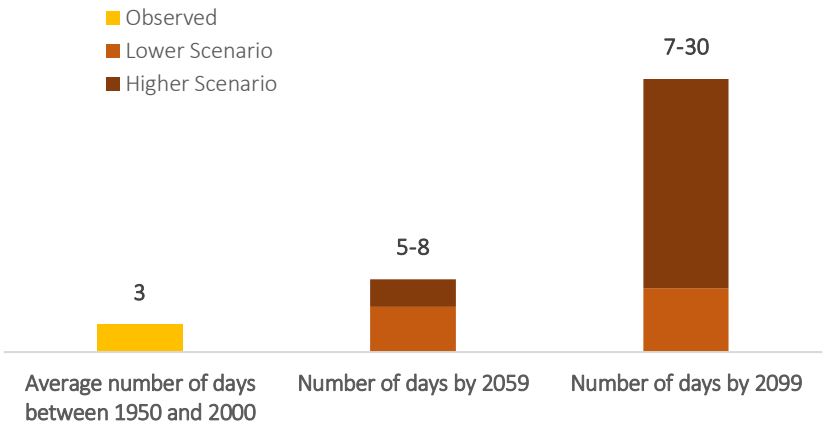


Figure 4-8. Projected average number of days per year above 100°F in 2040-2059 and 2080-2099



4.3.3.5 Vulnerability Assessment

Though extreme temperature events usually persist for short durations, they can cause a range of impacts to humans, animals, and infrastructure. This is especially concerning for Philadelphia where many areas of the city have a high concentration of populations more at-risk, particularly those with little or no access to adequate cooling or heating. According to the CDC, populations most at risk to extreme temperature events include the following (CDC, 2018):

- Individuals ages 65 and older, who are less able to withstand temperatures extremes due to their age, health conditions and limited mobility to access shelters
- Infants and children up to four years of age
- Individuals who are physically ill
- Individuals who have pre-existing conditions (e.g., heart disease or high blood pressure)
- Low-income people who do not have access to proper cooling
- Those living without adequate shelter
- Individuals with limited access to healthcare
- Individuals who may overexert during work or exercise outdoors during extreme heat events

Many Philadelphians meet criteria that make them more susceptible to hazardous effects of extreme temperatures, such as older adults (13.4% of the population), infants/children up to five years of age (6.7%), and those living below the poverty line (23.3%) (U.S. Census Bureau, 2019). Philadelphia's population experiencing homelessness is especially vulnerable. The City of Philadelphia plans for extreme weather and takes into consideration outreach strategies to connect unsheltered individuals to resources and community locations such as cooling or warming centers. In addition, Philadelphia's susceptibility to the urban heat-island effect exacerbates hazardous conditions. Consequently, people living in Philadelphia are at greater risk from the effects of a heat wave than those living in rural or less urbanized areas.

Some parts of Philadelphia's utility infrastructure are susceptible to extreme temperatures, which may overload the power grid or damage pipes that provide water, wastewater, and natural gas. During

extreme cold episodes, frozen or fractured pipes and frozen water intakes can create service interruptions in water, drainage, and gas supply. To limit potential service disruptions, utility providers such as PECO, PGW, and PWD monitor conditions, perform routine maintenance, and address problems as they arise.

Transportation infrastructure can also be impacted by extreme temperatures. During extreme heat, roads and bridges can buckle due to expansion and heat kinks can form on railway lines. The City, PennDOT, SEPTA, Amtrak, and private railroads routinely monitor their infrastructure's condition and perform maintenance and regular inspections. Extreme cold can result in freeze-thaw cycles that cause cracking or potholes in roadway surfaces. This requires the City and PennDOT to conduct regular repairs. Roadway repair from this type of winter damage is the major driver of economic losses related to extreme temperatures in Philadelphia.

Philadelphia's main challenge when faced with extreme temperatures is public health and safety, especially among populations that are more at risk due to increased exposure or intrinsic factors. NOAA's Storm Events Database tracks 'Heat' and 'Extreme Cold/Wind Chill' events along with deaths and injuries with data available for Philadelphia since 1996. From 1996-2021, there were 91 'Heat' events causing 260 deaths and 249 injuries. In the same period, there were 4 'Extreme Cold/Wind Chill' causing 3 deaths and no injuries. The deadliest extreme temperature events were heat events dated: 7/12/1997, 7/4/1999, 8/6/2001, 7/1/2002, and 8/1/2006. The July 4, 1999 heat event killed 58 people and injured 124. When hot weather results in poor air quality, health impacts on those with respiratory conditions are also a concern. In Philadelphia, an estimated 20% of children under age five have Asthma (PHMC, n.d.) and asthma-related hospitalizations are more than five times as likely to impact Black children compared to White children (Philadelphia DPH, 2019).

Figure 4-4 maps the heat index in Philadelphia, which are very high and high in North and West Philadelphia, coinciding with Philadelphia's most socially vulnerable populations (**see 2.3.8 Social Vulnerability**).

More broadly, future trends that result in increased temperatures are generally associated with climate change. Extreme temperatures, particularly hot temperatures that extend through more of the year, can be an underlying factor in increased risk and damage from many of the other natural hazards discussed in this plan. Additionally, longer-term effects on the environment such as disruptions in farming and fisheries could result in other future vulnerabilities that are not yet well quantified.

4.3.4 Flood, Flash Flood, Ice Jam

Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all natural hazards in Pennsylvania. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams (PEMA, 2020).

4.3.4.1 Location and Extent

Pennsylvania is one of the most flood-prone states in the United States. Southeastern Pennsylvania, where Philadelphia is located, is one of the most susceptible regions in the state. Philadelphia is situated between two tidal rivers: the Delaware River and the Schuylkill River. The City experiences tidal effects along its entire eastern border, as well as on the Schuylkill River, Cobbs and Darby Creeks in southwest Philadelphia, Tacony/Frankford Creek, and the Pennypack and Poquessing Creeks in northeast Philadelphia. Other creeks and streams within Philadelphia, like the Wissahickon Creek, are not influenced by tides.

Due to Philadelphia's geographic location and densely urbanized city center, there are multiple types of flooding that can occur within the City. Some of the most damaging floods occur within designated floodplains – the areas along rivers and major creeks – or in areas with limited drainage capacity.

The primary types of flooding that occur in Philadelphia include:

- Riverine (including due to ice jams) and coastal flooding;
- Flash floods; and
- Infrastructure or Urban flooding.

Riverine & Coastal Flooding

Philadelphia's rivers and creeks cause flooding in the City's floodplains. **Riverine flooding** generally results from excessive and/or prolonged rainfall, snowmelt in upstream areas, ice or debris jams in the river channel, or failure of structural flood control devices like dams and levees (See **4.3.14 Dam Failure**). Because Philadelphia is located at the lower end of major watersheds, it is particularly susceptible to flooding when heavy rainfall accumulates as it flows downstream, leading to higher and faster flowing floodwaters. Riverine flooding can result in the following:

- *Overbank flooding:* the increase in volume of water within a river channel and the overflow of water from the channel onto the adjacent floodplain.
- *Flash flooding:* a rapid and extreme flow of high water into a normally dry area, or a rapid rise in stream or creek elevation above a predetermined flood level, beginning within six hours of storm event.

Although Philadelphia is roughly 90 miles from the open ocean, the City is situated on two rivers that are influenced by the tides, so the City experiences both riverine and coastal flooding. The primary difference between riverine and coastal flooding has to do with the source of the floodwaters. The tidal Delaware River and its tributaries are susceptible to **coastal flooding** because they are impacted by ocean tides and storm surge. Coastal flooding can result from high tides and/or storm surge, as defined by the National Oceanic and Atmospheric Administration. High tides on the Delaware River and Schuylkill River can also contribute to basement backups. See **4.3.5 Hurricane, Tropical Storm, Nor'easter** for more information on coastal flooding and storm surge.

If rainfall-induced riverine flooding and tide or storm surge-induced coastal flooding occur simultaneously, this is referred to as **compound flooding**.

Flash Floods

Flash floods are a rapid and extreme flow of rain or high water into a normally dry area, or rapid water level rise in a stream or creek above a predetermined flood level. Flash floods occur because of the rapid accumulation and release of runoff waters caused by heavy rainfall, cloudbursts, landslides, or the sudden break-up of an ice jam. Ongoing flooding can intensify into flash flooding in cases where intense rainfall results in a rapid surge of rising floodwaters. Densely populated areas have a high risk for flash floods, as the construction of buildings, highways, driveways, and parking lots increases runoff by reducing the amount of rain absorbed by the ground. When available ground surfaces become saturated, existing groundwater levels may increase, and seep through the floors and walls of basements. Flash flooding may also lead to localized, overwhelmed sewer systems and basement backups though basement fixtures and drains.

Infrastructure or Urban Flooding

Philadelphia's sewer system was originally designed and built in the late 1800s and early 1900s. Since then, the amount of impervious area in the city has drastically increased. Impervious area is defined as a surface that water cannot penetrate, like traditional street paving material, roofs, sidewalks and parking lots. Today, over half of the City is considered impervious (phillywatersheds.org). Rain that used to soak into the ground now quickly runs across impervious surfaces and into the sewer system. When large amounts of precipitation fall over a small area in a short period of time, this can overwhelm the sewer system and caused **localized surface flooding**. Additionally, groundwater infiltration can be a factor that increases flooding risks. When the ground becomes saturated, groundwater may seep through the floors and walls of building basements.

Rising sea levels are expected to increase the frequency and severity of flooding in Philadelphia. Sea Level Rise will cause new parts of the city to be permanently inundated due to an increase in daily tide levels, and extreme storm events on top of sea level rise will cause more areas to be temporarily inundated as storm surges reach farther inland with greater depths.

The most damaging floods in Philadelphia occur in the designated floodplains, though flooding can occur in areas outside of designated floodplains. **Figure 4-9** locates Philadelphia's designated 100-year (Flood Zones A and AE, 1% Annual Chance) and 500-year (Flood Zone X, 0.2% Annual Chance) floodplains. **Figure 4-10** provides more detail about the type of flooding and where it occurs in Philadelphia.

Anywhere that it can rain it can flood. Flash flooding can happen throughout the City. Additionally, Philadelphia has aging infrastructure and many homes with basements. Groundwater and basement backups and a concern throughout the City as well.

Riverine flooding is location specific and in Philadelphia present along creeks that weave through neighborhoods and along the larger Schuylkill and Delaware Rivers. Neighborhoods throughout the City are impacted by riverine flooding, see **Table 4-48. *Flooding Concerns by Planning District*** for impacts throughout the City. Two areas in Philadelphia repeatedly experience catastrophic flooding: Eastwick, in southwest Philadelphia, and Manayunk, in northwest Philadelphia. Both of these neighborhoods and have many priorities with Repetitive Losses tracked by FEMA. Eastwick was constructed on the Tinicum marsh, the confluence of the Schuylkill, Darby Creek, and Cobbs Creek (PRA, 2019). From the early 1600s onward, the marsh was diked, dammed, and – starting in 1920 – filled with hydraulic fill, a combination of silt, solid waste, sand gravel, and incinerator ash. Changes to the marsh disrupted the natural flow of water and reduced Eastwick's ability to handle flood waters. When Darby and Cobbs Creek watersheds

are overwhelmed, water spills into the Lower Schuylkill Watershed, causing floodwaters to flow through Eastwick to Mingo Creek to the Schuylkill River. Flooding can be exacerbated in Eastwick due to the potential compound effects of flooding from both the tidal Delaware River and from the Schuylkill, Darby Creek, and Cobbs Creek.

Manayunk is located along the banks of the Schuylkill River and developed into a water-powered, industrial hub in the 19th Century (PA SHPO, 2020). Industrial, commercial, and residential buildings are located in a narrow floodplain that extends from the river to properties flanking Main Street. Flooding in Manayunk along Main Street is the result of the rising Schuylkill River which can be exacerbated by severe storms. Some areas of Roxborough are typically affected simultaneously with Manayunk, also due to being adjacent to the Schuylkill River, at an even lower elevation than Main Street.

Central Philadelphia saw significant flooding in 2021 from the remnants of Hurricane Ida. Flooding along the Schuylkill River was above flood stage which caused flooding along parts of I-76, I-676, and 30th Street Station. Additional residential and commercial properties in Central Philadelphia were impacted and the flooding was recognized with a Presidential Disaster Declaration.

Northwest Philadelphia neighborhoods also experience localized flash flooding. This flash flooding is caused by a combination of natural conditions and human development that exacerbated and concentrated stormwater run-off. Natural conditions that contribute to flooding are steep slopes and historic stream beds. Development exacerbated flooding by filling in stream beds and encapsulating streams through the development of the sewer system starting in the late 1800's. Development of the commuter rail in the early 1900's created infrastructure and lowered roadway underpasses which contributed to flash flood conditions.

South Philadelphia can be affected primarily when the two river bodies that lie on other side – the Schuylkill and Delaware Rivers – are at high tide during an extreme storm event, which affects the ability of the outfalls to drain effectively by gravity as designed.

Figure 4-9. FEMA Effective Flood Zones

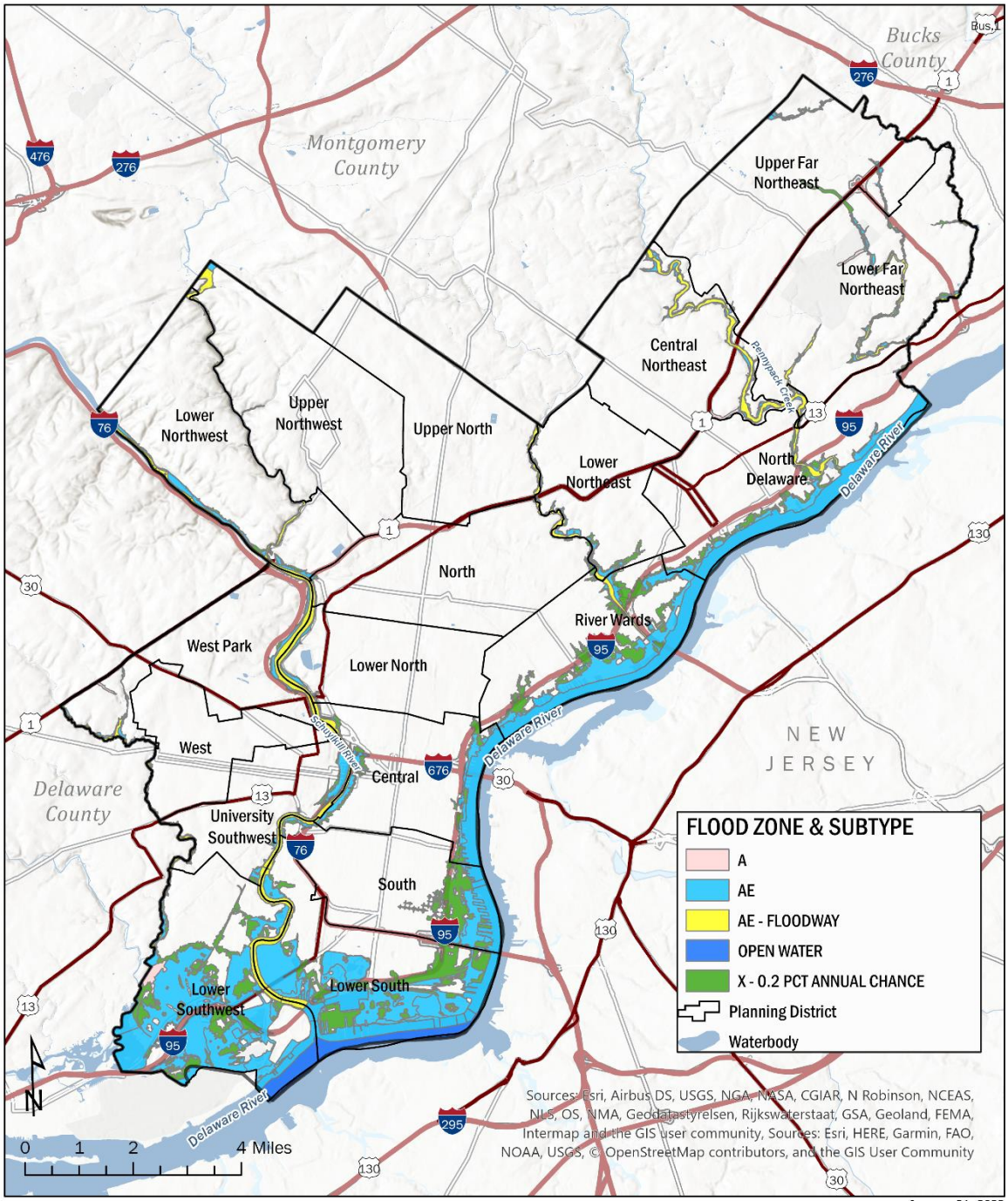


Figure 4-10. Where Philadelphia Floods Infographic

Source: Flood Risk Management Task Force, 2017

4.3.4.2 Range of Magnitude

The severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the time of year, the coverage area of the storm, and the land's ability to absorb the amount of water. The National Weather Service (NWS) issues several different flood products, listed below, depending on the degree of flooding that is expected.

Table 4-14. NWS Flood Products

National Weather Service Product	Criteria
Flood Advisory	Flood event warrants notification but is less urgent than a warning. Issued for conditions that may result in nuisance flooding and/or streams just out of their banks. Issued when rain will cause flooding of streets and low-lying areas in both urban and rural settings. May be upgraded to a Flash Flood Warning if flooding worsens and poses a threat to life and property. Forecaster confidence is at least 80 percent.
Flood Watch	Issued 6-48 hours before an event where conditions are favorable for flooding. Usually associated with non-convective events. Indicates current or developing hydrologic conditions are favorable for flooding in and close to the watch area, but the occurrence is neither certain or imminent. Forecaster confidence is approximately 50 percent.
Flood Warning	Flooding is imminent or occurring. May be issued for river and/or areal (overland) flooding. Caused from either a convective or non-convective event. There is a serious risk to life and property. Can be issued several hours before flooding occurs. Forecaster confidence is at least 80 percent.
Flash Flood Watch	Issued 6-48 hours before an event where conditions are favorable for rapidly rising water to pose an immediate hazard to life and property. Usually associated with quick-hitting convective rain events. Indicates current or developing hydrologic conditions are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent. Forecaster confidence is approximately 50 percent.
Flash Flood Warning	Rapidly rising water poses an immediate threat to life and property. This warning may also be issued for ice jams and dam breaks. If flooding is expected to persist for more than several hours, the product may be converted to a Flood Warning.
Flash Flood Emergency	Rapidly rising flood waters pose an immediate threat to life and property, and a state of emergency that may include evacuation orders has been declared by emergency managers in affected area.
Coastal Flood Advisory	Issued for minor tidal flooding. Impacts include nuisance flooding across roads or low-lying areas with potential for isolated property damage. Generally non-life-threatening.
Coastal Flood Watch	Coastal flooding with significant impacts (moderate or major coastal flooding) may occur within the next 12-48 hours. Inundation of people, buildings and coastal structures on land at locations that, under normal conditions, are above the level of high tide is possible.
Coastal Flood Warning	Coastal flooding with significant impacts is occurring, imminent, or highly likely within the next 24 hours. Issued for moderate or severe tidal flooding. Impacts for moderate flooding range from flooded roads to property damage. Severe flooding impacts include widespread flooding with significant property damage. Both moderate and severe tidal flooding can be life-threatening.

National Weather Service Product	Criteria
Storm Surge	There is possibility of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area generally within 48 hours in association with a tropical cyclone (may be issued in conjunction with a tropical storm watch/warning or hurricane watch/warning).
Storm Surge Warning	There is a danger of life-threatening inundation from rising water moving inland from the shoreline somewhere within the specified area, generally within 36 hours, in association with a tropical cyclone (may be issued in conjunction with a tropical storm watch/warning or hurricane watch/warning).

The NWS Advanced Hydrological Prediction Service also issues river flooding guidance for rainfall events based on river flood gauge readings. Residents can subscribe for e-mails or text messages by the U.S. Geological Survey WaterAlert Services when real-time data exceeds certain thresholds. The flood stage categories are detailed in the table below.

Table 4-15. Flood stage based on river flood gauge readings.

Flood Stage	Description
Low Stage	At or below the expected water level. No flooding expected.
Action Stage	The stage which, when reached by a rising stream or river, represents the level where the NWS or a partner/user needs to take some type of mitigation action in preparation for possible significant hydrologic activity.
Flood Stage	An established gage height for a given location above which a rise in water surface level begins to create a hazard to lives, property, or commerce. The issuance of flood advisories or warnings is linked to flood stage.
Moderate Stage	The stage at which there is some inundation of structures and roads near the river or stream. Some evacuations of people and/or transfer of property to higher elevations may be necessary.
Major Flood Stage	The stage at which there is extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations are necessary.

Flooding can have a wide range of impacts on natural and human environment, including erosion, debris flow, contaminated groundwater, and mold and fungi.

The worst case scenario for the City would be heavy rainfall and/or rapid snowmelt in combination with high storm surge levels on the tidal Delaware River causing catastrophic flooding along all creeks and major rivers in the metropolitan area. Heavy rainfall or snow melt could occur upstream of Philadelphia. Repetitive loss properties in Eastwick and Manayunk that have experienced repeated flooding would be catastrophically impacted and homes and businesses in South Philadelphia that have experienced basement flooding would have flooding on the first floor. Flash floods would endanger individuals and vehicles, necessitating evacuations and difficult rescues in high water with fast currents. Wastewater system would be overwhelmed and cause sewage to spill into creeks, rivers, and back flow into homes without a backflow system. Flooding would close roadways for several days along I-95, the Schuylkill Expressway, Kelly and Lincoln Drives, and likely result in mudslides and roadway damage. Regional rail and other transit infrastructure would be damaged and result in delays and closures. The Philadelphia International Airport would likely experience significant delays or close for a period of time.

4.3.4.3 Past Occurrence

As the most common hazard for Philadelphia, flooding is a near routine occurrence for some regions of the city. Numerous instances happen throughout the year, each causing various levels of damage. The Schuylkill often has high crests, with the top ten crests averaging between 14 and 15 feet. The following table summarizes significant flood events and their estimated property damage from 1996-2022.

Table 4-16. Summary of Significant Flood Events and Estimated Property Damage in Philadelphia (1996-2022)

Date	Estimated Property Damage	Description
1/19/1996	$3 million	The combination of snowmelt from the previous week's two storms, unseasonably warm temperatures, and an addition 1-2" rain caused flash flooding of almost every small stream and significant roadway flooding the afternoon and early evening hours on the 19th. Major flooding of larger streams and rivers in Pennsylvania continued through the 21st. The flooding resulted in three deaths, all in Montgomery County, three injuries and about $50 million dollars in property damage. In Philadelphia, flooding along the Schuylkill River caused the worst damage, especially in Manayunk. Main Street in Manayunk was under 2-3' of water with up to 5' of water in basements. Kelly, West River, and Lincoln Drives were all closed due to river flooding. A mudslide compounded problems along Kelly Drive.
9/16/1999	$4.2 million	Hurricane Floyd battered Eastern Pennsylvania, especially southeast sections around Philadelphia, on September 16th and brought with it torrential and in some places record-breaking rains and damaging winds. The hurricane caused widespread flash flooding as storm totals from 8-12" in the Greater Philadelphia metropolitan area. Six people died directly from the hurricane – four drownings and two persons were hit by trees. The hurricane also indirectly contributed to death of about seven other people and forty people were seriously injured. About 7,000 people were evacuated from Delaware and Bucks Counties. Preliminary damage estimate was $60 million. Damage to infrastructure was around $20 million and hundreds of roads and dozens of bridges were damaged or closed. About 200 houses were seriously damaged or destroyed and another 1,000 were damaged but still inhabitable. Over 10,000 homes were flooded. Over 500 apartments were also damaged as were over 100 businesses. Floods affected fourteen regional rail service lines and many were closed or damaged. About 501,000 and businesses lost power – 412,000 in the PECO service area in SE Pennsylvania, the second worst outage in the company's history. Sewage treatment plants were so overwhelmed with runoff that many spewed raw sewage into the streams and rivers. In Philadelphia, the worst flooding occurred along Cobbs Creek along the Philadelphia/Delaware County border. About 1,000 people were evacuated and 3,500 homes were flooded. In Manayunk, flooding covered Main Street. Four hundred people were stranded at the Radisson Hotel near the Philadelphia International Airport. Tidal flooding along the Delaware River also caused some moderate flooding in low-lying areas on the river.

Date	Estimated Property Damage	Description
8/1/2004	$18 million	Thunderstorms with torrential downpour caused widespread creek, basement, and poor drainage flooding in Philadelphia. Around 400 homes were damaged, and 18 businesses suffered major damage. Nearly 200 people were evacuated, mainly from Kensington. Emergency services responded to 1,075 incidents mainly rescuing people from their homes or vehicles. There was a major disruption in nearly every transportation system the next morning. The eastbound lanes of the Schuylkill Expressway at the Conshohocken Curve were blocked by over four feet of mud. Municipal property damage was estimated at $15.3 million. PECO reported that 35,000 homes and businesses lost power in their service area. Homes and businesses were flooded in the Germantown, Kensington, Mount Airy, North Philadelphia, Overbrook and Roxborough sections of the city. In some instances, entire basements and parts of the first floor were flooded. In East Mount Airy, water and gas service were shut to about 100 homes after a huge sink hole formed. The retaining wall at the Roosevelt Middle School collapsed and blocked one road. Flooding waters along Cobbs Creek (bordering Delaware County) contained raw sewage. A couple of fire engines were stuck in its flood waters. In Chestnut Hill, the macadam was stripped from a couple of roads. Extensive damage occurred within Fairmount Park (about an estimated $5 million dollars) as trails, park vehicles and Forbidden Drive's banks were swept away. Two bridges over the Cresheim Creek were badly damaged.
9/28/2004	$2 million	The remnants of Hurricane Jeanne interacting with two frontal boundaries in the region caused torrential downpours to occur during the late afternoon and evening of the 28th. Doppler Radar storm total estimates averaged between 4-8” with the most rain in the northwest part of Philadelphia. Widespread poor drainage and creek flooding occurred throughout the city. All roads near creeks flooded. A woman drowned when she was swept off her feet while waiting to board a SEPTA bus in the East Falls section of the city. The flood waters carried her downhill and she became trapped her under a parked pickup truck where in spite of the efforts of six people, she drowned. The heavy rain also caused several abandoned buildings to collapse.
6/28/2006	$1 million	Several days of heavy rain throughout the Delaware and Schuylkill River Basins culminated with flooding along the Schuylkill River. During bursts of heavier rain, flash flooding occurred on the smaller streams and exacerbated the ongoing flooding on the larger rivers. Event totals in Philadelphia averaged 3-4”. Flooding in Philadelphia was concentrated along the Schuylkill River and affected the city's Manayunk and East Falls sections. In Manayunk, about 70 families were evacuated as rowhouses flooded on Main Street. Many businesses were also flooded. Flooding was described as the worst since Floyd in September of 1999. The eastbound Schuylkill Expressway were closed at South Street and sections of Interstate 95 were closed at Penn's Landing. In the East Falls section, sandbagging was used to prevent the spread of flood waters on Kelly Drive and

Date	Estimated Property Damage	Description
		Midvale Avenue. Farther downstream, the Schuylkill River flooded Boathouse Row.
8/9/2009	$25,000	Heavy rain caused flooding along the Green Tree Run for the second consecutive Sunday on the 9th. Many vehicles were caught in the intersection of Eva Street and Gettsburg Avenue when it flooded. Debris accumulated near homes and erosion occurred along Gettsburg Avenue. Along Shawmont Avenue, Green Tree Run blew away three feet of stream bed. Elsewhere within Philadelphia, the Frankford Creek at Castor Avenue also flooded. Doppler Radar storm total estimates reached between 1-2" within Philadelphia.
10/1/2010	$50,000	A series of low-pressure systems that moved north along a slowly moving cold front brought heavy rain into Eastern Pennsylvania on September 30th and October 1st. Event precipitation totals average 5-10" with the highest amounts in the Philadelphia western suburbs. The heavy rain and flooding forced residents to evacuate in Manayunk and East Falls along the Schuylkill River. Main Street and Shurs Lane were under water in Manayunk. One restaurant was flooded. The Manayunk Dragon Boat Racing Team saw its dock and five boats swept away in the Schuylkill River. Six businesses and 68 residences suffered minor flood damage in Philadelphia with most of the damage occurring in Manayunk (Schuylkill River) and Eastwick (Cobbs Creek). Most of it was basement flooding. One apartment complex was evacuated. The building was elevated so the apartments did not sustain any damage, however approximately 20 of the ground level garages flooded.
8/28/2011	$100,000	Irene produced heavy flooding rain, tropical storm force wind gusts with hundreds of thousands of outages, moderate tidal flooding along the Delaware River and one flooding-related death in Eastern Pennsylvania over the weekend of August 27th and 28th. There were two direct storm caused deaths: a wind related death in Monroe County and a drowning in Montgomery County. The Schuylkill River flooded businesses in Manayunk. Preliminary damage estimates were around six million dollars. SEPTA halted all commuter rail service during the evening of the 27th as multiple tornado warnings were issued. Three large shelters on the evening of August 27th in Philadelphia. The Philadelphia International Airport closed at 1030 p.m. EDT on the 27th and reopened on Monday the 29th. In Philadelphia, the storm left thousands without power. More than 500 trees fell in the city. Lincoln Drive was flooded by the Wissahickon Creek. The heavy rain caused the collapse of seven buildings and damage to thirteen other structures within the city.
7/23/2013	$10,000	On July 23, 2013, slow-moving thunderstorms produced torrential rain and some wind damage. Storm total rainfall measurements ranged between 2-7" across eastern Pennsylvania. Run-off from waves of heavy precipitation resulted in areas of poor drainage and roadway flooding, with some creeks and streams also overflowing their banks. Heavy rain fell through the night of the 22nd and caused urban and poor drainage flash flooding. Several areas of significant flooding were reported on

Date	Estimated Property Damage	Description
		the Schuylkill Expressway. Significant flooding was also reported on Broad Street in South Philadelphia under Interstate 95, with vehicles trapped. The water level was reported to be nearly up to the car windows. Deep standing water occurred on Interstate 95. The heavy rain flooded sections of the 8th and Market PATCO Commuter rail line stop. In addition, the combination of the heavy rain and higher than normal astronomical tides caused minor tidal flooding along the tidal Delaware River.
4/30/2014	$1 million	Event precipitation totals averaged from 3-6", with the highest amounts in the Philadelphia suburbs. This caused poor drainage and creek and river flooding that reached major levels around the Philadelphia Metropolitan Area. Over 1,000 people had to be evacuated from flooded homes and apartments. The American Red Cross opened several shelters and comfort stations in Delaware and Chester Counties. Numerous water rescues and road closures occurred. In Manayunk, three people were rescued from the top of a SEPTA bus as Main Street was severely flooded. Residents were evacuated from an apartment complex on the river. The worst damage to city structures occurred at the Water Works facility and to the Gorgas Bridge on Forbidden Drive. About thirty residents on Venice Island Lofts suffered heavy apartment flooding and about thirty vehicles were towed. The paper factory on Venice Island was also damaged. The Manayunk Brewery suffered significant damage and was closed for several weeks as were some of its neighboring businesses. The Green Towne Montessori School was also heavily flooded. The water department responded to over 100 reports of residential basement flooding. Regional commuter rail lines in and around Philadelphia had major delays. SEPTA service was suspended through May 1st between Manayunk and Norristown. Road closures included Martin Luther King, Kelly and Lincoln Drives.
08/2020	Unknown	Heavy rainfall from Tropical Storm Isaias contributed to flooding throughout Philadelphia. A total of 4.16 inches of rainfall was reported at the Philadelphia International Airport. The Delaware river reached minor flood stage, cresting at 9.13 feet. The Schuylkill River reached moderate flood stage, cresting at 12.28 feet. Significant flooding to homes and businesses in Southeast and Northwest Philadelphia resulted, with storm impacts that necessitated emergency evacuations and temporary sheltering.
09/01/2021	TBD	Heavy rainfall from the remnants of Tropical Storm Ida results in flooding to homes and businesses in several areas of Philadelphia including Northwest Philadelphia, South Philadelphia, and Center City and significant impacts to infrastructure. A total of 3.97 to 5.69 inches of rain fell in certain parts of the city within a 12-hour period. Of the six waterways in Philadelphia with water gages, both the Schuylkill River and Pennypack Creek significantly exceeded major flood stage with the Schuylkill River reaching 16.35 feet and the Pennypack Creek reaching 14.57 feet. Impacts caused numerous emergency evacuations and temporary sheltering and necessitated the closure of many local roads and major roadways including I-676.

Date	Estimated Property Damage	Description
		A Disaster Declaration was received as a result of this storm. Residents and businesses are still recovering at the time of this plan update. Total costs have not yet been calculated.

Source: NOAA & OEM

The U.S. Congress, through the National Flood Insurance Act of 1968, created the National Flood Insurance Program (NFIP) to enable property owners in participating communities to purchase federally backed flood insurance. To maintain NFIP eligibility, Philadelphia adopted floodplain management ordinances to regulate proposed development in floodplains and designated a local Floodplain Manager (Licenses & Inspections) to enforce these ordinances. Philadelphia's ordinances ensure that new construction better withstands flooding and does not exacerbate existing flood hazards.

Philadelphia has effective Flood Insurance Rate Maps (FIRMs) that depict floodways, the 1-percent annual chance flood zones, and the 0.2-percent annual chance flood zones. The FIRM is an older floodplain map with most of the City on panels effective January 17, 2007. The southern portion of the tidal Delaware is part of a coastal study effective November 18, 2015. Flood Risk Products are available for the coastal studies effective in 2015 but are not available for the 2007 effective panels. Flood Risk Products include additional analysis that FEMA provides with many newer FIRM studies including a Flood Risk Map, Flood Risk Report, and Flood Risk Database. The exact mapping data available with Flood Risk Products varies with the scope of the study and can include Water Surface Elevation Grids (WSEL) and depth grids.

NFIP also collects information on insured structures, including the number and location of flood insurance policies, number of claims per insured property, dollar value of each claim, and repetitive loss claims. NFIP Flood insurance statistics for Philadelphia, according to FEMA as of 12/20/21, are as follows:

- Number of policies: 2,935
- Total premium coverage: $744,271,200

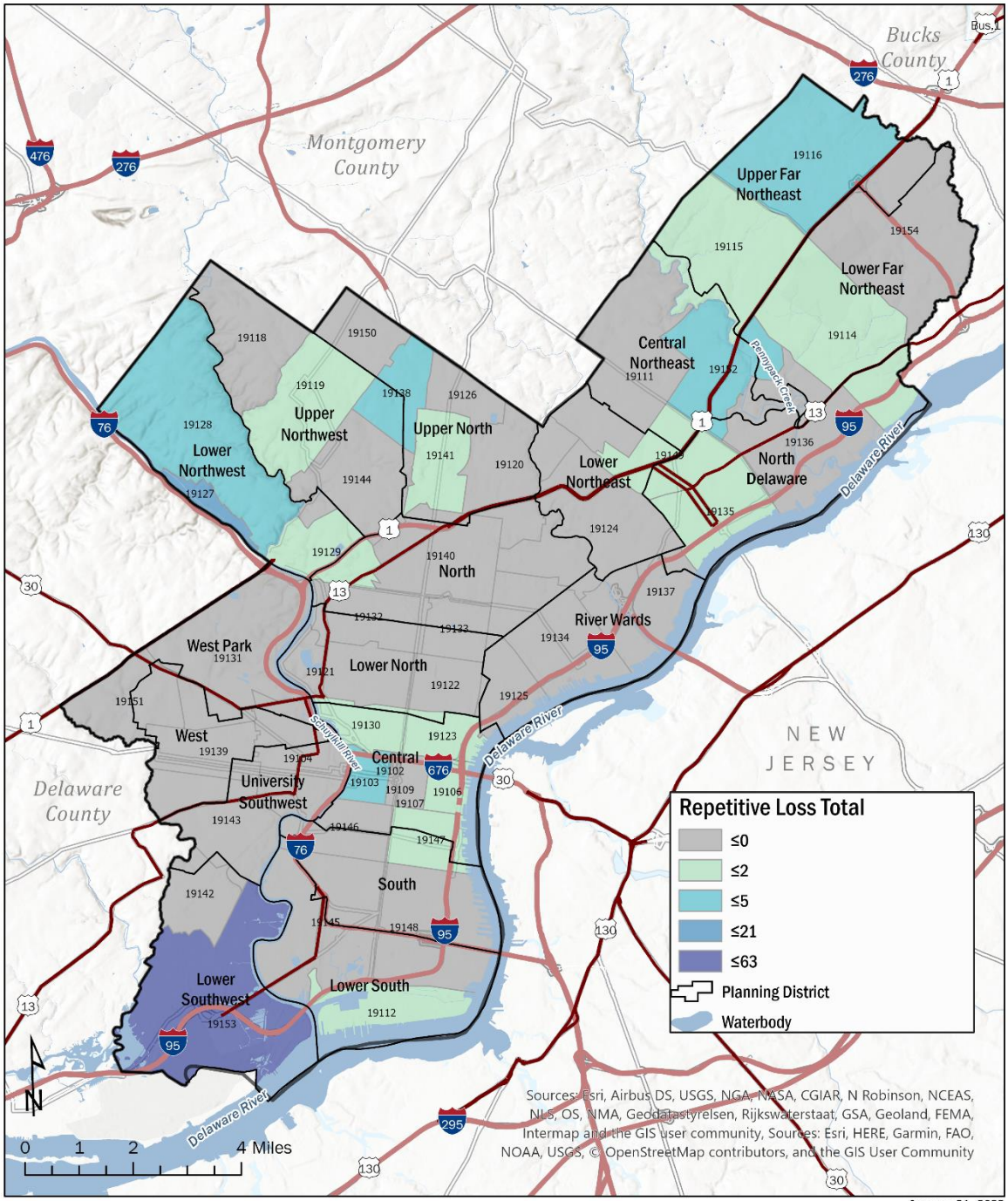
The NFIP also collects information on properties that frequently experience flooding. **Repetitive loss properties** are structures insured under the NFIP which have had at least two paid flood losses of more than $1,000 over any ten-year period since 1978. According to PEMA data pulled in November 2021, there are 126 repetitive loss properties in Philadelphia. The information supporting the table below can be utilized by the City to target mitigation. The vast majority of the properties, 109 properties, in the table have had less than $150,000 in claims each. In this group, 2 to 9 claims per property totaled between $3,100 to $137,000 per property. Only 4 of the properties have claims totaling over one million dollars per property with 30 claims between 4 buildings. The City could target mitigation for buildings with high value claims and a high volume of claims to impact the long-term resiliency of NFIP insurance costs and the safety of people living and working in theses flood prone properties.

Table 4-17. Summary of RL Properties in Philadelphia (PEMA, November 2021)

	RL Properties	Sum of Losses	Sum of Cumulative Building Payment	Sum of Cumulative Contents Payment	Sum of Total Paid
2-4 FAMILY	2	4	$138,430	$0	$138,430
ASSMD CONDO	4	27	$3,917,504	$2,626,138	$6,543,643
BUSI-NONRES	6	27	$2,383,778	$686,996	$3,070,774
OTHER RESID	7	17	$1,369,404	$16,877	$1,386,282
OTHR-NONRES	16	54	$1,325,857	$747,274	$2,073,132
SINGLE FMLY	91	282	$3,588,773	$900,267	$4,489,041
Grand Total	**126**	**411**	**$12,723,749**	**$4,977,554**	**$17,701,303**

NFIP data helps indicate the location of potential flood events. **Figure 4-11** shows the location of RL Properties by zip code. Repetitive loss properties are a high priority for flood mitigation for federal, state, and local mitigation partners. More precise information is available to City, State and Federal officials, but the information is generalized in public facing plans to protect the privacy of property owners.

Figure 4-11. NFIP Repetitive Loss Properties by Zip Code



4.3.4.4 Future Occurrence

The probability of future flooding in Philadelphia is high, especially for communities located in the 1.0-percent annual chance zone (see **Figure 4-9**). Repetitive loss neighborhoods, such as Eastwick and Manayunk, will likely continue to experience significant flooding.

The 2021 Pennsylvania Climate Impacts Assessment 2021 states: "Sea level rise has, and will continue, to inundate Pennsylvania with flooding. These damages can cost Pennsylvania billions of dollars but will center around Philadelphia". More specifically the same report states, "In the Delaware River Basin, some 147,000 jobs and $20.4 billion in residential property values could be affected by the combined impact of sea level rise, storm surge and flooding". SLR will impact the tidal Delaware and Schuylkill Rivers both increasing flooding and salinity levels in the water. Saltier water will impact the ecology of these rivers, as well as industry that depends on fresh water in these rivers (PA DEP, 2021).

The probability of flooding increases with the compounding effects of climate change. Several circumstances resulting from climate change — such as higher sea levels and increased rainfall – could increase the risk of flooding to the City. Higher sea levels could cause Philadelphia's Delaware and Schuylkill rivers to rise (despite being 90 miles inland from the mouth of the Delaware Bay). SLR impacts will begin with nuisance flooding from high tide and smaller rain events and continue until low lying areas of the City are permanently inundated with water. There is a limit to the ability to engineer a solution to SLR. Some areas will be able to plan mitigation measures that continue to provide safe access and use of properties and some properties may need to be abandoned because the cost of repeated and/or permanent flooding is too high to mitigate.

0shows the projections for SLR by scenario type for Philadelphia; 4' of sea level rise would be projected between 2060 and 2100 for the intermediate to high scenarios. **Figure 4-12** maps census blocks of losses due to 4' of sea level rise. 4' feet of sea level rise by 2100 aligns with the scenarios used for coastal flood risk assessment in the City's *Growing Stronger* document and is considered an intermediate projection according to NOAA Local Scenario Sea Level Rise Viewer 2017 Projections.

Table 4-18. NOAA Local Scenario Sea Level Rise Viewer 2017 Projections

Year	Intermediate Low	Intermediate	Intermediate High	High
2020	0.39 feet	0.56 feet	0.72 feet	0.85 feet
2040	0.82 feet	1.21 feet	1.67 feet	2.10 feet
2060	1.21 feet	2.07 feet	2.89 feet	3.94 feet
2080	1.64 feet	3.08 feet	4.49 feet	6.07 feet
2100	1.94 feet	4.20 feet	6.40 feet	9.02 feet

The Hazus run in January 2022 for 4' sea level rise resulted in $685 million in projected building loss and a projected economic loss totaling $1 billion. The model estimates 9,645 people would be displaced and 767 would need to seek shelter. This information is provided to complement data on Hazus runs for Flood and Hurricane. While the footprint of SLR is smaller than the area impacted by a flood or hurricane, it is permanent and represents a different type of loss.

An increase in temperature, as local climate data projects, will result in more frequent and intense rainfall events. Total annual precipitation is projected to increase from 44" between 1950-1999 to about 47-49" by mid-century, and 49-50" towards the end of the century. All seasons are projected to experience increasingly wetter futures. The largest three-day winter precipitation event is projected to

get heavier over the coming century from a 2" event in 1950-1999 to a 2.5-2.7" event in mid-century and a 3.0-3.3" event towards the end of the century. As temperatures warm, precipitation will shift from snow to rain/mixed conditions. Daily precipitation projections were processed across 4 grid cells over Philadelphia for a moderate future warming scenario (RCP4.5) and the high future warming scenario (RCP8.5) across two sets of climate models.

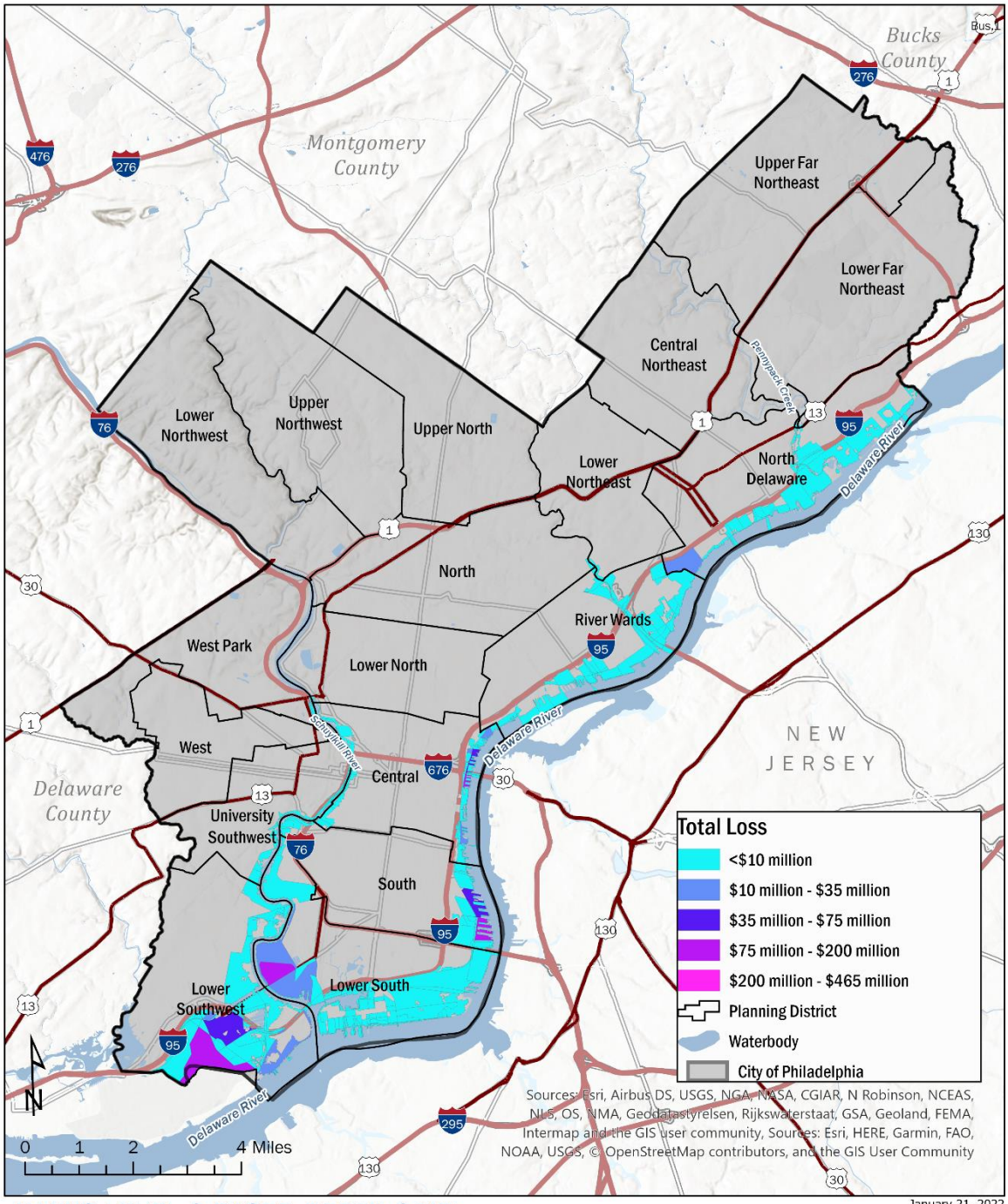
Table 4-19. Historical and projected precipitation indicators for Philadelphia

	Observed (1950-1999)	Projections for 2040-2059	Projections for 2080-2099
Average annual precipitation (inches)	44.0	47.3 - 48.1	49.2 - 49.9
Winter precipitation (inches)*	9.9	11.0 - 11.4	11.7 - 12.6
Largest 3-day precipitation event - Winter (inches)	2.0	2.5 - 2.7	3.0 - 3.3
Spring precipitation (inches)	11.4	11.9 - 11.5	11.9 - 12.3
Summer precipitation (inches)	12.2	13.1 - 13.3	13.3 – 14.0
Fall precipitation (inches)	10.5	10.9 - 11.3	11.0 - 11.3

*One inch of winter precipitation equates to one inch of rain, two inches of sleet, or 13 inches of snow

Together, sea level rise and the anticipated increase in precipitation are expected to increase the severity and chance of catastrophic flooding in Philadelphia.

Figure 4-12. Four-foot Sea Level Rise Flood Total Loss by Census Block



HAZUS LEVEL 2-BASED DEPTH GRID:
PWD 4FT SEA LEVEL RISE FLOOD TOTAL LOSS
BY CENSUS BLOCK
CITY OF PHILADELPHIA

January 21, 2022

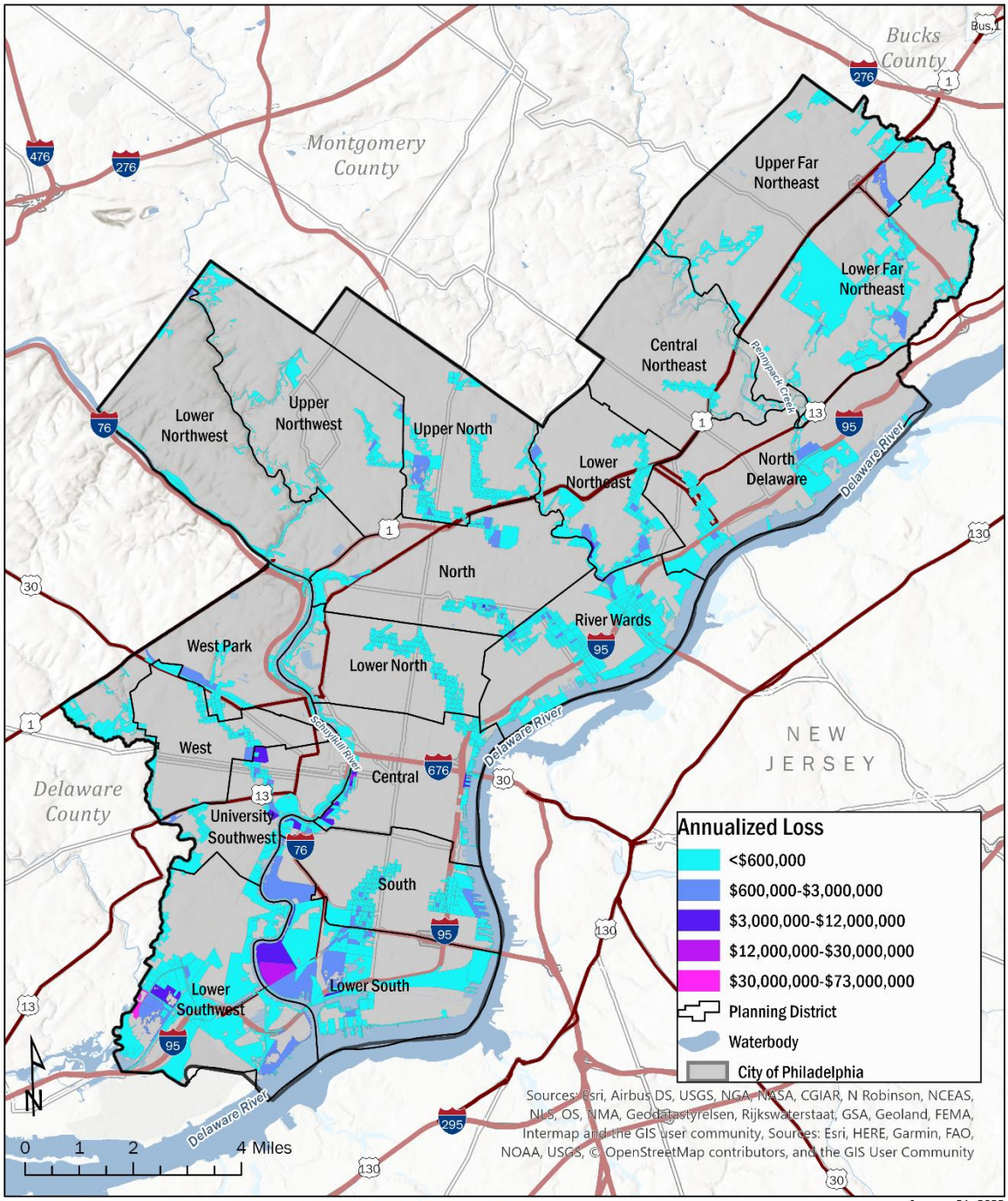
Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

4.3.4.5 Vulnerability Assessment

Flooding is a significant concern for Philadelphia. To assess vulnerability, this analysis includes potential losses for 100-year mean return period for flood events. Office of Property Assessment (OPA) tax account data from 2021 was used to upgrade the Hazus aggregated data tables, including building counts, square footage, and exposure by census block; City GIS data was also incorporated for critical facilities. For capital stock loss estimates, OPA building market values were used in addition to building replacement costs, as this was the best currently available source of data. See **4.4.3 Potential Loss Estimates Methodology** for addition information on the Hazus methodology. A Hazus depth grid was created based on the Base Flood Elevation; the depth of water in this model varies based on ground level and the projected Base Flood Elevation throughout the City study area.

Hazus was run in two ways; a Hazus Level 1 analysis was complete with default data (**Figure 4-13**) and a Level 2 analysis was completed with local OPA building data (**Figure 4-14**). The difference shows more accurate loss information for areas of the City that one would expect to be impacted by flooding. The areas with the highest potential loss include several blocks on the west end of Center City adjacent to the Schuylkill River, as well as blocks in Manayunk along the Schuylkill River. In addition, the Navy Yard in South Philadelphia and areas in Southwest and Northeast Philadelphia could experience significant economic loss during a 1-percent annual chance flood event. The maps show losses in slightly different ways with **Figure 4-13** displaying annualized losses from Hazus which is the value of damages or losses expected each year due 1-percent annual flood events. **Figure 4-14** shows total losses from the flood event modeled in Hazus. It is important to note that the FEMA 1-percent annual flood events is based on past occurrences which will be /already are occurring more frequent due to climate change.

Figure 4-13. Hazus Level 1 Annualized Loss by Census Block

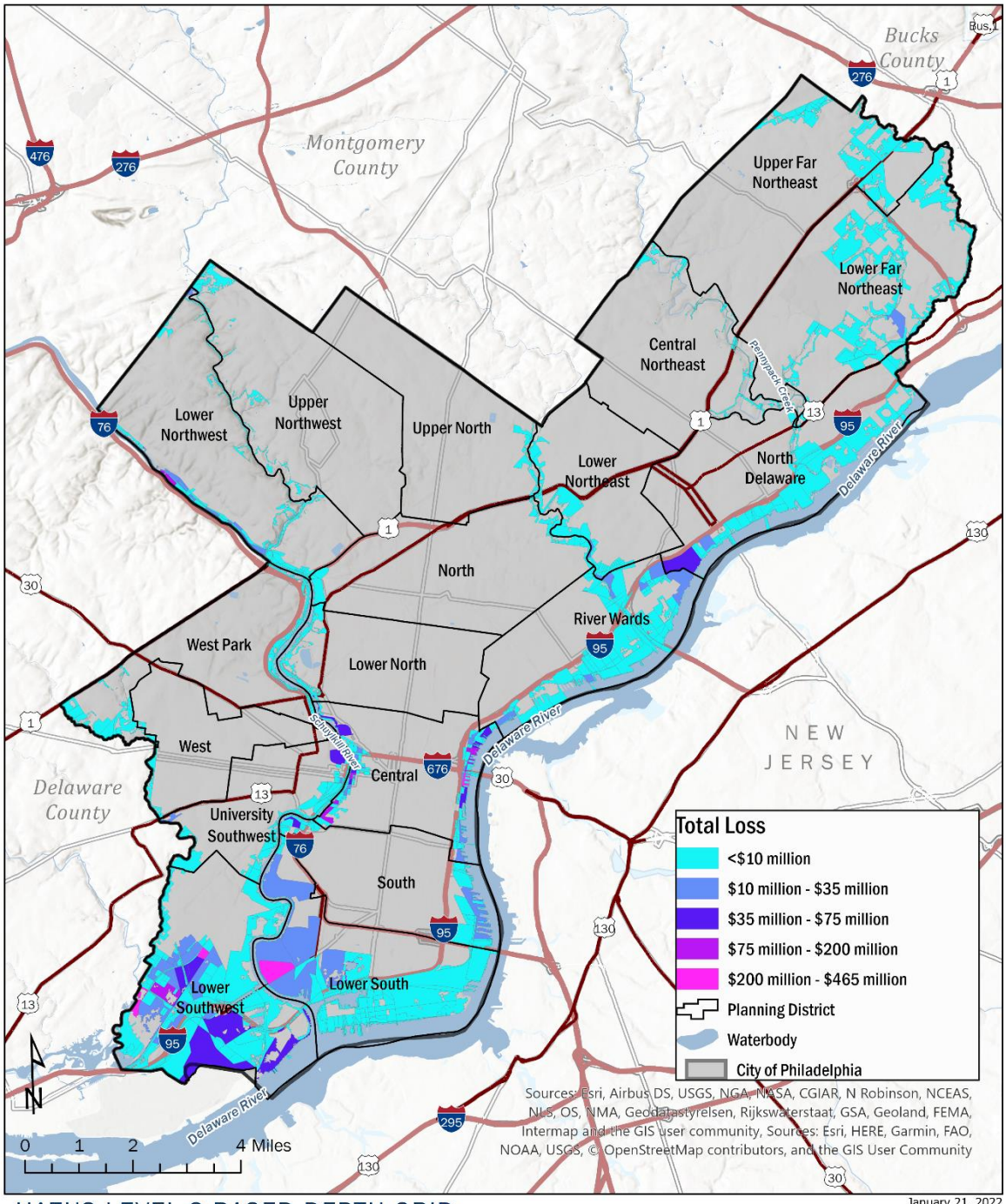


HAZUS LEVEL 1-BASED DEPTH GRID:
ANNUALIZED LOSS BY CENSUS BLOCK
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

Figure 4-14. Hazus Level 2 Total Loss by Census Block



HAZUS LEVEL 2-BASED DEPTH GRID:
REFINED EFFECTIVE 1% FLOOD TOTAL LOSS
BY CENSUS BLOCK
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

Flooding can cause structural losses within the City of Philadelphia, including homes, businesses, and critical facilities. According to the 2021 OPA tax account data, there are an estimated 534,717 properties in Philadelphia, a decrease from the estimate of 579,912 properties included in the 2017 Hazard Mitigation Plan. Approximately 6,965 of those are located within the 1-percent annual chance area. Some of the properties within the 1-percent chance area include critical facilities. A **critical facility** is a facility that provides services and functions essential to a community, especially during and after a disaster. These properties include a number of critical facilities, listed in the table below.

Table 4-20. Hazus Expected Damage to Critical Facilities in the 1% Annual Chance Floodplain

Critical Facility	Total	Expected to Sustain Damage
Emergency Operations Center + 911 Centers	3	0
Fire Stations	65	2
Hospitals	38	0
Police Stations	36	0
Schools	577	16

The tables below provide the building-related economic loss estimates and building damage by occupancy type based on the Hazus analysis for a 1-percent annual flood event. The Hazus software calculated that in a 1-percent annual flood event, building-related damages would total $4.67 billion. Hazus analysis calculated that 5 fire stations and 4 schools would likely be damaged in a 100-year flood.

Table 4-21. Hazus Building-Related Economic Loss Estimates in the 1% Annual Chance Floodplain

Building Category	Estimated Cost for Building Loss	Estimated Cost for Business Interruption	Total Building-Related Economic Loss Estimate
Residential	$602 million	$202 million	$804 million
Commercial	$878 million	$1.14 billion	$2.02 billion
Industrial	$1.02 billion	$64 million	$1.08 billion
Others	$187 million	$578 million	$765 million
Total	**$2.68 billion**	**$1.99 billion**	**$4.67 billion**

The results of the Hazus building-related economic loss estimates for 2022 are much greater than the estimates from previous plan updates. The increase is due to using more accurate locally available OPA data rather than the default inventory within Hazus Flooding.

Table 4-22. Hazus Building-Related Economic Loss Estimates in the 1% Annual Chance Floodplain

Type of Loss	Dollar Amount ($)		
	2022	2017	2012
Building Loss	$923 million	$425 million	$212 million
Contents Loss	$1.7 billion	$525 million	$341 million
Inventory Loss	$100 million	$14 million	$82 million
Income Loss	$598 million	-	-
Relocation Loss	$241 million	$733,000	$1.2 million
Rental Income Loss	$191 million	$421,000	$941,000
Wage Loss	$958 million	$1.6 million	$4.3 million
Total Loss	**$4.7 billion**	**$986 million**	**$643 million**

While no casualty data calculations are currently available, modelling can predict the extent to which a 1-percent annual flood event affects the housing needs of individuals. Hazus estimates that a 1-percent annual chance flood event would displace 33,329 individuals, with 4,041 people needing short-term shelter. Hazus calculates displaced persons as anyone who would evacuate in any portion of a flooded census block. The number of persons requiring sheltering is a subset of the displaced or evacuated population based on the extent of projected building damage within a census block. This data is weighted by income and age, such that elderly and low-income persons are more likely to require sheltering. We know Eastwick, a predominantly Black neighborhood, has had a lot of Repetitive Loss properties from flooding. Future conditions show the frequency and severity of flooding will increase in areas of the City that currently have flooding. Addressing this existing vulnerability in Eastwick is an equity issue directly addressed in the **6 Mitigation Strategy** and in detailed Mitigation in Focus actions.

4.3.5 Hurricane, Tropical Storm, Nor'easter

Hurricanes, tropical storms, and nor'easters are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counterclockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. Potential threats from hurricanes include powerful winds, heavy rainfall, storm surges, coastal and inland flooding, rip currents, tornadoes, and landslides. The Atlantic hurricane season runs from June 1 to November 30 (PEMA, 2020).

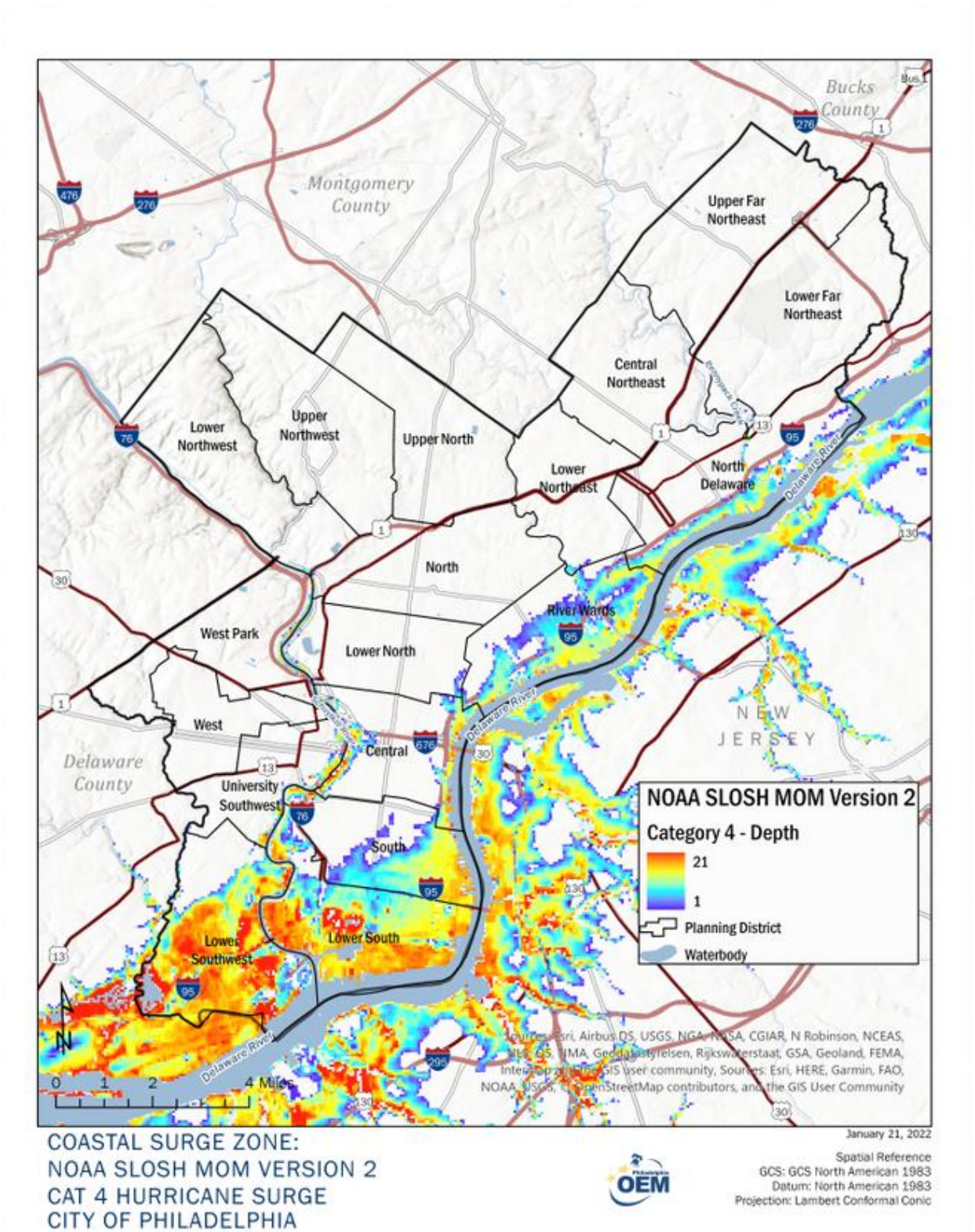
4.3.5.1 Location and Extent

Philadelphia is located on the west bank of the Delaware River, about 30 miles north of where it empties into the Delaware Bay and 80 miles from its mouth. The city is also approximately 60 miles inland from New Jersey's Atlantic Coast. This means that Philadelphia is situated in an area where cyclones can track inland causing heavy rain, strong winds, and storm surge in low-lying areas along tidal waterways. Most tropical systems that reach Philadelphia have weakened and no longer have hurricane-force winds. Nor'easters typically impact the region along the Northeast Corridor from Washington, D.C. to Boston, MA – including Philadelphia.

All cyclones are regional events that can affect an area hundreds of miles long; therefore, all neighborhoods within Philadelphia are subject to the impacts of these storms. However, certain factors such as proximity to tidal waterways like the Delaware and Schuylkill rivers may make some areas more vulnerable to specific effects, including storm surge. **Storm surge** is coastal flooding that is caused by a storm's strong winds and low atmospheric pressure pushing water onto land, above the expected high tide level (NOAA, n.d.). Storm surge is a hazard unique to cyclones that can severely impact structures near tidal waterways. This type of flooding can cause destruction of buildings as well as utility and transportation infrastructure.

Because storm surge only occurs along tidal waterways, it can be considered a localized impact. NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model provides guidance that can help understand the local variation in potential coastal flooding. The figure below shows the extent and depth of inundation that could be caused by a Category 4 hurricane that directly impacts the Philadelphia region. This is considered an extreme scenario because all known tropical cyclones that have impacted Philadelphia have been much weaker, the strongest being Hurricane Sandy as a Category 1 hurricane. Nonetheless, the map provides an overview of which areas are low-lying enough to potentially experience coastal flooding from storm surge.

Figure 4-15.Storm Surge Inundation Potential for a Category 4 Hurricane (SLOSH Maximum-of-Maximums)



4.3.5.2 Range of Magnitude

Meteorologists at NOAA's National Hurricane Center classify hurricanes by their wind speed, storm surge, and duration on a damage-potential ranking system called the Saffir-Simpson Scale. The scale divides hurricanes into five categories based on the highest one-minute average wind speed in the storm, as seen the table below. A hurricane's category will change as it intensifies or weakens. Meteorologists describe hurricanes that reach Category 3 or above as major hurricanes. All hurricanes can produce strong winds, tornadoes, powerful waves, storm surge, and torrential rains that may lead to flooding.

Table 4-23. Saffir Simpson Scale

Category	Storm Surge (ft.)	Sustained Winds (mph)	Damage	Damage Description
1	**6.1-10.5**	**74-95**	**Moderate**	• Damage primarily to trees and unanchored homes • Some damage to poorly constructed signs • Coast road flooding
2	**13.0-16.6**	**18**	**Moderate - Severe**	• Some roofing material, door, and window damage to buildings • Considerable damage to shrubbery and trees • Flooding of low-lying areas
3	**14.8-25**	**111-130**	**Extensive**	• Some structural damage to residences and utility buildings • Foliage blown off trees and large trees blown down • Structures close to the coast will have structural damage by floating debris
4	**24.6-31.3**	**131-155**	**Extreme**	• Curtain wall failures with utilities and roof structures on residential buildings • Shrubs, trees, and signs all blown down • Extensive damage to doors and windows • Major damage to lower floods of structures near the coast
5	**Not predicted**	**> 155**	**Catastrophic**	• Complete roof failure on many residences and industrial buildings • Some complete building and utility failures • Severe, extensive window and door damage • Major damage to lower floors of all structures near the coast

Wind speeds in most hurricanes diminish exponentially once they make landfall; typically halving within about seven hours after crossing the coastline. However, hurricanes occasionally do not weaken and instead interact with other air masses, often a strong cold front. When this happens, a storm will transition to become an extratropical cyclone. This happened after Hurricane Sandy made landfall in New Jersey, leading to unprecedented impacts along shorelines as far north as New York and New England.

The Dolan-Davis Nor'easter Intensity Scale categorizes the intensity of Nor'easters, see **Table 4-24.** Instead of looking at wind speed to categorize storms, this scale primarily considers the duration and size of waves that can cause beach and coastal erosion. Because this scale primarily deals with coastal

impacts, it is less commonly used, and has limited utility for assessing a storm's potential impacts in an inland city like Philadelphia. However, the scale does allow for general comparison of Nor'easters by using these factors as a proxy for overall strength and severity.

Table 4-24. Dolan-Davis Scale

Storm Class	Avg. Wave Height (ft.)	Avg. Duration (hrs.)	Impact
1	6	8	Minor beach erosion
2	8	18	Some beach erosion and property damage
3	11	34	Extensive beach erosion, significant dune loss, many structures lost
4	16.5	63	Severe beach erosion and recession, wider scale of building loss
5	23	96	Extreme beach erosion, massive overwash, extensive property damage

Hurricanes, tropical storms, and nor'easters are associated with damage from sustained winds as well as wind gusts. Wind can cause damage to trees that can partially block waterways, affecting turbidity if the downed tree is large enough, or the tributary is small enough. High winds can also cause erosion of topsoil if it is dry or loose enough and can spread trash and debris over a large area, complicating cleanup efforts. Nor'easters can sometimes also result in substantial snow accumulations, causing tree damage that can lead to other impacts like impassable roadways and downed electrical wires. Cyclones can lead to flooding from storm surge as well as riverine flooding and flash floods from heavy rainfall. For more information on the flood hazards, see **4.3.4 Flood, Flash Flood, Ice Jam.**

The worst-case scenario for Philadelphia would be a major hurricane moving up the Delaware Bay during high tide with the center of the storm slightly to the west of Philadelphia. Storm surge from the Delaware River would inundate low-lying areas and hurricane-force winds would cause tree damage, utility damage, and building collapses. Extensive glass damage to Center City high rises is also likely. Heavy rainfall could cause flash flooding as it overwhelms the drainage system and additional flooding along creeks and rivers as rainfall totals grow across the region. Critical infrastructure, homes, and businesses would be flooded or destroyed.

4.3.5.3 Past Occurrence

The following table lists the ten most destructive hurricanes and tropical storms of the past 100 years in terms of damage estimates and loss of life with centers of circulation passing within 65 miles of Philadelphia. Note that the storms are listed in chronological order.

Table 4-25. Ten Most Destructive Tropical Cyclones in Philadelphia (Since 1920)

Year	Storm Name	Peak Intensity	Strength Near Philadelphia	Impacts and damage in Philadelphia
2021	**Ida**	**Category 4**	**Tropical Storm**	• Extreme flooding along the Schuylkill River, cresting at 16.35ft. and causing substantial damage in nearby areas such as Manayunk. • The crest was only exceeded once in history when the river reached 17ft. in 1869. • Five deaths in the Philadelphia region • Multiple tornadoes across the region, including an EF3 storm in Mullica Hill, NJ

Year	Storm Name	Peak Intensity	Strength Near Philadelphia	Impacts and damage in Philadelphia
2020	**Isaias**	**Category 1**	**Tropical Storm**	• A total of 4.16 inches of rainfall was reported at the Philadelphia International Airport. • The Delaware river reached minor flood stage, cresting at 9.13 feet. • The Schuylkill River reached moderate flood stage, cresting at 12.28 feet. • Significant flooding to homes and businesses in Southeast and Northwest Philadelphia resulted, with storm impacts that necessitated emergency evacuations and temporary sheltering.
2012	**Sandy**	**Category 3 Hurricane**	**Category 1 Hurricane**	• Two deaths and $20 million in damage • 850,00 customers without power • Flooding along the Delaware River • Suspended Amtrak and SEPTA service • Closed major highways across the region
2011	**Irene**	**Category 2 Hurricane**	**Tropical Storm**	• Flooded Manayunk and Lincoln Drive along the Schuylkill, with a 13.5 ft. crest recorded • The Delaware River recorded a 9.77 ft. crest • Caused seven structure collapses and damaged at least thirteen others
2011	**Lee**	**Tropical Storm**	**Tropical Storm**	• One fatality in Philadelphia • Rockslides and widespread flooding and flash floods • Destroyed 22 homes and businesses with hundreds more affected
1999	**Floyd**	**Category 4 Hurricane**	**Tropical Storm**	• Eight deaths in Philadelphia • 2.8 ft. Storm surge recorded • 3,500 homes flooded and 1,000 people evacuated
1972	**Agnes**	**Category 1 Hurricane**	**Tropical Storm**	• Three deaths in Philadelphia • Major flooding on the Schuylkill River
1955	**Connie**	**Category 1 Hurricane**	**Tropical Storm**	• Evacuations • Flooding along the Delaware River
1955	**Diane**	**Category 1 Hurricane**	**Tropical Storm**	• Flooding along the Delaware River • Heavy runoff led to extensive downstream flooding along rivers and streams
1954	**Hazel**	**Category 4 Hurricane**	**Tropical Storm**	• Substantial wind impact • 94 mph gust recorded
1933	**Unnamed**	**Category 4 Hurricane**	**Tropical Storm**	• Major flooding along Schuylkill River • Major road and highway damage

4.3.5.4 Future Occurrence

Climate change will increase sea surface temperature, leading to more intense tropical cyclones, with higher winds speeds and more precipitation (US EPA, 2021a). Some research suggests that the greatest increase in major hurricanes could occur over the western Atlantic basin in response to warmer sea surface temperatures and reductions in vertical wind shear (Mayor's Office of Sustainability and ICF International, 2015). This increase in severity places Philadelphia at increasing risk of tropical cyclone impacts. Based on the NOAA Hurricane and Research Division's North Atlantic hurricane season

classifications, the Atlantic basin can expect the following number of storms in a typical hurricane season. Seasonal ranges of storms and means in parentheses for a below-normal, near-normal, and above-normal season are shown in **Table 4-26.**

Table 4-26. NOAA's Seasonal Range of Tropical Storms and Hurricanes

Season Type	Range of Tropical Storms (Mean)	Range of Hurricanes (Mean)	Range of Major Hurricanes (Mean)
Above-Normal	11 to 30 (15.9)	6 to 15 (9.2)	2 to 7 (4.5)
Near-Normal	6 to 18 (11.7)	3 to 9 (6.2)	1 to 4 (2.2)
Below-Normal	4 to 14 (8.6)	2 to 6 (3.8)	0 to 2 (1.2)

Source: NOAA, 2021a

Nor'easters are also expected to impact the Delaware and Chesapeake Bay regions more severely, including Philadelphia. High resolution modelling from the Argonne National Laboratory suggests that the region could see more storm surge during extreme events (Spizziri, 2021).

4.3.5.5 Vulnerability Assessment

High winds and flooding are the primary hazards associated with cyclones, with heavy snowfall also occurring during some nor'easters depending on the storm track. Generally, the vulnerabilities associated with each of these hazards are consistent with those laid out in **4.3.8 Tornado, Windstorm; 4.3.4 Flood, Flash Flood, Ice Jam**; and **4.3.9 Winter Storm**. Flooding from storm surge is a hazard unique to cyclones and can cause severe structural damage to buildings along the immediate coast as they are inundated and subjected to wave action. To understand the extent of vulnerability to storm surge, refer to **Figure 4-15** which shows possible flooding under an extreme Category 4 scenario.

While wind-related hazards are more fully described in section **4.3.8 Tornado, Windstorm**, potential damage related to hurricane winds was computed using FEMA's Hazus model. This model is probabilistic – meaning that it categorizes simulated storms based on the likely interval between storms of a certain magnitude (return period). This can be annualized as average expected loss per year. **Figure 4-16** shows the annualized localized losses due to hurricane wind damage by Census tract. This varies widely across the city but is generally highest in the central and southern portions of the city. Similarly the results from using NOAA storm surge data in Hazus show damage in South Philadelphia and along the tidal Delaware and Schuylkill Rivers in **Figure 4-17.**

Figure 4-16. Hazus Annualized Losses due to Hurricane Wind Damage by Census Tract

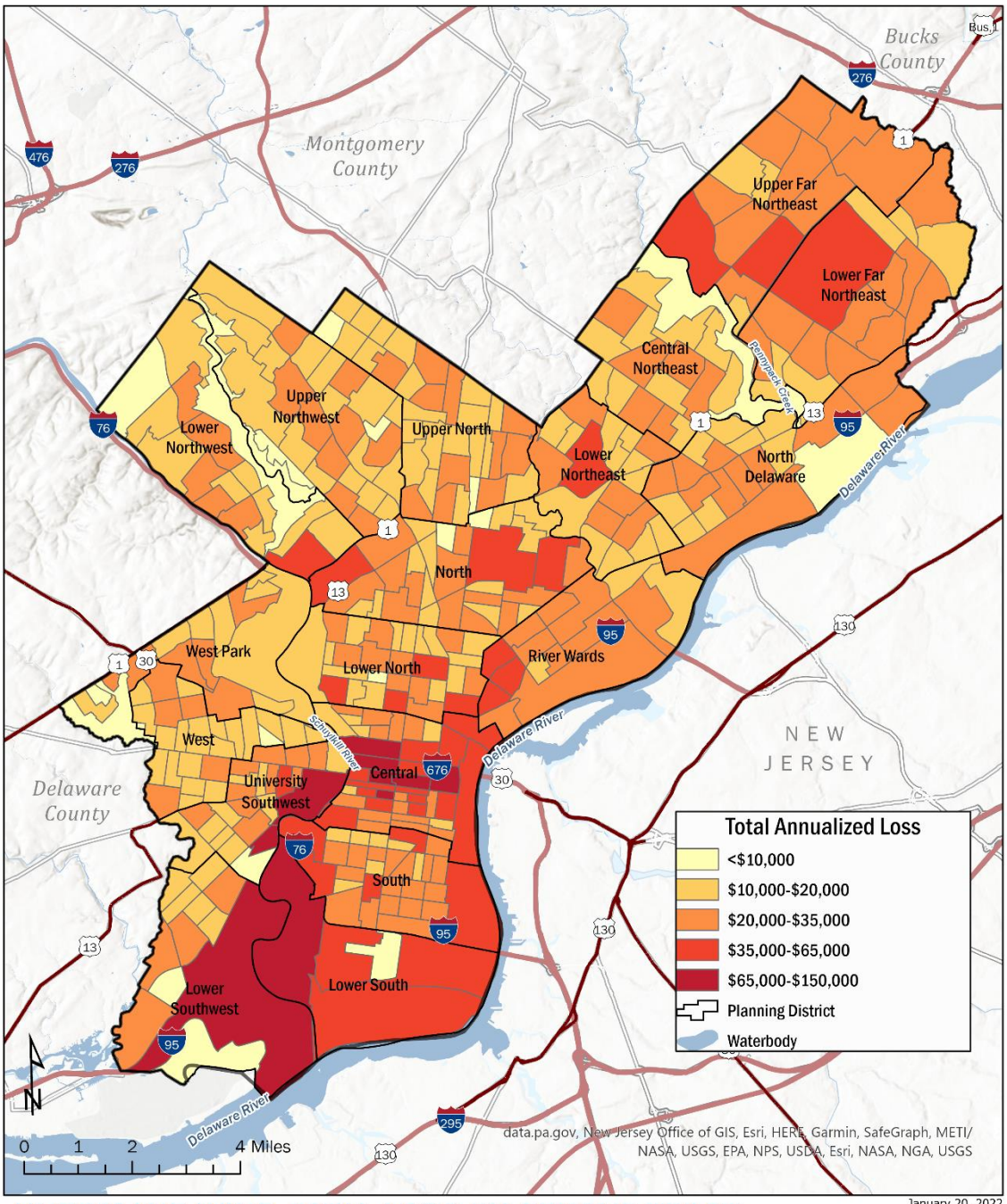
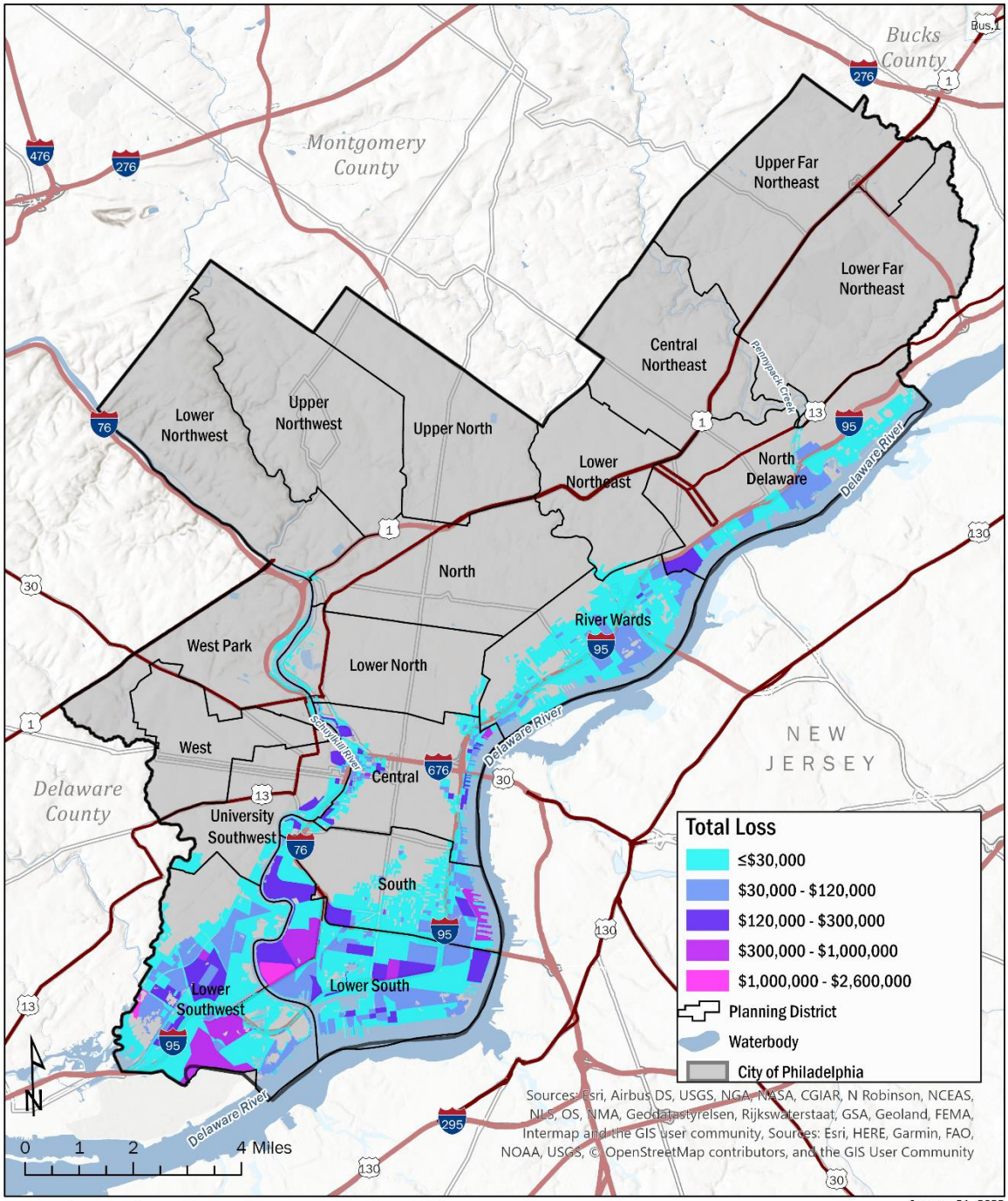


Figure 4-17. Hazus Total Loss Based on NOAA Category 4 Hurricane Storm Surge



COASTAL SURGE ZONE HAZUS LOSS:
NOAA SLOSH MOM VERSION 2
CAT 4 HURRICANE SURGE
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

To fully understand the impact of a hurricane on Philadelphia, all potential effects must be looked at together. The full scope of Philadelphia's predicted economic losses from hurricanes is outlined in the tables below. This data is also from Global Risk Reports generated by FEMA's probabilistic Hazus model. These tables outline vulnerability in terms of buildings damaged, displaced people and people requiring short-term shelter, and the economic loss of structures and business interruption. Depending on the severity of the event, monetary losses could reach billions of dollars in a worst-case (500 or 1,000-year) event.

Table 4-27. Hazus Hurricane Results for Number of Buildings Damaged

Return Period	Minor	Moderate	Severe	Destruction	Total
10-year	0	0	0	0	0
20-year	336	5	0	0	341
50-year	533	12	0	0	545
100-year	1,868	101	0	0	1,969
200-year	6,767	559	7	0	7,333
500-year	25,920	2,873	27	10	28,831
1,000-year	48,857	6,783	85	54	55,778

Table 4-28. Hazus Hurricane Results for Displacement and Shelter Requirements

Return Period	Displaced Households	People Needing Short-term Shelter
10-year	0	0
20-year	0	0
50-year	0	0
100-year	0	0
200-year	0	0
500-year	182	131
1,000-year	659	479

Table 4-29. Hazus Hurricane Building-Related Economic Loss Estimates

Return Period	Property Damage (S)		Business Interruption
	Residential	Total	
10-year	$0	$0	$0
20-year	$0	$0	$9,000
50-year	$24 million	$24 million	$29,000
100-year	$106 million	$115 million	$972,000
200-year	$284 million	$308 million	$14 million
500-year	$710 million	$807 million	$47 million
1,000-year	$1.2 billion	$1.4 billion	$141 million

Hurricanes impacts as shown by the Hazus analysis are greater in some of the neighborhoods of North Philadelphia and West Philadelphia that also have a high Social Vulnerability Index as shown in **Figure 2-32** and **Figure 2-33** social vulnerability maps. The high winds in hurricanes and tropical storms can cause utility outages that impact people that need electricity for medical devices and to keep temperatures

comfortable in their homes. Populations that are socially vulnerable can have more difficulty recovering from disaster events including hurricanes and connecting with resources to assist their recovery. A hurricane and flood specific outreach plan is identified along with other mitigation measures to address equity in hurricane preparedness, mitigation, response and recovery.

4.3.6 Pandemic and Infectious Disease

A pandemic is a global outbreak of disease that occurs when a new virus emerges in the human population, spreading easily in a sustained manner, and causing serious illness. An epidemic describes a smaller-scale infectious outbreak, within a region or population, that emerges at a disproportional rate. Infectious disease outbreaks may be widely dispersed geographically, impact large numbers of the population, and could arrive in waves lasting several months at a time (PEMA, 2020).

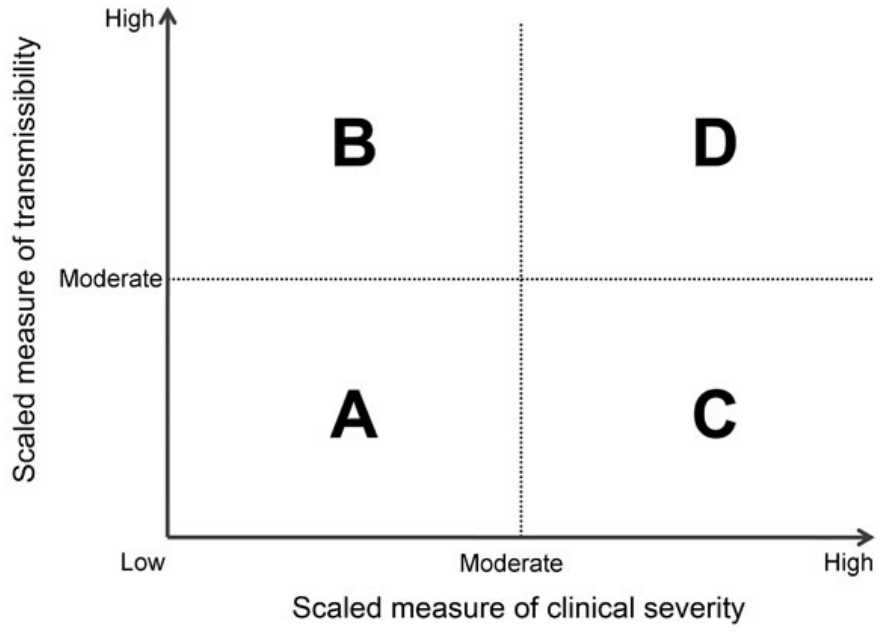
4.3.6.1 Location and Extent

It is difficult to anticipate where an epidemic or pandemic may spread. Contact tracing is helpful for mapping out the locations and persons infected with a contagious disease. During an epidemic or pandemic, the City can support the CDC and local public health efforts by preparing their staff and operations and providing contract tracing information.

4.3.6.2 Range of Magnitude

The severity of a pandemic, epidemic, or infectious disease varies and can be dependent on how it is transmitted (e.g., airborne or skin-to-skin contact), how contagious the disease is, how long it can live on surfaces, and how long an individual is contagious before showing symptoms. The CDC uses the Pandemic Severity Assessment Framework (PSAF) (see **Figure 4-18**) to determine the impact of a pandemic, or how "bad" the pandemic will be (CDC, 2016). The PSAF includes two main factors to determine impact: clinical severity (how serious the illness is associated with infection) and transmissibility (how easily the pandemic virus spreads from person-to-person) (CDC, 2016).

Figure 4-18. Framework for the initial assessment of the effects of an influenza pandemic



Source: Reed et. al, 2013

There are two steps for health officials to follow: an initial assessment early on during a pandemic and a refined assessment that happens when more information becomes available (Centers for Disease Control, 2016). The following table describes scaled measures of transmissibility and clinical severity for refined assessments of pandemic influenza effects.

Table 4-30. Scaled measures of transmissibility and clinical severity for the refined assessment of pandemic influenza effects

Parameter no. and description	Scale 1	2	3	4	5	6	7
Transmissibility							
1. Symptomatic attack rate, community, %	<10	11–15	16–20	21–24	>25	-	-
2. Symptomatic attack rate, school, %	<20	21–25	26–30	31–35	>36	-	-
3. Symptomatic attack rate, workplace, %	<10	11–15	16–20	21–24	>25	-	-
4. Household secondary attack rate, symptomatic, %	<5	6–10	11–15	16–20	>21	-	-
5. R_0: basic reproductive no.	<1.1	1.2–1.3	1.4–1.5	1.6–1.7	>1.8	-	-
6. Peak % outpatient visits for influenza-like illness	1–3	1–3	1–3	1–3	1–3	-	-
Clinical Severity							
1. Case-fatality ratio, %	<0.02	0.02–0.05	0.05–0.1	0.1–0.25	0.25–0.5	0.5–1	>1
2. Case-hospitalization ratio, %	<0.5	0.5–0.8	0.8–1.5	1.5–3	3–5	5–7	>7
3. Ratio, deaths: hospitalization, %	<3	4–6	7–9	10–12	13–15	16–18	>18

Source: Reed et. al, 2013

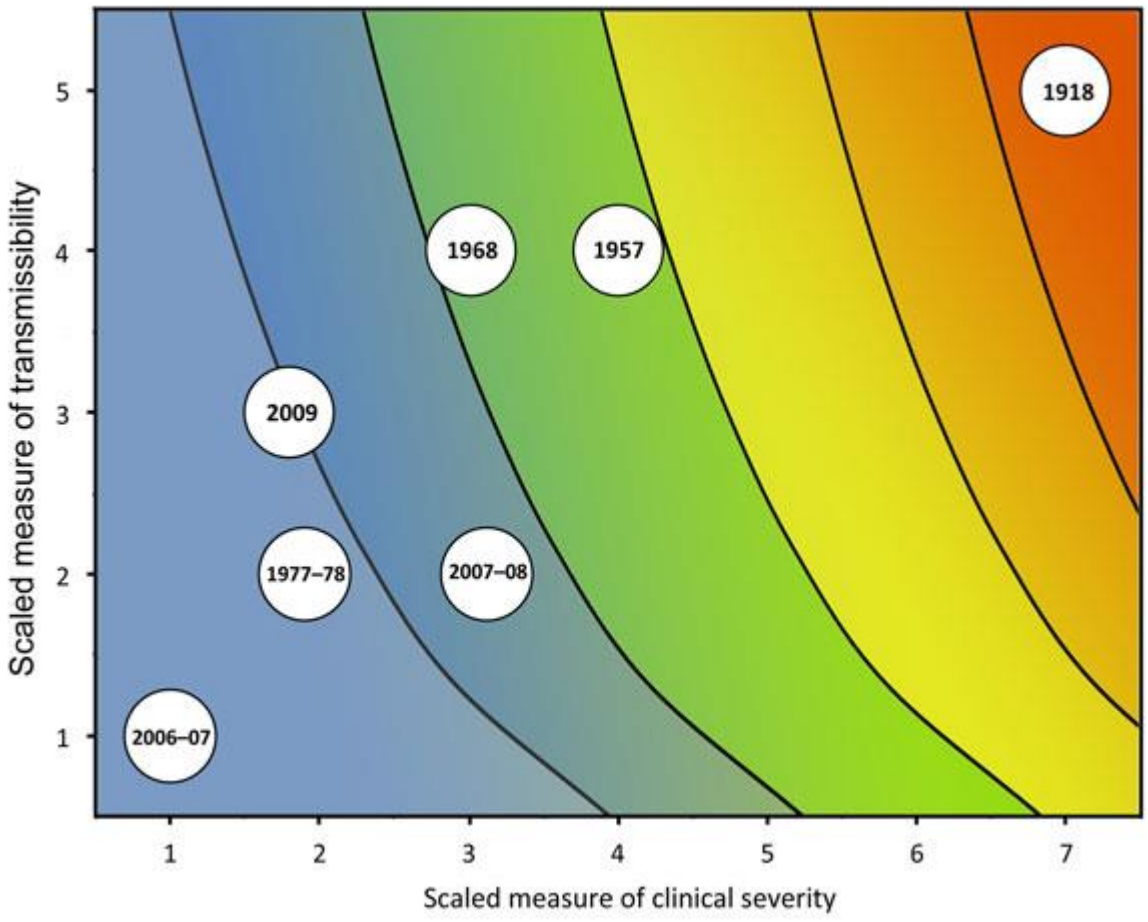
Federal, state, and local public health agencies provide instructions to all organizations and individuals based on the severity of a pandemic and the infectious diseases' transmission methods.

The worst-case scenario for Philadelphia would be a disease with high clinical severity (7) and high transmissibility (5) in the CDC's PSAF (a pandemic that would fall into quadrant D in **Figure 4-18**).

4.3.6.3 Past Occurrence

Per the CDC's PSAF, the following figure shows scaled examples of past pandemics and past influenza seasons.

Figure 4-19. Framework for the refined assessment of the effects of an influenza pandemic, with scaled examples of past pandemics and past influenza seasons



Source: Reed et al., 2013

The Spanish Flu Pandemic killed an estimated 675,000 Americans between 1918 and 1919 (CDC, 2019). In Philadelphia, the disease progressed rapidly by late September 1918 following a Liberty Loan parade that attracted 200,000 spectators to Center City. Hospitals were overwhelmed with patients in October and city businesses and public services were severely strained by widespread worker absences. Morgues overflowed with bodies of flu victims, with some stored outside in the streets. Flu cases largely subsided in November 1918, but at least 12,000 Philadelphians ultimately succumbed to the disease. The Spanish Flu represents the most significant pandemic of the 20th Century and remains the deadliest in Philadelphia history (Kopp and McGovern, 2018).

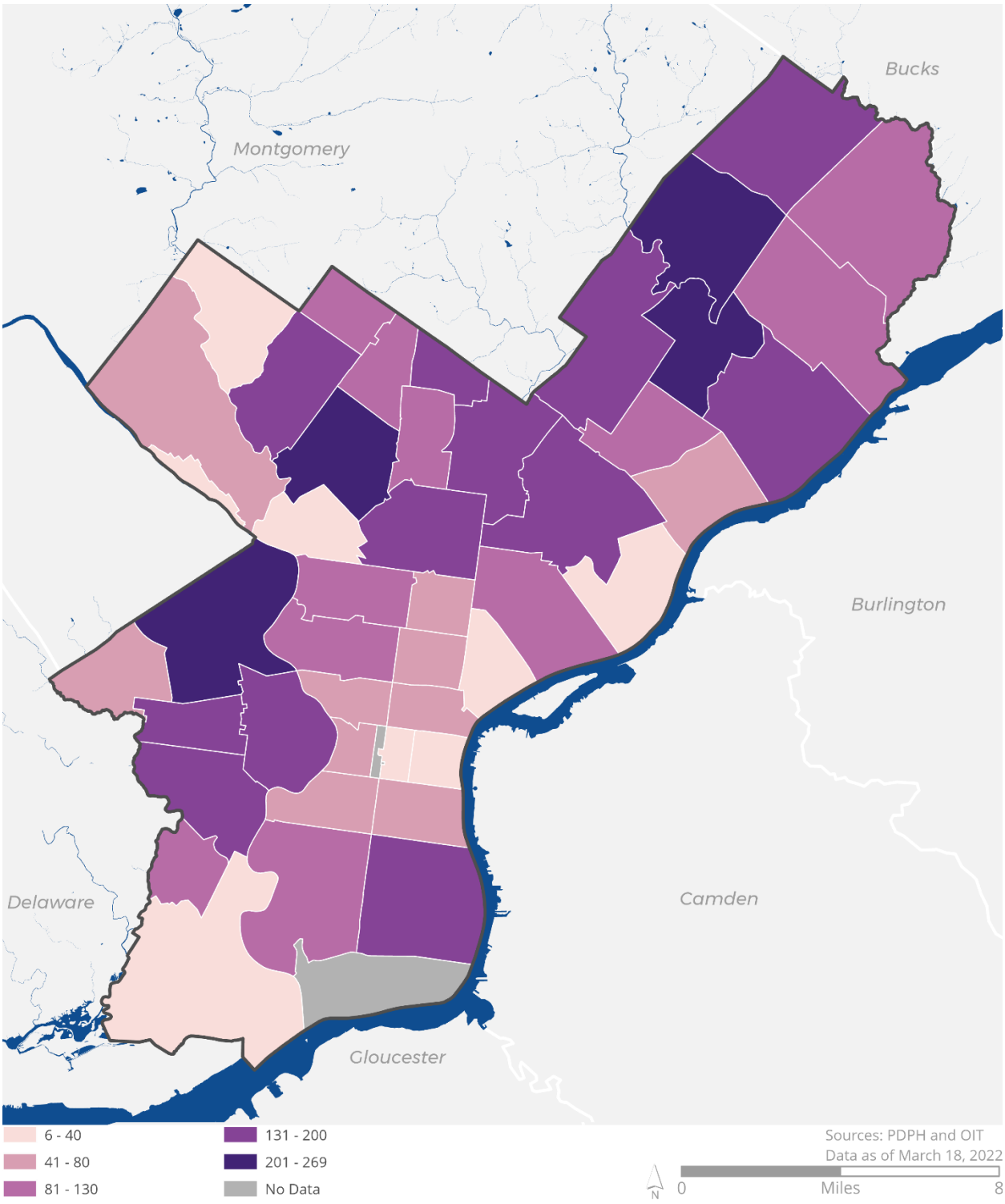
In early May 2009, novel influenza A / H1N1, also known as swine flu, emerged in the Philadelphia area. Due to a lack of immunity in the local population, H1N1 spread rapidly, resulting in hospitalizations and deaths in the city. H1N1 was the first influenza pandemic of the 21st Century (Philadelphia DPH, 2008).

This plan was developed during the novel COVID-19 Pandemic. The virus had an unprecedented effect globally and directly influenced critical operations. As of January 4, 2022, the COVID-19 rates for Philadelphia County / City of Philadelphia were approximately 235,000 infection cases and 4,271 deaths

(Pennsylvania Department of Health, 2022). One study from early in the COVID-19 Pandemic (April 2020, based on Chinese data through February 2020) assessed the severity of the COVID-19 Pandemic using the PSAF (Freitas et al., 2020). In their assessment, they rated COVID-19's scaled transmissibility at 5 and its scaled clinical severity from 4-7, placing the COVID-19 Pandemic in the "very high severity" quadrant (Freitas et al., 2020). As of early 2022, the CDC has not published a PSAF rating from the COVID-19 Pandemic.

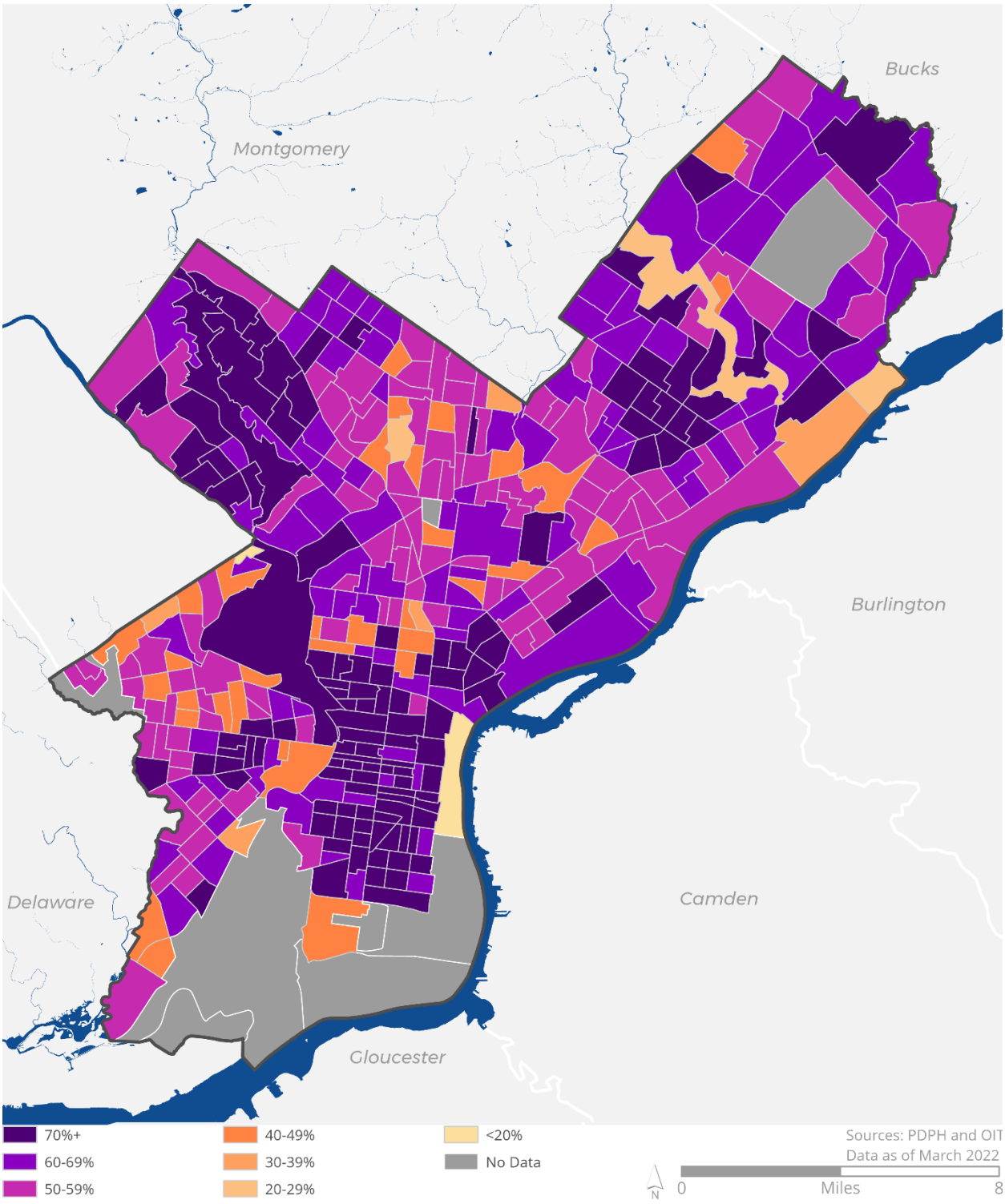
The COVID-19 Pandemic impacted the entire city with some zip codes have greater number of death from the virus. The zip codes with the highest number of deaths are slightly different than the neighborhoods with Philadelphia's most socially vulnerable populations (see **2.3.8 Social Vulnerability**). The locations with the highest number of deaths are in West Park, Northwest and Northeast Philadelphia. It is encouraging to see that these neighborhoods have high rates of vaccination along with Center City Philadelphia. See Figure 4-21. COVID Deaths by Zip Code below.

Figure 4-20. COVID-19 Deaths by Zip Code



Source: PDPH and OIT, 2022

Figure 4-21.Percentage of People Who Received a 1st Dose of The COVID-19 Vaccine



Source: PDPH and OIT, 2022

4.3.6.4 Future Occurrence

Historical events indicate that epidemics and pandemics are happening more frequently and spreading farther over the past century. This increase is likely due to multiple factors, such as increased global travel, economic globalization, urbanization, and increased population growth in natural environment areas (Madhav, et al., 2017). The City of Philadelphia shows a rise from 2015 to 2019 in certain infectious diseases, see **Table 4-31.**

Table 4-31. Number of Cases by Infectious Diseases in Philadelphia, 2015-2019

Disease Name	Agent	Vector	2015	2016	2017	2018	2019
Malaria	Parasite	Mosquito	18	22	30	40	45
Hepatitis A	Virus	Fly / Contaminated Food or Water	6	9	19	21	426
Hepatitis C, Acute	Virus	Blood	79	130	155	183	445
Mumps	Virus	Airborne	1	5	8	24	130+*
Syphilis	Bacteria	Sexually transmitted	916	927	1256	1214	1240**

Sources: Philadelphia DPH, 2020; Penn Medicine, 2019; Philadelphia DPH, 2021
**Outbreak of Mumps at Temple University*
***Estimation based off graph*

Future climate conditions can influence the spread of infectious diseases. Temperature differences can affect where insect populations live and what diseases they can carry (see projected increases in temperature due to climate change in **4.3.3 Extreme Temperature**). For examples, insects such as fleas, ticks, and mosquitoes can carry diseases like Lyme, West Nile, malaria, Zika, etc. The WHO identified potential climate change factors that could increase the number of infectious disease outbreaks and types of diseases that occur in the planning area (WHO, 2003):

- Increased use of dams, canals, and irrigation to manage water flow changes can increase the risk of schistosomiasis, malaria, and helminthiasis
- As annual average temperatures change, new agricultural areas can succumb to infestation, increasing the risk of malaria and Venezuelan hemorrhagic fever
- Urbanization or urban crowding can cause sanitation and contamination issues, increasing the risk of cholera, dengue, and cutaneous leishmaniasis
- Deforestation and populations spreading into wildland interurban areas can cause a rise in insect populations bringing malaria, oropouche, and visceral leishmaniasis
- Conversely, reforestation to combat tree loss can increase the risk of Lyme disease
- Ocean warming can increase the chance of toxic algae blooms like red tide
- Increased precipitation provides additional environment for mosquito breeding and rodent habitat, which increases the risk to rift valley fever and hantavirus pulmonary syndrome

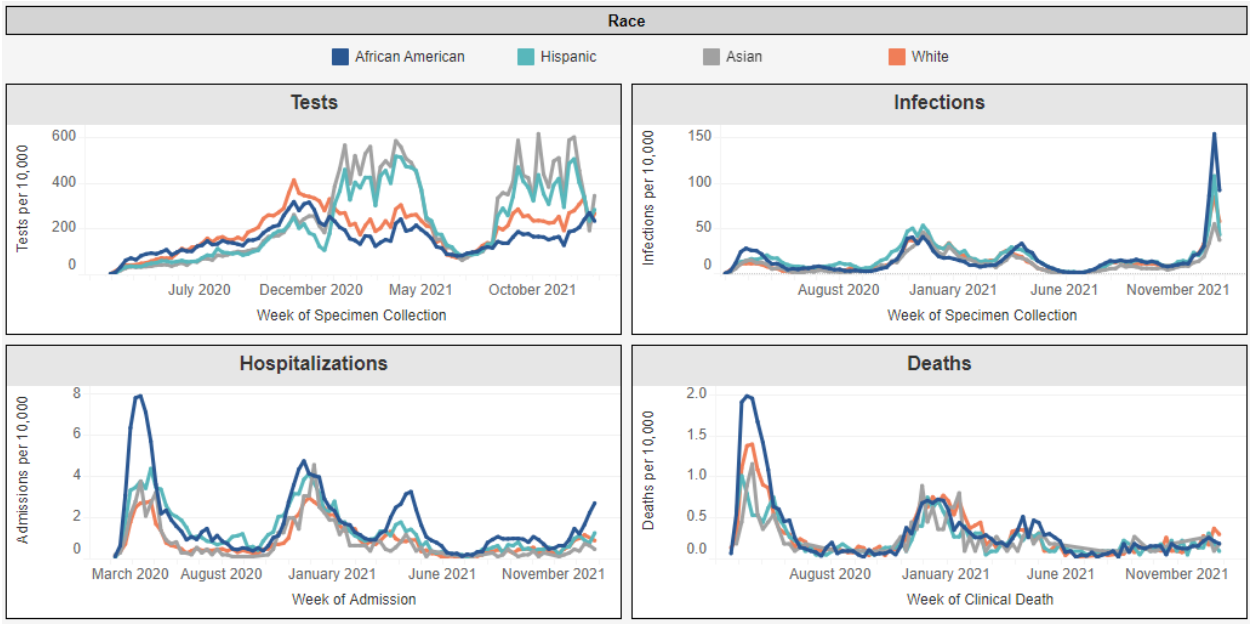
4.3.6.5 Vulnerability Assessment

All residents and visitors of the City of Philadelphia could be susceptible to the effects and exposed to infectious disease. However, some residents of Philadelphia are placed at a greater risk for infection than others including those with compromised immune systems, those with pre-existing medical conditions, individuals over the age of 65 (13.4% of the population), individuals with limited access to adequate health care, individuals who are socioeconomically disadvantaged (23.3% of the population), and children (6.7% of the population) (U.S. Census Bureau, 2019). The Center of Disease Control (CDC)

Social Vulnerability Index is a database to help emergency response planners and public health officials identify and map communities that will most likely need support before, during, and after a hazardous event. The CDC Social Vulnerability Index uses U.S. Census data to examine social vulnerability at the census tract level for 15 social factors, including poverty, lack of vehicle access, and crowded housing. See **Figure 2.32** in the **Community Profile** for more information on social vulnerability across the City and concentrations of populations that may be more vulnerable to extreme temperatures.

During the COVID-19 Pandemic, higher rates of infection are observed in African American and Latinx residents in Philadelphia, likely due to longstanding social disadvantage. Those living in long-term care facilities and congregate settings as well as those with chronic medical conditions are also more at risk of infection and are experiencing higher transmission rates.

Table 4-32. COVID-19 Tests, infections, hospitalizations, and deaths by race as of January 2022.



Source: City of Philadelphia, 2022

Epidemics and pandemics do not typically impact property directly. However, adjustments can be made to existing buildings and new projects, such as upgrading HVAC system ventilation and air filtration, improving cleaning and sanitizing procedures and frequency, and allowing more space for social distancing (Megahed and Ghoneim, 2020). In contrast, epidemics and pandemics can significantly impact development, although the impacts are likely temporary and would last only as long as the infectious disease continues to spread (Derven, 2020). When COVID-19 swept through the planning area, the City adapted to the pandemic and adjusted projects as needed to continue development and renovations safely. These adjustments and procedures can inform planning area development in future epidemic/pandemic incidents.

Depending on the severity of an epidemic or pandemic, critical services can be significantly impacted due to reduced staffing and safety measures put in place to limit transmission. Industry and commerce can also suffer losses. Businesses in Philadelphia and across the United States were significantly impacted by the COVID-19 Pandemic. According to an Economy League of Greater Philadelphia study, as

of July 9, 2020, approximately 16,403 Small Business Administration (SBA) COVID-19 Paycheck Protection Program (PPP) loans were distributed to Philadelphia businesses with an estimated 2,492 loans valued at $150,000 or more and 13,911 loans valued at $150,000 or less (Economy League of Greater Philadelphia, 2020). The average loan size of all distributed loans in the United States was $104,682. According to a December 2021 report from PEW Charitable Trusts, Philadelphia's total jobs remain below pre-pandemic levels, further impacting the ability of Philadelphia to respond and recover from other, concurrent disasters (Pew Charitable Trusts, 2021).

During the COVID-19 Pandemic, the City implemented safety accommodations to reduce exposure and spread risks at their critical facilities. Mitigation measures did not require significant changes to the structures. The City also took additional measures to protect populations placed at more risk, including providing additional support to hospitals, nursing homes, residential treatment centers, and shelters for people experiencing homelessness to prevent the spread of infection. A Racial Equity Plan was developed to outline the City's plan for mitigating the impact of the pandemic on the City's communities of color and more effectively directing response resources to those at higher risk. The City should consider building these epidemic and pandemic safety measures into future planning where applicable.

4.3.7 Subsidence, Sinkhole

Land subsidence is a gradual settling or sudden sinking of the ground surface due to the movement of subsurface materials. A **sinkhole** is a subsidence feature resulting from the sinking of surficial material into a pre-existing subsurface void. Subsidence and sinkholes are geologic hazards that can impact roadways and buildings and disrupt utility services. Subsidence and sinkholes are most common in areas underlain by limestone and can be exacerbated by human activities such as water, natural gas, and oil extraction (PEMA, 2020).

4.3.7.1 Location and Extent

According to USGS, one of the most affected states of sinkhole damage is Pennsylvania (USGS). There are two common causes of subsidence in Pennsylvania: 1) dissolution of carbonate rock such as limestone or dolomite, also known as karst topography, and 2) mining activity. However, most sinkholes in cities are caused by human activity rather than geology. Human decisions to impede the flow of water and to force water to flow along unnatural pathways can contribute to the formation of sinkholes. Sinkholes develop in urban areas like Philadelphia because of the underground network of piping and conduits (NBC 10 Philadelphia, 2013). Urban areas also have a high percentage of impervious surfaces (such as pavement) which impedes natural stormwater flow.

Aging infrastructure also plays an important role in the creation of sinkholes in urban areas. Most sinkholes that form in cities like Philadelphia occur because water slowly eroded the soil that supports buildings and roads. Pipes that carry drinking water, runoff, or sewage are susceptible to leaking as they age. Leaking pipes erode the soil surrounding pipes and create large voids below the surface.

4.3.7.2 Range of Magnitude

Land subsidence can be measured through the Global Positioning System (GPS). NOAA's National Geodetic Survey maintains a national network of high-precision GPS receivers, called a Continuously Operating Reference Station (CORS), that can be used to track height changes at the station. Areas

without a CORS can measure subsidence from satellite InSAR (Interferometric Synthetic Aperture Radar), temporary GPS receivers, repeated surveys of geodetic leveling, or installations of ground and water sensors.

The worst-case scenario in Philadelphia is a historic event that impacted the Logan Triangle neighborhood. In the 1920s, houses were built on poor quality ash fill on top of the Wingohocking Creek. The houses began sinking due to the depth and poor quality of the fill soil. The homes began to subside because of the unstable soil mix which led to a gas main break and fire in 1986. Inspections that same year by the Department of Licenses and Inspections found several homes "imminently dangerous" or "structurally dangerous." In August 1986, Philadelphia public officials recommended that residents of more than 950 houses permanently leave their homes. A nonprofit agency was established to help relocate residents over 15 years. In 2002, there was a last call to relocate with assistance from the Logan Assistance Corporation and the American Red Cross. The cost of this hazard was $38 million for relocations and $12 million to demolish houses covering 17 blocks. The area remains undeveloped in 2022 (Philadelphia Inquirer, 2010).

4.3.7.3 Past Occurrence

In the 1800s, Philadelphia began installing a municipal sewer system. Engineers dug into the ground to construct these sewers, lined them with bricks, then buried them to build the street level above. This created a sinkhole and cave-in risk all over the city. The Mill Creek Sewer in West Philadelphia has had sinkholes occur for well over a century. In 1874, a sinkhole occurred at 43rd St and Chestnut St. In 1961, another sinkhole over the Mill Creek Sewer resulted in two fatalities. In 2019, a sinkhole on Baltimore Avenue was caused by a failure of an offshoot sewer connecting to the Mill Creek Sewer (Murrell, 2019). The largest past occurrence impact in Philadelphia is the Logan Triangle sinking homes disaster described as the worst-case scenario for Philadelphia.

Since 2015, the City of Philadelphia Streets Department received more than 17,000 reports of sinkholes (Murrell, 2019). In December 2020, a major sinkhole formed in South Philadelphia after a water main break at 2nd and Fitzwater Street in Queen Village (CBS3, 2020). In July 2021, "The Great Philly Sinkhole" appeared when a 130-year-old water main failed (Holton, 2021).

4.3.7.4 Future Occurrence

Because sinkholes are unpredictable, it can be difficult for property owners, prospective homebuyers, real estate agents, and municipalities to predict when and where they will appear. Several signs can signal potential sinkhole development. These include:

- Slumping or falling fence posts, trees, or foundations
- Sudden formation of small ponds
- Wilting vegetation
- Discolored well water
- Structural cracks in walls, floors

The highest risk areas for subsidence are linked to areas of poor fill on former creek beds. The risk of sinkholes may also increase more generally as infrastructure ages and climate change causes extreme temperature and precipitation events to become more common, stressing sewers, water mains, and the surrounding soil.

4.3.7.5 Vulnerability Assessment

The presence of sinkholes can result in environmental impacts such as groundwater contamination. Due to their porous nature, sinkholes are sometimes used to enhance groundwater recharge. However, if hazardous materials are spilled at a recharge point, groundwater can be contaminated due to the lack of soil substrate which normally would slow migrating contaminants. Vegetation is usually damaged during abrupt subsidence events. Land subsidence can also result in increasingly frequent and expansive flooding and changes in river canal and drain flow systems.

Subsidence repair or preemptive mitigation can be costly. Developed areas have unique problems in re-designing and reconstruction after subsidence or a sinkhole. After-the-fact subsidence repairs are often expensive and are not safe from re-occurring subsidence and sinkhole issues.

Physical and monetary losses caused by sinkhole formation are difficult to calculate for all existing buildings, critical facilities, and infrastructure, because the hazard area can so widely vary in location and size. In addition to impacting buildings and facilities, subsidence can severely impact roads and infrastructure.

Mitigation actions to lessen the potential for sinkholes are costly. According to the city's estimates, the Water Department operates 3,200 total miles of shared water mains. Seventeen percent of the Water Department's sewer mains are from the 19th century. Fifteen percent of water mains and 3.5% of storm sewers, respectively, are from the same period. These pipes are reaching the end of their lifespan. The Water Department has allocated $200 million over the next five years for sewer reconstruction, along with an additional annual commitment of $16.5 million for regular system maintenance.

No two sinkholes are alike, making it difficult to gauge the average cost for a sinkhole repair. A small sinkhole with minimal damage to the structure may cost anywhere from $10,000 to $15,000. However, sinkholes that cause extensive damage and need a significant amount of repair work can cost between $20,000 to over $100,000 (Crosstown Engineering, 2021).

During a sinkhole investigation, a structural engineer will evaluate the damage and associated costs based on a variety of factors. These factors include:

- Property layout
- Depth of the sinkhole
- Severity of the remediation method
- Cost of materials, tools and any other methods that will fix the damage caused by the sink hole
- Additional fees such as restoration or monitoring

Philadelphia residents whose home is impacted by sinkholes can experience lengthy utility outages during repair work. Individuals that rely on electricity for life sustaining equipment are at greater risk of impact during these types of events. In extreme cases like the incident in the Logan Square Triangle, residents may be forced to relocate, placing an additional economic and social burden on community members. Research indicates that individuals over the age of 65 and minority populations are particularly vulnerable to harmful effects from relocating away from their social support systems (Siders, 2018). Additionally, socially vulnerable populations are less likely to have a financial safety net or insurance to support sinkhole repairs.

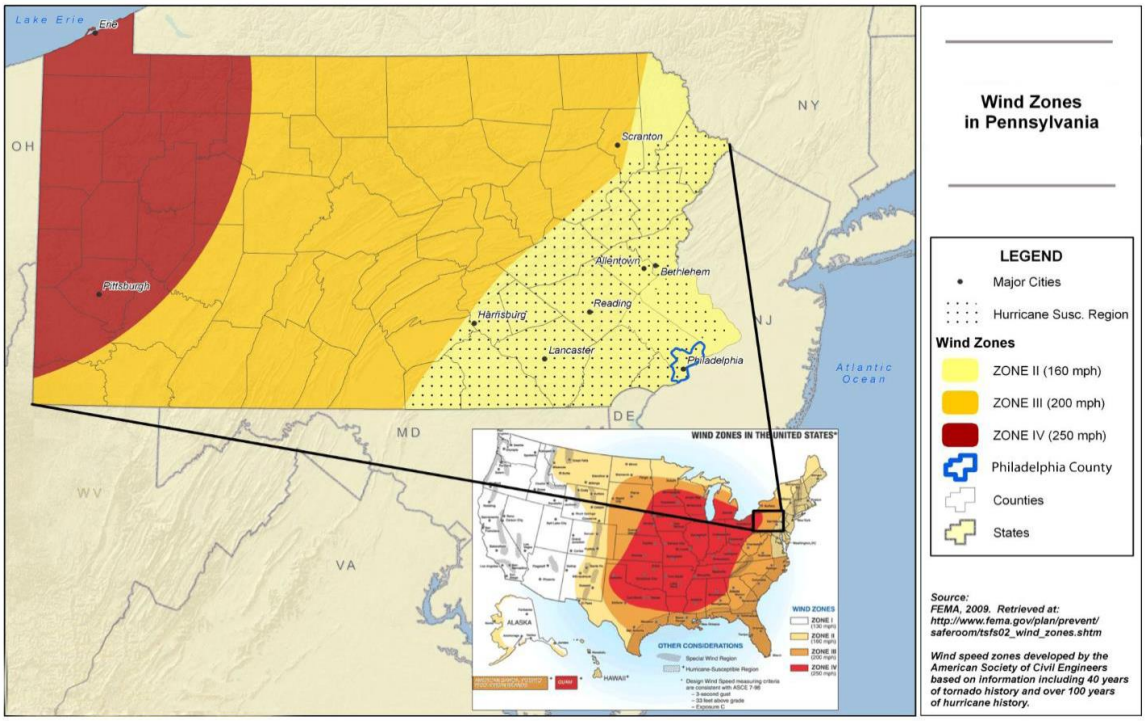
4.3.8 Tornado, Windstorm

A **tornado** is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. About 1,250 tornadoes hit the U.S. each year, with about 16 hitting Pennsylvania. Damaging winds exceeding 50-60 miles per hour can occur during tornadoes, severe thunderstorms, winter storms, or coastal storms. These winds can have severe impacts on buildings, pulling off the roof covering, roof deck, or wall siding and pushing or pulling off the windows (PEMA, 2020).

4.3.8.1 Location and Extent

Windstorms and tornadoes can occur anywhere throughout Philadelphia. Using over forty years of data, the American Society of Civil Engineers divided the United States into four zones that geographically reflect the frequency and strength of extreme windstorms. The identification of wind speeds contributes to a basis for design and evaluation for the structural integrity of shelters and critical facilities in these zones. Philadelphia falls within Zone II, meaning design wind speeds for shelters and critical facilities should be able to withstand a three-second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, or other windstorm event. The image below depicts the Wind Zone designation for the planning area (FEMA, 2010).

Figure 4-22. Wind Zones in Pennsylvania



Source: FEMA, 2010

4.3.8.2 Range of Magnitude

The Fujita Scale (F-Scale) is the standard measurement for rating the strength of a tornado. The NWS bases this scale on an analysis of damage after a tornado to infer wind speeds. This scale was designed to connect the Beaufort Scale with the speed of sound atmospheric scale, or Mach speed. On February 1, 2007, the Enhanced Fujita Scale (EF-Scale) replaced the use of the F-Scale. The EF-Scale is considerably

more complex and enables surveyors to assess tornado severity with greater precision. The EF-scale still is a set of wind estimates, not measurements, based on damage. The scale uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 indicators.

Table 4-33. Operational EF Scale

EF Number	3 Second Gust (mph)	Typical Damages
0	65-85	**Light damage:** some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; signboards damaged.
1	86-110	**Moderate damage:** peels surface off roofs; mobile homes pushed off foundations or overturned, moving autos blown off roads.
2	111-135	**Considerable damage:** roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
3	136-165	**Severe damage:** roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
4	166-200	**Devastating damage:** well-constructed houses leveled; structures with weak foundations away some distance; cars thrown and large missiles generated.
5	Over 200	**Incredible damage:** strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

When conditions warrant, the National Weather Service issues tornado-related products. A **Tornado Watch** is issued when conditions are favorable for the development of tornadoes. People should be prepared to move to a place of safety. A **Tornado Warning** occurs when either a radar shows a tornado or trained spotters sight imminent conditions. During a Warning, people should seek shelter immediately. A **Tornado Emergency** is an exceedingly rare tornado warning issued when there is a severe threat to human life and catastrophic damage from an imminent or ongoing tornado.

Both windstorms and tornados pose a threat to trees. Gusts and sustained winds can cause damage to trees through fallen and downed limbs. Fallen trees and limbs can partially block waterways, affecting turbidity if the downed tree is large enough, or the tributary small enough. High winds can also cause erosion of topsoil if the soil is dry or loose enough. Additionally, high winds can spread trash and debris over a large area, complicating clean-up efforts.

Additionally, windstorms and tornadoes can also impact local waterways. Tornados, should they damage chemical facilities or other facilities where chemicals are stored, can release hazardous materials into the ground, water, or air. The destruction of homes or businesses where asbestos or lead is present can also affect local health. Based on recent occurrences in the region, the worst-case scenario for Philadelphia would be an EF3 tornado occurring in the City.

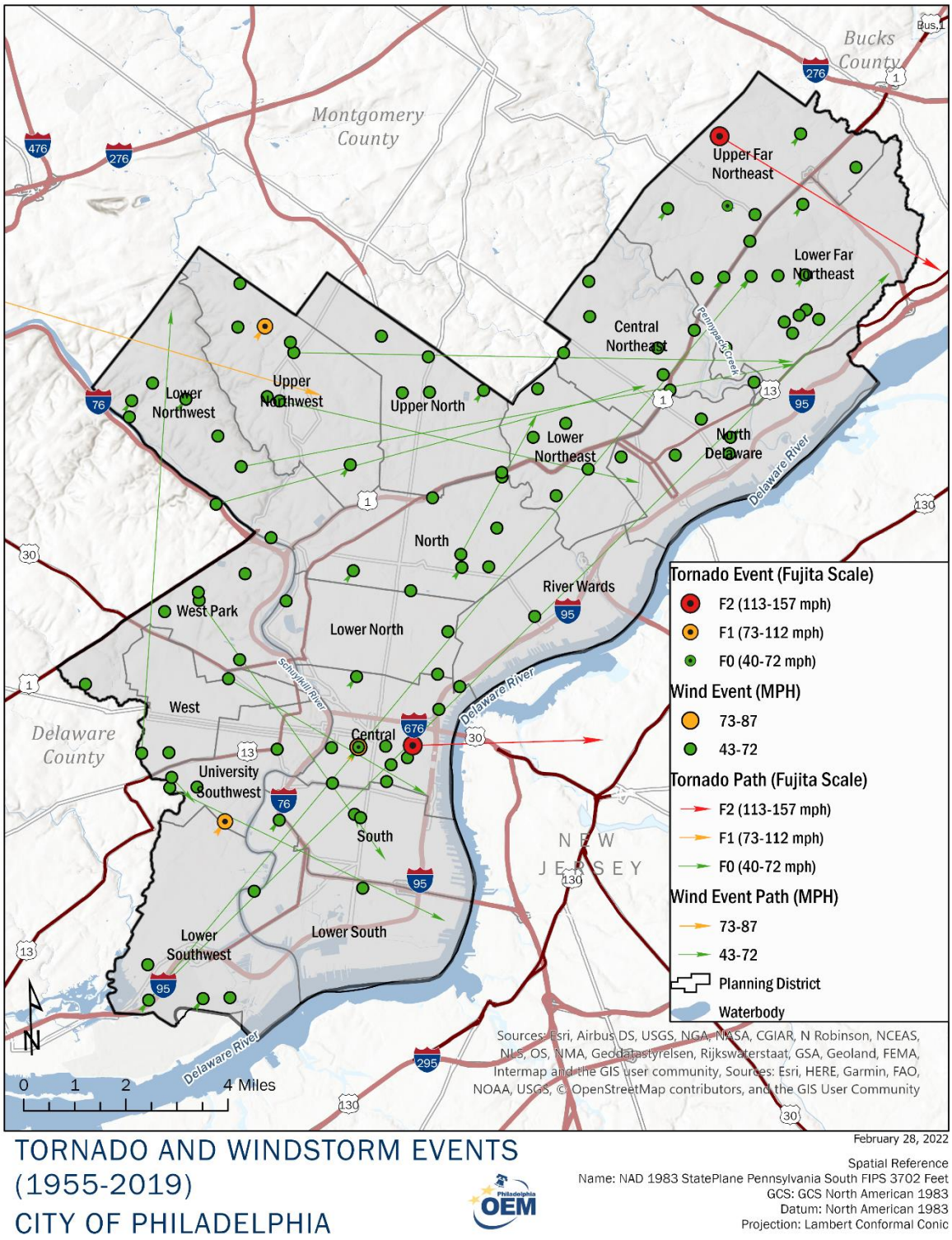
4.3.8.3 Past Occurrence

Between 1955 and 2019, there were 197 documented windstorms and tornados (NOAA, 2020). These windstorms have injured individuals, damaged buildings and vehicles, downed trees and power lines, and disrupted transportation, communications, and power services. Since 1955, seven wind events

classified as tornadoes directly impacted Philadelphia, all being classified an EF2 or weaker. **Figure 4-23** shows tornado events and tornado paths in Philadelphia from 1955 to 2019.

In July 2021, an EF3 tornado touched down in the neighboring suburb of Bensalem, PA. This tornado was the first of this intensity to impact the Philadelphia area in 27 years (Steele and Wood, 2021). Additionally, during Hurricane Ida in September 2021, seven tornados touched down throughout southeastern Pennsylvania and southern New Jersey (ABC, 2021). During this outbreak, a tornado that passed through Mullica Hill, N.J., about 10 miles south of Philadelphia, received an EF3 rating, making it the strongest to impact New Jersey in 31 years (Livingston, 2021).

Figure 4-23.Tornado and Windstorm Events (1955-2019) City of Philadelphia



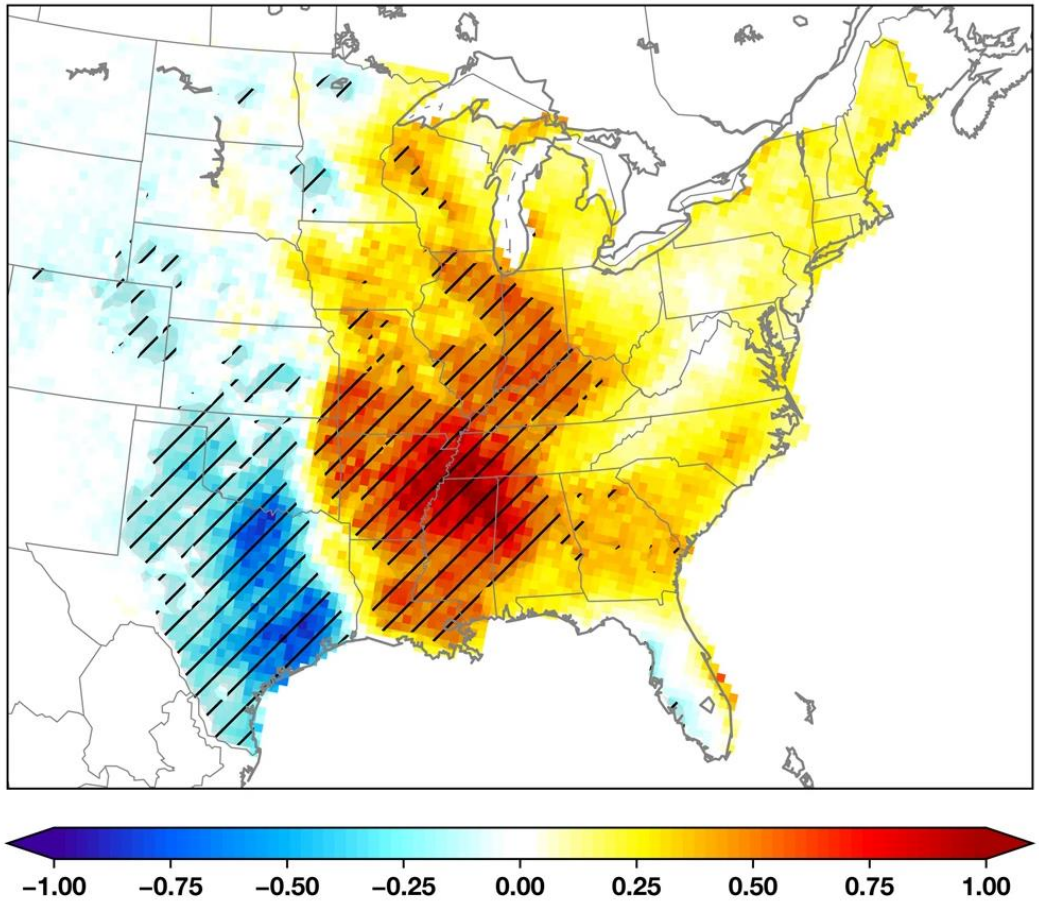
Source: [NOAA/NWS/Storm Prediction Center/SVRGIS]

4.3.8.4 Future Occurrence

Windstorms are a common occurrence in Philadelphia, making them a highly probable hazard in the future. Philadelphia experiences high-wind events at least three times a year based on 197 documented windstorms and tornados between 1955 and 2019. Tornadoes are infrequent occurrences in Philadelphia; since 1955, seven documented high-wind events were classified as tornadoes. However, the 2021 tornado outbreaks across the region highlight the risks associated with such occurrences.

While it is predicted that storms and hurricanes will become more intense in the coming decades due to climate change, no scientific studies have linked climate change and the increase or decrease of tornado events. However, a 2018 study (Gensini and Brooks, 2018) found that over the past 40 years, EF1+ tornadoes have increased in frequency from roughly Louisiana to Missouri eastward, especially south of the Ohio River, east of the Mississippi, and west of the Appalachians. Many of the deadliest and most destructive tornadoes of the 21st century have occurred in that region, including those in the catastrophic Super Outbreak of 2011 as well as the Tennessee tornadoes of 2020 that caused billions in damage and killed 28 (Henson, 2021). In other words, tornado alley is moving eastward. **Figure 4-24** from Gensini and Brooks' 2018 study shows an upward trend of tornados in portions of the Southeast, Midwest, and Northeast. Isolated stronger tornados in the Philadelphia region, such as the two EF3 tornados that occurred in Bensalem and Mullica Hill in 2021, are not inconsistent with this trend.

Figure 4-24. Trends of Increase and Decrease of Tornado Events in the United States



Source: Gensini and Brooks, 2018

**Note: Theil-Sen slope analysis (a robust linear trend estimator which is insensitive to outliers) of 1979-2017 annual grid-point sum of daily max STP (significant tornado parameter) from NARR. *p* values are hatched at values less than or equal to 0.05 significance using Kendall's τ statistic. Slope units are sum of daily max STP per year.

4.3.8.5 Vulnerability Assessment

Severe windstorms and tornadoes pose a significant risk to life and property in Philadelphia by creating conditions that disrupt essential systems such as public utilities, telecommunications, and transportation routes. Fallen trees and debris are common after high wind events, which can block access to roads, bring down power and utility lines, and damage building stock. Areas with tall buildings, such as Center City and University City, are at greater risk as increased wind pressure occurs at greater heights. Construction sites are also especially vulnerable to high winds. Loose tools and construction materials, cranes, and scaffolding may loosen from exposure to high winds and become flying debris.

In the case of both windstorms and tornadoes, the greatest impact on the natural environmental is on trees and woodland. High winds can easily uproot trees, shrubs and bushes. Street trees in particular are highly susceptible to high winds. A street tree is a tree located between the sidewalk and the curb, in the public right-of-way. There are approximately 135,000 street trees in Philadelphia.

Populations at greater risk to the impacts of windstorms and tornadoes include, but are not limited to, adults 65 years and older (13.4% of the population), children under the age of 5 (6.7%) of the population, individuals living below the poverty line (23.3% of the population) (U.S. Census Bureau, 2019), individuals who are unsheltered, individuals who experience language and communication barriers (24.1 % of the population over age 5 primarily speaks a language other than English), and individuals needing support with functional needs and activities of daily living (See **Figure 2-4:** Geographic distribution of individuals with a disability in Philadelphia) . Socio-economic factors may not only hinder an individual's ability to prepare for and respond to a disaster, but also affect their capacity to access services in the aftermath of an incident. Individuals that rely on electricity for life-sustaining equipment are also more at-risk during these events due to the high likelihood of utility disruptions associated with windstorms and tornadoes. For more information on the distribution of these populations in Philadelphia, please see **Section 2: Community Profile**, specifically **Figure 2.5 - Geographic Distribution of Philadelphia's Population, Age 65 years and older** and **Section 2.3.2: Age Breakdown** .

Structural vulnerability to wind correlates with a building's construction type. Wood structures and manufactured homes are more susceptible to wind damage, while steel and concrete buildings are more resistant. Mobile homes are the most susceptible structures to tornadoes and windstorms, though the number of mobile homes in Philadelphia is less than 1%. High-rise buildings are also susceptible to damage caused by high winds and/or tornadoes. For high rise buildings, Philadelphia adheres to the National Code requirement for Structural Wind Load Designs as spelled out in ASCE-7 and Uniform Building Code (UBC).

Tornados and windstorms also increase the risk of building collapse. Factors that increase risk of a building collapse during high wind events include building age, vacancy rate, and status as an

imminently dangerous structure. Thirty-nine percent of Philadelphia's properties were built before 1939. The North and West planning districts are the next most populated with older buildings.

Vacant properties also increase the risk of a building collapse because these properties fall into disrepair and neglect. Philadelphia has a higher percentage of vacant properties than the national average, with 12.3% of properties vacant as of 2019 census five-year estimates. Most areas in Philadelphia with a large percentage of vacant properties align with neighborhoods identified by the CDC as having high social vulnerability.

See **Section 4.3.10 Building and Structure Collapse** for more information and maps demonstrating locations of structures built before 1939, vacant housing units, and imminently dangerous structures. These maps demonstrate areas more susceptible to structural impacts from wind.

Additionally, there are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services. Industry and commerce can suffer losses from interruptions in electric service and extended road closures. In addition, they can also sustain direct losses to buildings, personnel, and other vital equipment.

4.3.9 Winter Storm

A winter storm is a storm in which the main types of precipitation are snow, sleet, or freezing rain. A winter storm can range from a moderate snowfall or ice event over a period of a few hours to blizzard conditions with wind-driven snow that lasts for several days. Most deaths from winter storms are not directly related to the storm itself, but result from traffic accidents on icy roads, medical emergencies while shoveling snow, or hypothermia from prolonged exposure to cold (PEMA, 2020).

Since nor'easters are cyclical storms, they are covered under section **4.3.5 Hurricane, Tropical Storm, Nor'easter**.

4.3.9.1 Location and Extent

Historically, Philadelphia is prone to winter weather due to its northern location and proximity to the Atlantic Ocean. In the past, winter weather events have started as early as October in Philadelphia. The frequency and intensity of winter weather events strengthens in December when winter temperatures average between 20°F and 40°F. Winter storms are often regional events, and all neighborhoods within Philadelphia are equally subject to their impacts. Roads and bridges are especially vulnerable because of transportation accidents and disruptions related to severe winter storms.

4.3.9.2 Range of Magnitude

The magnitude or severity of a winter storm depends on several factors including temperature, wind speed, types of precipitation, rate of deposition (how fast the snow is falling), and the time of day and/or year the storm occurs. The magnitude of a winter storm can be classified by meteorological measurements and by evaluating its societal impacts.

There is no widely used scale to classify snowstorms, though there are several descriptive classifications used to define the scale of a snow event. Paul Kocin of the Weather Channel and Louis Uccellini of the NWS developed The Northeast Snowfall Impact Scale (NESIS) to characterize and rank high-impact Northeast snowstorms. NESIS differs from other meteorological indices in that it uses population

information in addition to meteorological measurements, thus providing an indication of a storm's societal impact.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The distribution of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over 10 for extreme storms, as shown in **0**The raw score correlates with one of the five NESIS categories.

Table 4-34. NESIS Scale

Category	Description	NESIS Range	Definition
1	Notable	1.0-2.49	Category 1 storms produce up to four inches of snow over a widespread area. A few smaller areas may experience up to 10 inches of accumulation in a Category 1 storm.
2	Significant	2.5-3.9	Includes storms that produce significant areas of greater than 10-inch snows while some include small areas of 20-inch snowfalls. A few cases may even include relatively small areas of very heavy snowfall accumulations (greater than 30 inches).
3	Major	4.0-5.9	This category encompasses the typical major northeast snowstorm, with large areas of 10 inch snows (generally between 50 and 150 x 103 mi^2) with significant areas of 20 inch accumulations
4	Crippling	6.0-9.9	These storms consist of some of the most widespread, heavy snows. Effects of such a storm are crippling to the northeast, U.S., with impacts to transportation and the economy felt throughout the United States. These storms encompass huge areas of 10-inch snowfalls, and each case is marked by large areas of 20 inch and greater snowfall accumulations.
5	Extreme	Over 10	These storms represent those with the most extreme snowfall distributions, blanketing large areas and populations with snowfalls greater than 10-inch accumulations. The storms effects exceed 200 x 103 mi^2 and impact more than 60 million people.

The NWS-issued winter weather products for Philadelphia include Winter Storm Outlook, NWS Watches, NWS Advisories, and NWS Warnings. A **Winter Storm Outlook**, which is distributed when forecasters believe winter storm conditions are possible, is usually issued 3 to 5 days in advance of a winter storm. **NWS Watches**, which include Blizzard Watch, Winter Storm Watch, and Wind Chill Watch, are issued when the potential for a blizzard, storm, or extremely low temperatures are probable and approaching. **NWS Advisories**, including Winter Weather Advisory and Wind Chill Advisory, are issued when weather or temperature conditions are expected to be significant and hazardous. **NWS Warnings**, including Blizzard Warning, Heavy Snow Warning, Ice Storm Warning, Winter Storm Warning, and Wind Chill Warning, are issued immediately before (12-24 hours) or during a storm event to warn people of hazardous conditions outside.

Winter storms have the potential to cause significant damage to trees. Winter storms also kill plant life, which affects other plants and wildlife. When winter storms kill plants and flora, this affects the food supply for local animals and wildlife.

Winter storms also create wet or damp conditions for an extended period, increasing the likelihood of mold and fungi. While some types of mold and fungi assist with breaking down fallen trees, other types of mold and fungi can kill plants and trees that help sustain the local ecosystem.

As temperatures begin to rise following a winter storm, there is the increased risk of flooding if snow melts too quickly for the ground to absorb. For more information on the environmental impacts of flooding, see section **4.3.4 Flood, Flash Flood, Ice Jam**.

In man-made environments, such as the City of Philadelphia, winter storms can disrupt air and rail service to the region, make roadways impassable, and cause prolonged power outages. If temperatures remain low after the storm has passed, recovery will be more difficult.

A worst-case scenario for Philadelphia would be a blizzard similar to the blizzards of 1996, 2010, and 2016, with snowfall ranging from 24-48 inches (Crippling to Extreme on the NEIS scale). High, sustained winds would complicate plowing efforts and air, rail, and road service would be interrupted or halted for days. Power outages would affect the region and potentially endanger lives due to low temperatures. For more information on the impacts of these storm events, see **Section 4.3.9.3 Past Occurrence**.

4.3.9.3 Past Occurrence

Philadelphia averages 22.3 inches of snowfall annually based on NOAA data from 1971 to 2020. Historically, seasonal totals range from just a trace during the 1972/1973 season to 78.7 inches during the 2009/2010 season. Storm totals have reached as high as 30/7 inches, which was observed during the January 1996 Blizzard. Snowfall in excess of 24 inches was also observed during one other winter storm that occurred in February 2010.

Table 4-35. Notable Winter Storms in Philadelphia, 1996-2020 Storm Events

Date	Total Snow	Impacts
1/7/1996 - 1/8/1996	30.7 inches	The City of Philadelphia declared a Snow Emergency and The Governor declared a State of Emergency. Philadelphia schools were closed for a week. SEPTA suspended services. PennDOT operations took two days to clear streets and main arteries. Excess snow piles dumped into the Schuylkill River caused a dam. Numerous emergency vehicles were stranded in the snow, unable to respond to emergencies and PFD experienced access problems due to unplowed streets. The Schuylkill River near Manayunk froze, causing ice flows to dam the river and cause flooding. SEPTA shutdown and Philadelphia International Airport closed for 3 days.
12/19/2009 - 12/20/2009	23.2 inches	SEPTA reported suspended bus and rail operations. Trash pick-ups were delayed. Special events in the area were delayed due to storm impacts. Philadelphia International Airport cancelled 77% of flights. Retail shops and malls closed early.
2/9/2010-2/10/2010	15.8 inches	The Governor declared a State of Emergency. Thousands of residents lost power in Philadelphia due to the storm with wind gusts peaking at 37 mph. Philadelphia Schools were closed for two days. The

Date	Total Snow	Impacts
		Philadelphia International Airport closed for one day. SEPTA suspended regional rail and bus services. Two fatalities occurred in Philadelphia.
2/5/2010-2/6/2010	28.5 inches	Governor declared a Statewide Disaster Emergency. The City of Philadelphia declared a Snow Emergency. Amtrack and SEPTA suspended services. Philadelphia International Airport cancelled flights. Philadelphia Schools were closed for a day.
1/11/2011	5.2 inches	Schools were closed, a snow emergency was placed into effect, SEPTA reported disruptions and detours on some bus routes and delays up to 20 minutes on Regional Rail lines, and some flights were cancelled out of Philadelphia International Airport. The timing of this storm between 8pm-2am resulted in minimal impacts to the City.
1/26/2011 - 1/27/2011	15.1 inches	A Snow Emergency was declared by the City of Philadelphia. SEPTA regional transportation reported service disruptions and systemwide delays. Numerous flights were cancelled at the Philadelphia International Airport, with over 1,500 travelers stranded at the airport overnight. 311 experiences 4x the normal rate of calls. Numerous vehicles and buses were stranded, with some SETPA buses stranded for up to 12 hours. Schools were closed on the 27th and the 28th . Estimated clean-up costs in Philadelphia were close to $6 million.
12/8/2013 - 12/09/2013	8.6 inches	The snow caused numerous accidents and road closures in the region, including the closure of the Platt Street Bridge. Philadelphia International Airport experienced delays of up to four and half hours. SEPTA Regional Ral service suspended the Manayunk/Norristown Line.
02/12/2014 - 02/14/2014	11.5 inches	Heavy snow led to numerous 911 calls and vehicle accidents. SEPTA Regional Rail suspended service overnight, and ran with 60-minute delays following the storm. Over 400 flights were cancelled at the Philadelphia International Airport. A chain reaction multi-vehicle accident occurred on the Eastbound Pennsylvania Turnpike in Bucks County causing it to be closed for 8 hours.
2/21/2015 - 2/22/2015	0.15 inches of ice, 4.8 inches of snow	About 20% of flights in and out of the Philadelphia International Airport were cancelled. SEPTA reported bus routes detoured and regional rail service experienced delays up to 30 minutes.
3/01/2015	0.2 inches of ice, 0.4 inches of snow	Storm brought a combination of snow, sleet and freezing rain to Philadelphia causing scattered power outages and minor impacts to the area.
1/22/2016 - 1/23/2016	22.4 inches	A Blizzard Warning was issued for this storm. The City of Philadelphia declared a Snow Emergency. SEPTA suspended services and schools were closed for one day. 911 calls were significantly higher than normal. Numerous vehicles were abandoned in right of ways due to blizzard conditions, resulting in city-led towing operations. No significant disruptions to electric or gas services reported. President declared a Federal Disaster with Public Assistance approved for Philadelphia. This storm event cost over $6.2 million dollars in Streets Department costs alone
01/04/2018	4-6 inches	Snow and high winds caused the greatest impacts. Snowfall varied greatly across the City. Numerous flights were cancelled, and a Code Blue was activated due to extreme cold conditions following the storm event.

Date	Total Snow	Impacts
03/06/2018- 03/07/2018	7 inches	The City of Philadelphia declared a Snow Emergency. City offices and schools were closed. Flights were cancelled a tall major airports and numerous power outages were reported due to downed trees, limbs and wires.
03/21/2018	7.6 inches	Storm brought a mix of ice and snow to the area. Numerous power outages reported due to downed trees, limbs and wires. Ice fell during rush hour causing significant traffic and vehicle accidents in the area.
12/16/2020	6.6 inches	Heavy snow and sleet were reported. Strong winds in the region led to numerous power outages due to downed trees, limbs and wires.
1/28/2022	7.5 inches	The timing of this storm led to minimal impacts in the Philadelphia region. Some power outages were reported due to downed trees, limbs, and wires.

Source: NOAA Storm Events Database and local historical data.

4.3.9.4 Future Occurrence

Winter storms will continue to occur in Philadelphia. Based off monthly climate averages from 1991 to 2020, the City potentially will experience snowfalls in the amounts and months shown in the following table.

Table 4-36. 30-Year Snowfall Averages in Philadelphia, 1991-2020

Month	Inches
January	7.1”
February	8.4”
March	3.6”
April	0.3”
November	0.2”
December	3.5”
Winter Total	**23.1”**

Source: Current Results

Climate change is expected to impact winter storms. The frequency of extreme snowstorms in the eastern two-thirds of the contiguous United States has increased over the past century (NOAA). Warmer-than-average ocean surface temperatures in the Atlantic can lead to more intense storms (NOAA). Precipitation projections in Philadelphia for the coming century prepared for the HMP support NOAA’s predictions. The largest three-day winter precipitation event in Philadelphia is projected to increase from a 2.0” event (average for 1950-1999) to a 2.5”-2.7” event mid-century. Towards the end of the century, it is projected to be a 3.0”-3.3” event. It is also likely that as temperatures warm, precipitation will shift from snow to rain and mixed conditions.

4.3.9.5 Vulnerability Assessment

Severe winter weather can immobilize a region, shutting down all air and rail transportation, stranding commuters, stopping the flow of supplies, and disrupting medical and emergency services. Winter weather can also cause building collapses and can bring down trees, electrical wires, telephone poles, lines and communication towers. Damages to utilities can disrupt communications and power for days

while utility companies work to repair the issues. In addition, severe winter weather can affect rail beds and the switch systems. Winter weather may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

Several secondary effects of winter storms can increase the risk to life and health in Philadelphia's population. Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. Winter storms can disproportionately affect the sick, older adults aged 65 or older, and children under the age of 5 due to the exacerbation of chronic illnesses such as asthma, and the inability to effectively regulate body temperatures. Low-income, displaced persons, and unsheltered populations frequently lack access to adequate home heating systems during winter storm events. No matter age or vulnerability, people exposed to cold temperatures for extended periods of time run the risk of developing dangerous conditions such as hypothermia or frostbite. Severe winter storm events can also reduce the ability of these populations to access emergency services.

In addition to effects on populations, winter storms can cause secondary environmental effects, such as riverine, surface, and flash flooding. Private residences and businesses located in the floodplain are therefore vulnerable during winter months. Severe winter storms can cause flooding through ice jams (in hydrologic terms, a stationary accumulation that restricts or blocks streamflow), blockage of streams or through snow melt. The **4.3.4 Flood, Flash Flood, Ice Jam** hazard profile of this plan identifies residential properties most at-risk for such flooding events.

Winter storms can also cause structural losses. Building collapses and structural damage can occur when snow accumulates on flat rooftops, or porch awnings. As snow melts, it can collect in depressed or recessed areas, a condition commonly known as ponding. This additional weight from either snow accumulation or ponding jeopardizes a building's structural soundness and may lead to total collapse. Vulnerability to the effects of winter storms on buildings is dependent on the age of the building, what building codes may have been implemented at the time of construction, the type of construction and condition of the structure, including how well has the structure been maintained.

Additional costs outside of structural losses occur during winter storms in the form of road maintenance and labor. The cost of snow and ice removal, salting roads, repairing roads from the freeze/thaw process, and the loss of business can have a severe economic impact on Philadelphia.

Human-made Hazards

4.3.10 Building and Structure Collapse

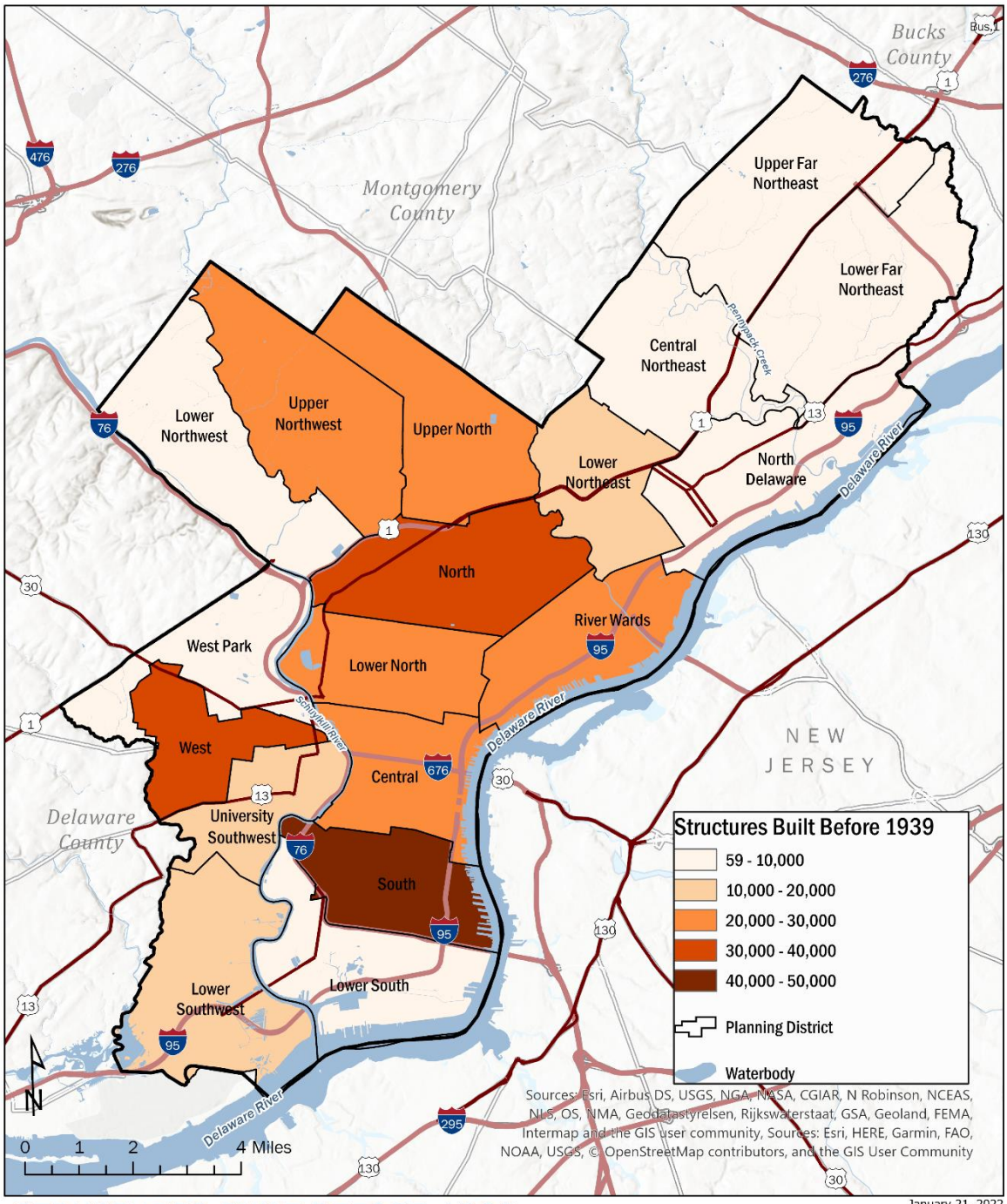
Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards (PEMA, 2020).

4.3.10.1 Location and Extent

Three factors contribute to the collapse of buildings in Philadelphia and can assist in identifying those areas at greater risk for building collapses. These three factors are building age, vacancy rates, and imminently dangerous property designation.

Building age and ongoing maintenance affect the risk of building collapse. Older, vacant and under-maintained structures are at particular risk. Thirty-nine percent of Philadelphia's properties were built before 1939. The following map shows the number of properties built before 1939 in each planning district. Many older buildings are located in the South planning district. The North and West planning districts are the next most populated with older buildings.

Figure 4-25. Structures Built Before 1939 by Planning District in Philadelphia



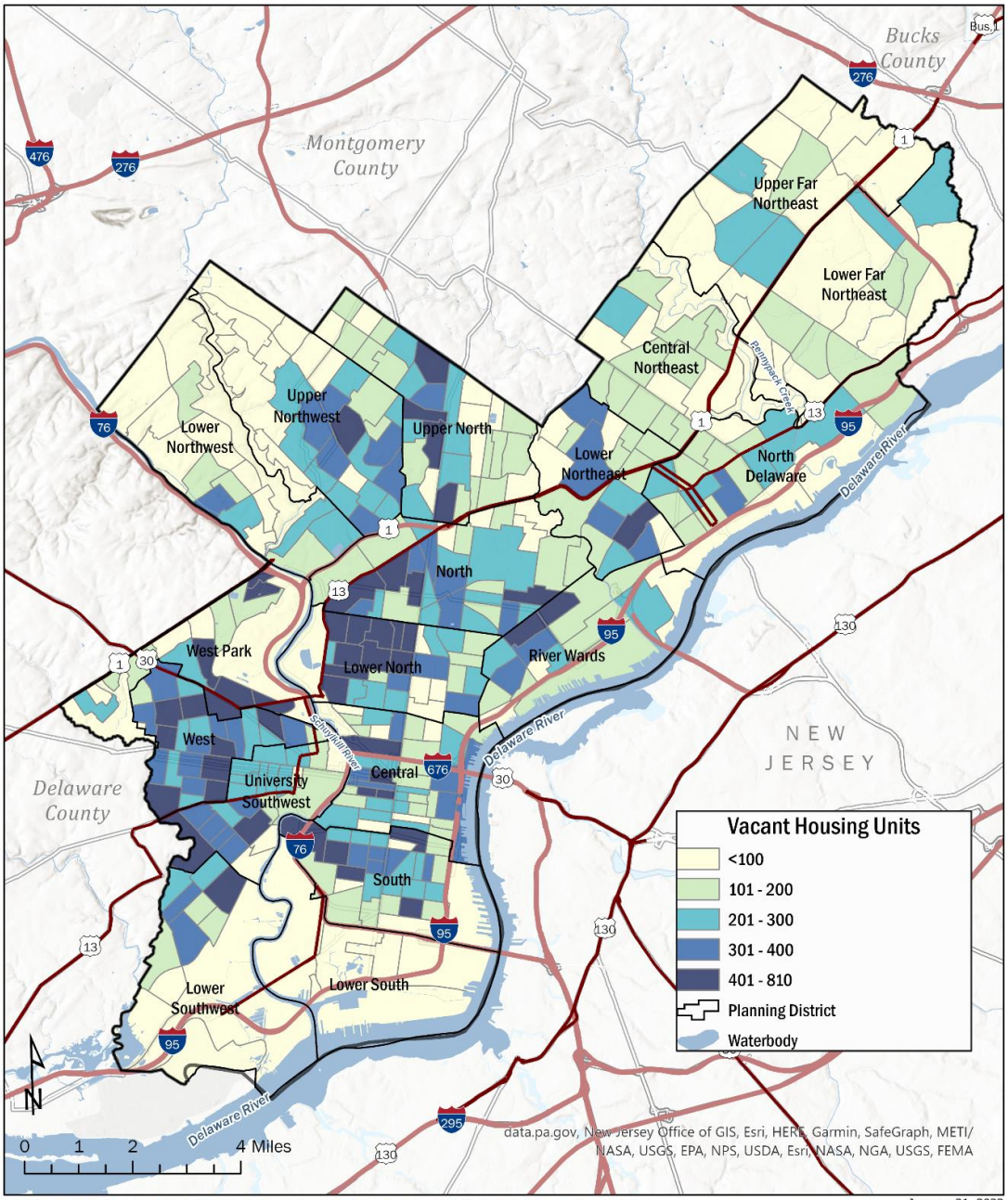
STRUCTURES BUILT BEFORE 1939
BY PLANNING DISTRICT
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
Name: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

Vacant properties also increase the risk of a building collapse, as these properties fall into disrepair and neglect. Philadelphia has a higher percentage of vacant properties than the national average, with 12.3% of properties vacant as of 2019 census five-year estimates. Most areas in Philadelphia with a large percentage of vacant properties align with neighborhoods identified by the CDC as having high social vulnerability.

Figure 4-26. Estimated Vacant Properties by Census Tract in Philadelphia, 2019



A bridge collapse consists of a failure of decking, superstructure, or foundation leading to a progressive or immediate collapse of the entire assembly. Bridges can span waterways, railways, or roadways and provide overpasses for surface transportation or passenger/freight rail lines. Potential causes of bridge collapse include unchecked oxidation (rust degrading the integrity of structures), concrete deterioration, repetitive stress fractures, harmonic vibration (oscillation or vibration of a structure), excessive traffic loads, or wind load (stress on a structure caused by the push and pull of wind).

4.3.10.2 Range of Magnitude

Infrastructure collapses typically affect adjacent structures and properties. Secondary impacts can range from temporary traffic disruption to longer-term traffic congestion on alternate routes. Obstruction or damage to infrastructure, rail systems, and waterways can lead to temporary disruptions. In worse-case scenarios, individuals can be trapped, injured, or killed due to structure and building collapse.

The collapse of a bridge above a waterway can have additional effects on the environment through the destruction of coastal habitats. Larger pieces of debris in a waterway could disrupt flow and local currents, leading to sediment build-up and increases in turbidity. The environmental impact of a building collapse depends on the size, type, and location of the building. Smaller, residential buildings, for example, will have a smaller environmental impact footprint due to the limited size of the debris field generated because of the collapse.

A worst-case scenario for Philadelphia would include the collapse of the Delaware Expressway over Palmer-Cumberland streets, causing damage, injuries, and severe traffic. Another worst-case scenario would include the accidental collapse of a large building outward, which would likely involve casualties, injuries, and closed roads.

4.3.10.3 Past Occurrence

In recent decades, the city has experienced numerous small or partial building collapses, mostly involving vacant residential buildings, each year. However, several more significant events have occurred in the 20th and 21st Centuries.

One of the most significant collapses in Philadelphia history occurred at the 1903 Baker Bowl Phillies game when a temporary wooden balcony failed. The seating area's collapse resulted in at least 12 fatalities and more than 200 injuries. This event led to changes in large stadium design that eliminated the use of wooden balconies and seating structures in favor of steel and concrete (Fitzpatrick, 2003).

Another significant event occurred in 2000 when a pier housing the Heat Nightclub on the Delaware River waterfront collapsed into the river. Problems with the pier's foundation had already been discovered but were not yet repaired at the time of the incident. The collapse caused 3 fatalities and led to a citywide effort to assess the safety of piers and pile-supported structures along the city's riverfront (Gibbons et al, 2000).

The most recent major building collapse in Philadelphia happened in 2013 at 2138-2140 Market Street when a demolition crew triggered the collapse of a vacant building onto an occupied Salvation Army Thrift Store. Six people were killed and 14 were injured. Two employees of the demolition contractor were prosecuted for performing improper work on the building (Williams, 2013).

In addition to the significant events described above, several building collapses of varying severity occurred since the last update of this plan in 2017. Recent events available for analysis in local news archives are shown in the table below.

Table 4-37. Building Collapses in Philadelphia Since 2017

Location	Date	Structure Type	Details
2200 block of N. Front Street	September 2021	Residential	Multiple buildings collapsed along N. Front Street resulting in two injuries.
717-719 Mercy Street	July 2020	Construction Site / Residential	Construction-related collapse of two rowhomes resulting in no injuries.
3300 block of N. 6th Street	May 2020	Vacant Residential	Vacant building collapsed, injuring one person walking nearby.
2621 W. Jefferson Street	June 2018	Construction Site / Residential	Construction-related partial collapse of a vacant building killed a contractor working on demolition at the site.
1728 Ridge Avenue	December 2018	Construction Site / Residential	Construction-related collapse of a rowhouse resulting in injuries to two construction workers.
6100 block of Yocum Street	April 2017	Vacant Residential	Vacant rowhouse collapsed, injuring one person inside.

Source: Philadelphia Inquirer

There have been no bridge collapses in Philadelphia history. Bridge inspections have identified bridge sections at greater risk for collapse in the past. Inspectors declared these bridges as functionally obsolete until maintenance crews conducted significant repairs. Once re-inspected, those bridges re-opened since repairs reduced the risk for collapse.

PennDOT found significant bridge damage in March 2008 beneath Interstate 95 when they observed a large crack in a support column. This resulted in the closure of the road for several days until emergency repairs were completed.

4.3.10.4 Future Occurrence

Philadelphia continues to have a high building vacancy rate and aging housing stock. As these factors persist, or in the case of aging housing stock, increase, there is an ongoing risk of building collapses in the future. Climate change also increases the risk of winter storms, nor'easters, and tropical cyclones impacting the city. These types of storms stress structures through wind damage and the weight of heavy snow, causing an elevated risk of collapse.

The failure rate for bridges is one out of 4,700 annually according to predictive modelling using national data (Cook et al., 2015). The failure rate data set shows that the causes for bridge collapse are:

- 52% hydraulic
- 20% collision
- 12% overload
- 7% deterioration

PennDOT inspects and categorizes bridges throughout the Commonwealth. According to PennDOT, there are 82 bridges listed in Poor condition in Philadelphia. This rating indicates that these bridges are

considered structurally deficient. Structurally deficient bridges have an increased risk of collapse with an elevated risk level of 1/1,100 annually. Though, the classification of structurally deficient does not mean the structure is unsafe for vehicular traffic.

4.3.10.5 Vulnerability Assessment

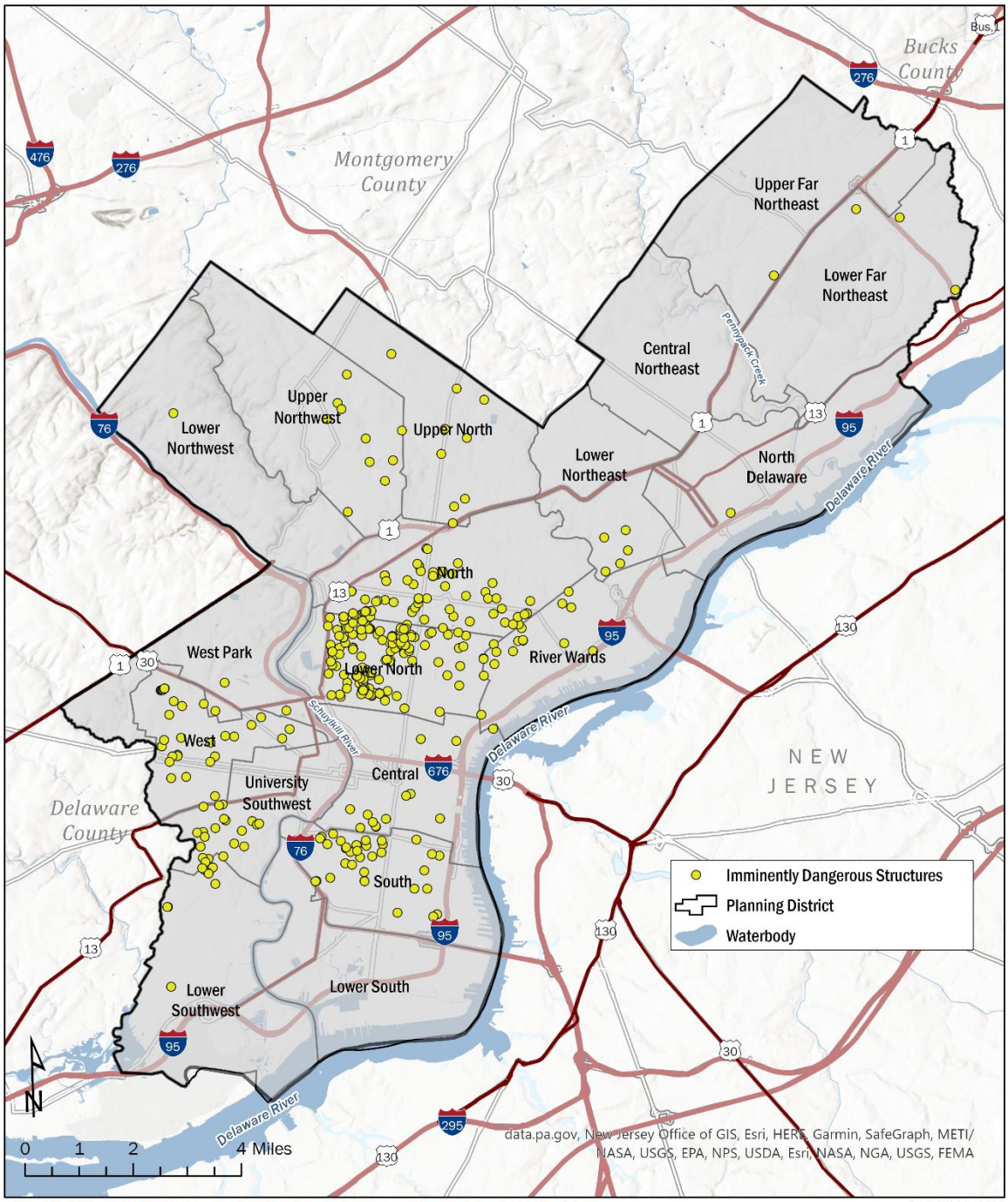
Imminently dangerous buildings are those buildings that are at risk for collapse. Philadelphia Licenses and Inspections keeps statistics on imminently dangerous buildings that inspectors find. Some have partially collapsed, others are found and acted upon before they collapse. The table below lists the number of imminently dangerous structures by zip code.

Table 4-38. Imminently Dangerous Buildings in Philadelphia by Zip Code, 2021

Zip Code	Imminently Dangerous Structures	Zip Code	Imminently Dangerous Structures
19104	3	19135	1
19107	1	19138	1
19115	1	19139	11
19119	4	19140	24
19120	1	19141	4
19121	68	19142	10
19122	4	19143	20
19123	3	19144	5
19124	5	19145	10
19125	7	19146	26
19126	2	19147	4
19130	1	19148	6
19131	4	19150	1
19132	90	19151	20
19133	15	19153	1
19134	20	19154	3

Philadelphia's socially vulnerable populations are more at risk for building and structure collapse impacts (injury, death, property damage/loss). **Figure 4-27** maps imminently dangerous buildings in Philadelphia, which are concentrated in North and West Philadelphia, coinciding with Philadelphia's most socially vulnerable populations (see **2.3.8 Social Vulnerability**).

Figure 4-27. Imminently Dangerous Structures in Philadelphia, 2021

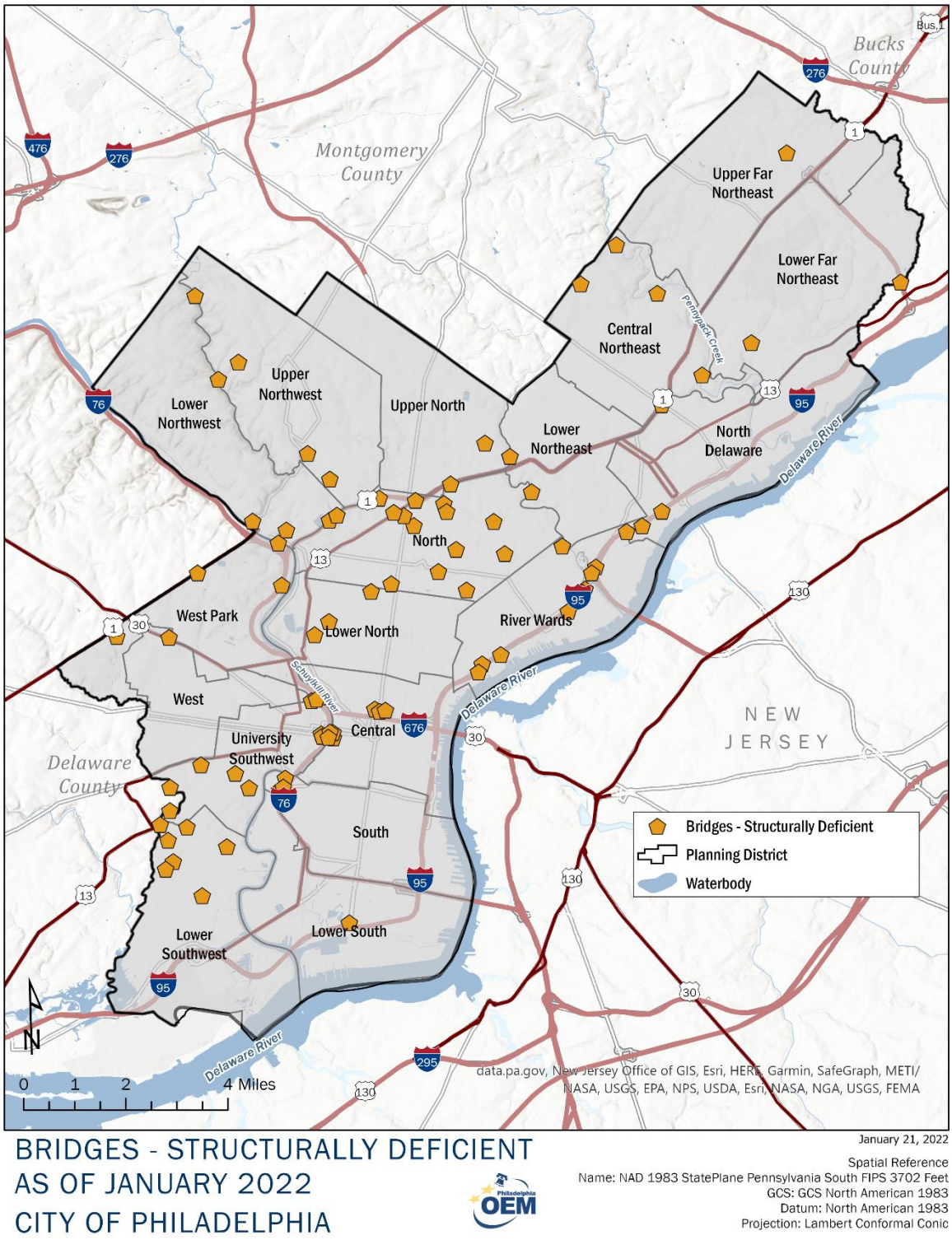


IMMINENTLY DANGEROUS STRUCTURES
AS OF JANUARY 2022
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
Name: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

Figure 4-28.Structurally Deficient Bridges in Philadelphia, 2021



Source: PennDOT

The most vulnerable areas of the County are those with the highest concentration of deteriorating structures. In the case of bridges, this involves the number and location of structurally deficient bridges throughout the City of Philadelphia. The table below shows the locations of structurally deficient bridges in the City, as well as the year the bridge was built.

Table 4-39. Structurally Deficient Bridges in Philadelphia, 2021

Bridge	Location	Year Built
49th St over SEPTA	S of Chester Ave	1894
Greenland Dr over Conrail	W of West River Dr	1974
30th St	Btwn Market St & Chestnut St	1931
61st St over SEPTA	S of Eastwick Ave	1928
Delaware Expressway over Sergeant St & Huntingdon St	Near Aramingo Ave	1965
Calumet St over SEPTA	W of Cresson St	1925
Cherokee St over Valley Green Rd	W of Springfield Ave	1960
Betsy Ross Bridge Ramps over Wheatsheaf Ln	Betsy Ross Bridge Interchange	1974
Chestnut St over 24th St	.8 mi. W of City Hall	1864
Cottman Ave over Roosevelt Blvd	At Roosevelt Blvd	1967
Chestnut St over CSX	1 mi. W of City Hall	1901
Byberry Rd over CSX	1 mi. NW of Route 1	1996
Whitby Ave over Cobbs Creek	W of Cobbs Creek Pkwy	1932
Woodhave Rd EB over Poquessing Creek	Near Route 13	1964
49th St over Amtrak	49th St and S Woodland Ave	1923
65th St over Cobbs Creek	SW Philadelphia	1906
70th St over SEPTA	S of Lindbergh Blvd	1980
34th St over CSX	Grays Ferry Ave	1930
Hunting Park Ave over Conrail	W of G St	1930
Margie St over Amtrak & Conrail	At 19th St	1919
W Coulter St over SEPTA	.5 mi. S of Wayne Ave	1901
City Line Ave over SEPTA	.5 mi. S of Belmont Ave	1910
Willits Rd over Wooden Bridge Run	Near Ashton Rd	1953
Krewstown Rd over Pennypack Creek	N of Algon Ave	1907
Tabor Rd over Tacony Creek	E of Olney Ave	1957
Wharton St over CSX	200' W Of 34th	1918
Fisher's Ln over Tacony Creek	W of Ramona St	1801
Schuylkill Ave W over Schuylkill Expressway Ramp A	Between Walnut St and Chestnut St	1959
I-95 over Fraley St	Near Bridge St	1967
Whitby Ave over SEPTA	S of Baltimore Ave	1917
Broad St SB over 1-95 Ramp A & Ramp C	N of Philadelphia Navy Yard	1969
Roosevelt Blvd Ext over Roberts Ave & SEPTA & CSX	Wayne Junction	1960
Delaware Expressway over Venango St	Near Tioga St	1965

Bridge	Location	Year Built
Old York Rd over Conrail	.5 mi. S of US-13	1913
59th St over Amtrak & SEPTA	N of Lancaster Ave	1926
Pine Rd over Pennypack Creek	S of Bloomfield Rd	1977
I-95 over Tacony St & Bridge St	Near Wakelin St	1967
Market St over CSX	Center City Philadelphia	1932
I-76 Ramp A over River Bank	I-76 WB Ramp at Chestnut St	1955
Spring Garden St over Amtrak and SEPTA	N of 30th St Station	1964
5th St over Conrail Richmond Branch	Near Allegheny Ave	1918
34th St over CSX	Grays Ferry Ave	1896
Cobbs Creek Pkwy over Cobbs Creek	SW Philadelphia	1924
Falls Bridge over Schuylkill River	Falls Bridge	1895
Ridge Ave over Amtrak & Norfolk Southern	.1 mi. SE of 29th St	1918
Cemetery Ave over CSX	Cemetery Ave	1886
Fox St over Roosevelt Blvd Ext	E of Henry Ave	1960
68th St over CSX	At Kingsessing Ave	1926
Delaware Expressway over Wheatsheaf Ln	Near Richmond St	1965
Walnut Ln over SEPTA	S of Wayne Ave	1900
MLK Jr. Dr over Schuylkill River	Schuylkill River	1966
Lycoming St over Conrail	W of Broad St	1929
Abbottsford Ave over Contrail and SEPTA	W of Wissahickon	1929
Rhawn St over Pennypack Creek	.5 mi. S of Roosevelt Blvd	1930
Olney Ave over SEPTA	.3 mi. W of Rising Sun Ave	1929
Market St over Schuylkill River	Center City Philadelphia	1932
Ridge Ave over Wissahickon Creek	Gustine Lake Interchange	1888
G St over Amtrak	N of Venango St	1914
Cambria St & A St over Conrail	Cambria St & A St	1916
Cayuga St over Conrail (Abandoned)	W of 5th St	1930
Sherwood Ave over Indian Creek	W of 66th St	1918
Roosevelt Blvd under 5th St	1 mi. N of Route 611	1955
2nd St over Amtrak	N of Venango St	1926
Aramingo Ave SB over Girard Ave and I-95	Near Delaware Ave	1968
70th St over Amtrak NEC	S Paschall Ave	1949
5th St over Conrail (Tracks Removed)	5th St	1917
Valley Green Rd over Wissahickon Creek	Wissahickon Creek	1915
Pine Rd over SEPTA	N of Rhawn St	1964
72nd St over Amtrak	S of Paschell Ave	1913
Cecil B. Moore Ave over Amtrak	Near 31st St	1909
Germantown Ave over Conrail	Hunting Park Ave	1960
Spring Garden St over Amtrak	Near Vine St Expressway & 31st St	1964
15th St over Conrail (Abandoned)	N of Callowhill St	1898

Bridge	Location	Year Built
Bell's Mill Rd	SW of Germantown Ave	1820
I-95 over Comly St	Near Van Kirk St	1967
I-95 over Earth Fill & Sewer Access	Near Frankford Creek	1968
Glenwood Ave over SEPTA	At 15th St	1912
SB Off Ramp over Roosevelt Blvd Ext	.5 mi. N of Broad St	1961
Kennedy Blvd over SEPTA	W of 30th St	1955
Chestnut St over Schuylkill River	1 mi. W of City Hall	1912
Broad St over Reading RR	Center City	1895
I-76 On-Ramp	Walnut St to I-76 EB	1955
I-95 On-Ramp	Ramp B SB	1974
Delaware Expressway over Palmer St and Cumberland St	Near Cumberland St	1971
Girard Ave over CSX	At Philadelphia Zoo	1890
Frankford Ave over Frankford Creek	Near Hunting Park Ave	1903
Noble St over N 13th St	East of Broad St	1892

4.3.11 Civil Disturbance

A civil disturbance is defined by FEMA as a civil unrest activity (such as a demonstration, riot, or strike) that disrupts a community and requires intervention to maintain public safety (PEMA, 2020).

4.3.11.1 Location and Extent

The scale and scope of civil disturbance events varies widely. Government facilities, landmarks, prisons, commercial areas, and universities are common sites where crowds and mobs may gather. The concentration of federal buildings in Philadelphia may be targets of civil disturbance. Furthermore, Philadelphia has four correctional facilities, two community corrections centers, and nine contract facilities (Department of Corrections). Typically, the severity of the action coincides with the level of public outrage. In addition to a form of protest against socio-political problems, civil disturbances can also arise out of protest, institutional population uprising, or from large celebrations that become disorderly (Pennsylvania Emergency Management Agency, 2018). Civil disturbance is sometimes coupled with arson, looting, and illegal behavior which means it is a compounding hazard with profiles for Urban Fire and Explosion and War and Criminal Activity.

4.3.11.2 Range of Magnitude

Civil disturbances can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities. There are two types of large gatherings associated with civil disturbances: a crowd and a mob. A **crowd** may be defined as a casual, temporary collection of people without a strong, cohesive relationship. A **mob** can be defined as a large disorderly crowd or throng. Mobs can be loud, tumultuous, violent, or lawless.

The worst-case scenario in Philadelphia is a mob that results in loss of life, damage to property, and arson. In a worst-case scenario event the City of Philadelphia would require support from neighboring jurisdictions for law enforcement and emergency services.

4.3.11.3 Past Occurrence

Philadelphia has had several civil disturbances take place which were notable enough to be recorded in the state's history or that garnered widespread media attention (Klein, 1973). The following list includes notable civil disturbances:

- 1742 – Philadelphia Election Riot
- 1775 – Philadelphia Anti-Loyalist Riot
- 1844 – Philadelphia Nativist Riots
- 1877 – Philadelphia Railroad Strike
- 1910 – Philadelphia General Strike
- 1919 – Red Summer (July 7, July 31)
- 1964 – Philadelphia Race Riot
- 1967 – Long Hot Summer of 1967
- 2008 – Phillies Parade
- 2011 – Occupy Philadelphia protests
- 2018 – Philadelphia Eagles Winning the Super bowl
- 2020 – George Floyd Protests
- 2020 – Death of Walter Wallace
- 2020 – Anti-Trump Protest (November 5)
- 2021 – Israel-Palestine Protests (May 15, May22)

The events from the recent civil disturbances range from calm organized protests to incidents of arson and explosions that risk the safety of residents and first responders. Several incidents that took place between HMP updates have included violence and illegal behavior. There was property damage from the 2018 Superbowl Parade and celebration, and civil unrest in 2020. Additionally, there were injuries to civilians and police. After the George Floyd protests there were incidents of Urban Fire and Explosion reflecting a compounding hazard.

Crowds during the 2008 Phillies parade and celebration caused unsafe conditions in transit stations were there was the potential for injury or death because of overwhelmed transit platforms. Crowds can create unsafe conditions both in celebration and protest.

4.3.11.4 Future Occurrence

Civil disturbances will continue to occur in the city, but it is not possible to accurately predict the probability or triggers for a large-scale civil disturbance event. Civil disturbances are always a possibility as long as there is discrimination or other perceived social or economic injustices. Past patterns of the location of civil disturbances suggest civil disturbance events are more likely to happen near universities, sporting events, government facilities, commercial districts, landmarks and where large crowds gather. Local law enforcement should continue to anticipate civil disturbance events and be prepared to handle a crowd or mob.

4.3.11.5 Vulnerability Assessment

The impacts of civil disturbance events are contingent upon a variety of factors including social, economic, or political issues and/or response. Generally, the impact of civil disturbance events is nominal and short-lived unless acts of sabotage are performed. There may be injuries to first responders or participants from physical confrontations, and vandalism may cause damage to property, facilities, and infrastructure.

The vulnerability of facilities to civil disturbances depends on the type and function of a facility, as well as whether it is centrally located or not. As visible symbols of government, government facilities and national monuments are more vulnerable to civil disturbance events.

The maximum threat of civil disturbance is difficult to project. It has the potential (in terms of injuries, loss of life, and economic, property, and infrastructure damage) to inflict tremendous losses. Additionally, National monuments do not have a replacement value, meaning that potential losses should be considered an underestimation. For large civil disturbance events, there may be losses related to work stoppages.

Philadelphia is the most threatened jurisdiction for civil disturbances in the state due to higher concentrations of local, state, and federal facilities. According to State estimates, Philadelphia could have a total estimated loss of approximately $165 billion (PEMA, 2018). This total includes only building value, and not content or inventory value.

4.3.12 Cyber Terrorism

Cyber terrorism refers to acts of terrorism committed using computers, networks, and the Internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism…is generally understood to mean unlawful attacks and threats of attack against computers, networks, and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear" (PEMA, 2020).

4.3.12.1 Location and Extent

Cyberattacks can occur from anywhere. Cyber terrorists can be difficult to identify because the internet provides a meeting place for individuals from various parts of the world. Individuals or groups planning a cyber-attack are not organized in a traditional manner, as they are able to effectively communicate over long distances without delay. Attackers may be local, wishing harm on county governments, officials, or individuals. People in Philadelphia can also be affected by mass breaches elsewhere in the United States or the world, such as a breach at a bank or credit card institution. It is frequent that the source and location of the cyberattack is unknown. Cyberattacks are unpredictable and typically occur without warning.

4.3.12.2 Range of Magnitude

The magnitude of a cyberattack can vary greatly. An attack against an individual can cost a few hundred dollars immediately or an attack can cost much more in cases of identity fraud, which can affect livelihoods years or decades later. Attacks against governments or government officials can create a lack

of trust and a loss of reputation. Small businesses can go out of business and cyberattacks on larger businesses can cost shareholders and consumers. Hacked transportation systems can cause delays and impact service. Every person and sector can be affected by cybersecurity threats.

The magnitude of the effect of a cyberattack varies based upon which system is attacked, the ability to preempt an attack, and an attack's effect on continuity of operations. The largest threat to institutions from cyberterrorism comes from any processes that are networked and controlled via computer.

In recent years, cyberterrorism has become an increasingly significant threat. In 2014, the Center for Strategic and International Studies estimated that cybercrimes cost the global economy almost $500 billion. In 2018, they estimated that number to be close to $600 billion. In the United States, the Internet Crime Complaint Center reported $2.7 billion in losses for 2018. Personal data breaches resulted in $149 million in losses, and identify theft caused $100 million in losses. Hacked companies pay an average of $36,295 to retrieve their data, but public entities pay an average of $338,700 according to a Coveware study (Coveware, 2021). In a ransomware attack on the City of Atlanta, getting the city back online cost over $8 million. A similar attack occurred in Baltimore and cost the city $18.2 million (Morris, 2019). The worst-case scenario for Philadelphia would be a ransomware attack that cost the City millions of dollars to restore online functionality, similar to what occurred in Baltimore.

4.3.12.3 Past Occurrence

Between 2018 and 2021, there have been eight cyberterrorism related incidents impacting Philadelphia facilities. In addition to City of Philadelphia-specific cyberattacks, national or global cyberterrorism can also affect Philadelphians. The Equifax data breach in 2017 exposed the personal information of 147 million people. The information accessed included names, Social Security numbers, birthdates, addresses, and driver's license numbers (Federal Trade Commission, 2020). In 2014 the largest data breach in history impacted over 3 billion Yahoo user accounts, including the names, email addresses, dates of birth, and telephone numbers of over 500 million users (Hill and Swinhoe, 2021). Other large-scale data breach events have also occurred in recent years and are becoming more common.

In addition to large-scale acts of cyberterrorism, smaller cyberattacks occur on a daily basis. Billions of emails are sent each day, and spam and phishing emails account for a significant share of all email traffic. Additionally, brute force attacks, which are trial and error attempts to obtain user passwords and pins, are frequently used by criminals to attempt to crack encrypted data or gain access to private accounts.

4.3.12.4 Future Occurrence

Cyberterrorism is an emerging hazard that has the potential to severely impact Philadelphia computer services and systems. Cyberattacks are unpredictable, typically occur without warning, and can happen from anywhere. Even if a cybersecurity threat does not take place within the City of Philadelphia, its citizens can be affected by cyberterrorism.

Entities or individuals that can be affected by cyberterrorism in Philadelphia, such as local governments, businesses, medical facilities, and schools, have taken steps to prevent and defend against cyberattacks. Employing multiple layers of security limits vulnerability, minimizes damage, and reduces recovery time. While the link is tenuous, long-running research by the Department of Defense ties climate change to increasing instability that has the potential to increase the risk of certain man-made hazards, this can include cyber terrorism (Griner, 2021).

4.3.12.5 Vulnerability Assessment

All communities and city-owned facilities are vulnerable to a cyberterrorism attack. As a city with a high concentration of local, state, and federal facilities, Philadelphia may have a higher risk of attack. Additional actions have been taken to increase local defenses against cyberterrorism.

4.3.13 Dam Failure – For Official Use Only – In Appendix D

4.3.13.1 Location and Extent

4.3.13.2 Range of Magnitude

4.3.13.3 Past Occurrence

4.3.13.4 Future Occurrence

4.3.13.5 Vulnerability Assessment

4.3.14 Hazardous Materials Release

Hazardous material releases can contaminate air, water, and soils and have the potential to cause injury or death. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events (PEMA, 2020).

4.3.14.1 Location and Extent

Hazardous material releases can occur wherever hazardous materials are manufactured, used, stored, or transported. Such releases can occur along transportation routes or at fixed-site facilities. Highways, railroads, waterways, and pipelines ship products containing hazardous materials daily. Hazardous materials are contained at fixed-site facilities such as military installations, nuclear facilities, and industrial or commercial buildings.

Transportation of hazardous materials on highways involves tanker trucks or trailers, which are responsible for the greatest number of hazardous material release incidents (FEMA, 1997). Roadways throughout Philadelphia are built over wetlands, across streams and rivers, and exist near marine waters, creating a risk for hazardous materials release to pollute surface water and groundwater.

Hazardous material releases can also occur along freight rail lines due to collisions or derailments. Several freight railroad accidents have occurred in Pennsylvania involving hazardous materials, such as a CSX train derailment in Hyndman, Pennsylvania in August 2017 that resulted in a hazardous materials release and fire (NTSB, 2018). In addition, hazardous materials can be transported by aircraft or by watercraft. Crashes, spills, and fires on these vessels can pose a hazard.

Pipelines also transport hazardous liquids and flammable substances such as natural gas and liquid petroleum. Incidents can occur when pipes corrode, are damaged during excavation, or are incorrectly operated. According to the Pipeline and Hazardous Materials Safety Administration, Philadelphia has 9 miles of natural gas pipeline and 70.8 miles of petroleum gas pipeline (PHMSA 2018).

Hazardous waste management facilities receive hazardous wastes for treatment, storage, or disposal. Facilities larger than 10 full-time employees that manufacture or process 25,000 pounds or more (or otherwise use 10,000 pounds or more) of any SARA Section 313-listed toxic chemical during a calendar

year are required to report TRI information to the EPA. These facilities are often referred to as treatment, storage, and disposal facilities, or TSDFs. EPA also tracks key information about chemicals handled by industrial facilities through its Toxics Release Inventory (TRI) database. OEM coordinates tracking of Tier II Facilities with the LEPC. As of 2021, there were 110 facilities on EPA's TRI for Philadelphia County.

No nuclear power facilities or nuclear-equipped military bases are in Philadelphia County.

PWD protects Philadelphia waterways from threats and pollution sources with the Early Warning System and complementary programs. The PWD's Watershed Protection Program combines emergency preparedness systems, public and private communication networks, computer modeling systems, laboratories, regional and national partnerships, planning, and infrastructure investment.

Hazardous materials release can be a compounding hazard. Natural hazard events can disrupt hazardous materials storage or temperatures and lead to a release. Flooding can move appliances away from the wall and lead to gas leaks and fires or cause a release by flooding locations that store hazardous materials. Hazardous materials compound the impact of urban fire and explosion. Transportation accidents can also lead to hazardous materials release if there is a crash when traveling by freight train or other vehicles.

4.3.14.2 Range of Magnitude

Hazardous material releases can contaminate air, water, and soils and can result in injuries and/or fatalities. Damage from hazardous materials can occur from a material's flammability, toxicity, corrosiveness, chemical instability, and/or combustibility. Material releases can seep through the soil and groundwater, contaminating drinking water. Vapors from released materials can collect in houses and businesses, creating fire, explosion, and toxic inhalation hazards. Public health impacts of a hazardous materials release can vary from temporary skin irritation to fatality. Exposure can pose short- and long-term toxicological threats to humans, terrestrial and aquatic plants, and to land and marine wildlife.

Damages resulting from a hazardous material incident can be on a scale from limited to disastrous. The level of damage depends on the material spilled and the distance and response time for emergency response teams. In addition, weather conditions, micro-meteorological effects of buildings and terrain, and non-compliance with applicable codes or maintenance failures can either mitigate or exacerbate a hazardous materials release. The areas in close proximity to a release are generally at greatest risk. However, depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (e.g. centuries to millennia for radioactive materials), resulting in extensive impacts on people and the environment.

The worst-case scenario in Philadelphia would be a disastrous release of hazardous chemicals that results in short-term loss of life and long-term damage to livability for humans, plants, and wildlife.

4.3.14.3 Past Occurrence

Facilities that produce, use, or store hazardous chemicals must notify the public via Philadelphia's emergency dispatch center and PEMA if an accidental release of a hazardous substance meets or exceeds a designated reportable quantity and has the potential to affect persons and/or the

environment outside the facility. The following table shows the number of hazardous material incidents in Philadelphia from 2018 to 2021.

Table 4-40. Hazardous Material Incidents (2018-2021)

County	Incidents in 2018	Incidents in 2019	Incidents in 2020	Incidents in 2021*
Philadelphia	19	60	83	13

Source: (PEMA-KC 2018)

*As of September 1, 2021

The Philadelphia Energy Solutions (PES) Refinery explosion on June 21, 2019 was a hazardous materials release that resulted in a fire and explosion in Southwest Philadelphia. PES estimated that over 600,000 pounds of hydrocarbons were released and combusted during the event (U.S. Chemical Safety and Hazard Investigation Board, 2019).

4.3.14.4 Future Occurrence

While many hazardous material release incidents have occurred in Philadelphia, they vary and are difficult to predict. An occurrence is largely dependent upon the accidental or intentional actions of a person or group. However, hazardous materials releases can occur as a result of severe weather or flooding events, which are expected to increase in frequency and intensity as a result of climate change. Overall, risk associated with hazardous materials release is expected to remain moderate.

4.3.14.5 Vulnerability Assessment

The entire population of Philadelphia is vulnerable to a hazardous material release event due to widespread use and storage of hazardous materials throughout the City. Residential properties, businesses both small and large, industry, government, and non-governmental organizations all use hazardous material that range from cleaning supplies to industrial chemical processing and transport. Communities along major highways and rail transportation routes are at a higher risk for an incident.

Some hazardous materials pose a reactivity, fire, or explosion risk. Materials improperly stored in buildings have the potential to mix with incompatible substances which can result in polymerization, the production of heat, combustion or fire, and even an explosion. Water treatment facilities and water suppliers are particularly vulnerable to hazardous material releases. If a hazardous materials release impacted a water treatment facility, effects could be widespread depending on the service area.

4.3.15 Opioid Addiction Response

According to the Pennsylvania State Hazard Mitigation Plan, opioid addiction occurs when an individual becomes physically dependent on opioids, which include opiates and narcotics. Opioids are a synthetic substance found in certain prescription pain medications: morphine, codeine, methadone, oxycodone, hydrocodone, fentanyl, and hydromorphone, and street drugs like heroine. Opioids block the body's ability to feel pain and can create a sense of euphoria. Individuals often build a tolerance to opioid drugs, which leads them to take more of the medication than originally prescribed (PEMA, 2020).

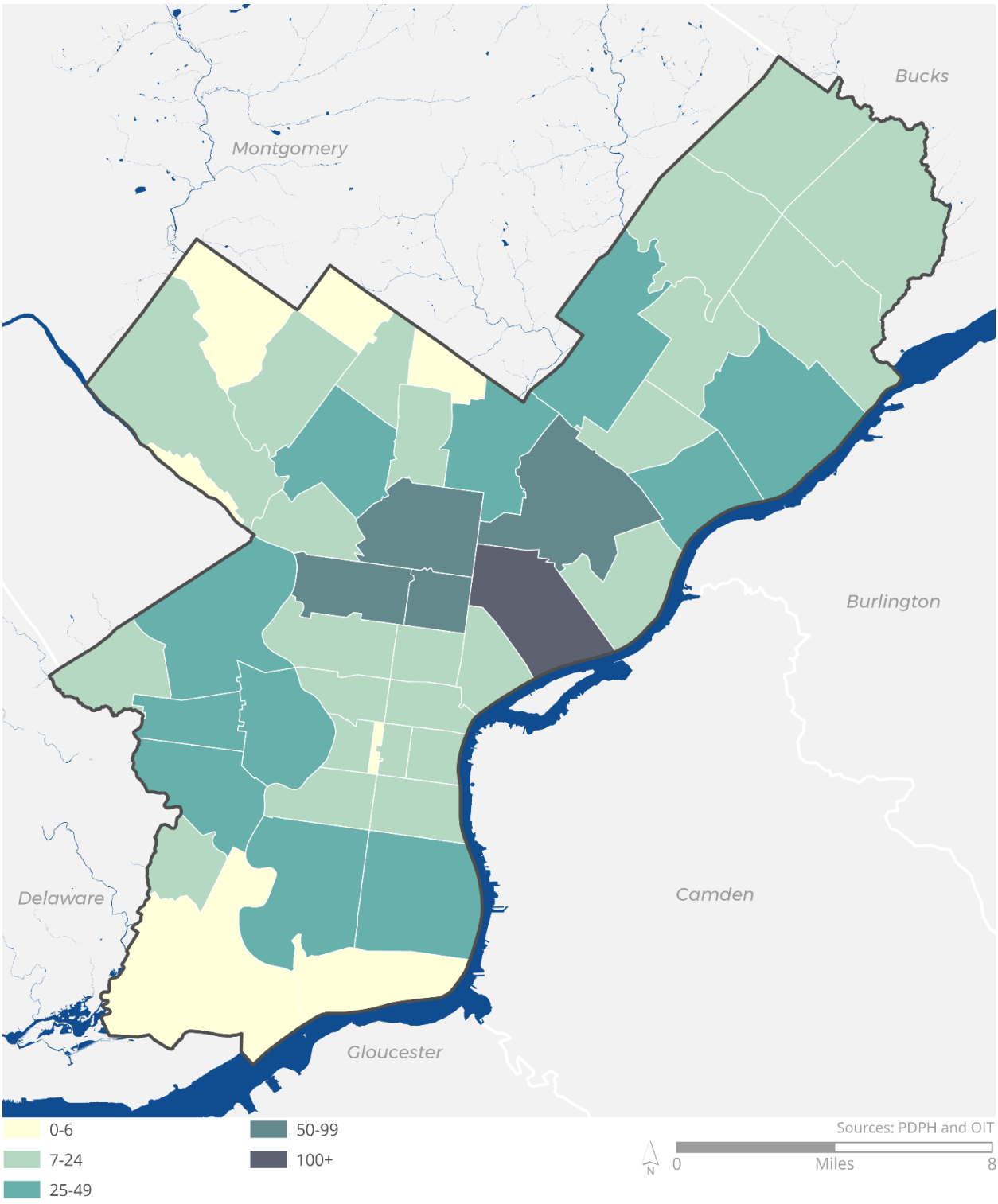
Philadelphia uses the phrases 'opioid overdose crisis' and 'opioid substance-use disorder' to refer to aspects of this hazard.

4.3.15.1 Location and Extent

The opioid overdose crisis refers to the increased number of unintended overdoses because of increased use of fentanyl which is highly addictive and can be lethal in certain doses. The opioid overdose crisis affects all Philadelphian's including the families of individuals with opioid substance-use disorder and Philadelphia's communities. Drug-related litter and violence are creating unsanitary and unsafe neighborhoods. The number of opioid-related overdose deaths within Philadelphia increased almost 300% in the last decade, with 297 overdose deaths in 2010 and 1,041 overdose deaths in 2020 (Substance Use Philadelphia, 2020).

While the highest number of unintentional opioid-related overdose deaths occurred in the North and River Wards planning districts (see **Figure 4-29**), particularly in the Kensington neighborhood, there have been overdoses in every single zip code throughout the city. The South, Lower Northeast, and North Delaware planning districts also had a high number of unintentional opioid-related overdose deaths in 2019. In 2020, the western part of the West Park district, the northeastern corner of the Central planning district, and the area at the intersection of the North, Lower Northeast, and Upper Northwest planning districts experienced the greatest percent increases in deaths across the City.

Figure 4-29. Incidence of Unintentional Overdose Deaths in Philadelphia, 2020



Source: [Philadelphia Medical Examiner's Office](), 2020

4.3.15.2 Range of Magnitude

Opioid substance-use disorder can lead to fatal overdoses. Individuals often build a tolerance to the opioid drugs, which leads them to take more of the medication than originally prescribed. The most dangerous side effect of an opioid overdose is depressed breathing; the lack of oxygen to the brain causes permanent brain damage, leading to organ failure and death.

The opioid overdose crisis has had an impact on many in Philadelphia. Substance-use disorder often affects families and relationships, and drug-related litter and violence has an impact on the surrounding community, creating unsanitary and unsafe conditions in Philadelphia's communities (Opioid Response Unit, 2021).

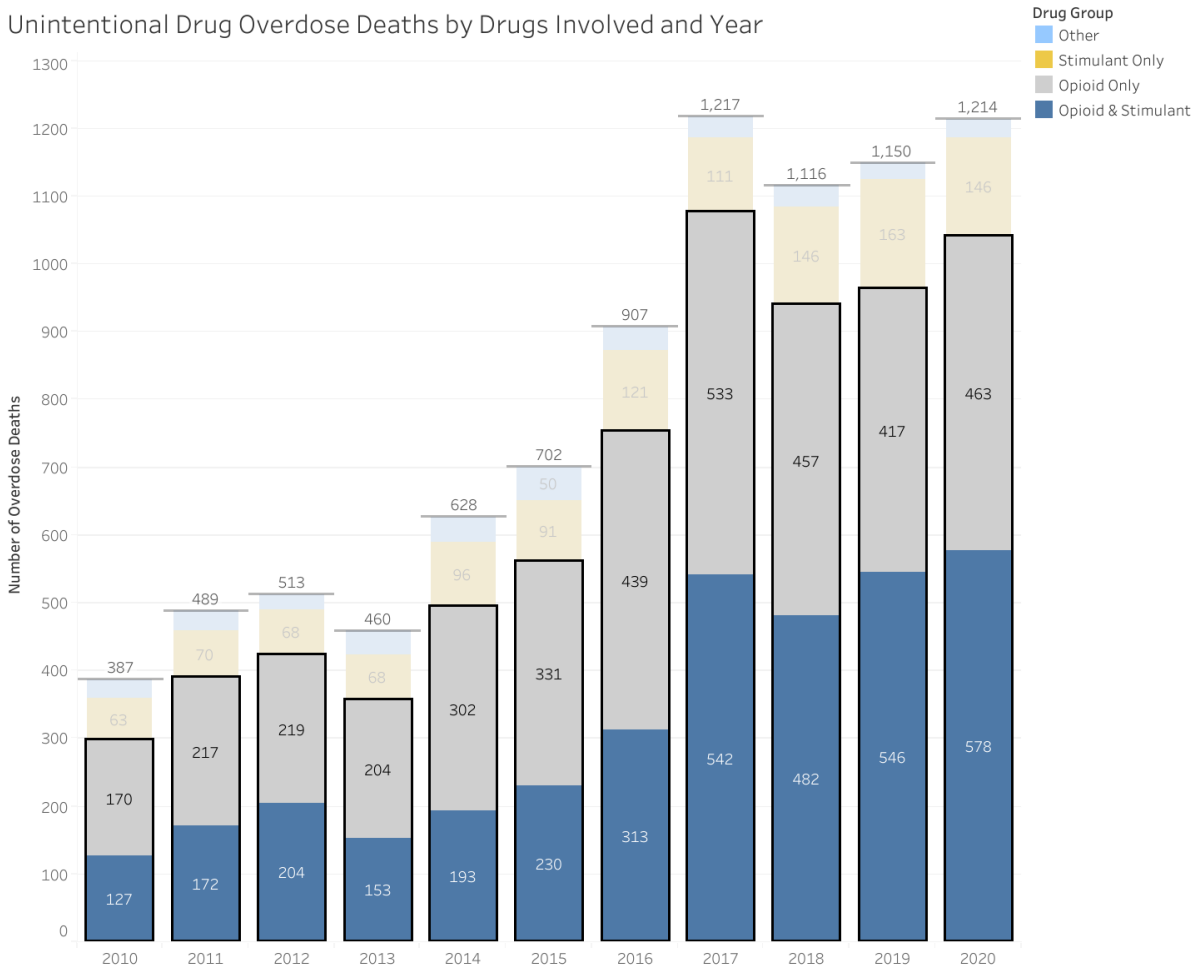
First responders—paramedics, police officers, and fire fighters –are also affected by Pennsylvania's opioid overdose crisis. In addition to consuming time and resources, first responders also face exposure risk, particularly to synthetic fentanyl. According to the DEA, it takes two to three milligrams of fentanyl to induce respiratory depression, arrest, and possibly death. Since fentanyl is indistinguishable from several other narcotics and powdered substances, first responders must take extra precaution when dealing with calls related to drug abuse (DEA, 2017).

The worst-case scenario in Philadelphia is the continued increase in overdose deaths and the accompanying impacts on communities.

4.3.15.3 Past Occurrence

The total number of unintentional opioid-related overdose deaths increased almost 300% between 2013 through 2017 (see **Figure 4-30**). In 2018, Philadelphia saw a 14% decrease in unintentional opioid-related overdose deaths. In 2020, unintentional overdose deaths increased from 2018 by 11% (Substance Use Philadelphia, 2020).

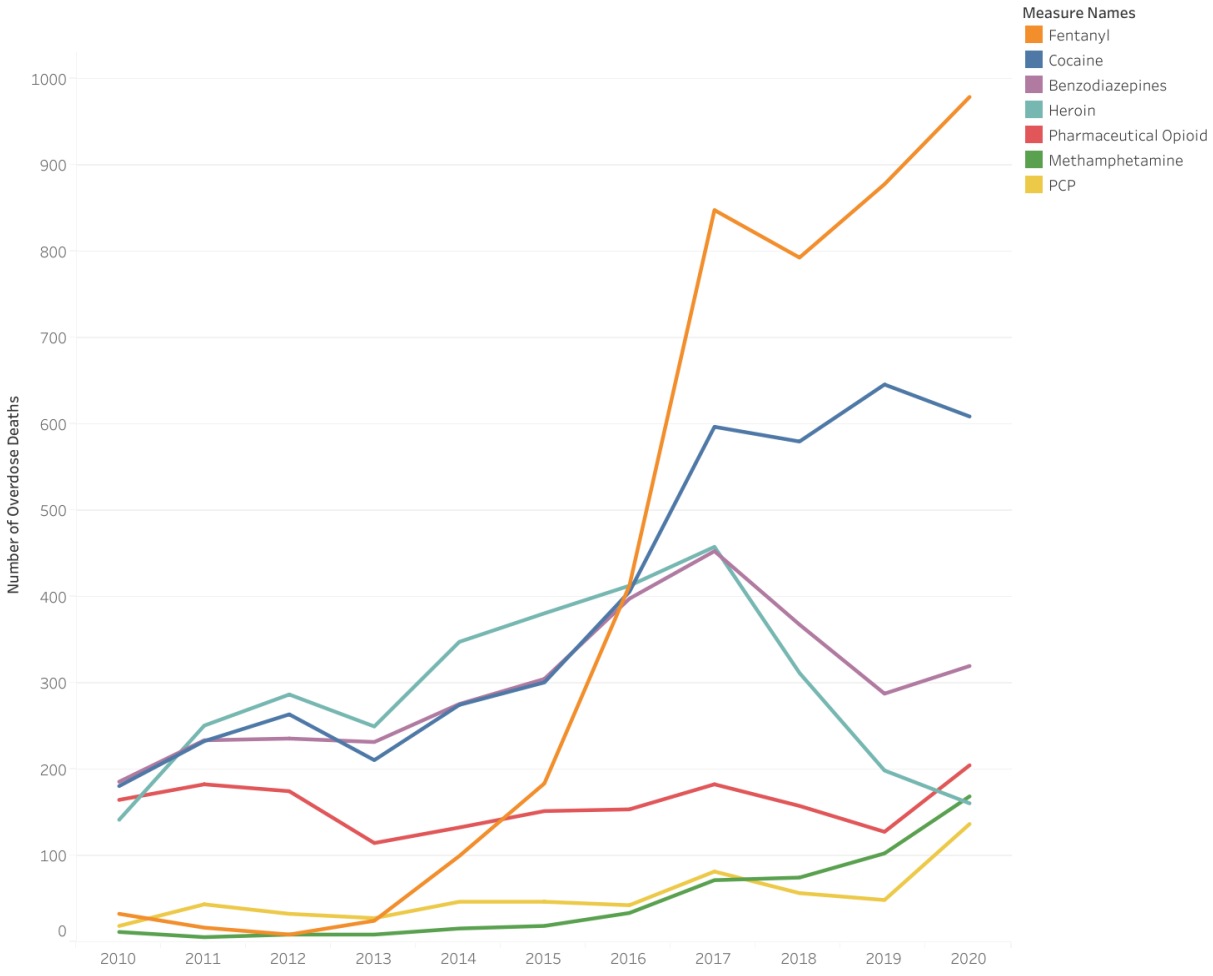
Figure 4-30. Unintentional Drug Overdose Deaths by Drugs Involved and Year in Philadelphia, 2010-2020



Source: Substance Use Philadelphia, 2020

Beginning in 2017, fentanyl and fentanyl analogs surpassed all other drugs as the most detected among people unintentionally fatally overdosing (see **Figure 4-31**). Since 2017, the number of unintentional overdose deaths involving heroin has declined. In 2020, the number of unintentional overdose deaths involving pharmaceutical opioids, methamphetamine, and PCP increased.

Figure 4-31. Unintentional Drug Overdose Deaths by Specific Drugs Involved in Death

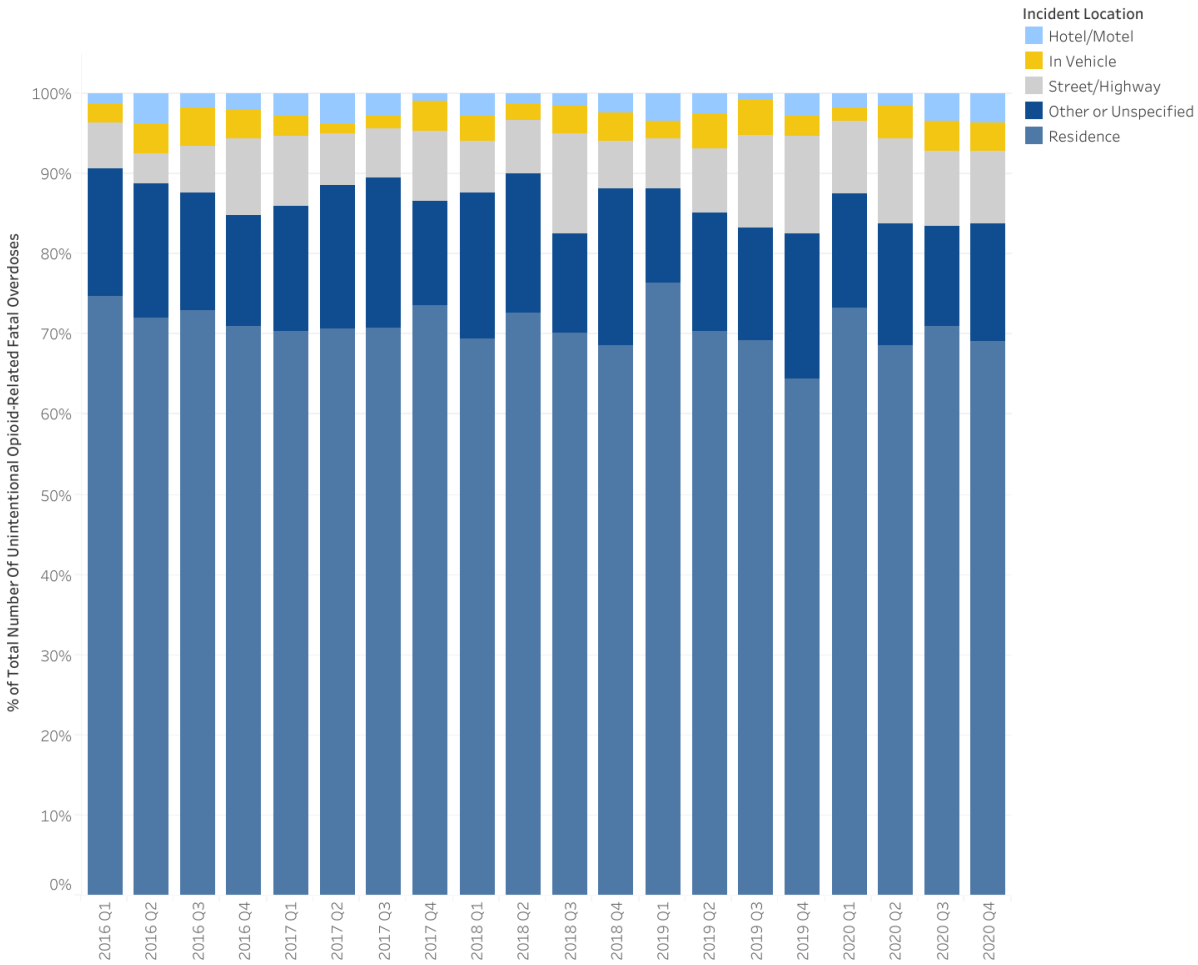


Source: Substance Use Philadelphia, 2020

Unintentional overdose deaths are high among those between the ages of 25-64 years old. Men die at higher rates from unintentional overdose deaths than women. In 2020, the number of overdose deaths for non-Hispanic Black individuals increased 29%, while the number of overdose deaths among non-Hispanic White individuals decreased 10%.

From 2017 to 2019, the largest percentage of unintentional overdose deaths each have occurred in the victim's residence (see **Figure 4-32**).

Figure 4-32. Unintentional Opioid-Related Fatal Overdoses by Incident Location, 2016-2020



Source: Substance Use Philadelphia, 2020

4.3.15.4 Future Occurrence

Philadelphia County has seen a large increase in opioid related deaths over the last decade years. To address this trend, in January 2018, Governor Tom Wolf declared Pennsylvania's opioid crisis a disaster emergency, which enhanced coordination and data collection, improved tools for families and first responders, and expanded treatment access. The declaration also improved access to naloxone, a lifesaving drug that reverses the effects of a drug-overdose. However, the opioid emergency declaration ended on August 25, 2021 after the General Assembly declined to extend it. In Fall 2018, Major Jim Kenney signed an executive ordered to combat the opioid crisis in Philadelphia. This led to the formation of the Philadelphia Resilience Project, a joint emergency response by 35 City agencies. Today, the City's Opioid Response Unit (ORU) coordinates the multi-departmental response to this public health epidemic.

Despite how far the City has come in combatting the challenge of reducing opioid deaths, there is not a quick fix to this complex problem, and the probability of future opioid overdoses and deaths within the next five years is likely. This indicates a continued need for investment in this response.

4.3.15.5 Vulnerability Assessment

Philadelphia's socially vulnerable populations are more at risk for opioid substance-use disorder and overdose deaths. **Figure 4-29** maps opioid overdose deaths in Philadelphia, which are concentrated in North Philadelphia, coinciding with Philadelphia's most socially vulnerable populations (see **2.3.8 Social Vulnerability**).

In addition, trends within the last year indicate an increased number of overdoses since the start of the COVID-19 Pandemic. Philadelphia also experienced a significant increase in overdoses among Black and Latinx Philadelphians in 2020. Experts link this trend to challenges caused by the COVID-19 Pandemic, including high unemployment rates, social isolation, and reduced access to treatment and social services (Opioid Response Unit, 2021). The table below shows a spike in overdose deaths in Philadelphia's non-white populations (particularly the non-Hispanic black population) between the first quarter through the third quarter of 2019 when compared to the first quarter through the third quarter in 2020.

Table 4-41. Percent Change in Overdoses by Demographic Q1-Q3 2019-2020

Overdose Deaths by Race, Ethnicity, and Year				
Demographic Group	**2019 Deaths**	**2020 Deaths**	**Total**	**% Change**
Non-Hispanic, White	425	394	819	-7.3%
Non-Hispanic, Black	283	397	680	+40.3%
Hispanic	136	144	280	+5.9%
Non-Hispanic, Other	14	17	31	+21.4%
Total	858	952	1,810	+11.0%

Source: Opioid Response Unit, 2021

The main loss in the opioid overdose crisis is loss of lives. Additionally, opioid substance-use disorder and opioid overdose crisis result in lost wages, productivity, and resources. Philadelphia has devoted time and resources to the opioid crisis as overdose and response rates increase; however, there is no comprehensive tracking mechanism to record total local losses associated with the opioid crisis. The total estimated cost of opioid substance-use disorder through 2015 based on per capita estimates for Philadelphia was $2,843,972,537 (AEI 2018, US Census 2018).

According to a recent study, environmental scientists at the Cary Institute of New York found traces of opioids and other drugs in streams, rivers, and lakes. These traces came from human urine and feces, and medications that have been flushed down the toilet. However, the ecological and environmental impacts are unknown. The United States Environmental Protection Agency (EPA) suggests that while the risks of pharmaceuticals found in wastewater, ambient water, and drinking water is low, further research is needed (EPA, 2014).

4.3.16 Terrorism

Terrorism is use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear and radiological weapons. Cyber-attacks have become an increasingly pressing concern (PEMA, 2020).

4.3.16.1 Location and Extent

Terrorism is a threat everywhere. There are many important considerations in evaluating terrorism hazards, such as the existence of facilities, landmarks, or other buildings of international, national, or regional importance. Military and civilian government facilities, international airports, large cities, and high-profile landmarks are considered high-risk targets, according to FEMA. Other targets can include large public gatherings, water and food supplies, utilities, and corporate centers. Terrorists can also send explosive, chemical, or biological agents through the mail (FEMA, 2009). Terrorism can take many forms and terrorists have a wide range of personal, political, or cultural agendas. Any location could therefore be a potential terrorist target.

The majority of terrorism-related attacks used explosives (DHS, 2015). An improvised explosive device (IED) attack is the "use of a 'homemade' bomb and/or destructive device to destroy, incapacitate, harass, or distract" (DHS, 2015). IEDs come in a range of forms, from a small pipe bomb to a larger scale, more sophisticated explosive capable of causing large loss of life. Delivery of the explosive can be by a device strapped to an individual, in a package, or in a vehicle, among various other techniques. Explosive materials can range from simple to complex based upon the difficulty of procurement or the technical capability required to develop them from constituent substances. Shrapnel material, propellant, or additional hazardous materials can worsen the impact of an IED.

In regard to IEDs, locations at the greatest risk are those that have high densities of people; low security measures; high visibility; and an iconic, religious, or geopolitically significant location. Locations that meet such criteria include, but are not limited to museums, government buildings with a public interface, landmarks, and festivals. Terrorists may target numerous locations and types of facilities at the same time.

As a major city, Philadelphia is at an increased risk of terrorism hazards compared to surrounding, rural jurisdictions. The city contains corporate and government buildings; national landmarks, such as the Liberty Bell, the Philadelphia International Airport, many critical facilities such as police stations, hospitals, fire stations, schools, and water treatment plants; critical infrastructure such as bridges, tunnels, and public water supplies. Damage to these facilities and infrastructure could cripple the area.

4.3.16.2 Range of Magnitude

The term "terrorism" refers to intentional, criminal, and malicious acts, but the functional definition of terrorism can be interpreted in many ways. The Federal Bureau of Investigation (FBI) classifies terrorism into two categories:

- **International terrorism**: Violent acts committed by individuals and/or groups inspired by or associated with designated foreign terrorist organizations or nations, and

- **Domestic terrorism**: Acts carried out by individuals and/or groups inspired by or associated with primarily U.S.-based movements that support extremist ideologies of a political, religious, social, racial, or environmental nature.

FEMA defines the three main goals of terrorism as:

1. Causing public fear,
2. convincing citizens that the government cannot protect against terrorism, and
3. making the motivating causes known to the public.

Terrorist attacks can take many forms. FEMA identifies the following as some of the common tactics of terrorism:

- Agroterrorism—food contamination or destruction of crops via pest introduction or disease agents
- Arson/incendiary attack
- Armed attack
- Assassination
- Biological agent
- Chemical agent
- Cyber Terrorism (covered in section 4.3.12)
- Conventional bomb
- Hijackings
- Intentional hazardous material release
- Kidnapping
- Nuclear bomb
- Radiological agent

Explosives, such as IEDs, have been a prominent method of conducting terrorism. While impacts of an IED are generally limited to the area of detonation, health effects resulting from an IED are often deadly and include overpressure damage, fragmentation injuries, impact injuries, and thermal injuries (DHS, 2015). Intelligence suggests that the possibility of biological or chemical terrorism is increasing (DHS, 2019). The Internet, the rise of social media, and domestic extremists known as Homegrown Violent Extremists (HVEs) are reshaping terrorism and changing its form (DHS, 2019).

The severity of terrorist incidents depends upon the method of attack, the proximity of the attack to people, animals, or other assets and the duration of exposure to the incident or attack device. For example, chemical agents are poisonous gases, liquids or solids that have toxic effects on people, animals, or plants. Many chemical agents can cause serious injuries or death. In this case, severity of injuries depends on the type and amount of the chemical agent used and the duration of exposure.

Loss estimates can vary greatly in a terrorism event based on the magnitude and type of terrorist action. Catastrophic terrorism events will have proportionally catastrophic losses for the jurisdiction in question. An incident impacting critical infrastructure would be a worst-case scenario – specifically, infrastructure involving energy providers, mass transportation, communications, emergency services/continuity of government, water/wastewater and financial sectors – because they have the

largest potential to initiate cascading consequences while disrupting the good order and daily business of Philadelphia's citizens, visitors and business communities.

4.3.16.3 Past Occurrence

The Philadelphia Police Department Bomb Disposal Unit (BDU) responds to numerous suspicious object calls every week. Few are legitimately dangerous. The BDU renders dangerous devices safe and properly disposes of them. The frequency of founded devices requiring actions is sensitive and beyond the scope of this document.

There has been a high consciousness of terrorist activity in the press following significant terrorist events, such as September 11th, 2001 or the Boston Marathon bombing. While these events did not happen in Philadelphia, the area is a major city that hosts similar large scale outdoor activities. PEMA was on a state of heightened alert for the Philadelphia Marathon in 2014, which occurred shortly after the bombing in Boston.

4.3.16.4 Future Occurrence

Philadelphia continues to host high-profile events, and to serve as a rich cultural and historical city drawing local, national, and international crowds. As a result, there is an ongoing risk that terrorists may target sites and events that draw large groups of people. The Philadelphia Police Department Bomb Disposal Unit, along with other local and federal partners address suspicious devices and activities as swiftly and safely as possible. While the link is tenuous, long-running research by the Department of Defense ties climate change to increasing instability that has the potential to increase the risk of certain man-made hazards, including terrorism (Griner, 2021).

4.3.16.5 Vulnerability Assessment

Since the probability of terrorism occurring cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability in terms of likelihood of occurrence. Instead, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in Philadelphia, planning efforts can be put in place to reduce the risk of attack. Site-specific assessments can provide relative importance of a particular site to the surrounding community or population, threats that are known to exist and inherent and tactical vulnerabilities. Inherent vulnerabilities include visibility or public knowledge of the facility, the value of the facility to meet objectives of a terrorist, accessibility and mobility of the facility, presence of hazardous materials at the facility (flammable, explosive, biological, chemical, radiological), potential for collateral damage, and occupancy of the facility. Tactical vulnerabilities include site perimeter and security, building structure and resistance to damage, and interior engineering and security.

Philadelphia is a major city with large urban areas, high population density, large concentrations of critical infrastructure, and port facilities with roles as logistics hubs; therefore, the city is more vulnerable to terrorist attacks compared to surrounding local jurisdictions.

The impacts of terrorism can vary in severity from nominal to catastrophic and are contingent upon the method of the attack, the volume of force applied, and the population density of the attack site. There may be significant loss of life for humans and animals as well as economic losses. Additionally, the impact of the attack itself may be exacerbated by the fact that human services agencies like community support programs, health and medical services, public assistance programs, and social services can

experience physical damage to facilities, supplies, and equipment, as well as disruption of emergency communications. There may also be ancillary effects of terrorism such as urban fires or, in the case of a radiological device, radioactive fallout that can multiply the impact of a terrorist event.

Loss estimates can vary greatly in a terrorism event based on the magnitude and type of terrorist action. Catastrophic terrorism events will have proportionally catastrophic losses for the jurisdiction in question. For example, an explosive device attack at a landmark or near a stadium could result in economic losses. The cost to rebuild a landmark or stadium, compounded with a loss of revenue at and around the location, could exceed $500 million dollars. Large quantities of debris must also be cleared from around bombed sites. Officials or site operators may close major cultural venues indefinitely because of an attack, affecting schedules of concerts, sporting events, and other cultural activities. Short- and long-term economic consequences could occur within travel, tourism, and entertainment industries. Losses may be greater in an event that results in the complete destruction of a high-rise building; in that scenario, losses will stem from loss of life, the actual destruction of the building, and business interruptions. For comparison's sake, the total losses incurred by New York City in the September 11, 2001 attacks are estimated at $83-95 billion. This loss estimate includes lost tax revenue for the city, the cost of response and recovery, business interruptions, deaths, building damage, and infrastructure damage. While Philadelphia is certainly smaller than New York, losses would still be severe.

4.3.17 Urban Fire and Explosion

Urban fire and explosion hazards include vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. This hazard occurs in denser, more urbanized areas statewide and most often occurs in residential structures. Nationally, fires cause over 3,000 deaths and approximately 16,000 injuries each year (PEMA, 2020).

4.3.17.1 Location and Extent

Urban fires and explosions often occur because of another natural or human caused event—storms, lightning strikes, drought, earthquakes, transportation accidents, hazardous materials releases, criminal activity (arson), and terrorism. Philadelphia has varying risks for each of these events. For more information on the level of risk for each of these events, see their respective hazard profile.

Urban fires are a more significant threat in areas of Philadelphia with a significant number of buildings built before 1970. Older buildings often were not built up to modern codes, do not follow National Fire Protection Association (NFPA) regulations, and have less safety measures for fire prevention, detection, and extinguishment then newer housing units. Furthermore, urban fires and explosions tend to occur in denser, more urbanized areas statewide. A map of fire risk due to open fire code violations is shown in **Figure 4-33**. Densely built urban environments can assist in the spread of fire through shared roofs and narrow separations between homes Philadelphia has numerous alleys and narrow streets throughout the City, with many concentrated in the Old City neighborhood and a significant amount of attached rowhomes located throughout the City.

Density mapping assists in the identification of areas prone to urban fire. The map in **Figure 4-34** uses the most recent housing unit density information from the United States Census to demonstrate where the greatest concentration of buildings exists. The map shows that areas where housing density is the

greatest are located in the Central and South planning districts of the City. These locations are therefore at a greater risk for widespread fire, and in turn, urban conflagration.

Figure 4-33.Open Fire Code Violations in Philadelphia, 2021

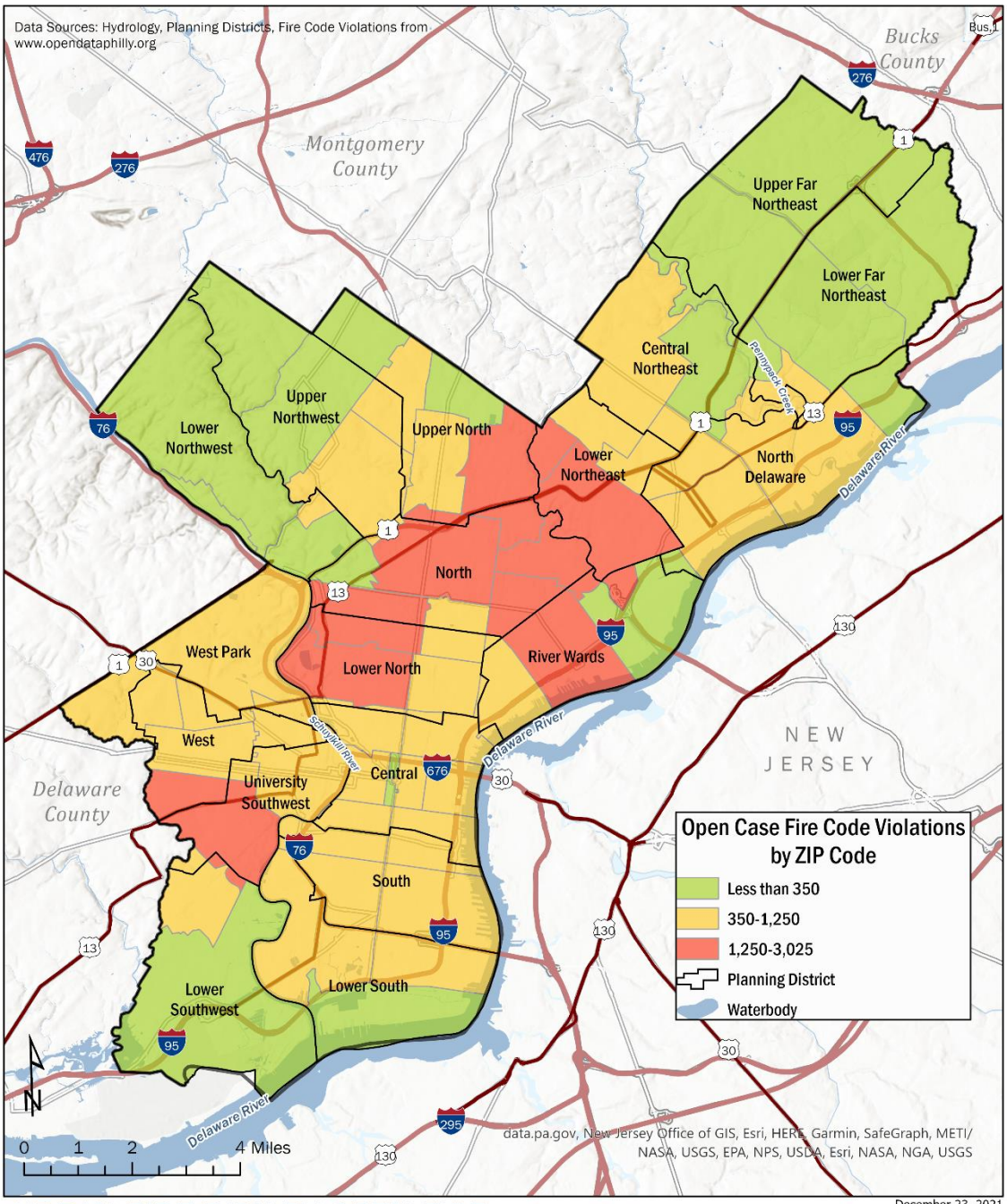
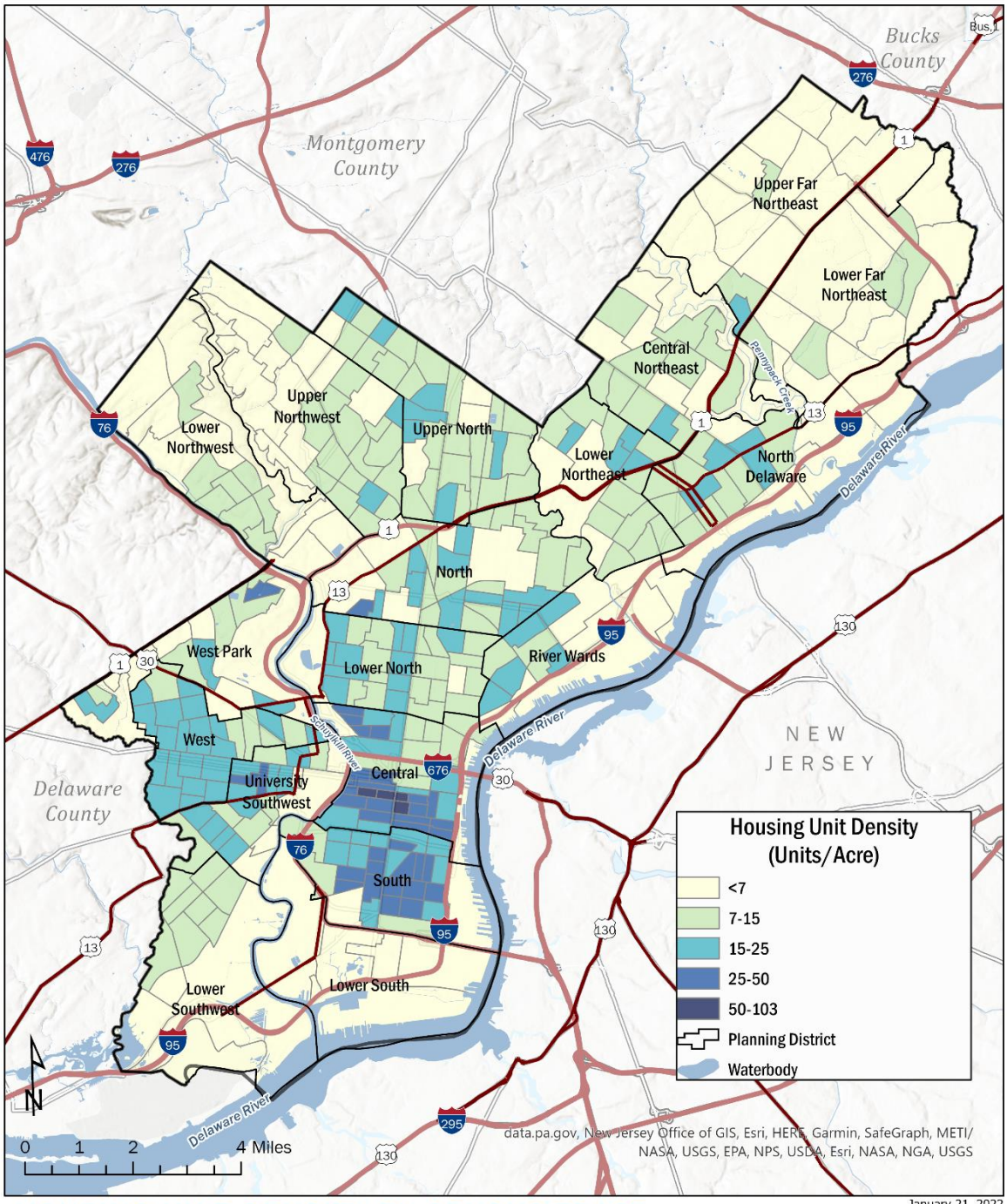


Figure 4-34. Housing Unit Density in Philadelphia by Census Tract, 2019



HOUSING UNIT DENSITY BY CENSUS TRACT
(AS OF 2019, CENSUS ACS)
CITY OF PHILADELPHIA

January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

4.3.17.2 Range of Magnitude

Urban fires have the potential to cause extensive damage to residential, commercial, or public property. Damage ranges from minor smoke and/or water damage to the destruction of buildings. People are often displaced for several months to years depending on the magnitude of the event. Urban fires and explosions can also cause injuries and death.

The duration of an urban fire is dependent on weather conditions, the magnitude of the fire, and fire suppression resources. Structural fires could burn for several hours before being fully contained, and the presence of fire fuel can cause fires to spread away from their source.

In serious urban fire events, the extreme heat of a fire event can damage the underlying infrastructure. For example, in 1996, an eight-alarm tire fire ignited in Philadelphia under Interstate 95. The extreme heat of the fire caused the bridge to buckle which required two months of repairs to the bridge. The governor declared this event a disaster shortly after it occurred. Additionally, the City's deadliest fire occurred in January 2022 in a Philadelphia Housing Authority rowhome in the Fairmount neighborhood. Twelve people died, including eight children (Todt, 2022). These would be considered worst-case scenarios for the City.

Additionally, fires can also release numerous pollutants into the atmosphere through the burning of chemicals, household goods, plastics, and other potentially dangerous off-gassing substances. Fire also releases carbon dioxide into the atmosphere, increasing greenhouse gas emissions. Hazard Materials Release and Urban Fire and Explosion are linked hazards that can contribute to and compound the impacts of each hazard.

4.3.17.3 Past Occurrence

During fiscal year (FY) 2018 (October 1, 2018 through September 30, 2019), there were 2,525 structural fires in Philadelphia, averaging 7 a day. In FY2019, there were 4,849 (average of 13 a day) structural fires and in FY2020, there were 3,884 (11 per day) structural fires (City of Philadelphia, 2020).

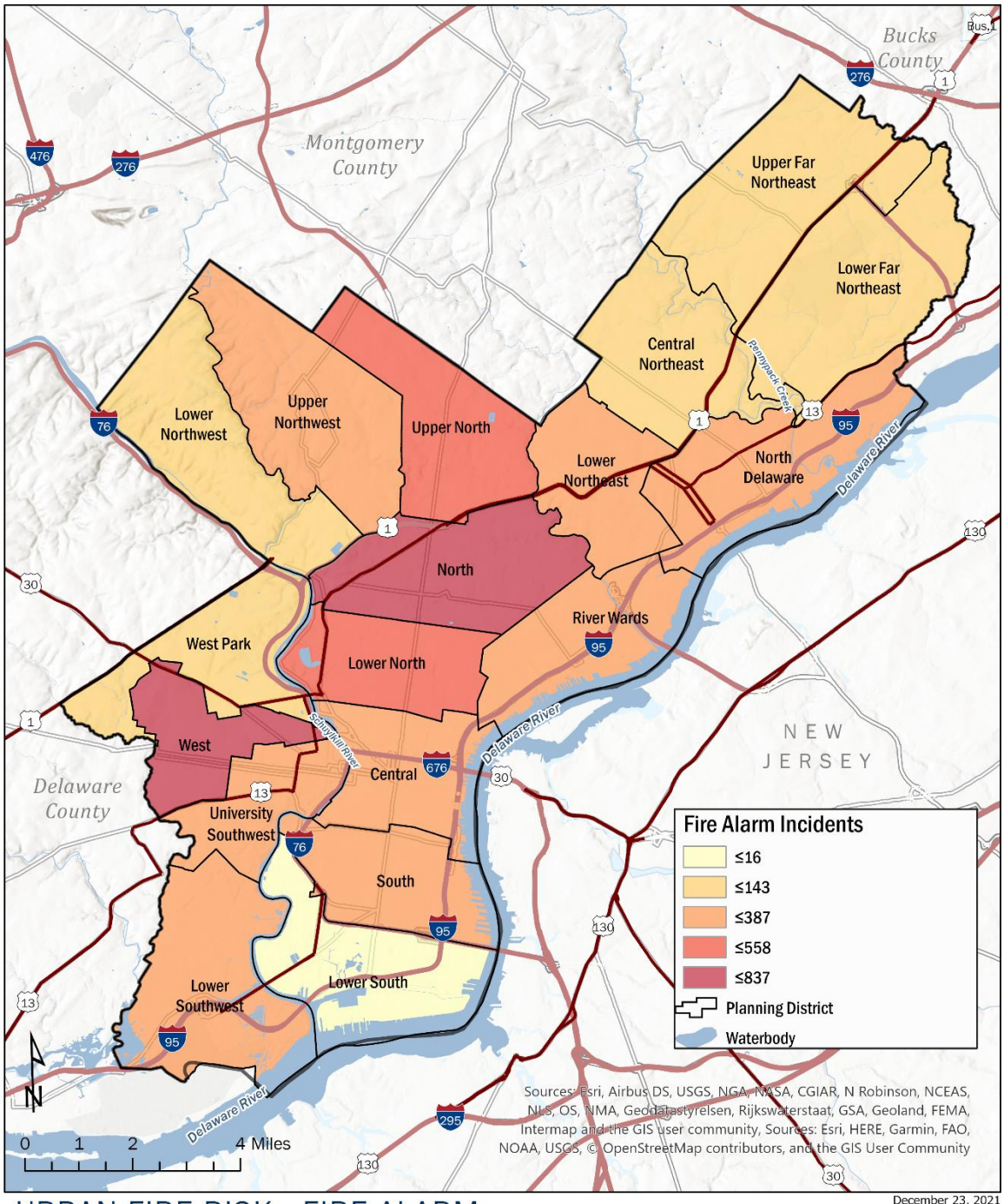
Table 4-42. Total number of Fire Incidents, Structure Fires, EMS Incidents and 911 Fire Calls Received in Philadelphia between 2018-2020

Year	2018	2019	2020
Fire Incidents	48,797	49,526	47,864
Structure Fires	2,525	4,849	3,884
EMS Incidents	271,450	274,659	266,090
Calls Received	378,849	374,408	362,101

Source: City of Philadelphia, 2020

Fires are clustered in North and West Philadelphia based on **Figure 4-35** shows the location of fire incidents by zip code.

Figure 4-35. Fire Alarm Incidents in Philadelphia by Planning Area (2017-2020)



URBAN FIRE RISK - FIRE ALARM INCIDENTS (2017-2020)
CITY OF PHILADELPHIA

December 23, 2021

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

4.3.17.4 Future Occurrence

Many factors contribute to the cause of urban fires and explosions. Due to Philadelphia's dense, urban areas, aging building stock, vacant properties, and storage of flammable and hazardous materials in businesses and homes, the City is considered at risk for situations that would lead to a fire or explosion. However, the probability of future occurrences may decrease with the construction of new buildings to building codes that address fire prevention, detection, and extinguishment. Also, the City's extensive network of fire hydrants, the ongoing and extensive training of the Philadelphia Fire Department, temperate climate, and efforts to increase public awareness of the dangers of urban fires all reduce this risk of injury, death, and property loss. Generally, the probability of future occurrence may increase in communities whose populations are growing and where new areas are developed.

4.3.17.5 Vulnerability Assessment

The impact of urban fire and explosion events varies based on the size of the incident, population, and building density where it occurs. There may be environmental impacts related to hazardous materials when a fire event or explosion releases dangerous materials.

There are additional economic consequences related to this hazard. Urban fires and explosions may result in lost wages due to temporarily or permanently closed businesses, destruction and damage involving business and personal assets, loss of tax base, recovery costs, and lost investments in destroyed property.

Fire risk is not the same for each person. Specific populations placed at greater risk include individuals over the age of 55, individuals under the age of 4, individuals with access and functional needs, and anyone with decreased mobility who may require support evacuating during a fire (NFPA). According to a 2019 study conducted by the U.S. Fire Administration, adults ages 55 and older have a greater risk of fire death than the general population, with adults aged 85 and older having the highest risk of death compared to the general population. Males were found to be 1.7 times more likely to die in fires than females, and African Americans and American Indians/ Alaska natives had higher rates of fire death than the general population. Children under the age of 5 also have a greater risk of fire death and injury than older children (USFA, 2021). Studies show that children from low-income families have been found to be 5 times more likely to die in a fire (FEMA, 2021). Fire prevention education, like what is offered by the Philadelphia's Fire Department's Fire Prevention Unit, is an effective way to mitigate fire hazard risk especially when outreach targets populations more at risk.

The secondary effects of urban fire and explosion events relate to the ability of public, private, and non-profit entities to provide post-incident relief. Human service agencies (community support programs, health and medical services, public assistance programs and social services) can be affected by urban fire and explosion events as well. Effects may consist of physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies, or an overwhelming load of victims who are suffering from the effects of the urban fire, including loss of their home or place of business

A single-dwelling fire typically has minimal impact to the citywide economy. Average loss per structure has remained relatively unchanged since 1977, with costs on average losing $19,500 per structure in 2020 (NFPA, 2021). More extensive fires or explosions that affect larger areas of business or commercial districts can have a large impact on economy. From 2015 to 2019, the median value of owner-occupied

housing units in Philadelphia was $163,000. From June 2020 to August 2021, Philadelphia home values went up by nearly 14%, making the new typical price for a home approximately $225,000 (Zillow, 2021). The structural loss costs for the total loss of a single block of homes in the City could easily be several million dollars.

There is the potential for loss of life and injuries in any structural fire for both first responders and property owners. According to the 2017 Philadelphia HMP, fire fatalities in Philadelphia declined between 2006 and 2015. Fire fatalities from 2015 to 2018 are displayed in the table below. More recent data has not yet been published by the Pennsylvania Office of the State Fire Commissioner (OSFC). While the risk for loss of life remains, fire fatalities should continue to decrease with the construction of new buildings built up to code and efforts to increase public awareness of the dangers of urban fires. Absent catastrophic events, the City possesses sufficient resources to respond to routine events.

Table 4-43. Fire Fatalities in Philadelphia, 2012-2021

Year	Number of Fatalities
2012	25
2013	24
2014	32
2015	12
2016	21
2017	20
2018	19
2019	37
2020	34
2021	37

4.3.18 War and Criminal Activity

War and criminal activity hazards are intentional acts of violence, damage to property, and other criminal activities. This category specifically includes the following hazards:

- War, Enemy Attack; foreign attack on territory of the United States.
- Disinformation, Sabotage; intentionally spread inaccurate information, for example; interfering or impairing an operator's management or control of an organization.
- Criminal Activity; lawlessness, acts committed for which punishment is imposed upon conviction after due process.
- Physical or Information Security Breach; contravening security and confidentiality laws and procedures; burglary, unreasonable search and seizure, for example.
- Workplace, School Violence; some environments are more likely than others to experience violence including occupations involving contact with the public.
- Harassment; a pattern of conduct that causes substantial emotional distress with no legal purpose.
- Discrimination; widespread treatment based on class, category, or prejudice rather than merit, applies extensively to civil and labor law (PEMA, 2020).

The City of Philadelphia profiled 'War and Criminal Activities' to address the following human-caused hazards: active assailant and gun violence. While these two hazards are profiled in the same category for

the purposes of meeting the requirements of this planning process, active assailant and gun violence have many unique differences. Each hazard, and their differences, is outlined in the hazard profile below.

The Department of Homeland Security defines an **active assailant** as an individual actively engaged in killing or attempting to kill people in a confined and populated area; there is no pattern or method to their selection of victims (Department of Homeland Security). The FBI defines an **active shooter assailant** as one or more individuals "actively engaged in killing or attempting to kill people in a populated area. In most cases, active assailants use firearm(s); however, active assailant incidents involving other types of weaponry are increasing. Other types of weaponry include but are not limited to knives, bombs or IEDs, and even the use of cars to drive through crowds of people.

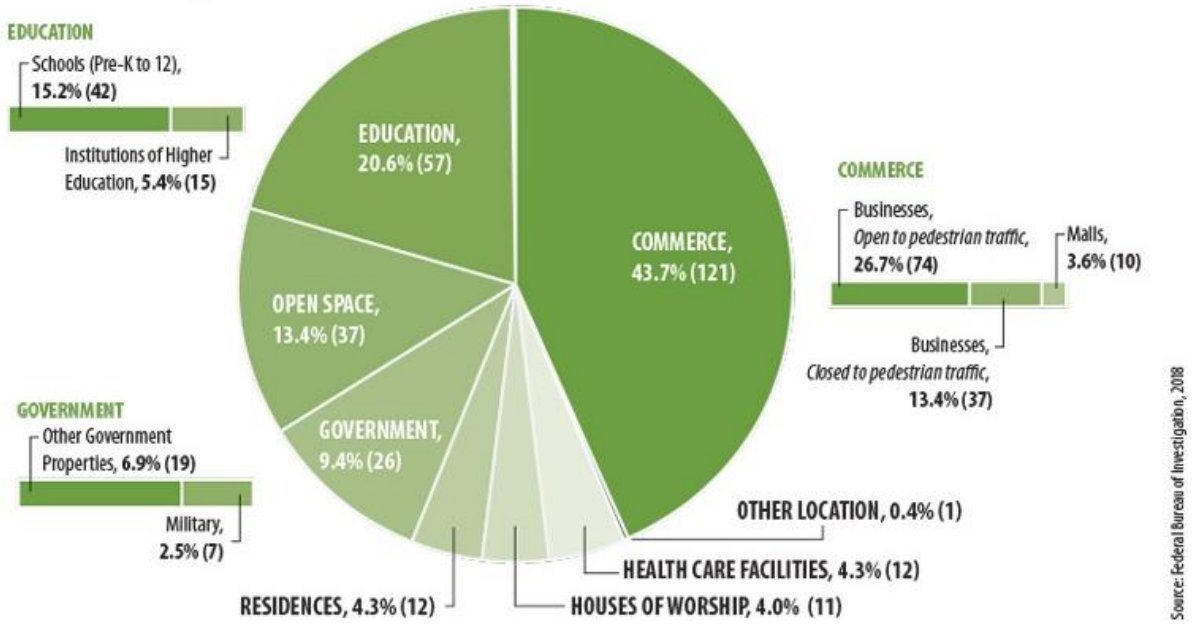
Gun violence is violence committed with the use of firearms. Gun-related violence may be considered criminal or non-criminal. Criminal violence includes homicide, assault with a deadly weapon, and suicide or attempted suicide. Non-criminal violence includes accidental or unintentional injury and death. The City of Philadelphia considers gun violence a public health problem that disproportionately affects specific areas, races, and economic classes of the City (Philadelphia DPH, 2021). There are underlying causes at the root of gun violence within communities, which will be discussed in more detail below.

4.3.18.1 Location and Extent

Active Assailant

According to the FBI, active shooter assailant incidents occur primarily in commercial or educational environments; other locations may include private residences, places of worship, open spaces, hospitals, or military bases. In some cases, an active assailant may target more than one place or use more than one method of attack. These are called Complex Coordinated Attacks (CCA) or complex coordinated terror attacks (CCTA). **Figure 4-36** below shows the number of incidents by location as identified by the FBI where the public may be most at-risk for active assailant attacks in the United States (FBI, 2019).

Figure 4-36. Location and Number of Active Shooter Incidents in the US, 2000-2018



Gun Violence

Gun violence can occur almost anywhere; however, most gun violence occurs in cities. Over half of all firearm homicides in 2015 occurred in just 127 cities (Aufrichtig et al., 2017). Between 2015 and 2019, Philadelphia had one of the highest rates of firearm homicides (EFSGV, 2021). Gun violence occurs in public places — streets, parks, front porches — or in private residences.

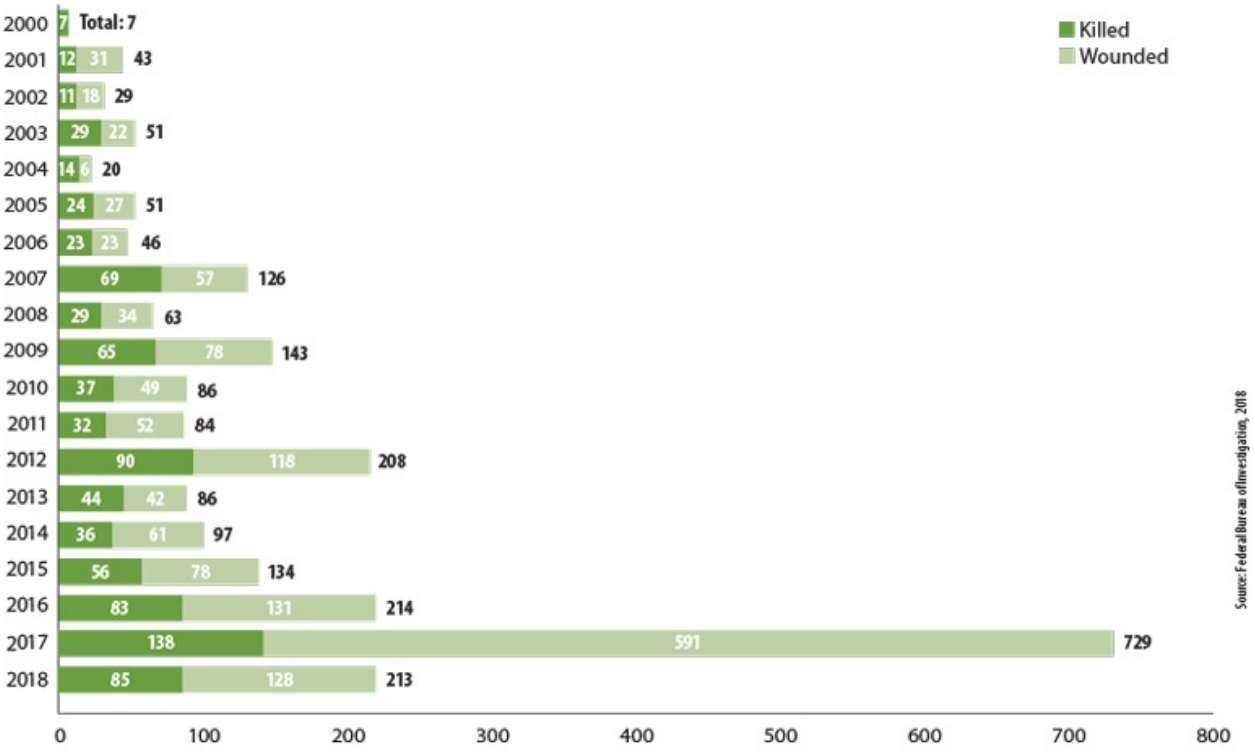
While gun violence occurs throughout Philadelphia, it is concentrated in under-resourced neighborhoods. Neighborhoods disproportionately affected by community gun violence are the often the same neighborhoods impacted by social and economic inequities that can be traced to racism, segregation, and current discriminatory policies, like redlining, exclusionary zoning, and mass incarceration (Jacoby et al., 2018; Sampson, 2012). These inequities often are at the root of gun violence within communities.

4.3.18.2 Range of Magnitude

Active Assailant

The immediate consequences of an active shooter attack include death or injury to people. The extent of those affected depends on the level of training, motivation, ammunition, and targeted area of the attacker. **Figure 4-37** below illustrates incidents by casualty type between the years 2000 and 2018 (FBI, 2019).

Figure 4-37. Casualty Breakdown by year for Active Shooter Incidents in the Us, 2000-2018



A worst-case scenario for Philadelphia would be comparable to other high-profile active shooter incidences like the 2016 Pulse nightclub shooting in Orlando, Florida, the 2017 Las Vegas shooting where a gunman opened fire in a concert setting, or the 2012 Sandy Hook Elementary School shootings.

Gun Violence

The most obvious consequence of gun violence is death or injury to people. The extent of damage depends on the type of firearm and proximity of incident to other people. The less obvious consequences of gun violence stem from exposure to it. Exposure to gun violence is associated with PTSD, antisocial behavior, depression, stunted cognitive and emotional development, increased risk for substance use, and increased likelihood of engaging in violence (EFSGV, 2020).

The worst-case scenario in Philadelphia for gun violence would be a continued increase in death and injury to people, accompanied by indirect consequences to the community of exposure to gun violence.

4.3.18.3 Past Occurrence

Active Assailant

Most of the gun violence in the City is largely criminal in nature rather than active assailant or active shooter. Active assailant is newer terminology based on more recent events of assailants using vehicles and weapons other than guns to attack; since it is a newer grouping or term, the analysis focuses on active shooter events. The table below shows active shooter incidents in Philadelphia between 2000 to 2021; deaths and injuries do not include the shooter. Additionally, twenty-four school shootings occurred in Philadelphia from 1974 to 2021, seven of which occurred in 2021. Three incidents were considered active shooters by the FBI and are also included in the table below.

Table 4-44. Active Shooter Incidents in Philadelphia, 2000-2021

Date	Type/Description
10/4/2021	Education; School of the Future; active shooter fled workplace shooting scene, shootout with police behind school
08/14/2019	Private Residence; shooter armed with a gun began shooting at police who were serving a warrant at the house. Suspect surrendered after a barricade lasting multiple hours; 6 police officers shot and wounded
9/16/2016	Open Space; shooter armed with a handgun, began shooting at a police patrol car and continued to fire the weapon after leaving the scene; 1 deaths, 5 injuries including 1 police officer
9/9/2010	Commerce; shooter armed with a handgun, began shooting at co-workers in the Kraft Foods Factory after job suspension; 2 deaths, 1 injury
2/12/2007	Commerce; shooter armed with a rifle and a handgun, began shooting during a ZigZag Net, Inc. board meeting at the Naval Business Center; 3 deaths, 1 injury
10/7/2005	Open Space; shooter armed with a handgun, shot two people in different parking lots; 2 deaths, 0 injuries
12/9/1985	Education; Archbishop Ryan High School; psychiatric patient took 6 people as hostages using a starter pistol
5/9/1978	Education; Downtown Junior High School; shots deliberately fired a school bus

Sources: FBI, 2019; CHDS, 2021; PPD, 2022

Gun Violence

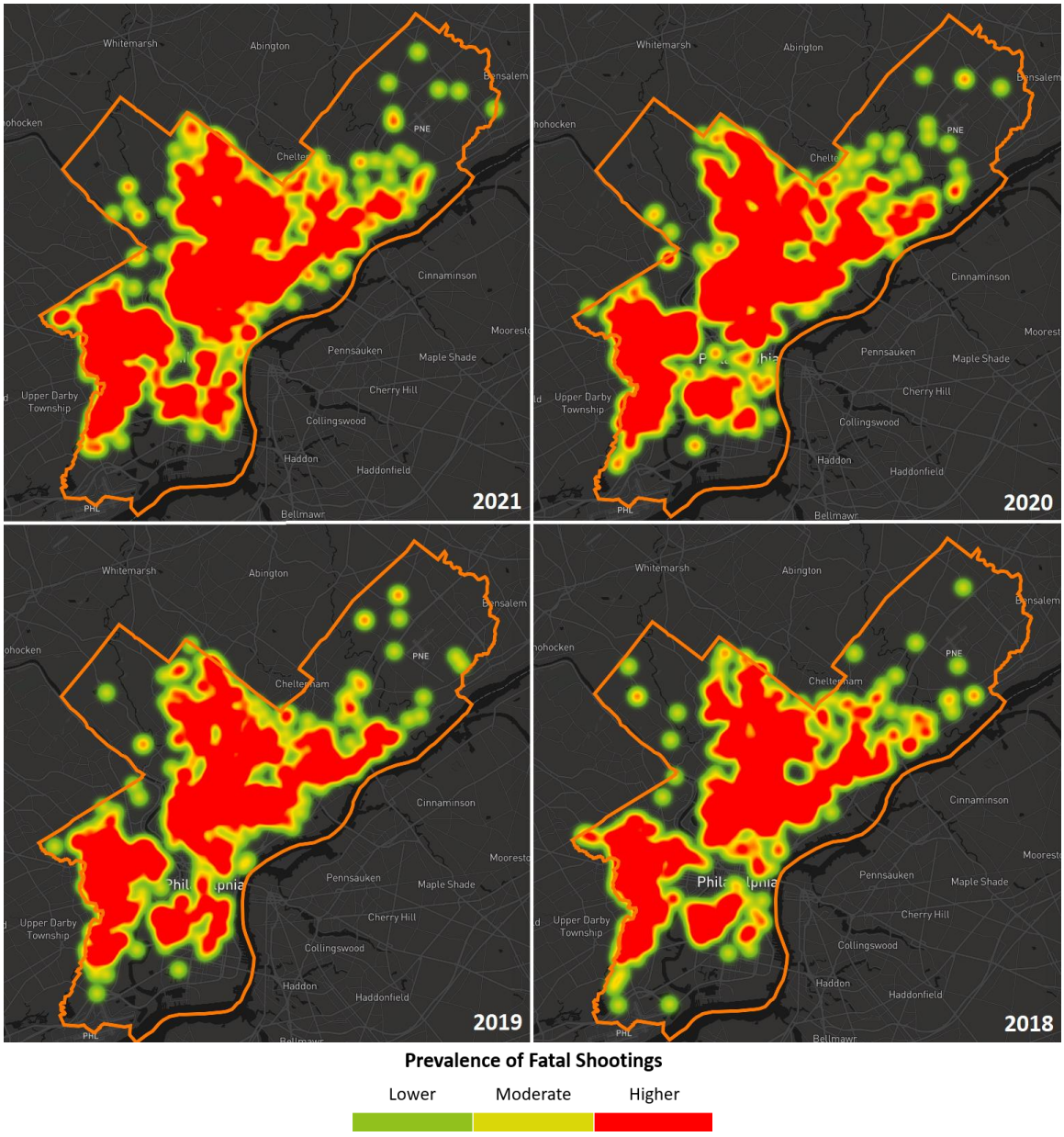
Between 2015 and 2019, Philadelphia had an average of 270 firearm homicides annually, which is 3.6 times higher than the national firearm homicide rate (EFSGV, 2021). The following table shows the fatal and nonfatal totals for gun violence victims in Philadelphia from 2015 through 2021. **Figure 4-38** shows the locations of shootings (fatal and non-fatal) from 2018 through 2021.

Table 4-45. Fatal and Nonfatal Victims of Gun Violence in Philadelphia, 2015-2021

Year	Victims of Gun Violence		
	Total	Nonfatal	Fatal
2015	**1,303**	1,070	233
2016	**1,346**	1,097	249
2017	**1,270**	1,041	229
2018	**1,454**	1,173	281
2019	**1,472**	1,187	285
2020	**2,253**	1,836	417
2021	**2,308**	1,841	486

Source: Philadelphia Office of the Controller, 2021

Figure 4-38.Heat Map of Fatal and Non-fatal Shootings in Philadelphia, 2018-2021



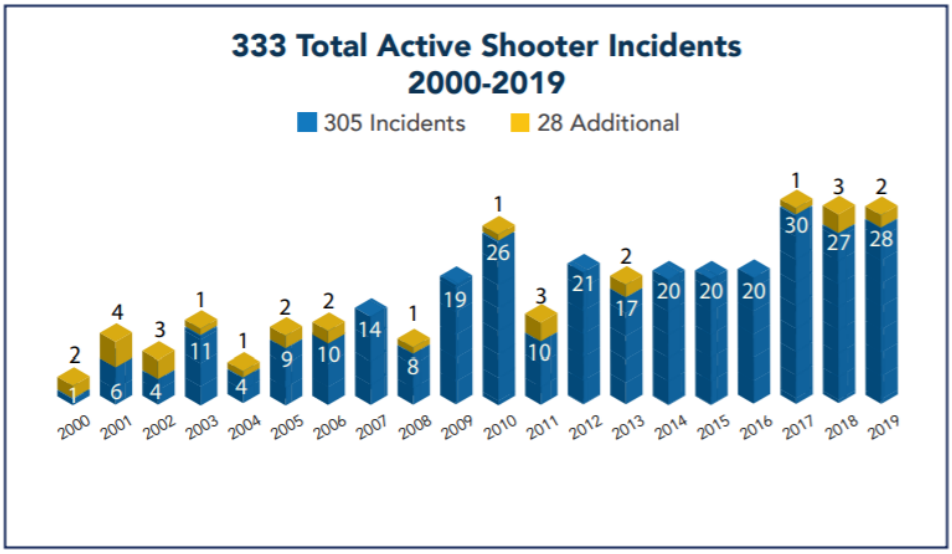
Source: Office of Attorney General, 2021

4.3.18.4 Future Occurrence

Active Assailant

There is no discernible pattern to the location chosen by the shooters. Past active shooter incidents in Philadelphia do not provide enough data to determine a local trend. The chart below depicts national trends for active shooter incidents from 2000 to 2019 (FBI, 2021a). In 2020, the FBI designated 40 shootings as active shooter incidences- the highest number of incidences per year on record (FBI, 2021b). It is anticipated that active assailant rather than active shooter data will grow and be available for the next HMP update. While the link is tenuous, long-running research by the Department of Defense ties climate change to increasing instability that has the potential to increase the risk of certain man-made hazards, including active assailant incidents (Griner, 2021).

Figure 4-39. National trends for Active Shooter Incidents ,2000-2019



Source: FBI, 2021a

Gun Violence

Many instances of gun violence are a symptom of other issues, including income inequality, poverty, underfunded public housing, under-resourced public services, and access to firearms (EFSGV, 2020). In turn, the presence of gun violence can exacerbate social and economic inequalities, such as significantly reducing the growth of new retail and service businesses and jobs, and lowering home values, credit scores, and homeownership rates, which then further perpetuates gun violence (EFSGV, 2020; Irvin-Erickson et al., 2017). Until systematic social and economic inequities are addressed, it is highly unlikely gun violence will decrease, indicating a need for continued investment in gun violence prevention and mitigation. While the link is tenuous, long-running research by the Department of Defense ties climate change to increasing instability that has the potential to increase the risk of certain man-made hazards, including gun violence (Griner et al., 2021).

4.3.18.5 Vulnerability Assessment

Active Assailant

The largest impact of an active assailant is the loss of life and injuries caused by the event. During an active assailant event, local hospitals and medical centers may be inundated, resulting in shortages of blood and supplies that put day-to-day patients at risk. Additionally, active assailant incidents put people

at an increased risk of psychological trauma and future mental health issues. Consequences of mass violence such as an active assailant can result in anxiety, depression, reduced sense of safety, stress or posttraumatic stress disorder (PTSD), sleep problems, feelings of guilt and shame, an increased risk of smoking and misuse of alcohol and other substances (SAMHSA, 2017). Trauma from an active assailant event can affect not only the individual involved in the incident, but family, friends, and the community of the individual.

Other impacts from active assailant incidents can include loss of business and revenue or loss of labor hours. Property damage can come from the weapon (such as a gun, vehicle, fire, or explosives). Mass shootings have the potential to serve as a catalyst for demonstrations related to the incident, putting additional strain on local law enforcement. Ingress and egress routes would close around the immediate area of the event, except to allow first responders priority access to victims. Short-term economic disruption could occur in the area due to transportation corridor closures.

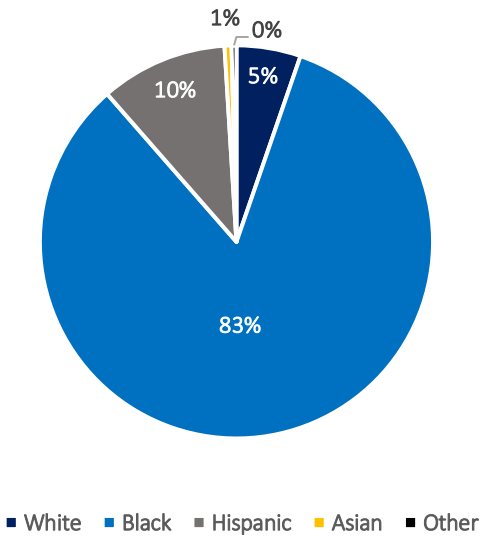
Social, ethnic, and religious minorities (places of worship, social service centers, etc.) are often targets of attack by an active assailant. Recent high-profile examples include the 2018 Pittsburgh Tree of Life synagogue shooting and the 2016 Pulse nightclub shooting in Orlando.

Gun Violence

Gun violence can lead to significant public health, psychological, and economic costs. There are also the indirect costs for lost quality of life for gun victims and for lost wages (Follman et al., 2015). Whole neighborhoods are exposed to and impacted by the adverse health effects of gun violence (Abt, 2019).

Gun violence disproportionately effects disadvantaged and socially vulnerable communities. As **Figure 4-38** shows above gun violence is concentrated in the most socially vulnerable communities in North and West Philadelphia (see 2.3.8 Social Vulnerability). **Figure 4-40** below shows the distribution of gun violence victims between 2018-2020 by race/ethnicity. Black and Hispanic people make up an overwhelming majority of gun violence victims in Philadelphia.

Figure 4-40. Gun Violence Victims in Philadelphia by Race/Ethnicity, 2018-2020



Source: City of Philadelphia, Office of the Controller

4.4 Hazard Vulnerability Summary

4.4.1 Methodology

Ranking hazards helps communities set goals and strategies for mitigation based on their vulnerabilities. The PA Standard Operating Guide (SOG) provides a Risk Factor (RF) Methodology that can be used as a tool used to measure the degree of risk for hazards profiled in local HMPs. Philadelphia utilized the RF methodology outlined in the PA SOG to rank and prioritize which hazards pose the most significant threat to the City based on a variety of factors. The ranking was reviewed by the Steering Committee and by all plan stakeholders during the Draft Plan Review period.

The RF approach produces numerical values that allow identified hazards to be ranked against one another (the higher the RF value, the greater the hazard risk). RF values are obtained by assigning varying degrees of risk to five categories for each hazard: probability, impact, spatial extent, warning time, and duration. Each degree of risk is assigned a value ranging from 1 to 4 with a corresponding weighing factor. The RF approach is summarized in the RF Approach table below. To calculate the RF value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation:

Risk Factor Methodology Equation

RF Value = [(Probability x .30) + (Impact x .30) +
(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Summary of Risk Factor (RF) Methodology				
Risk Assessment Category	**Degree of Risk**			**Weight Value**
	Level	**Criteria**	**Index**	
PROBABILITY What is the likelihood of a hazard event occurring in a given year?	**UNLIKELY**	LESS THAN 1% ANNUAL PROBABILITY	1	30%
	POSSIBLE	BETWEEN 1% & 49.9% ANNUAL PROBABILITY	2	
	LIKELY	BETWEEN 50% & 90% ANNUAL PROBABILITY	3	
	HIGHLY LIKELY	GREATER THAN 90% ANNUAL PROBABILTY	4	
IMPACT In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?	**MINOR**	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	1	30%
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE DAY.	2	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE WEEK.	3	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR 30 DAYS OR MORE.	4	
SPATIAL EXTENT How large of an area could be impacted by a hazard event? Are impacts localized or regional?	**NEGLIABLE**	LESS THAN 1% OF AREA AFFECTED	1	20%
	SMALL	BETWEEN 1 & 10.9% OF AREA AFFECTED	2	
	MODERATE	BETWEEN 11 & 25% OF AREA AFFECTED	3	
	LARGE	GREATER THAN 25% OF AREA AFFECTED	4	
WARNING TIME Is there usually some lead time associated with the hazard event? Have warning measures been implemented?	**MORE THAN 24HRS**	SELF-DEFINED	1	10%
	12 TO 24 HRS	SELF-DEFINED *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	2	
	6 TO 12 HRS	SELF-DEFINED	3	
	LESS THAN 6 HRS	SELF-DEFINED	4	
DURATION How long does the hazard event usually last?	**LESS THAN 6 HRS**	SELF-DEFINED *(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	1	10%
	LESS THAN24 HRS	SELF-DEFINED	2	
	LESS THAN 1 WEEK	SELF-DEFINED	3	
	MORE THAN 1 WEEK	SELF-DEFINED	4	

4.4.2 Ranking Results

Using the methodology described in section **4.4.1**, the following table lists the Risk Factor calculated for each of the twenty-two potential hazards identified in the 2022 HMP. Hazards identified as **high risk** have risk factors greater than or equal to 2.5. Risk Factors ranging from 2.0 to 2.4 are considered **moderate risk** hazards. Hazards with Risk Factors less than 2.0 are considered **low risk**. According to the default weighting scheme applied, the highest possible RF value is 4.0.

Table 4-46. Risk Factor Rankings

Hazard	0.3	0.3	0.2	0.1	0.1	Overall Risk
	Probability	Impact	Spatial Extent	Warning Time	Duration	
Flood, Flash Flood, Ice Jam	4	4	3	2	4	3.6
Opioid Addiction Response	4	4	3	1	4	3.5
Pandemic and Infectious Disease	3	4	4	1	4	3.4
Extreme Temperature	4	3	4	1	3	3.3
Hurricane, Tropical Storm, Nor'easter	3	4	4	1	3	3.3
Urban Fire and Explosion	4	3	3	4	1	3.2
War and Criminal Activity[9]	3	4	3	4	1	3.2
Hazardous Materials Release	3	3	2	4	4	3.0
Winter Storm	4	2	4	1	3	3.0
Tornado, Windstorm	4	3	2	2	1	2.8
Terrorism	1	4	2	4	1	2.4
Drought	2	1.5	4	1	4	2.4
Cyber Terrorism	3	1	2	4	3	2.3
Building and Structure Collapse	2	2	2	4	1	2.1
Dam Failure	1	3	2	2	3	2.1
Civil Disturbance	2	2	2	2	1	1.9
Earthquake	1	1	4	4	1	1.9
Subsidence, Sinkhole	2	2	1	2	3	1.9

4.4.3 Potential Loss Estimates Methodology

The 2022 HMP update included Hazus analysis for Earthquakes, Floods, Hurricane, and Sea Level Rise. The results of this analysis are woven into the hazard profiles for sections **4.3.2 Earthquake**, **4.3.4 Flood, Flash Flood, Ice Jam** which includes the flood and SLR runs, and **4.3.5 Hurricane, Tropical Storm, Nor'easter**. This section of the plan outlines the methodology used while the results remain in the hazard profiles to inform risk and vulnerability.

The Steering Committee defined a list of natural and human-caused hazards and threats that was utilized to define both the GIS-based data and mapping that was developed in support of the Hazard Identification and Risk Assessment (HIRA). In support of the list, GIS data were leveraged to create mapping. In some cases FEMA's Hazus Version 5.1 was utilized to estimate damage and loss estimates, then subsequently mapped. The following sections provide information pertaining to the data utilized,

[9] War and Criminal Activity includes the following human-caused hazards: Gun Violence and Active Assailant.

data processed and/or analyzed to produce the hazard(s), an inventory of assets at-risk, issues or challenges encountered, and recommendations for future analysis considerations.

4.4.3.1 Asset Inventory

The primary data resources leveraged included data provided directly by City of Philadelphia staff and data resources gathered from OpenDataPhilly (https://www.opendataphilly.org/dataset). Data processed to develop an updated Hazus Inventory included:

- City/OpenDataPhilly
    - PWD Parcels
    - OPA Properties Public – note that a 'private' version was requested and considered in hopes that non-public attribution would lead to greater detail of data to produce the best possible inventory dataset, however the private version was not available and furthermore; it was determined that the private version may not have had much more detail that would allow for improved inventory data development.
    - Building Footprints
    - Business License
    - Emergency Operation Centers
    - Long Term Care Facilities
    - Shelters
    - OHS Facilities
    - Tier II Facilities
    - Fire Department Facilities
    - Police Stations
    - Schools
    - Hospitals
- American Community Survey (ACS) - U.S. Census Bureau
    - 2019 5-Year Data Release
        - Hazus stock Demographics data were updated w/ ACS estimates

Data were processed and analyzed in a GIS environment to define the appropriate database schema (proper fields and attribute domain values) required of Hazus. Notably, the smallest geography of the Census Demographic ACS data includes the census block group, which is larger is geographic area compared to census blocks. Therefore, the block group-based data were proportioned based on area to distribute data values from the block group to the block. Overall, data integrity testing is managed through data check functionality within FEMA's Hazus CDMS utility.

4.4.3.2 FEMA's CDMS – Updated Hazus Inventory

Parcel and building-related data resources noted were leveraged to develop user defined facility data that were aggregated through the Comprehensive Data Management System (CDMS), a companion utility to FEMA's Hazus software. Various Hazus aggregated data categories were updated with revised data:

- Essential Facilities
    - Medical Care

    - Emergency Operations
    - Schools
    - Fire Stations
    - Police Stations
- Demographics
    - Aggregated Demographics by Census Block (Flood Model)
    - Aggregated Demographics by Census Tract (Earthquake & Hurricane Model)
- Aggregated General Building Stock
    - Structure Exposure by Census Tract & Block
    - Exposure Content by Census Tract & Block
    - Building Square Footage by Census Tract & Block
    - Building Counts by Census Tract & Block

4.4.3.3 Hazus Version 5.1 Damage & Loss Analyses Runs

The following Hazus runs were performed:

- Earthquake
    - Arbitrary 5.0 MM Earthquake Scenario
    - Probabilistic Earthquake
- Flood
    - 1% Annual-Chance Flood Depth Grid
    - (Level 1) Multi-Frequency/Annualized
    - 30-meter National Elevation Dataset (NED) Digital Elevation Dataset (DEM)
    - 1 Square-Mile Stream Generation Threshold to mirror typical FEMA flood insurance study thresholds
- Hurricane/Tropical Cyclone/Coastal Surge
    - Probabilistic Hurricane Wind per Updated GBS
    - Coastal Surge (SLOSH) generate Depth Grids per NOAA, NHC SLOSH MOM, Version 2, Category 4 Inundation Depths
- Sea-Level Rise
    - PWD Modified Inundation Bathtub Model (4-Foot of SLR Model)

4.4.3.4 Hazus Modeling Challenges & Issues

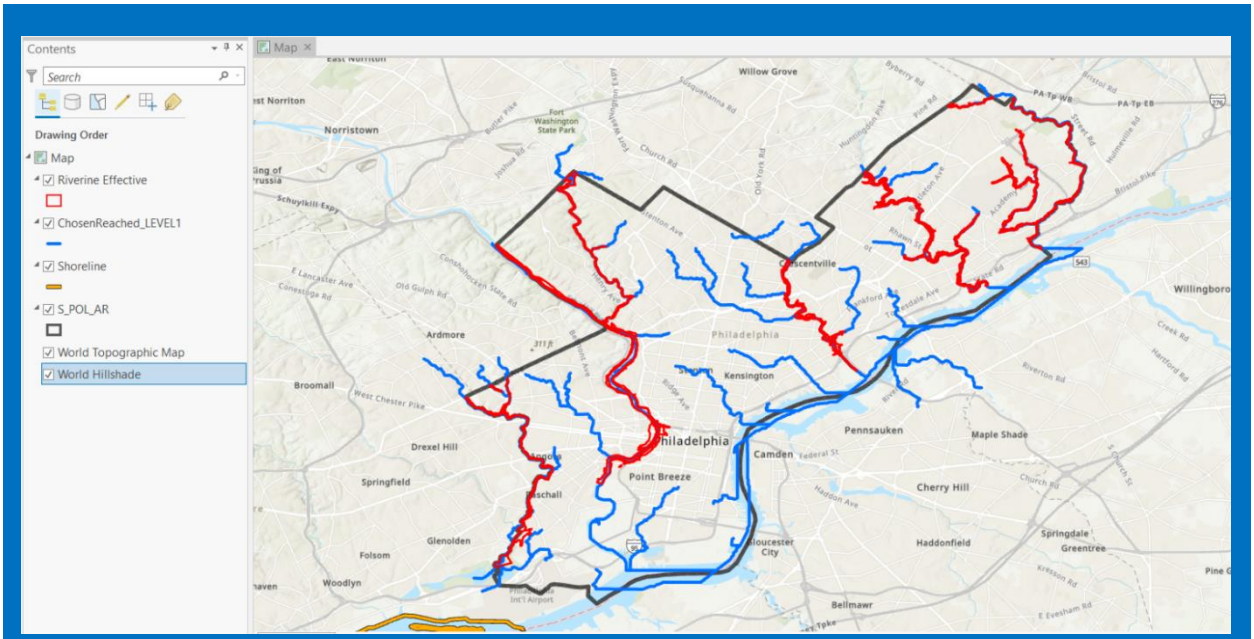
Hazus is a software that includes many pre-defined data and methods that are designed to support small-scale modeling and analyses of natural phenomena and earth processes. This makes Hazus a very beneficial resource for regional-scale analyses. At times, large-scale projects or those intended to analyze a smaller and specific geography may have difficulties. In short, the software may be able to produce results, but the results may be limited in some manner (or) in other cases the software may not be capable of producing any results due to one or more limitations. Two primary challenges were encountered within the Hazus flood model; namely failed reaches during Level 1 Riverine Hydrology & Hydraulics and lack of a coastal definition within the Delaware River that extends upstream to the City of Philadelphia.

4.4.3.5 Level-1 Failed Reaches

FEMA's Risk Map Program introduced the concept of multi-frequency riverine modeling to the traditional Flood Insurance Study methods which historically only modeled and mapped the 1% and 0.2% annual exceedance chance events. While newer studies are obtaining the multifrequency analyses, the City of Philadelphia flood insurance study in riverine-influenced areas are still only subject to the pre-Risk Map era modeling. Consequently, while these detailed analyses are unavailable, a reasonable alternative for this plan update cycle includes allowing Hazus to perform a multi-frequency modeling run. It is very important for users to understand that the Hazus Level-1 hydrology and hydraulics methods are not as detailed as a typical Flood Insurance Study, but the Hazus Level-1 methodology offers the benefit of having a regional-scale estimate of potential flooding and damage/loss estimates. This is particularly true and beneficial for areas (or) riverine stream sections that have not been analyzed in previous flood studies.

The following demonstrates the Hazus-generated stream lines using NED 30-meter DEM as compared to the FEMA effective flood hazard area for riverine streams:

Figure 4-41. Hazus-generated Stream Lines Using NED 30-meter DEM



Context map to show step in process of creating Hazus maps previously shown in Hazard Profiles

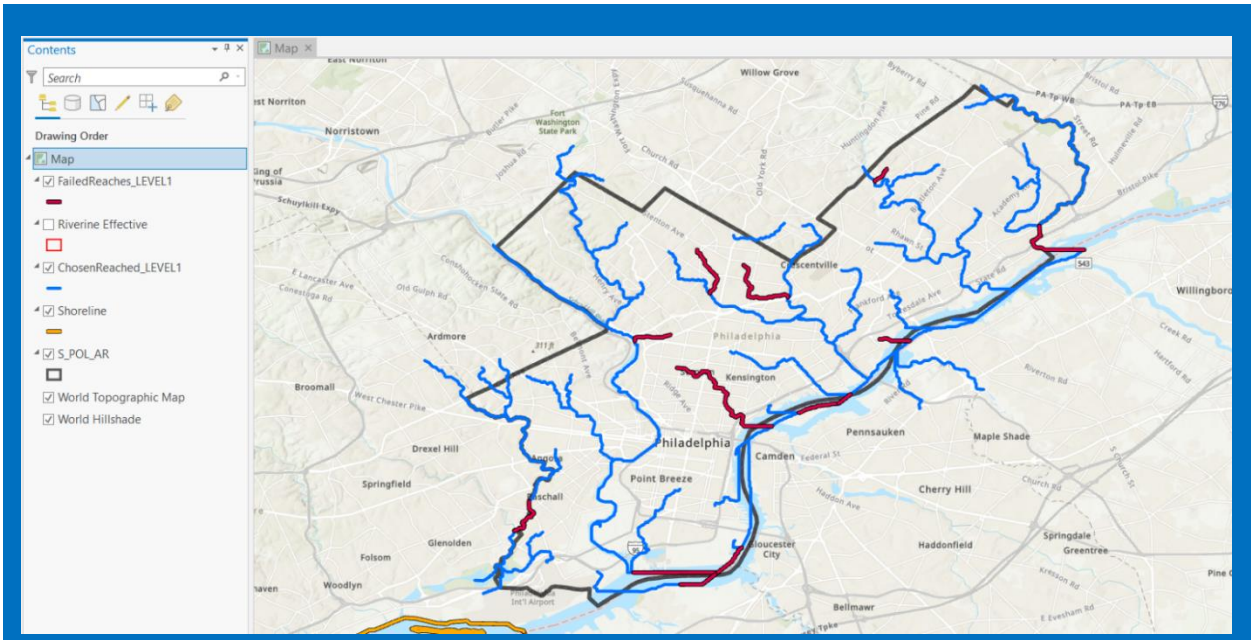
FEMA refers to the current flood study for a community as "effective". An effective study includes a variety of products based on the scope of the study. Effective products include a Flood Insurance Study, Flood Insurance Rate Maps (FIRMs), and sometimes include additional Flood Risk Products like depth grids and Changes Since Last FIRM GIS products. For Philadelphia, the effective flood hazard area for riverine streams in certain areas are not mapped. Consequently, the Level-1 analysis offers the mitigation planning community a reasonable sense of the multi-frequency risk in the additionally analyzed areas – and can help support actions that can be taken in upcoming mitigation planning cycles as well as provide FEMA Region III with data potentially justifying the need for an updated Flood Insurance Study to be performed in these areas. Ultimately, we can see the benefit of these results by

visualizing that we have depth grids (Only 0.2% Hazus Level-1 shown) from which to generate damage/loss estimates for a great number of riverine areas throughout the City.

While there were reaches for which the Hazus Level-1 hydrology and hydraulics were able to produce results, there were some issues with failed reaches. Failed reaches are stream segments for which Hazus was not able to produce hydrologic and/or hydraulic results. One of the issues that may have played into the failed reaches includes the fact that the automated processes for DEM analyses (Fill, Flow Path & Flow Accumulation) directed flow northward at the Delaware River. Consideration for re-running the process was foregone noting that the predominant benefit of the multi-frequency results (i.e., generation of depth grids) within the core of the city will serve the purpose of indicating that the City should likely be considered for an updated Flood Insurance Study. Furthermore, the other flood model-based depth grids that were run through the Hazus model will provide reasonable results for regional planning; recall the other depth grids processed include:

- 1% Annual-Chance Flood Depth Grid
- Coastal Surge (SLOSH) generate Depth Grids per NOAA, NHC SLOSH MOM, Version 2, Category 4 Inundation Depths
- PWD Modified Inundation Bathtub Model (4-Foot of SLR Model)

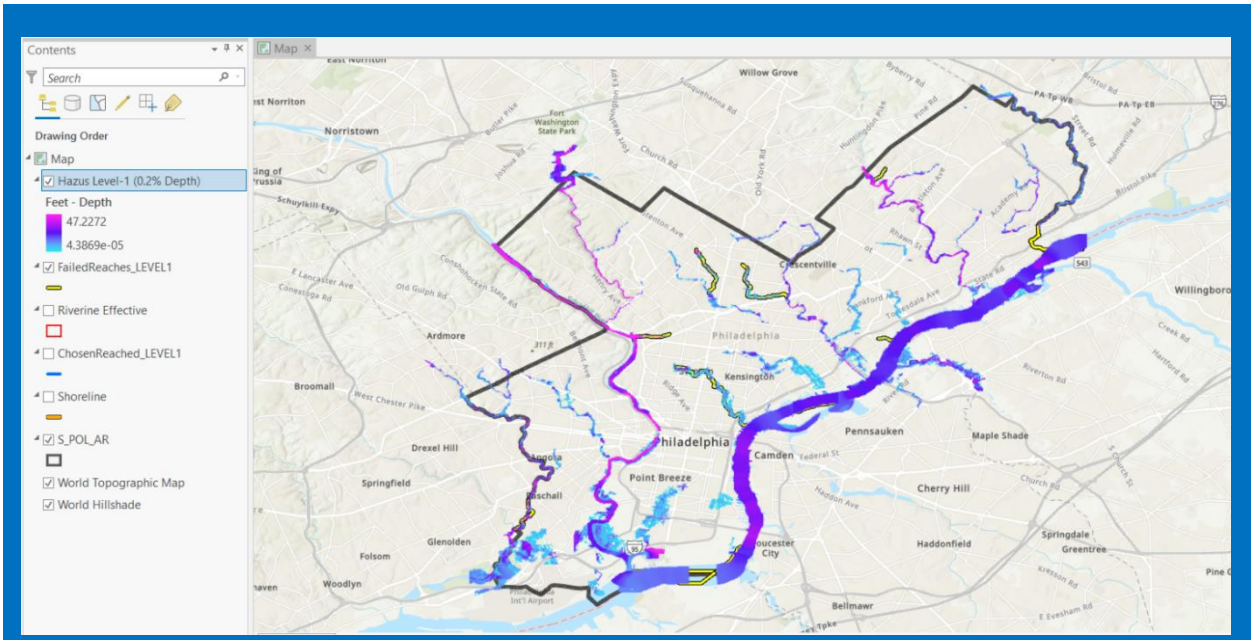
Figure 4-42. Improved Stream Line Layer



Context map to show step in process of creating Hazus maps previously shown in Hazard Profiles

It is also important to note that many of the stream segments for which Hazus indicates a failed reach, is primarily because backwater influence exists from the modeled outputs of the hydrology and hydraulics, which does NOT negatively affect the production of depth grids. So, even though the reach is indicated as failing, the modeling method still provides a reasonable depth grid result for regional-based analyses.

Figure 4-43. Depth Grid Layer

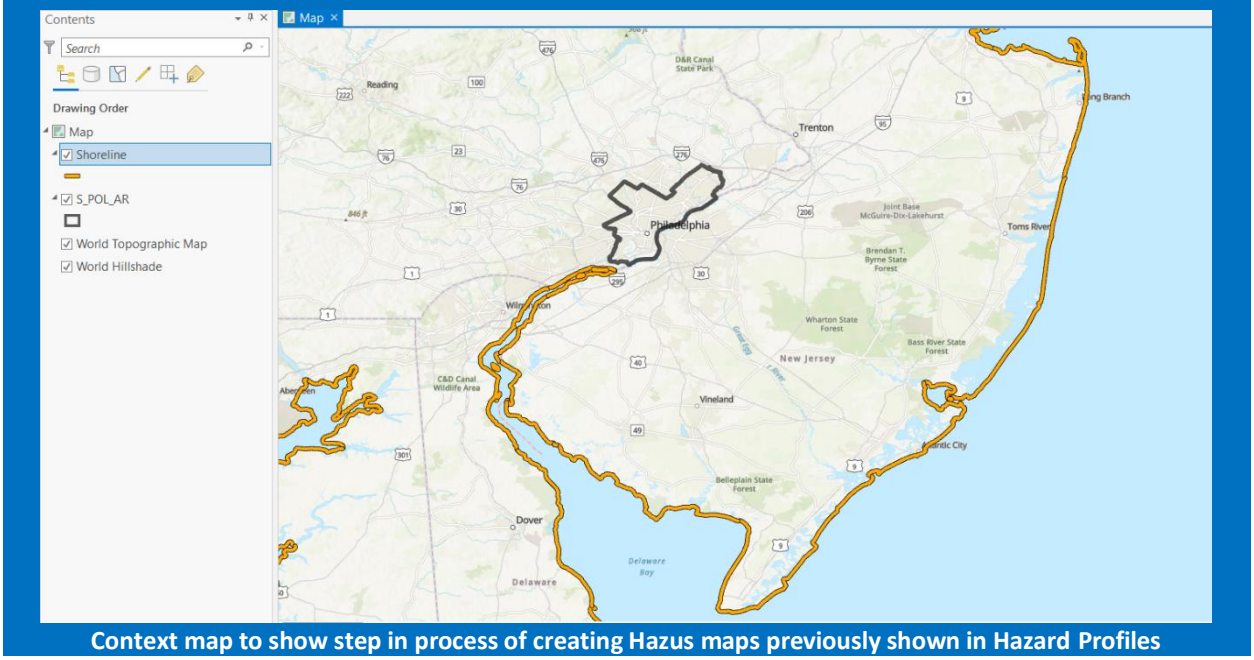


Context map to show step in process of creating Hazus maps previously shown in Hazard Profiles

4.4.3.6 Hazus Coastal Shoreline

The Hazus coastal shoreline file defines the extents or geographic areas where Hazus will perform coastal-based analyses. To date, Hazus does not extend upstream along the Delaware River far enough to capture the City of Philadelphia as being 'influenced' by coastal hazard. This means that the user is limited to ONLY being able to perform riverine-based flood analyses. Furthermore, it also limits the use of riverine-based damage functions to be utilized when performing damage/loss estimates.

Figure 4-44. Hazus Coastal Shoreline



Context map to show step in process of creating Hazus maps previously shown in Hazard Profiles

An attempt to modify the coastal shorelines was performed, however indeterminate issues were encountered and Hazus would not operate properly producing errors clearly indicating that more research is necessary to determine the issue(s) to be able to "trick" Hazus into performing Hazus further upstream along the Delaware River. Notwithstanding, the coastal-based depth grids that were imported into Hazus, to include the Coastal Surge (SLOSH) NHC SLOSH MOM, Version 2, Category 4 and the PWD Modified Inundation Bathtub Model (4-Foot of SLR Model) Inundation Depths were able to be imported and run as being riverine-influenced. The benefit is that results were able to be attained (versus no results) however it needs to be understood that the damage functions utilized will ONLY include those that are riverine-based.

4.4.3.7 Future Considerations

As noted, a few times in the previous sections, FEMA's Risk Map Program should consider an updated riverine-based flood insurance study update. Stream sections identified to the 1-square mile from 30-meter DEM indicate that the City of Philadelphia has more areas of potential flooding that are defined by the effective flood study. FEMA's Hazus program could consider model and method updates to include coastal influences that extend further upstream from the existing and pre-defined Hazus geographies. A Level-1 re-run of the Philadelphia area with a 10-meter or 3-meter NED DEM may indicate a greater level of detail and may also improve the flow regime along the Delaware River, however it should be noted that an increase in DEM resolution will considerably increase the level of effort required to obtain results from Hazus. Specifically, the City may need to be broken into a series of sub-sections to model separately due to file size and processing limitations.

Specific to building data development for Hazus future runs and updates, detailed building information that captures details about the core structural design components will allow for a detailed structural analysis that transcends the existing Hazus mapping schemes for Hurricane and Earthquake model buildings. As an alternative, detailed research regarding structural requirements relative to building code requirements could be leveraged in the future to evaluate whether key assumptions would support defining structural sub-types. Notably, the existing data is too generalized to be able to accurately assign Hurricane and Earthquake model building sub-types.

4.4.4 Future Development and Vulnerability

Over time, changes to land use and development patterns, transportation and utility infrastructure, and population are expected to impact Philadelphia's vulnerability to the natural and human-made hazards discussed in this plan. To assess how the city's risk level may shift, population trends are an important starting point because population growth or decline will drive patterns in other key factors, especially land use and development. While Philadelphia's population grew by only 0.6% between 2000 and 2010, growth accelerated in the most recent decade with a 5.1% growth rate. If growth continues at this pace, it could result in new pressure on the built environment impacting land use and development as well as infrastructure if a growing population strains existing utility and transportation systems.

Table 4-47. Population Change in Philadelphia

2000	2010	Change		2010	2020	Change	
1,517,550	1,526,006	8,456	0.6%	1,526,006	1,603,797	77,791	5.1%

Source: US Census Bureau, Decennial Census, 2000, 2010, and 2020

Recent growth exceeded population projections made by the Delaware Valley Regional Planning Commission (DVRPC) in 2016 by around 14%[10]. Even under the DVRPC's projections, the city's population is expected to grow considerably over the next two decades, reaching 1,643,971 by 2030 and 1,683,402 by 2040. This could strain the city's housing supply and lead to more pronounced affordability challenges if enough new units are not produced to absorb population growth. A DVRPC analysis showed that an average of 2,620 new housing units were permitted in Philadelphia each year between 2010 and 2016, but recent reports suggest that permits are now being issued for up to 4,000 units per year. In part due to a change in a tax abatement policy, permits for as many as 10,000 units were filed in 2021, though some of these units may not be built until future years (Moselle, 2022). These strong construction numbers hide the lack of affordable units – a critical factor when considering future vulnerability.

If new units are not affordable to low-income residents and other vulnerable groups, growth in population could result in overcrowded housing conditions. According to research by the Housing Initiative at the University of Pennsylvania, only a small share – around 41,000 – of the 206,000 households in the Philadelphia MSA eligible for housing vouchers receive them (Aiken, et al, 2021). This gap results in many families with extremely limited options for housing, resulting in multiple households sharing substandard apartments, sometimes leading to unsafe conditions that amplify human-made risks like urban fires or building collapses. Lack of affordable housing units may also expose residents to greater risks from environmental hazards like extreme temperatures if apartments lack proper heating and cooling systems and are in areas with substantial urban heat island effects. Such future risks underscore the importance of the city's strategies to pursue equity in affordable housing.

Even if new construction meets demand for housing at all income levels, growth generally does increase the overall number of people and structures exposed to a range of hazards that affect the city. For example, new construction near the existing floodplain could be impacted if flood levels change over time, leading to additional loss potential during storms that lead to flooding along waterways. Philadelphia's comprehensive plan is *Philadelphia2035*. This plan provides a citywide vision and plans for 18 planning districts in the City. The Philadelphia City Planning Commission is taking steps to begin the next comprehensive plan update and integrating additional hazard and resiliency information into the plan. The highest hazard that has a spatial impact on development is flooding. The following table highlights development concerns by planning district:

[10] DVRPC estimated that Philadelphia would have a population of 1,594,787 in 2020, growing by more than 68,000 people; the 2020 Decennial Census found that the population grew by nearly 78,000 people since 2010.

Table 4-48. Flooding Concerns by Planning District

Planning District	Summary of Risk
Central	The Central district had floodplains near the Delaware and Schuylkill Rivers; these areas will see additional impacts from flooding with SLR. It will be important to protect and expand natural spaces that exist in the floodplain and consider the long-term resiliency of waterfront property particularly along the Delaware which has developments on piers. There is a cluster of repetitive loss properties near the Schuylkill River and some scattered repetitive losses throughout the district. The housing density of the district is higher and would benefit from opportunities to reduce impervious surfaces and integrate stormwater management.
Lower North	The Schuylkill River is the border between West Park and Lower North districts. The thoughtfulness of early city planning keeps this floodplain protected as part of Fairmount Park. The housing density of the district is higher and would benefit from opportunities to reduce impervious surfaces and integrate stormwater management.
North	The North district is bordered by Tacony/Frankford Creek with a portion of the Schuylkill River also in Fairmount Park. The Tacony/Frankford Creek is an example of an urban river with a lot of hardening by attempts to contain the creek with walls and embankments. The development near the floodplain should consider nature based solutions and providing space for managing the waterway.
Upper North	The Upper North has a few scattered repetitive losses throughout the district to consider in mitigation. The housing density of the district is higher and would benefit from opportunities to reduce impervious surfaces and integrate stormwater management. Germantown is a neighborhood within this and the Upper Northwest district that is flood prone.
Upper Northwest	The Upper Northwest has a few scattered repetitive losses throughout the district. The area along Wissahickon Creek is protected parkland providing mitigation benefits. Germantown is a neighborhood within this and the Upper North district that is also flood prone.
Lower Northwest	The Schuylkill River is a significant source of flooding in Manayunk. Recent storms have flooded residences and businesses along Main Street Manayunk. This is one of two locations in Philadelphia with more than 20 Repetitive Loss properties.
Riverwards	The Riverwards have significant flood prone areas along the Delaware River. Despite its name, the Riverwards district does not have any FEMA identified repetitive losses. Port Richard is a neighborhood within the planning district with historic flooding. This district is at high risk from additional flood related risks due to storm surge from hurricanes and tropical storms and the impacts of SLR.
North Delaware	The North Delaware district is flood prone along the Delaware River and has a few scattered repetitive losses throughout the district. This district is at high flood risk from storm surge from hurricanes and tropical storms and the impacts of SLR.
Lower Northeast	The Lower Northeast district is border by Tacony Creek to the west. The Tacony/Frankford Creek is an example of an urban river with a lot of hardening by attempts to contain the creek with walls and embankments. The development near the floodplain should consider nature-based solutions and provide space for managing the waterway.
Central Northeast	Pennypack Creek borders the Central Northeast; though there are no Repetitive Losses in this district from the creek, there are in neighboring districts. Appropriate caution and flood mitigation in this district should continue.
Upper Far Northeast	The Upper Far Northeast has a few scattered repetitive losses in the district and a cluster along the Bucks County border near a tributary to Poquessing Creek. This area, near the border of Bucks County, was the sight of flash flooding in the summer of 2021. Examining the proximately of housing to creeks and identifying

Planning District	Summary of Risk
Upper Far Northeast continued	opportunities to reduce impervious surfaces and manage stormwater would build resiliency to small and big storms alike.
Lower Far Northeast	The Lower Far Northeast has a couple scattered repetitive losses in the district and a cluster along Pennypack Creek. Protecting existing parkland as a buffer for the floodplain will be important for long term resiliency
West Park	The Schuylkill River is the border between the West Park and Lower North districts; however the thoughtfulness of early city planning keeps this floodplain protected park land.
West	Cobbs Creek and Indian Creek near the border with Montgomery County are given some suitable natural space for the floodplain in the form of parkland and a gold course. As these waterways flow further into the City, development is closer and more at risk of flooding. The housing density of the district is higher and would benefit from opportunities to reduce impervious surfaces and integrate stormwater management.
University Southwest	The University Southwest district has numerous flood prone areas along the Schuylkill River to consider. These areas are projected to have increased flooding with SLR.
Lower Southwest	This Planning district includes Eastwick, a predominantly black community at the confluence of Cobbs Creek and Darby Creek just before Darby creek winds into the Delaware River and where the Schuylkill River meets the Delaware River. Eastwick is a priority for flood mitigation with more than 20 Repetitive Loss properties. The Lower Southwest is flood prone with significant inundation areas depicted in maps for the 1% annual chance flood, 0.2% annual chance flood, storm surge, and SLR.
Lower South	The Lower South is also flood prone with significant inundation areas depicted in maps for the 1% annual chance flood, 0.2% annual chance flood, storm surge, and SLR. Mitigation must be considered for land use and development in this district. A compounding hazard concern is the inundation of flood waters onto brownfield sites, which could cause hazardous materials to enter sensitive waterways. This district is at high risk for additional flood related risks due to storm surge from hurricanes and the future impacts of SLR.
South	The South district has significant flood prone land along the Delaware and Schuylkill Rivers. Additionally, basement flooding is a hazard in many South Philadelphia homes that can be mitigated by on-site pumping and larger stormwater management projects as planned by PWD. There is a cluster of repetitive losses in the South district. This district is at high risk from additional flood related risks of storm surge from hurricanes and tropical storms and the impact of SLR. The housing density of the district is higher and would benefit from opportunities to reduce impervious surfaces and integrate stormwater management.

Additional impermeable surfaces added during construction also impact the city's ability to handle runoff and may further exacerbate the urban heat island effect. This makes the incorporation of green infrastructure key to managing future vulnerabilities. Green infrastructure increases permeable surfaces and natural components such as bioswales that employ trees and native plants to help slow and manage runoff. Currently, the Philadelphia Water Department has a 25-year plan that began in 2011 to substantially increase the share of green infrastructure in Philadelphia's wastewater system by 2036. Additionally, the City published a Tree Canopy Assessment in 2019 and is developing an Urban Forest Strategic Plan to increase the urban canopy which will help mitigate future hot weather events and help handle runoff in areas where new trees spread their roots. Currently, Philadelphia Department of Parks and Recreation also provides free street trees to city residents through the TreePhilly program.

5 Capability Assessment

5 Capability Assessment

The purpose of conducting a capability assessment is to examine the City's ability to implement a comprehensive mitigation strategy and to identify potential opportunities for establishing or enhancing specific hazard mitigation policies, programs, or projects. Philadelphia's capability assessment has two primary components:

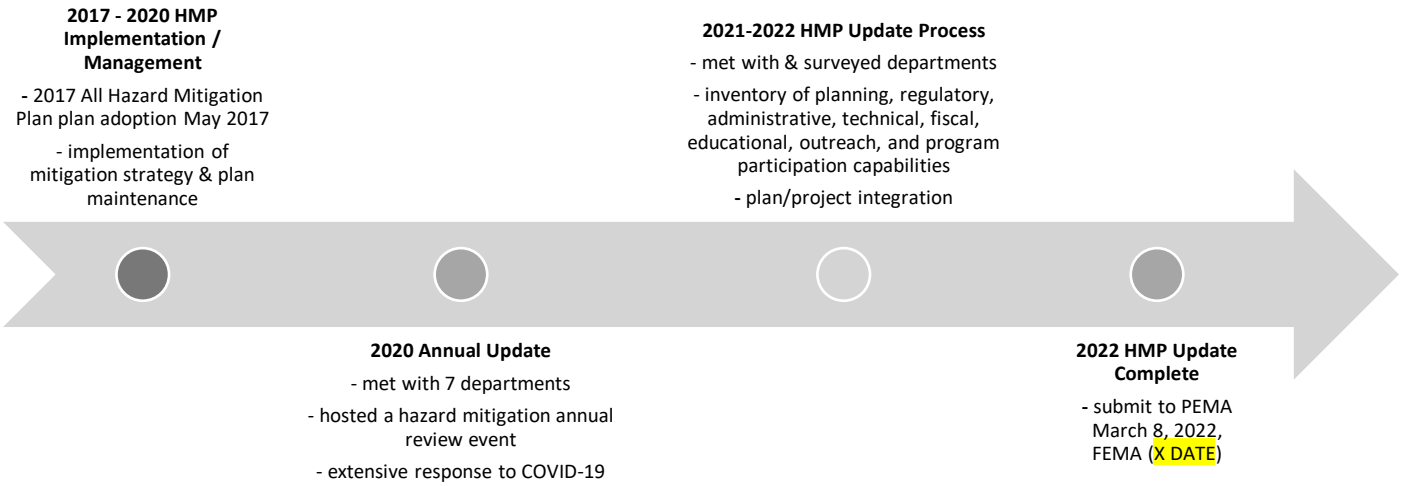
1) an **inventory** of the relevant plans, ordinances, or programs already in place; and
2) an **analysis** of the City's capacity to implement them.

Through this process, the City can pinpoint existing gaps or vulnerabilities that could hinder mitigation actions or exacerbate hazard vulnerability and highlight the positive mitigation measures already underway in Philadelphia.

5.1 Update Process Summary

To inventory Philadelphia's capabilities, a Capability Assessment Survey was distributed to the members of the Hazard Mitigation Plan Steering Committee and other key planning partners. The survey requested information on a variety of capability indicators, such as information related to Philadelphia's fiscal, administrative and technical capabilities, and access to local budgetary and personnel resources for mitigation purposes. A copy of the Assessment Capability Survey is available in Appendix C. Meeting and Other Participation Documentation. Philadelphia Office of Emergency Management (OEM) conducted an annual review of the Hazard Mitigation Plan (HMP) in 2020 to determine the status of mitigation projects, barriers to project implementation, and any major changes to Philadelphia's mitigation priorities.

Figure 5-1. Capability Assessment Process Timeline



5.2 Capability Assessment Findings

5.2.1 Planning and Regulatory Capability

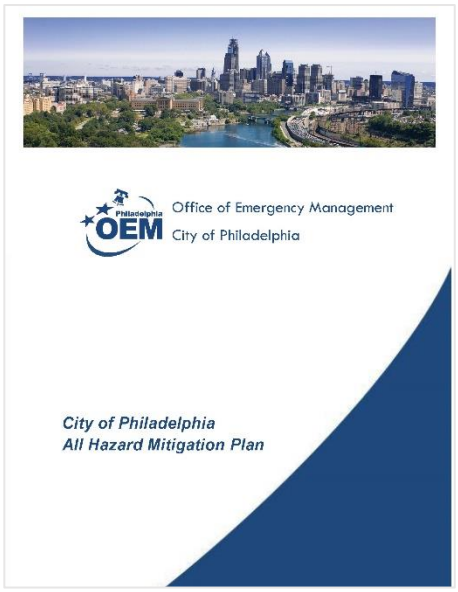
Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the community. The assessment is designed to provide a general overview of the key planning and regulatory tools, or programs in place or under development for Philadelphia along with their potential effect on risk reduction.

5.2.1.1 Hazard Mitigation Plan & Hazard-Specific Planning

A hazard mitigation plan (HMP) represents a community's plan for how it intends to reduce the impact of hazards on people and the built environment.

The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy. State, tribal, and local governments are required to develop a hazard mitigation plan as a condition for receiving certain types of non-emergency disaster assistance including funding for mitigation projects.

Figure 5-2. Cover of the 2017 Hazard Mitigation Plan



The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act of 2000, provides the legal basis for state, local, and tribal governments to undertake a risk-based approach to reducing risks from natural hazards through mitigation planning. The City of Philadelphia created its first Natural Hazard Mitigation Plan in 2012. The 2022 Hazard Mitigation Plan is an update of the 2017 HMP and integrates information from City plans into its mitigation goals and objectives.

In addition, numerous City agencies have developed hazard-specific plans that focus on the natural and man-made hazards that impact the City of Philadelphia. Hazard-specific plans are routinely reviewed and revised. Hazard-based plans include but are not limited to a Severe Weather Plan, Winter Weather Plan, and Hazardous Materials Release Plan which are updated on a regular basis in coordination with City partners and subject matter experts.

Hazard-specific plans are used in the 2022 Hazard Mitigation Plan update to help identify response and recovery capabilities and gaps for future mitigation actions. In addition, these plans help to inform response techniques, hazard locations, and future risk of occurrences within the HMP. Individual hazard-specific plans reference the HMP for additional hazard and vulnerability information. Relevant plans and regulatory tools are listed in the table in **Plan Integration**.

In addition to hazard-specific plans there are hazard-specific focused initiatives, task forces and committees. One of the longer running committees is the Philadelphia Local Emergency Planning

Committee (LEPC) which was established in 1987 to maintain a comprehensive chemical emergency response plan for the City and follow hazardous materials reporting requirements. Philadelphia task forces include the Flood Risk Management Task Force and Gun Violence Reduction Task Force. Standing committees like the Committee on Public Health and Human Services became very active in response to the COVID pandemic. These groups have mixed responsibilities in preparedness, mitigation, response and recovery. The collaboration that groups foster leads to mitigation projects as the teams find other opportunities to mitigate hazards.

5.2.1.2 Emergency Operations Plan

The Pennsylvania Emergency Management Services Code, Title 35, requires all political jurisdictions in the Commonwealth to have an Emergency Operations Plan (EOP), an Emergency Management Coordinator (EMC), and an Emergency Operations Center (EOC). Philadelphia's EOP is an all-hazards plan that complies with the National Incident Management System (NIMS) and is the basis for how the City organizes and acts to protect lives and property in the event of emergencies and disasters. The EOP draws upon the risk and vulnerability assessment conducted through the hazard mitigation planning process and HMP mitigation strategies align with future actions identified in this plan. The EOP is informed by various other hazard-based plans, functional plans, and response plans from within OEM and other City partners. Philadelphia's EOP is reviewed biennially by the Pennsylvania Emergency Management Agency. Ongoing analysis will be conducted to identify opportunities for further integration with the HMP.

5.2.1.3 Evacuation Plan

The City of Philadelphia has never had cause to evacuate the entire City, and such an event would be exceptionally rare. However, the City does maintain evacuation plans in the event that they may be required. Evacuation plans include descriptions of the area(s) being evacuated, the demographics and characteristics of people within those area(s), transportation routes to safe areas, and how the City will support individuals who do not have access to their own transportation. OEM started revising the City's Evacuation Plan in 2018. The updated plan focuses on a neighborhood-level planning approach, with an emphasis on localized hazards identified through the risk and vulnerability assessment of the HMP. The update was completed in 2018.

5.2.1.4 Continuity of Operations Plan and Program

Continuity of Operations Planning (COOP) is the process of developing advance arrangements and procedures that enable an organization to continue its essential functions despite events that threaten to disrupt them. The continuity discipline aims to identify emergency or unconventional means to replace or work around those deficiencies in the short term until the organization can be reconstituted on a normal basis. In 2020, the Continuity of Operations plan for Philadelphia OEM was updated, expanding on recovery strategies, noting essential functions, technology, and equipment.

The updated COOP plan reflects changes in policies due to the COVID-19 pandemic including the addition of Telework capabilities. Several action items from the COOP plan are integrated into the HMP, including electrical systems enhancements, systems synchronization, and the installation of quick connects for generators.

In addition, OEM hired a COOP Program Manager who manages OEM's COOP program and provides technical assistance, trainings, and guidance about COOP/COG to other City agencies.

5.2.1.5 Function-Based Planning

OEM has developed a series of function-based plans that focus on how various hazard scenarios impact the City's phases of operation and citizens. Function-based plans are updated on a regular basis based on input from key stakeholders to account for changes in hazard risk and available resources. Since the 2017 HMP, OEM has completed three additional function-based plans:

- Human Services and Recovery Plan: plan that identifies key tasks and considerations for coordinating a citywide response to events that have the potential to create substantial unmet human service needs.
- Disaster Recovery Framework
- Receiving and Distribution Management Plan: A plan for receiving, tracking, and distributing resources as they are brought into the City to support large-scale incidents.

Four function-based plans have been in development since 2017, including:

- Logistics Staging Area Plan: A plan for gathering and distributing logistics resources from a common location prior to a large-scale event or incident.
- Resource Request Plan: A plan for tracking, receiving, and sourcing requests from City Agencies for additional resources to support a response or planned event.
- Distribution Management Plan: A plan detailing various methods and considerations for distribution of resources to support an event or incident
- Emergency Procurement Plan: Plan that identifies the contracting needs and gaps amongst City agencies who assist in disaster response. The goal is to establish additional Pre-Disaster contracts to eliminate the amount of time it would take to procure goods and services following a disaster.
- Regional Supply Chain Resilience Plan: A framework to inform strategic decision-making prior to, during, or following a major incident or disaster to ensure equitable access and distribution of critical goods and services throughout the Philadelphia region.

The HMP mitigation strategies align with future actions identified in these plans. Ongoing analysis will be conducted to identify opportunities for further integration with the HMP.

5.2.1.6 Emergency Action Plans

The US Army Corps of Engineers (USACE) requires all dam owners to develop emergency action plans and complete regular inspections of their dams. The emergency action plans are distributed to emergency managers and responders to review and keep on file. Philadelphia OEM receives copies of emergency action plans to review for operational effectiveness locally. Emergency action plans describe the induction areas and impacts to people and property if the dam were to fail. Statewide dams are regulated by the Pennsylvania Department of Environmental Protection (DEP) and PEMA. DEP reviews inspection reports and emergency action plans and makes recommendations for maintenance. PEMA and Philadelphia OEM will maintain copies of the plans impacting Philadelphia. All High Hazard Potential Dam (HHPD) plans are required to be created in CEM Planner which is and online tool for emergency management coordination.

5.2.1.7 Participation in the NFIP and Floodplain Management Plan/Floodplain Regulations

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968, which enabled property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the federal government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the federal government makes flood insurance available within the community as a financial protection against flood losses. The requirements of the program are listed in the table below with the City of Philadelphia's confirmation that it is taking actions to identify floodplains, manage them responsibly, and provide flood insurance. NFIP is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods.

National Flood Insurance Program in Philadelphia:

- 2,935 policies in force
- *2,076 in the Special Flood Hazard Area*
- *859 outside the Special Flood Hazard Area*

Table 5-1. Checklist to Identify Local Compliance with the National Flood Insurance Program (NFIP)

Topic	City of Philadelphia Response
Staff Resources	
Is the Community FPA or NFIP Coordinator certified?	The City's Floodplain Manager from 2017- 2021 was a certified floodplain manager. The city is in the process of scoping out and hiring a new floodplain manager as of December 2021.
Is the floodplain management an auxiliary function?	In 2017, Philadelphia hired a designated Floodplain Manager for the City.
Provide an explanation of NFIP administration services.	The administration of NFIP services at the City of Philadelphia consists of: • Enforcement of both Zoning and Building Permits for all development within special flood hazard areas. Regulations related to this enforcement meet and exceed NFIP requirements • Maintenance of an inter-agency Flood Management Task Force to provide public outreach, mapping and regulatory review and enhancement, and City Council/ Public interface to tackle a variety of flooding concerns within the City. • Maintenance of Appeals Boards to hear all variance requests for compliance with floodplain management regulations in accordance with NFIP requirements.
What are the barriers to running an effective NFIP program in the community?	Specific barriers include: • Publication of revised LiMWA line by FEMA Region III via a FEMA initiated LOMR, but such line shown on the National Hazards Layer are not being updated to reflect this change per Region III direction. Due to the City's adoption of ASCE 24, such LiMWA line is a regulatory product so identification on official FEMA digital FIRMs is beneficial • NFIP definitions updates for "Residential" and "Other Residential" are not supported by FEMA guidance documents. Technical Bulletins also reflect older definitions that are not consistent with newer definitions Challenges include distinguishing between NFIP regulations and recommendations and incorporating those into local enforcement regulations, and completeness and reliability of historic records.

Topic	City of Philadelphia Response
Compliance History	
Is the community in good standing with the NFIP?	Yes
Are there any outstanding compliance issues?	Yes
When was the most recent Community Assistance Visits (CAV) or Community Assistance Contact (CAC)?	2016
Is there a CAV or CAC scheduled or needed?	No
Regulation	
When was the most recent Community Assistance Visits (CAV) or Community Assistance Contact (CAC)?	2016
Are the FIRMs digital or paper?	Digital FIRMS with effective panels from 01/17/2007 and 11/18/2015 are available.

Do floodplain development regulations meet or exceed FEMA or State minimum requirements? If so, in what ways?	City of Philadelphia has adopted the following higher standards:
	• Elevation of all development to the 1-1/2 feet or higher, "Freeboard" established per Philadelphia Code Title 4 Subcode B Section B-1612.2.1 and ASCE 24-14.
	• Prohibition of building, structures and activities not allowed within the "Waterfront setback" per Philadelphia Code Title 14 Section 14-704(5).
	• Prohibition of new construction and structural fill seaward of the reach of the Mean High Tide/Mean High Water (MHW) line per ASCE 24-14.
	• Prohibition of development in the floodway, except for docks, roadways, trails, bridges, and public utilities per Philadelphia Code Title 14 Section 14-704(5).
	• Prohibition of either of the following conditions per Philadelphia Code Title 14 Section 14-704(4) within the SFHA:
	  ○ "Hazardous materials" of any kind within a "Regulatory Floodway".
	  ○ Hospitals, Assisted Living Facilities, Correctional Facilities and new/ substantially improved "Manufactured Homes" anywhere within the SFHA.
	
	(Per pages 25-26 of Guide for DEVLOPEMENT IN THE FLOODPLAIN (phila.gov).

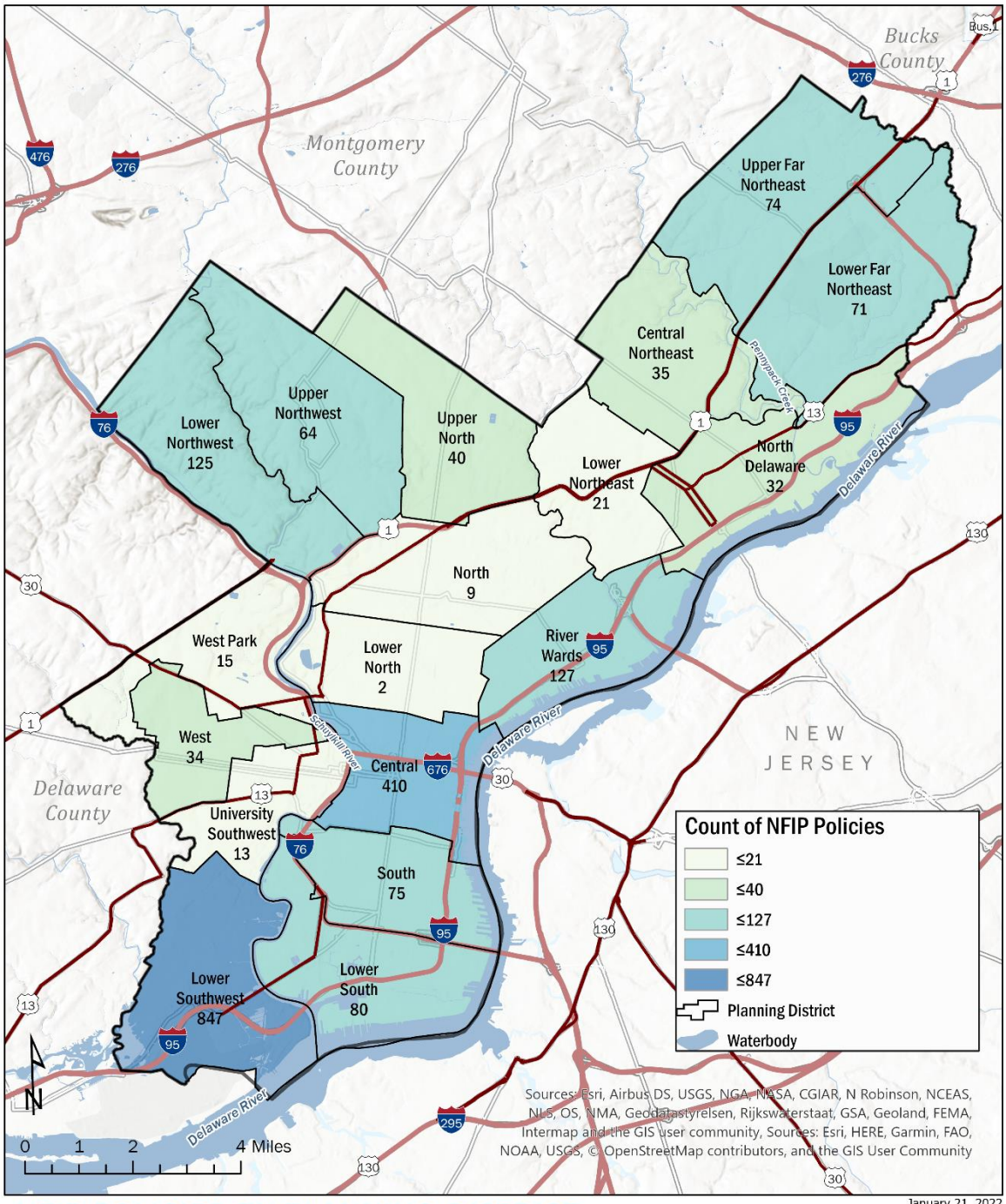
Provide an explanation of the permitting process.	You must submit flood protection documents with all zoning or building permit applications for construction in the SFHA. If the cost for a project is $50,000 or more, you must attend a flood protection scoping meeting before submitting your building permit application. See the information sheet about the mandatory scoping meeting for more information. More information is available in the code bulletin for development in special flood hazards areas (PDF) and the L&I guide for development in the floodplain (PDF).

Topic	City of Philadelphia Response
Insurance Summary	
How many NFIP policies are in the community? What is the total premium coverage?	As of 12/20/21, there are 2,935 total NFIP policies in Philadelphia. 2,076 policies are the SFHA, 859 policies are not. The total premium coverage is $744,271,200.
How many claims have been paid in the community? What is the total amount of paid claims? How many substantial damage claims have there been?	• 1,486 paid losses, totaling $38,163,971 • 57 substantial damage claims since 1978
How many structures are exposed to flood risk within the community?	11,306 buildings (over 250 ft^2) are in the floodplain
Describe any areas of flood risk with limited NFIP policy coverage.	Philadelphia is prone to flooding in some areas that are outside the SFHA. These areas are subject to urban infrastructure flooding, flooding as a result of groundwater, basement backups, overland or Street Runoff and Combine Sewer System overflows. NFIP coverage is not as prevalent in these areas.
Community Rating System	
Does the community participate in CRS?	No
If so, what is the community's CRS Class Ranking?	N/A
What categories and activities provide CRS points and how can the class be improved?	N/A
Does the plan include CRS planning requirements?	N/A

Philadelphia is an active participant in the NFIP. As of November 4, 2021, there were 3,566 insurance policies in force within Philadelphia, a decrease from 4,216 policies at the time of the 2017 Hazard Mitigation Plan. During this period, private flood insurance became available. Therefore, the decrease in NFIP policies may – in some cases – represent a shift to private coverage. **Figure 5-3** shows the locations of policies across the City.

The U.S. Congress mandates that federally regulated or insured lenders require flood insurance on properties that are in areas at high risk of flooding. In high-risk areas, home and businesses have at least a one-in-four chance of flooding during a 30-year mortgage. Participating cities are regularly mapped by federal assessors to delineate areas at high, moderate, and low risk of flooding. The latest Flood Insurance Rate Map (FIRM) update, conducted by FEMA, was finished in mid-2015. The update became effective in November 2015. As of December 2021, The Philadelphia Department of Licenses and Inspections (L&I) is the City's lead coordinating agency for NFIP and is responsible for updating the floodplain management ordinances for the City. L&I reviews project permits, including those in a floodplain, for approval. Permits include construction details such as delineation of flood hazard areas, floodway boundaries, and flood zones; the design flood elevation as appropriate; and the elevation of the proposed lowest occupied floor, including a basement.

Figure 5-3. NFIP Policy Count By Planning District



NFIP POLICIES BY PLANNING DISTRICT
FIMA REDACTED V1 (11-11-2020)
CITY OF PHILADELPHIA

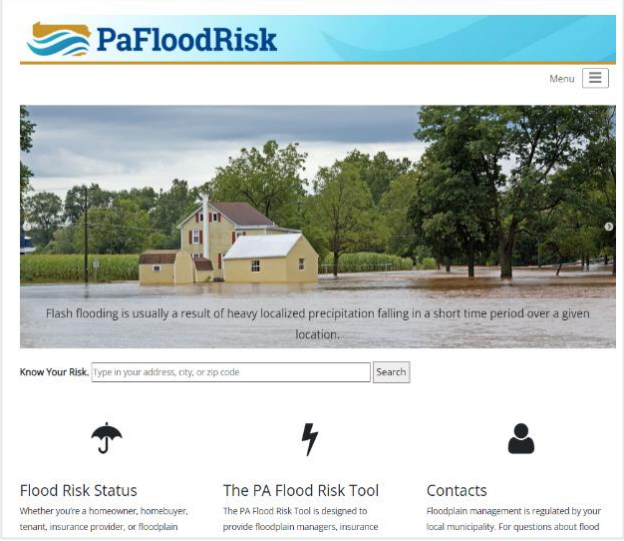
January 21, 2022

Spatial Reference
GCS: GCS North American 1983
Datum: North American 1983
Projection: Lambert Conformal Conic

Flood maps for the City of Philadelphia were last updated in early 2014, with the map updates taking effect on November 18, 2015 for parts of the tidal Delaware River near Philadelphia International Airport. Panels throughout the rest of the City are based on a 2007 floodplain map update. During the 2015 FIRM map updating process, the City of Philadelphia partnered with FEMA to provide public outreach and meetings to review changes to the maps for those who were affected. Households were contacted with information regarding their inclusion or removal from moderate or high-risk flood areas. Open houses were offered across the city to help citizens understand the impact that the new maps would have on their households and residents were offered a chance to appeal. Ongoing flood map developments include: three modeling projects to update flood map designations in Eastwick; Tacony Creek trail inundation updates; and Schuylkill River floodplain map updates. Based on the flood risk and population of Philadelphia it would be helpful to have a new Flood Insurance Study with updated maps and Flood Risk Products for the whole City. Philadelphia has the capacity to use comprehensive Flood Risk Products as demonstrated by the use of PWD data in Hazus and the creation of a depth grid to using in Hazus analysis.

Ongoing support is provided through the Flood Risk Management Task Force (FRMTF), comprised of several city agencies in the city, including PCPC, Philadelphia Water Department (PWD), Office of Sustainability, and OEM. The FRMTF was convened in 2015 to address the circumstances of flooding as it impacts various Philadelphia neighborhoods. In 2019, the FRMTF released a Strategic Plan that outlines a strategy to position the City to become a CRS Community (see below for more information). In addition, in June 2021 the state released a new mobile mapping tool to visualize flood risk. The PA Flood Risk Tool is designed to provide a clear picture of flood risk for a specific area or property.

Figure 5-4. PA Flood Risk, Pennsylvania's new mobile tool that provides the latest flood mapping information



5.2.1.8 Community Rating System

The City of Philadelphia is continuing to explore pathways for participation in the Community Rating System. The City is currently in the process of working with FEMA to complete the City's 2015 Community Assistance Visit (CAV), address outstanding issues, and developing a plan for how Philadelphia should proceed.

5.2.1.9 Capital Improvement Plan

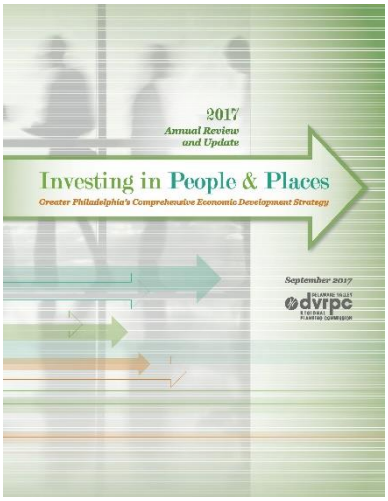
The Capital Program is Philadelphia's six-year plan for investing in its physical infrastructure, community facilities, and public buildings. While much of the Capital Program focuses on improvements to the City's neighborhoods and the quality of life of its citizens, the plan supports numerous other municipal government priorities. More specifically, the Capital Program includes projects that promote economic recovery and job creation, enhance public safety, invest in youth, protect the most vulnerable, and reform city government. A focus of the Capital Improvement Plan is climate change, risk, and resilience. The plan is updated annually.

The Capital Improvement Plan reflects several objectives in the HMP, including storm flood relief and winter weather preparedness. The City will further integrate hazard mitigation and capital improvement planning in the future as it assesses city assets deemed at-risk of extreme heat, increased precipitation, and sea level rise, and will better align mitigation funding with the timeline for capital improvements.

5.2.1.10 Growing Greater: Comprehensive Economic Development Strategy

Growing Greater was created to satisfy provisions for a Comprehensive Economic Development Strategy (CEDS) for the Greater Philadelphia region, encompassing portions of Pennsylvania, New Jersey, and Delaware. This document was developed according to provisions outlined in 13 CFR § 303.7(c) Consideration of non-EDA funded CEDS and was formally approved by the U.S. Economic Development Administration as the Greater Philadelphia region's CEDS on September 30, 2009. This document is the product of a public-private consortium jointly managed by DVRPC (Delaware Valley Regional Planning Commission), Select Greater Philadelphia, and Ben Franklin Technology Partners. The most recent Growing Greater Plan was released in 2017 (DVRPC, 2017).

Figure 5-5. Cover of Growing Greater (2017)



5.2.1.11 Zoning Codes & Subdivision Regulations

Zoning seeks to protect public health, safety, and welfare by regulating the use of land and controlling the type, size, and height of buildings. The Philadelphia Zoning Code Commission was charged in 2007 with developing a zoning code that is easy to understand, improves the City's planning process, promotes positive development, and preserves the character of Philadelphia's neighborhoods. The City of Philadelphia passed its most recent, comprehensive zoning code update in 2012. Zoning changes are made by City Council and the Mayor with recommendations from the Philadelphia City Planning Commission. The Department of Licenses and Inspections enforces the Zoning code. Zoning variance requests are heard by the Zoning Board of Adjustment (SBA).

Subdivision is defined as the division of any parcel of land into a number of lots, blocks or sites as specified in a local ordinance, law, rule or regulation, with or without streets or highways, for the purpose of sale, transfer of ownership, or development. Title 14 of the Philadelphia City Code and Home Rule Charter contains the land subdivision regulations for the city.

Floodplain regulations were included in the 2012 zoning code as currently adopted and enforced by the City of Philadelphia. The zoning code requires review for construction if it is in the Special Flood Hazard Area (as defined by FEMA). In addition, the City provides a Guide to Development in the Floodplain and the Flood Protection Form, which is part of the permit submission for construction. Updates to the Floodplain Regulations are anticipated per the recommendations of the City's Community Assistance Visit (CAV) report with FEMA in 2016.

Stormwater management regulations were included in the 2012 zoning code. In 2015, PWD updated its Stormwater Regulations for private development to prioritize river health, minimize local flooding,

encourage green infrastructure, and to offer community resources to improve local stormwater management.

5.2.1.12 Building Codes

Building Codes regulate construction standards. In Philadelphia, permits are issued for new construction and renovations of existing structures. L&I is responsible for reviewing plans to ensure they conform to existing code in Philadelphia and issuing permits. Decisions regarding the adoption of building codes are made through the Department of Licenses and Inspections, City Council, and the Commonwealth of Pennsylvania.

The 2018 International Codes (ICC Codes) and the 2015 International Residential Code (IRC) were adopted by Philadelphia and became effective October 1, 2018. Philadelphia also adopted ASCE 24 (2014) edition, Flood Resistant Design and Construction and ASCE 7: Minimum Design Loads for Building and Other Structures. Philadelphia currently has the highest building code standards in the state.

The City's Flood Risk Management Task Force (FRMTF) regularly reviews building codes and zoning ordinances to determine if higher standards can be adopted. A review of zoning ordinances was conducted in Spring 2020 and potential improvements to make zoning ordinances more disaster resilient were identified. These improvements will be added as potential projects in the 2022 Hazard Mitigation Plan.

Over 6000 people have been trained in floodplain management and floodplain regulations/building codes by Philadelphia's Floodplain Manager within the last 4 years. Persons trained include building and design professionals, community organizations, and city agencies.

5.2.1.13 Stormwater Management Plan and Green City, Clean Waters

Stormwater management planning is designed to address flooding associated with stormwater runoff. PWD manages stormwater by building and maintaining public stormwater infrastructure and by regulating development projects in the city. PWD uses a combination of traditional 'gray' infrastructure and green infrastructure projects to reduce localized flooding and minimize pollution entering the city's waterways. PWD actively updates the City's Stormwater Management plan. In addition to the plan, PWD provides the Philadelphia Stormwater Guidance Manual (2020) to help homeowners, contractors, and citizens better understand how to efficiently comply with Stormwater regulations. The Manual was last updated in October 2020.

Figure 5-6. Green City, Clean Waters website

Green City, Clean Waters is a 25-year plan launched in 2011 to reduce the

volume of stormwater entering combined sewer outfall, which serves approximately 60% of the land in Philadelphia. Green City, Clean Waters has implemented stormwater management solutions at almost 800 sites throughout the City to keep more than 2.7 billion gallons of polluted waters out of Philadelphia's rivers (Philadelphia Water Department, 2021). The Green City, Clean Waters program has become an international best practice for stormwater improvement and maintenance.

Green City, Clean Waters is expected to reduce the amount of sewer overflow entering city waterways by five to eight billion gallons per year as construction continues. This is an 80% to 90%reduction in flow. The plan includes several green infrastructure projects to attain water quality goals and to mitigate climate change impacts while stimulating economic development. Future projects include incorporating porous asphalt, bioswales, rooftop gardens, street repaving, roadside plantings, and thousands of new trees.

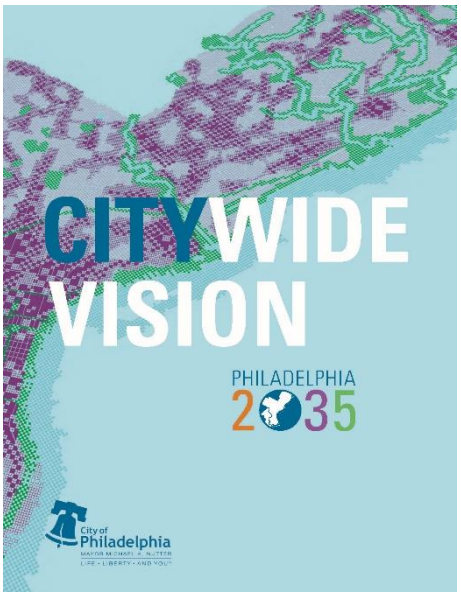
As of 2021, the Green City, Clean Waters program has now completed its 10th year of implementation. Significant progress has been made towards long-term goals, with the implementation of 2200 Greened Acres in Philadelphia from both public and private sources and the reduction of over 2 billion gallons of combined sewer overflow a year.

Approximately 40% of the City is in the drainage area for the Municipal Separate Storm Sewer System (MS4). The City manages stormwater and plans to reduce pollution in these areas of the City in compliance with the Clean Water Act and the MS4 permit from the Pennsylvania Department of Environmental Protection.

5.2.1.14 Comprehensive Land Use Plan

A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide for future public and private decision making. Comprehensive plans contain sections on demographics, land use, transportation elements and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions. *Philadelphia2035* is managed by PCPC in partnership with dozens of other agencies, organizations and individuals. Philadelphia2035 is one component of a broader initiative known as the "Integrated Planning and Zoning Process." This process is designed to align Philadelphia's zoning code changes with comprehensive and strategic planning, all of which is informed by the Citizens Planning Institute, a formalized public education and outreach organization.

Figure 5-7. Cover of Phila2035's citywide vision



As of September 2021, PCPC had completed and adopted all 18 district plans as part of *Philadelphia 2035*(PCPC, 2021). The 2022 Hazard Mitigation Plan integrates existing and future land use as laid out by *Philadelphia2035* district plans. The Philadelphia City Planning Commission has initiated the process for the next comprehensive plan update, Re-Imagine Philadelphia, which will focus on racial equity and resilience.

5.2.1.15 Open Space Management Plan

An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances, open space management practices are consistent with the goals of reducing hazard losses such as the preservation of wetlands or other flood-prone areas in natural state in perpetuity. Under the direction of the PCPC, *Philadelphia2035* provides guidelines on the expansion and maintenance of open space in the City by planning district.

Parks and Recreation and other departments have voiced a need for flood- and hazard-resilient infrastructure and open space. Current efforts at FDR Park to mitigate floodplain development with wetlands banking is a recent local example of resilient recreational infrastructure.

5.2.1.16 Historic Preservation Plan

In 2016, Pennsylvania State Historic Preservation Office conducted historical site assessments at historic sites threatened by flooding in Philadelphia. Five of the 25 buildings that were identified in the SHPO's site assessments were in Manayunk. In 2020, SHPO released a guide for flooding in Manayunk's Main Street Historic District. The Guide outlines recommendations to minimize the impact of flooding in the Historic District.

In 2018, the US Army Corps of Engineers National Nonstructural Flood Proofing Committee (NNFPC) completed a Philadelphia Historic Resource Flood Vulnerability Study that recommended flood mitigation actions for 25 historic resources in Philadelphia. Mitigation actions are identified in the 2022 Hazard Mitigation Plan.

Figure 5-8. Cover of the Manayunk Main Street Historic Flood Guide released in 2020 by PA SHPO following their 2016 site assessments of 25 historic sites in Philadelphia that are vulnerable to flooding. Source: PA Historic Preservation

5.2.1.17 Watershed Management Plan

PWD has developed Integrated Watershed Management Plans (IWMPs) for each of the five major tributary streams of the Schuylkill and Delaware Rivers, including the Cobbs, Tookany/Tacony-Frankford, Wissahickon, Pennypack and Poquessing. Designed to meet the goals and objectives of numerous water resources-related regulations and programs, integrated watershed management plans recommend the use of adaptive management approaches to implement recommendations watershed-wide. Philadelphia's watershed management plan ties directly into Green City, Clean Water with waterways restoration, waterways assessment, and the incorporation of green stormwater infrastructure.

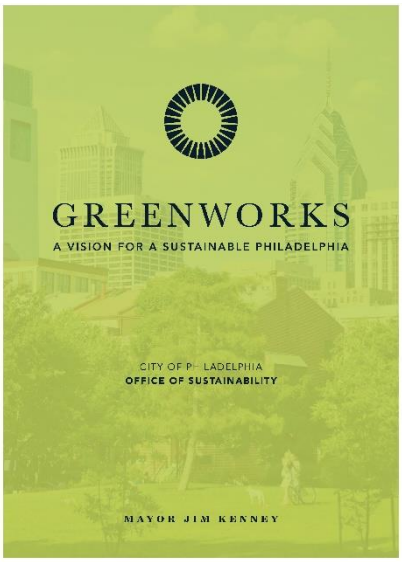
5.2.1.18 Greenworks Sustainability Plan

The Philadelphia Office of Sustainability works with partners around the City to improve quality of life in all Philadelphia neighborhoods. OTIS is responsible for implementing Greenworks Philadelphia, the City's comprehensive sustainability plan, which has eight visions:

1. Accessible food and drinking water
2. Healthy outdoor and indoor air
3. Clean and efficient energy
4. Climate-prepared and carbon-neutral communities
5. Quality natural resources
6. Accessible, affordable, and safe transportation
7. Zero Waste
8. Engaged students, stewards, and workers

Each Greenworks vision will help create a city where all Philadelphians enjoy benefits from sustainability, including improved public health, a clean environment, and opportunities to learn, work, and prosper (City of Philadelphia Mayor's Office of Sustainability, 2016).

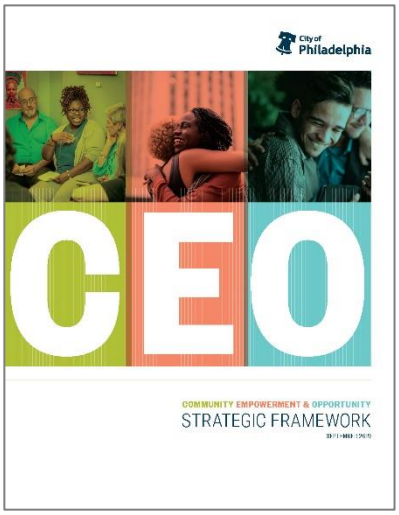
Figure 5-9. Cover of Greenworks Sustainability Plan



5.2.1.19 Community Empowerment & Opportunity Strategic Framework

The Mayor's Office of Community Empowerment & Opportunity (CEO) strategic framework, released in 2019, provides leadership on issues of economic justice by advancing racial equity and inclusive growth to ensure that all Philadelphians share in the City's prosperous future. CEO advocates at the program, operational, and system-level for solutions for mobility out of poverty and is guided by listening to, supporting, and including communities while working collaboratively to foster greater economic mobility (Mayor's Office of Community Empowerment & Opportunity, 2019).

Figure 5-10. Cover of CEO Strategic Framework

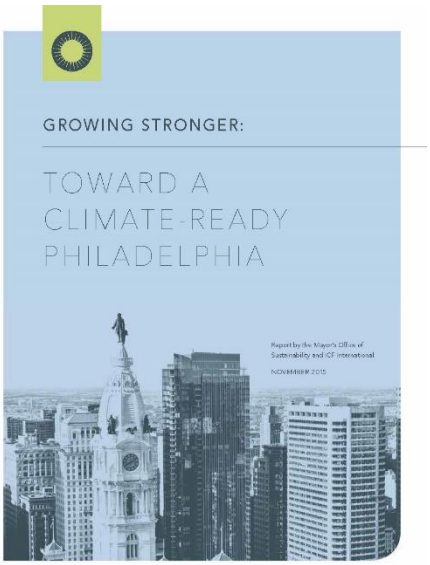


5.2.1.20 Environmental Justice (EJ) Advisory Commission

In February 2022, the City of Philadelphia launched the City's first Environmental Justice Advisory Commission. The Commission plans to assemble individuals with lived experience and personal interest in Philadelphia's environmental issues. Commission members will work to identify where multiple impacts occur, as well as where City policies or procedures result in barriers to achieving environmental justice. The

Commission will strive to amplify the concerns of frontline communities and will work with the City to co-develop plans to address disparities in exposure to environmental harm.

Figure 5-11. Cover of Growing Stronger



5.2.1.21 Growing Stronger: Toward a Climate-Ready Philadelphia

Growing Stronger: Toward a Climate-Ready Philadelphia, released in 2015 by the Office of Sustainability, identifies and provides strategies to address the risks and impacts of climate change in Philadelphia. Growing Stronger focuses on climate adaptation efforts (Office of Sustainability, 2015). Data from this plan were updated for use in the 2022 Hazard Mitigation Plan's Risk and Vulnerability Assessment.

5.2.1.22 Philadelphia Airport Sustainability Planning

The Philadelphia International Airport (PHL) released a sustainability policy statement in 2017 regarding their ongoing commitment to sustainability and an upcoming Sustainability Plan. PHL released a Climate Vulnerability Plan in 2019 that aimed to prepare the airport for the impacts of climate change (PHL, 2019).

5.2.1.23 READYPhiladelphia Program

OEM offers a variety of preparedness workshops to communities and businesses, including READYHome, READYBusiness, and READYCommunity. OEM will be updating small business preparedness and continuity programming within the next year and plans to pilot a new READYKids workshop. Over the last year READY programs were also made available virtually.

5.2.1.24 PHA Organizational and Individual Site Resilience Reports

The Philadelphia Housing Authority (PHA) completed an organizational assessment and assessments for 48+ individual PHA-owned sites for resiliency. The site-specific assessments looked at every property in PHA's "conventional" portfolio, which are the large congregate developments of public housing that PHA directly owns, manages, and subsidizes (as opposed to PHA's scattered sites, voucher-subsidized developments, or alternatively managed properties).

The organizational assessment included:

1. Core emergency management challenges that PHA staff and residents will likely face during most hazards
2. Organizational strategies to improve communication, coordination, and resilience of the residents to help build the agency's resilience
3. Portfolio-wide strategies for physical investments where PHA can improve its resilience
4. Summary of vulnerabilities and risks across PHA's portfolio of properties
5. Possible funding opportunities for PHA to pursue to continue the work proposed

The site-specific assessments contained:

1. Resilience strategies for specific on-site facilities
2. Citywide hazard mapping and mitigation plans
3. Vulnerability mapping of site within citywide context

4. Itemized list of proposed resilience strategies and costs

While the recommendations from these reports have been incorporated into ongoing capital improvements and design/planning of new units to some extent, a strategic plan for comprehensive implementation has not been initiated. The incoming Sustainability Coordinator at PHA working jointly with the Operations & Maintenance division will move this effort forward.

5.2.1.25 PHA Sustainability Report

PHA released a Green Action Plan in 2013 that focuses on improving sustainability at PHA in key areas such as energy, water, indoor air quality, greenhouse gas emissions, recycling and waste, and administration and operations (Philadelphia Housing Authority, 2013).

5.2.1.26 Threat and Hazard Identification and Risk Assessment

The Threat and Hazard Identification and Risk Assessment (THIRA) is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks by answering the following questions (FEMA, 2021):

- What threats and hazards can affect our community?
- If they occurred, what impacts would those threats and hazards have on our community?
- Based on those impacts, what capabilities should our community have?

Threats and hazards identified in this assessment are aligned with the Hazard Mitigation Plan.

5.2.1.27 City of Philadelphia Debris Management Plan

OEM is responsible for the development and maintenance of a Debris Management Plan for disaster recovery efforts. This plan identifies sites throughout the City to manage and process debris after disaster events. Debris management is a key element of helping residents, business, neighborhoods, and government recovery after a disaster. It also prevents a compounding hazard of debris attracting pests, more debris and dumping, and creating an obstacle in neighborhoods. A plan review and update is currently underway. The City will continue to review possible debris sites and identify new locations.

5.2.1.28 Eastwick Strategic Planning and Alignment: A Place-Based Framework

The Office of Sustainability is developing and will implement a strategic direction to enhance coordination between the 11 active City-sponsored initiatives focused on addressing environmental injustice taking place in Philadelphia's Eastwick neighborhood. The development of a strategic framework is necessary to advance environmental justice for Eastwick. The goals of this project include aligning existing initiatives, identifying opportunities for collaboration, and creating performance metrics to measure progress. This process and framework can then be used to address issues of environmental injustice across the city.

5.2.2 Administrative and Technical Capability

Philadelphia's administrative and technical capabilities span urban planning, emergency management, social equity, economic development, information technology, and overarching sustainability capabilities.

OEM's mission is to focus people, plans, and programs to promote a prepared and resilient Philadelphia.

- OEM averages four responses per month and 49 per year.

Philadelphia's ability to plan and implement mitigation programs is directly tied to its ability to focus staff time and resources for that purpose. To assess administrative capability this plan examines how mitigation-related activities are assigned to City departments, and how adequate the personnel resources are for carrying out those activities. Technical capability assesses the level of knowledge and technical expertise of City employees, such as personnel skilled in using GIS to analyze and assess community hazard vulnerability.

5.2.2.1 Operational Coordination & Emergency Management Accreditation Program (EMAP)

In Philadelphia, the responsibility for ensuring the City's preparedness and resiliency to emergencies and disasters falls to OEM. Adam Thiel is both the Commissioner of the Philadelphia Fire Department (PFD) and the Director of OEM. The synergies of OEM within the PFD provides additional administrative and organizational support for OEM's duties. OEM coordinates government, non-governmental organizations, and members of the community through the execution and continuous refinement of a comprehensive emergency management program. The program is supported by risk assessment, consultative mechanisms, and strategic planning processes. OEM also responds to both planned events and unplanned incidents to assist in coordination of resources and services.

To maintain a comprehensive, integrated program of mitigation, preparedness, response, and recovery for emergencies of any kind, OEM endeavors to create a more prepared and resilient Philadelphia through planning, operational coordination, and external engagement.

OEM has grown in its national recognition. In November 2015, OEM received EMAP accreditation, displaying proficiency in 64 industry standards and 41 subcomponent strategies, including planning, incident management, operations and procedures, crisis communications, public education, and numerous other aspects of emergency management. OEM is in the process of updating their EMAP accreditation.

Figure 5-12. The Emergency Operations Center on November 3, 2020 during the 2020 presidential election.

OEM maintains several centralized facilities to respond to incidents and events. The Emergency Operations Center (EOC) provides a common location for interagency coordination during large scale incidents and planned events. The EOC is consistently maintained and updated to include new technological resources to support interagency coordination both in-person and remotely. OEM also operates CP-1, a mobile command post provides a central location in the field for face-to-face coordination and communication during incidents and special events. In addition, OEM operates a warehouse that houses and distributes equipment for events and

incidents of various sizes and types. Equipment ranges from generators to durable medical equipment.

The PFD conducts a significant amount of educational outreach for mitigation and preparedness captured in section **5.2.4 Education and Outreach**. The PFD has a lead role in Urban Fire and Explosion mitigation and re-opened four companies to increase fire suppression capabilities in 2019.

5.2.2.2 DHS Emergency Plans and Resources for People with Disabilities

The City of Philadelphia's Department of Human Services (DHS) provides administrative and technical emergency resources, plans, and assistance for people with disabilities. Resources include:

- Risk Management Division, a flexible incident reporting requirement for all licensed programs used to identify high-risk trends and support development of mitigation strategies.
- DHS emergency plans required for group homes housing residents with autism (regulatory requirement of Chapter 6400).
- AIDinPA.org, a collaborative website between ODP, ASERT, and HQCU that hosts resources related to emergency preparedness, response, and recovery. The website is geared towards Philadelphians with disabilities.

5.2.2.3 Executive Order No. 1-20 on Diversity, Equity, and Inclusion

On January 6, 2021, Mayor Kenney signed Executive Order No. 1-20 to expand the Administration's focus on diversity, equity and inclusion and formalize the creation of the City's Racial Equity Initiative. Executive Order No. 1-20 includes five key areas, including the following:

1. Renaming the Office of Diversity and Inclusion to include "Equity"
2. Establishing formal oversight of the Office of LGBT Affairs and Mayor's Office for People with Disabilities
3. Launching a City-wide Employment Diversity and Inclusion Initiative
4. Introducing the City-wide Racial Equity Initiative
5. Mandating diversity, equity, and inclusion training

Executive Order No. 1-20 aims to create a city where race does not predict outcomes for its residents and diversity is recognized as one of Philadelphia's greatest assets. The Executive Order serves as the framework that will guide the City's efforts to implement sustainable change aimed at addressing inequities in all major indicators of success, including health, criminal justice, education, jobs, housing, and more (City of Philadelphia Mayor's Office of Diversity, Equity and Inclusion, 2020).

The requirement for City Departments to have Racial Equity Action Plans that focus on improving service delivery, internal practices, and community engagement aligns with the HMP mitigation strategies to proactively provide support to communities who suffer from historical racial inequities and increased risk from hazards.

5.2.2.4 Consolidation and improvement of IT operations

Since 2017, the City of Philadelphia's Office of Innovation and Technology (OIT) has consolidated the City's IT controls and policies, upgraded key emergency response systems, and improved IT security. Key actions include:

- Updated IT controls and policies based on NIST framework

- Endpoint threat detection and responsive software
- New environmental, fire suppression, and electrical systems with back-ups at 1234 Market Data Center
- Upgrades to existing E-911 system and procurement of next generation of E-911 software
- State-of-the-art data center for public safety

5.2.2.5 Philadelphia Map of Disability Characteristics

In Philadelphia, roughly 16% of residents have a disability. However, the Mayor's Office for People with Disabilities believes that disability data is more than numbers. It tells the story of our city and its people. The map of disability characteristics in Philadelphia linked below was created by the Mayor's Office for People with Disabilities in partnership with the Managing Director's Office and Philly Counts to support departments, residents and the community to learn more about the disability representation in our City. This map can also be used as a tool when planning for projects that reduce risk. Learn more about the map here: Guide to a map of disability characteristics in Philadelphia | Mayor's Office for People with Disabilities | City of Philadelphia

5.2.2.6 Staff/Personnel Resources

The Administrative and Technical Capability table below provides a summary of the administrative and technical capability of Philadelphia.

Table 5-2. Administrative and Technical Capability

Administrative and Technical Capability		
Staff/Personnel Resources	**Yes**	**No**
Planners (with land use/land development knowledge)	X	
Planners or engineers (with natural and/or human caused hazards knowledge)	X	
Staff/Personnel Resources	**Yes**	**No**
Engineers or professional trained in building and/or infrastructure construction practices (includes building inspectors)	X	
Emergency Manager	X	
Floodplain Manager	X	
Land Surveyors	X	
Scientists or staff familiar with the hazards of the community	X	
Personnel skilled in GIS and/or Hazus	X	
Grant writers or fiscal staff to handle large/complex grants	X	
Specialists in community resilience and social equity	X	
IT data center infrastructure team	X	

In addition, OEM hired a dedicated Hazard Mitigation Planning Coordinator in 2019. Philadelphia's Hazard Planning Coordinator focuses on maintaining and updating the City's HMP and supports

implementation of the plan through interagency coordination and identification of mitigation funding resources.

Licenses & Inspections (L&I) also hired a Floodplain Manager since the 2017 HMP. The Floodplain Manager administers and implements the City's flood loss reduction activities, including enforcing the community's flood damage prevention ordinance; updating flood maps, plans, and policies; and any of the activities related to the National Flood Insurance Program (NFIP).

In addition, OEM hired a COOP Program Manager who manages OEM's COOP program and provides technical assistance, trainings, and guidance about COOP/COG to other City agencies.

5.2.3 Financial Capability

The ability to implement mitigation-related activities relates to the resources available to fund them. Resource streams may include grant awards or locally based revenue and financing.

5.2.3.1 Local programs

Local programs that may provide financial support for mitigation activities include, but are not limited, to:

- Capital Improvement Programming
- Special Purpose Taxes
- Water/Sewer Fees
- Stormwater Utility Fees
- General Obligation, Revenue, and/or Special Tax Bonds
- Partnering Arrangements or Intergovernmental Agreements
- Cyber liability for all city government

5.2.3.2 State programs

State programs that may provide financial support for mitigation activities include, but are not limited to:

- Community Conservation Partnerships Program
- Community Revitalization Program
- Floodplain Land Use Assistance Program
- Growing Greener Program
- Keystone Grant Program
- Local Government Capital Projects Loan Program
- Land Use Planning and Technical Assistance Program
- Pennsylvania Heritage Areas Program
- Pennsylvania Recreational Trails Program
- Shared Municipal Services
- Technical Assistance Program

5.2.3.3 Federal programs

Federal programs that may provide financial support for mitigation activities include, but are not limited to:

- HUD Community Development Block Grants (CDBG)
- FEMA Disaster Housing Program
- USDA Emergency Conservation Program
- USDA Emergency Watershed Protection Program
- FEMA Hazard Mitigation Grant Program (HMGP)
- FEMA Flood Mitigation Assistance Program (FMA)
- USDA Non-insured Crop Disaster Assistance Program
- FEMA Building Resilient Infrastructure and Communities (BRIC) – *replaces Pre-Disaster Mitigation Program*
- FEMA Repetitive Flood Claims Program (RFC)
- HUD Section 108 Loan Guarantee Programs
- FEMA Severe Repetitive Loss Grant Program (SRL)
- DOE Weatherization Assistance Program
- FEMA Regional Catastrophic Preparedness Grant

FEMA Building Resilient Infrastructure and Communities (BRIC)

The Building Resilient Infrastructure and Communities (BRIC) grant program seeks to categorically shift the federal focus from reactive disaster spending toward research-supported, proactive investment in community resilience so when the hurricane, flood or wildfire comes, communities are better prepared. BRIC provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects prior to a disaster.

The data shown below represents a summary of the subapplications received by FEMA to apply for the funding available through BRIC ($500 million).

- FEMA received **1,227** subapplications that requested an estimated $**4** billion in funding across the BRIC and FMA grant programs.
- **91 applicants, including 38 Tribes** have subapplications that are selected for further review.

5.2.4 Education and Outreach

The Office of Emergency Management continuously performs analyses to identify potential areas for improvement, and conducts multi-agency exercises and training to test, validate and improve our plans.

5.2.4.1 Exercises & Trainings

OEM conducted numerous exercises and trainings since 2012, including a Mass Casualty/ Mass Decontamination Exercise series, a Public Alerting Conference, ICS trainings, and a Radiological Dispersion Device (RDD) Workshop, among others. Exercises and trainings also assist in response readiness.

In addition, OEM has offered HMP-specific trainings and workshops since the 2017 update. During 2021, OEM offered the G-319, a four-module hazard mitigation training program, to key hazard mitigation planning partners. OEM, in conjunction with the Mayor's Office of Recovery and Grants, have worked to create a more coordinated, city-wide approach towards pursuing mitigation funding. This includes hosting annual mitigation grants workshops trainings for City partners with presentations from PEMA and FEMA. In addition to the workshops, OEM has provided one-on-one technical assistance to City agencies interested in applying for BRIC, FMA, and HMGP.

The Philadelphia Fire Department's (PFD) Fire Prevention Division attends numerous community events and offers a variety of fire prevention workshops to educate the public on fire risk reduction. Below is a list of outreach events and smoke alarms installed by PFD in 2020:

- Traditional smoke alarms installed: 1100
- Adaptive alarms installed for individuals with hearing loss: 76
- School assemblies and events: 28 schools, 42 assemblies with 3490 children attendees
- Institutional Staff Trainings: 32 seminars with 546 individuals trained
- Outreach events for older adults: 6 events with 242 elder attendees
- Prevention & education events hosted by the Community Assistance Team (CAT): 208
- Summer Safety Camps: 49 camps with 1016 attendees
- Covid-19 Vaccination Clinic Outreach events: 11 with 2588 citizen contacts
- Youth Fire Setting Interventions: 9

5.2.4.2 Surveys

On January 27, 2021, OEM released a public survey to gather information on general emergency preparedness and community concerns. The survey was created and advertised in both English and Spanish. Members of the public without digital access, or who required the survey in a different language, were able to call Philly311 for support filling out the survey. This survey was open until December 13, 2021 and feedback received in the survey directly informed the update of the plan.

On September 13, 2021, OEM sent a **Capability Assessment Survey** to over 50 individuals (from partner/stakeholder organizations) and provided two months (with two reminder emails encouraging participation) for agencies to provide feedback. OEM received 8 responses to this survey. A copy of the Capability Assessment Survey is available in Appendix C. Survey topics included:

- Hazard mitigation in the context of each organization's mission and essential functions: most concerning hazards, biggest vulnerabilities, biggest strengths
- Capabilities each organization has to reduce vulnerability: plans, policies, and programs; staff and equipment; fiscal mechanisms; actions taken in last 5 years
- Summary of capability "self-assessment" measuring degree of capability across planning and regulatory, administrative and technical, financial, and educational & outreach areas
- Actions each organization can take to build on existing capabilities including potential future investments in the next 5 years to support risk reduction

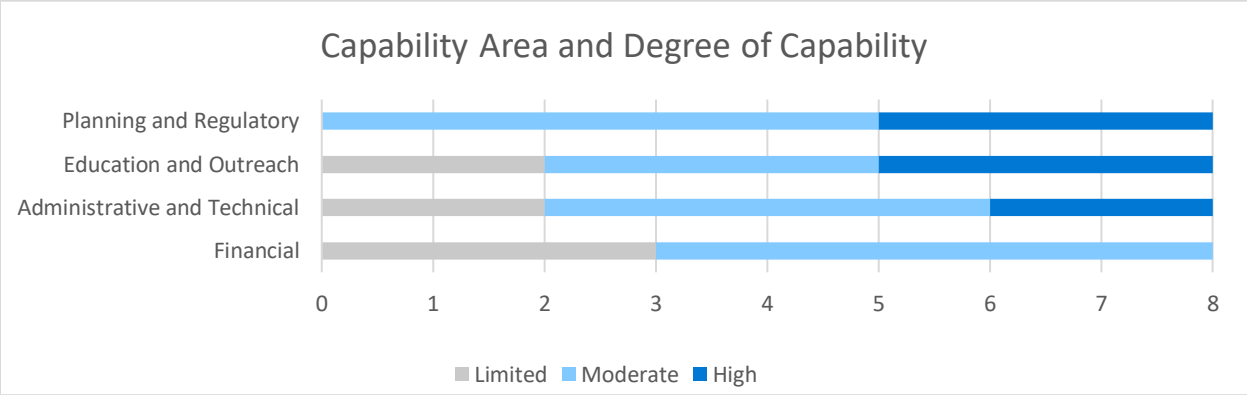
A summary of the Capability Assessment Survey is included below. Most respondents noted that plans, programs, and policies are continually assessed for efficiency and effectiveness to determine if any changes are necessary. These assessments are discussed as being data-driven, considerate of social equity and sustainability goals and challenges, and that changes are implemented as identified. Respondents also noted depending on the change or update identified, federal and/or state approvals may be required prior to implementation.

Table 5-3. Summary of Strengths, Vulnerabilities, and Future Investments

Strengths
• Operational flexibility, ability to adapt to changing conditions (e.g., shift staff, work remotely) • Regulatory and financial flexibility • Public ownership and management over city infrastructure • System redundancy, backup power and water supplies, secure data backups • Infrastructure upgrades and modernization including new environmental, fire suppression, electrical, water/wastewater, and IT systems • Mobile systems for communications and services (e.g., mobile command post, mobile clinics) and IT data center infrastructure • Early warning and 24-hour systems and operators • Dedicated long-term planning efforts, risk management planning, strategic plans • Dedicated staff trained to assist with emergencies and wide range of support services and public communication specialists / public information officers • Cross-training of staff and departments • Community-based workshops and information sessions • Partnerships and connections with city, state, federal, community organizations, departments, and private-sector partners (e.g., Partnership for Inclusive Disaster Strategies) • Monitoring and modeling capabilities including GIS and flood simulations • Adopted codes and regulations for disaster resilience (e.g., flood) for infrastructure/buildings • Expertise in climate change science and projections (e.g., engineers, planners)
Vulnerabilities
• Resources for most vulnerable populations (including youth and seniors, individuals with disabilities, residents in concentrated high-rise buildings, extremely low-income residents) • Staff safety, staff shortages, and workforce depletion • Ability for staff to reach locations for on-site functions/services, access remote equipment and systems • Housing, utilities, and other infrastructure located within 500-year floodplain • Disrupted/submerged assets, facility disruption/damage, loss of system functionality • Destabilization of service providers and supply chains (e.g., energy, IT/communications, data); ever-changing landscape of cyberterrorism/cybersecurity • Loss of public trust, misinformation/miscommunication
Future Investments
• Workforce development, staff trainings • Outreach and information sharing capacity, education and ongoing community engagement • Cybersecurity planning, workforce training, and data center expansion and modernization • Water system, flood control infrastructure, OEM facility upgrades • Backup generators and other system redundancies • Critical infrastructure resilience design, hardening, insurance • Increased water storage

In the self-reported assessment on the degree of capability the department or entity has across four key areas of capability, respondents had greatest confidence in planning and regulatory capabilities, followed by education and outreach, and then administrative and technical. Financial capabilities were reported as the most limited of the four areas, which highlights an area of opportunity for building greater capacity in this particular area.

Table 5-4. Survey Response on Degree of Capability Across 4 Key Focus Areas.



On October 2, 2021, OEM held a virtual two-hour **Capability Assessment Workshop** with 44 participants to discuss the background and purpose of the capability assessment, review and discuss initial capability assessment survey findings and city priorities and strategize areas of opportunity for plan integration and mitigation actions. The virtual session included interactive components (using the platform MURAL) where participants could vote in response to facilitation questions and provide ideas by adding virtual post-it notes to the virtual board. During this session, participants voted on the top natural and human made hazards that concern their organization, resulting in the following top three:

1. Flood, Flash Flood, Ice Jam
2. Hurricane, Tropical Storm, Nor'easter
3. Extreme Temperatures

Participants noted the importance of planning for multiple hazards occurring at once, the role of regulations and codes, and ensuring people with disabilities are accounted for and that inclusivity is included in all stages of the hazard mitigation process. Participants also raised the realities and challenges related to potential for cascading effects of hazard, such as the collapse of infrastructure triggered by a combination of deferred maintenance, outdated zoning, and the acute shock of an extreme weather event. Screenshots from the workshop's MURAL are included below.

Figure 5-13.Screenshot of interactive Capabilities Assessment workshop in October 2021.

5.2.4.3 Public Involvement & Education

The City of Philadelphia conducts numerous forms of education and outreach to citizens for activities that fall under mitigation projects, initiatives, or plans with mitigation components. The City of Philadelphia's capability to conduct public education and outreach is directly correlated with the programs, organizations, and agencies that support these services. City agencies that provide mitigation-related education and outreach activities include, but are not limited to:

- Office of Emergency Management
- Philadelphia Police Department
- Philadelphia Fire Department
- Philadelphia Water Department
- Mayor's Office of Sustainability
- Philadelphia City Planning Commission
- Philadelphia Department of Public Health

In addition to these efforts, Philadelphia participates in several programs and organizations that support mitigation-related education and outreach activities as shown below:

- Natural disaster school programs
- Safety-related training and school programs
- Ongoing public education on:
  - Responsible water use
  - Watershed initiatives
  - Green initiatives
- Business continuity programs
- Personal preparedness programs
- Ongoing targeted outreach to communities
- Fire preparedness training and outreach

Figure 5-14. Philadelphia Office of Emergency Management providing preparedness information to residents at a table event.

Several of OEM's partner stakeholders provide resources and public engagement tools to increase public preparedness for emergencies. Philadelphia Department of Public Health (PDPH) promotes emergency planning tools for organizations on their website (Philadelphia Department of Public Health, 2021). In addition, PDPH maintains its Community Response Partner Network, a network of community partners who can disseminate information to their members and neighbors during public health emergencies. The Philadelphia Fire Department also offers various fire preparedness workshops for individuals of all ages.

5.2.5 Plan Integration

Hazard mitigation planning is most effective when it is integrated into existing plans, regulations, and programs. By leveraging strengths and filling gaps through plan integration, the City of Philadelphia can ensure hazard mitigation goals and actions are applied in comprehensive planning efforts to improve the city's overall reduction of risk.

The Planning and Regulatory Capability Inventory table below provides a summary of the relevant local plans, ordinances, and programs currently in place or under development. The table includes detail about how each tool is integrated with the Hazard Mitigation Plan and what hazards each address.

Table 5-5. Planning and Regulatory Capability Inventory

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
Hazard Mitigation Plan	X	X	2022	▪ Inclusion of plan integration section ▪ Addition of new hazards: Pandemic and Infectious Disease; Subsidence, Sinkhole; Civil Disturbance; Cyber Terrorism; Opioid Addiction Response; War and Criminal Activity/Gun Violence ▪ General updates ▪ Executive Summary/StoryMap	The 2022 update builds on findings in the 2017 Hazard Mitigation Plan (HMP).	▪ All hazards
Emergency Operations Plan	X		2015	▪ General updates	This document draws upon the risk and vulnerability assessment conducted through the hazard mitigation planning process. HMP mitigation strategies align with future actions identified in this plan.	▪ All hazards
Hazard Based Emergency Plans	X	X	Varies	▪ Hazard Based Plans are updated on a regular basis based on input from key stakeholders to account for changes in hazard risk and available resources.	The HMP mitigation strategies align with future actions identified in these hazard-based plans. The hazard risk analysis conducted through the hazard mitigation planning process is used to inform citywide plans and responses to natural and human-caused hazards and threats. Gaps in our planning and mitigation capabilities are identified in the Hazard Mitigation Plan's Mitigation Strategy. Hazard-based plans align with and are informed by other plans within the city. For example, the Winter Weather Plan draws heavily upon the Street's Departments Snow	▪ All hazards

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
					and Ice Removal Operation Plan. Gaps in planning capabilities are identified in the HMP's mitigation strategy.	
Function-based Emergency Plans	X	X	Varies	▪ **New function-based plans completed since 2017 include:** Human Services Recovery Plan; Recovery Framework; Receiving and Distribution Management Plan ▪ **New Plans in development since 2017 include:** Logistics Staging Area Plan, Distribution Management Plan and Resource Request Plan; Emergency Procurement Plan; Regional Supply Chain Resilience Plan	Function based plans are updated on a regular basis based on input from key stakeholders to account for changes in hazard risk and available resources. The HMP mitigation strategies align with future actions identified in these plans. Gaps in our planning and mitigation capabilities are identified in the Hazard Mitigation Plan's Mitigation Strategy. Ongoing analysis will be conducted to identify opportunities for further integration with the plan.	▪ All hazards
Evacuation Plan	X	X	2017	▪ Neighborhood level route identification ▪ Hazard-informed approach	The Evacuation Plan utilizes known risks and hazards as identified through the risk and vulnerability assessment in the City's All-Hazard Mitigation Plan to develop appropriate evacuation routes.	▪ Earthquake ▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Hazardous Material Release
Continuity of Operations Plan	X		2021	▪ In 2020 the COOP program was completely updated to include a new template to encompass the new working reality. This included expanding on recovery strategies, noting essential	The HMP integrates COOP Site enhancement to its mitigation strategies.	▪ All hazards

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
				functions, technology, and equipment. In addition, this template also reflects changes in policies due to COVID-19 including the addition of Telework capabilities section in the plan. ▪ As the plan is continued to be updated a Test, Training, and Exercise schedule will be worked out for all COOP teams.		
National Flood Insurance Program	X				The HMP integrates NFIP content with the Risk and Capabilities assessments and includes data on the number and types of repetitive loss properties.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Building and Structure Collapse
National Flood Insurance Program: Community Rating System			TBD	▪ The City is assessing its future participation in the Community Rating System	Opportunities for further integration include deeper analysis of NFIP repetitive loss properties, mitigation projects that address these properties, and overall alignment of the HMP strategies with the qualifying standards of the CRS program.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Building and Structure Collapse
Floodplain Regulations	X		2021	▪ Flood Protection Form – part of permits submission ▪ Flood Protection Scoping Meeting ▪ Guide to Development in the Floodplain	Future opportunities for integration of floodplain regulations with the HMP includes coordinating the revision process of the City's floodplain regulations (as per recommendations in the City's Community Assistance Visit report) with the assessment and strategies outlined in the HMP.	▪ Flood, Flash Flood, Ice Jam

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
Flood Risk Management Task Force	X		2015	▪ The City hired its first Floodplain Manager ▪ Department of Licenses & Inspections further developed administrative processes to adequately enforce floodplain regulations ▪ The FRMTF released a Strategic Plan that outlines a strategy to position the City to become a CRS Community. ▪ Flood Management Program website launched in 2021.	FRMTF's mission and the Strategic Plan align with the mitigation strategies and actions in the HMP, including education the public about flood hazards, developing regulations and risk mapping for flood hazards, prioritizing a variety of flood concerns, and enhancing the City's resiliency to flooding through mitigation actions in the HMP.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Building and Structure Collapse
Zoning Codes	X		2012		The City will continue to review and revise these codes with respect to findings in the HMP risk assessment and mitigation actions. The zoning code requires review for construction if in the Special Flood Hazard Area.	▪ Flood, Flash Flood, Ice Jam
Building Codes	X		2018	▪ City adoption of new codes	The City will continue to review and revise these codes with respect to findings in the HMP risk assessment and mitigation actions.	▪ Building and Structure Collapse ▪ Urban Fire and Explosion ▪ Earthquake ▪ Tornado and Windstorm
Subdivision Regulations	X		2012		The City will continue to review and revise these codes with respect to findings in the HMP risk assessment and mitigation actions.	▪ Flood, Flash Flood, Ice Jam
Comprehensive Land Use Plan	X	X	Varies	▪ Adopted/completed all district plans ▪ Initiated process for next comprehensive plan update (Reimagine Philadelphia)	An opportunity for future integration with hazard mitigation planning is to coordinate with the upcoming updated comprehensive plan, which will focus on racial equity and	▪ Extreme Temperature ▪ Flood, Flash Flood, Ice Jam ▪ Subsidence, Sinkhole

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
				▪ Upcoming plan focused on racial equity and climate resilience	resilience. Document land use risk reduction strategies in district plans.	▪ Building and Structure Collapse ▪ Opioid Addiction Response
Open Space Management Plan	X		Varies	▪ Open space planning is completed on a case-by-case basis.	A key opportunity for future integration with hazard mitigation planning is to coordinate the plan's objectives and implementation strategies with those of the HMP. Parks and Recreation and other departments have voiced a need for flood and hazard resilient infrastructure. Current efforts at FDR Park to mitigate floodplain development with wetlands banking is a recent local example of resilient recreational infrastructure.	▪ Extreme Temperature ▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter
Stormwater Management Regulations	X		2015	▪ Stormwater Regulations were passed as a part of the 2012 Zoning Code ▪ In 2015, PWD updated its Stormwater Regulations for development ▪ 2015 update prioritizes river health, minimizing local flooding, encouraging green infrastructure, and offering community resources to improve local stormwater management	The HMP mitigation strategies reflect the priorities of the City's Stormwater Management regulations.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Subsidence, Sinkhole
Green City, Clean Waters	X		2011	• Significant progress has been made towards long-term goals, with the implementation of 2200 Green Acres in Philadelphia from both public and private sources and the reduction of over 2 billion gallons of combined sewer overflow a year.	The HMP mitigation strategies reflect the priorities of Green City, Clean Waters.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Subsidence, Sinkhole ▪ Criminal Activity

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
Watershed Management Plan	X		2014	▪ Updates the monitoring and assessment of surface waters, groundwater, rainfall, CSO discharges, sewer flows, and green infrastructure performance.	The HMP mitigation strategies reflect the priorities of the City's Watershed Management plan.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter ▪ Subsidence, Sinkhole
Capital Improvement Plan	X		Annual	▪ New General Obligation, enterprise, state, federal, and private funds ▪ Structural renovations for city facilities and investments in commercial centers around the city ▪ Focus on state of good repair, return on investment, and sustainability ▪ Considerations include climate risk	The City's Capital Improvement Plan reflects several objectives in the Hazard Mitigation plan, including storm flood relief, and winter weather preparedness. The city will further integrate hazard mitigation and capital improvement planning in the future as it assesses city assets deemed at-risk of extreme heat and precipitation.	▪ Winter Storm ▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam
Growing Greater: Comprehensive Economic Development Strategy	X		2017	Growing Greater Philadelphia (arcgis.com)	Growing Greater shares HMP goals, such as climate-resilient public infrastructure.	▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam
Historic Preservation Plan			Varies	▪ The US Army Corps of Engineers National Nonstructural Flood Proofing Committee (NNFPC) completed a Philadelphia Historic Resource Flood Hazard Vulnerability Study in 2018 that recommended hazard mitigation actions for 25 historic resources in the city	Mitigation actions developed as a part of PA SHPO (2016) and NNFPC's studies are included as HMP mitigation actions.	▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
Greenworks Sustainability Plan	X		2016		Greenworks and the HMP address the threat of climate change to Philadelphia.	▪ Addresses climate change for applicable hazards
Manayunk Main Street Historic District Flood Guide	X		2020	▪ Recommendations minimize the impact of flooding in the Manayunk Main Street Historic District	The Manayunk Main Street Historic District Flood Guide and the HMP share a focus on mitigation actions for different types of flooding.	▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam ▪ Building and Structure Collapse
Community Empowerment & Opportunity Strategic Framework	X		2019	▪ A framework to provide leadership on issues of economic justice by advancing racial equality and inclusive growth	An opportunity for future integration with hazard mitigation planning to coordinate the plan's objectives and implementation strategies with those of the HMP.	
Environmental Justice (EJ) Advisory Commission			2021		The work of the EJ Advisory Commission aligns with the HMP mitigation strategies to proactively provide support to communities who suffer from historical inequities and increased risk from hazards.	▪ Extreme Temperature ▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter
Growing Stronger: Toward a Climate-Ready Philadelphia	X		2016		HMP mitigation actions align with recommended mitigation and adaptation actions proposed in Growing Stronger.	▪ Extreme Temperature ▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter
Philadelphia Airport Sustainability Plan			2019	▪ PHL released a sustainability policy statement in 2017 – since then has been working on a Sustainability Plan ▪ In addition to annual Greenhouse Gas Emissions reports, PHL released a Climate Vulnerability Plan in 2019	PHL's Climate Vulnerability Plan aligns with the HMP's mitigation actions.	▪ Extreme Temperature ▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam ▪ Building and Structure Collapse

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
Consolidation and improvement of IT operations	X	X	Varies	▪ Updated IT controls and policies based on NIST framework ▪ Endpoint threat detection and responsive software ▪ New environmental, fire suppression, and electrical systems with back-ups at 1234 Market Data Center ▪ Upgrades to existing E-911 system and procurement of next generation of E-911 software ▪ State-of-the-art data center for public safety	Consolidation of and improvements of IT operations in Philadelphia align with HMP mitigation actions related to Cyber Terrorism.	▪ Cyber Terrorism ▪ Criminal Activity ▪ Civil Disturbance
READYPhiladelphia Program	X		2019	▪ Philadelphia OEM offers a variety of preparedness workshops to communities and businesses including READYHome, READYBusiness and READYCommunity. ▪ OEM will be updating small business preparedness and continuity programming within the next year and plans to pilot a new READYKids workshop. Over the last year, READY programs are now available virtually, expanding the programs reach across the City.	READYPhiladelphia directly supports the HMP's mitigation actions.	▪ All hazards
PHA Organizational and Individual Site Resilience Reports	X			▪ Completed organizational and individual site resiliency assessments and reports at 48+ sites	The site assessments and reports support HMP mitigation strategies to increase climate resiliency of the built environment with a focus on underserved communities.	▪ Hurricane, Tropical Storm, Nor'easter ▪ Flood, Flash Flood, Ice Jam ▪ Building and Structure Collapse

Planning / Regulatory Tool	In Place	Updating	Year Last Updated	Changes or additions since 2017	Notes on Current or Future Integration with the HMP	Hazards Addressed
PHA's Heat Cautions and Emergencies Operational Strategy	X				PHA's operational strategy around heat cautions/emergencies aligns with the HMP's Extreme Temperature mitigation actions.	▪ Extreme Temperature
PHA Sustainability Report	X		2012		Opportunity to integrate mitigation actions with PHA's sustainability principles.	▪ Aligns with hazards effected by climate change
Threat and Hazard Identification and Risk Assessment (THIRA)	X	X	2019, updating SPR for 2021	THIRA is a three-step risk assessment process that helps communities understand their risks and what they need to do to address those risks.	THIRA lays the foundation for the gaps in the Capability Assessment and is a part of the Stakeholder Preparedness Review.	▪ All hazards
Eastwick Strategic Planning and Alignment – A Place-Based Framework		X	2022	The Office of Sustainability is developing a strategic direction to enhance coordination between the 11 active City-sponsored initiatives focusing on addressing environmental injustice in Philadelphia's Eastwick neighborhood.	Coordination in Eastwick pertains directly to mitigating long-term hazards that impact Eastwick, such as Flood, Flash Flood, and Ice Jam and Hurricane, Tropical Storm, Nor'easter.	▪ Flood, Flash Flood, Ice Jam ▪ Hurricane, Tropical Storm, Nor'easter

6 Mitigation Strategy

6 Mitigation Strategy

The City of Philadelphia developed a Mitigation Strategy emphasizing core priorities to develop actions that improve equity, address current and future hazard risk, and to integrate the work and plans of multiple partners for mitigation. The strategy describes how Philadelphia will reduce or eliminate potential losses from natural and human-made hazards identified in **Chapter 4 Risk Assessment**. The strategy documents existing actions and adds new actions aimed at mitigating the effects of hazards on Philadelphia's population, economy, and infrastructure.

6.1 Update Process Summary

The 2017 Hazard Mitigation Plan (HMP) goals, objectives, and actions were significantly updated for the 2022 plan. **Mitigation goals** are general guidelines that explain what the City wants to achieve. Goals are expressed as broad policy statements representing desired long-term results. **Mitigation objectives** describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable. **Mitigation actions** provide more detailed descriptions of specific tasks to help the City achieve prescribed goals and objectives.

The 2017 plan had two categories of mitigation actions: 'existing' and 'potential'. This differentiation meant that the 'existing' actions captured a lot of items that were truly capabilities. **Chapter 5 Capability Assessment** was expanded in this update to include items that may have been considered actions in 2017, for instance regular training or public outreach initiatives that are core departmental capabilities. The 'potential' category existed to highlight the idea that not all mitigation actions will be accomplished in a 5-year period. The 'potential' category included actions that departments may have had concerns they wouldn't complete in 5-years based on time, funding, and the natural prioritization that takes place in City government. The existence of an 'existing' and 'potential' list is not necessary because hazard mitigation plans are aspirational. HMPs represent an opportunity for communities to outline what they hope and plan to accomplish to mitigate risk. Most HMPs have actions that are continued, revised, or discontinued as communities consider and re-consider current risks, vulnerabilities, and priorities for mitigation in annual reviews and HMP updates. Philadelphia OEM with Steering Committee review decided to eliminate the 'existing' and 'potential' designation and create one mitigation strategy for 2022. This process also provided the opportunity to combine mitigation actions that were duplicates between the 'existing' and 'potential' or combine similar actions. For instance, six very similar Hazus actions from 2017 were combined into one updated action for 2022.

The 2017 mitigation strategy also included a lot of response focused actions. These actions focused on training, equipment, and tools that departments use to respond to disasters. Philadelphia OEM with Steering Committee review elected to narrow down the mitigation strategy to truly focus on mitigation actions that provide sustained action taken to reduce or eliminate the long-term risk to hazards. Addressing response focused actions removed about 73 out of 331 existing/potential actions from 2017 and interim annual reviews. The mitigation review of 2017 actions and actions from interim annual reviews is included in **Appendix G.** This appendix provides an explanation of how each action was categorized: completed (65), removed (113), revised (63), or ongoing (90). There is some overlap between categories. For example, 6 Hazus actions from the 2017 plan were removed/revised into one

action. The concept of the 6 actions remains in the plan in one easier to understand and track action. In total, the 2022 mitigation strategy has 163 actions.

Similarly, the existing mitigation goals and objectives focused more on response and did not capture current equity, climate change, and plan integration priorities. The goals and objectives were reviewed in a Mitigation Strategy Workshop with the Steering Committee and stakeholders. Then, the revised list was reviewed and approved in a December Steering Committee meeting. Though the total number of goals and objectives were reduced, the new 2022 goals advance priorities to address current equity, climate change, and plan integration. Additionally removing the response focused goals and objectives will assist in focusing the plan and implementation on mitigation. The concepts in the 2017 goals and objections were cross-walked or compared to the new 2022 goals and objectives to ensure all key concepts continued. The final list of 2022 actions were nested under the matching goals and objectives following a format used in the Pennsylvania State Hazard Mitigation Plan. The purpose of combining the goals, objectives, and actions in the 2022 plan was to help organize the actions and focus the list on groups of similar actions. For instance, several equity focused actions are listed under *Objective 2.8: Address historic drivers of vulnerability and investment in community assets*. Not coincidentally, 4 out of 10 of the ***Mitigation in Focus*** actions are under Objective 2.8 illustrating the City's commitment to equity-focused mitigation.

The last significant update to the mitigation strategy is the addition of ***Mitigation in Focus*** actions. *Mitigation in Focus* actions represent a list of 10 priority actions that span a wide range of different hazards and project leads. Each *Mitigation in Focus* action features detailed information on potential implementation steps and funding opportunities. With 163 total actions, this list provides the City with a focused place to start with plan implementation over the next 5 years.

The mitigation goals and objectives from the 2017 HMP were revised and reviewed in detail in November and December 2022 by the Steering Committee. **Table 6-1.** below contains the 2017 HMP's mitigation goals and objectives.

Table 6-1. 2017 Hazard Mitigation Goals and Objectives

Goal 1: Sustain and enhance public safety, health, and security capabilities.	
Objective 1.1	Identify communities that would benefit from warning systems.
Objective 1.2	Prioritize mitigation actions that affect vulnerable populations
Objective 1.3	Provide essential training to key personnel.
Objective 1.4	Ensure policies, procedures and systems are in place to anticipate, identify and share information on emerging and/or imminent high risk, preventable threats.
Objective 1.5	Maintain a NIMS-typed local ordinance disposal unit, Major Incident Response Team, and tactical counter-terrorism SWAT team.
Objective 1.6	Conduct health and safety hazard assessments and disseminate guidance and resources.
Objective 1.7	Implement mitigation measures that reduce the loss of life as a direct result of a disaster.
Goal 2: Protect property.	
Objective 2.1	Develop and implement mitigation programs and strategies that protect critical facilities and services.
Objective 2.2	Integrate hazard and risk information into land use planning mechanisms, including evaluating a location's risk and vulnerability to known hazards when identifying new facility sites.
Objective 2.3	Educate public officials and the public about hazard risk and building requirements.
Objective 2.4	Promote post-disaster mitigation as part of restoration and recovery.

Objective 2.5	Reduce the impact and extent of debris to the built and natural environments.
Objective 2.6	Support property protection against flooding in known flooding areas and encourage personal property mitigation strategies.
Goal 3: Protect the natural environment.	
Objective 3.1	Support and enhance mitigation actions that protect the natural environment from natural hazards and climate change.
Objective 3.2	Maintain awareness of hazardous material storage sites.
Objective 3.3	Ensure the protection of waterways and drinking water sources.
Objective 3.4	Promote the purchase of low-carbon and energy efficient resources.
Objective 3.5	Prepare for the outcomes of climate change through climate adaptation strategies.
Objective 3.6	Restore water channels to improve safety and reduce flooding.
Goal 4: Promote a sustainable economy.	
Objective 4.1	Prioritize mitigation strategies that support the continuation of critical business operations during and following a disaster.
Objective 4.2	Sustain, promote, and enhance partnerships with external public and private entities to identify and share resources.
Objective 4.3	Educate businesses about contingency planning.
Objective 4.4	Partner with private and non-profit sectors to promote employee education about disaster preparedness while at work and at home.
Goal 5: Sustain and strengthen all hazards preparedness.	
Objective 5.1	Enhance understanding of natural hazards and the risks they pose through enhancing and updating risk and vulnerability assessments.
Objective 5.2	Increase the public's knowledge of hazards and protective measures.
Objective 5.3	Ensure equal access to mitigation and preparedness information by providing information and training through numerous mediums for those with access and functional needs.
Objective 5.4	Maintain and improve city owned equipment and structures that could impact mitigation and recovery efforts.
Objective 5.5	Identify and fill equipment and staging location gaps that support mitigation and recovery actions.
Objective 5.6	Invest in green and gray infrastructure to reduce the impacts of flooding.
Goal 6: Protect historical and cultural assets.	
Objective 6.1	Utilize historical preservation data to identify protective measures for historical properties.
Goal 7: Sustain and enhance communications and network security capabilities.	
Objective 7.1	Maintain and enhance communications systems for interoperability and reliability for mission critical voice and data information.
Objective 7.2	Enhance mission-essential networks for public safety and private assets.
Goal 8: Protect critical infrastructure.	
Objective 8.1	Repair, restore, and upkeep existing infrastructure.
Objective 8.2	Protect against access to and theft of dangerous materials.
Objective 8.3	Create redundancies for critical networks such as water, sewer, digital data, power, and communications.
Objective 8.4	Identify, assess, catalog, and prioritize the risk to its critical infrastructure and key resources (CIKR) from acts of terrorism, technological hazards, and natural hazards.
Objective 8.5	Restore essential services within 30 days of a major incident.

6.2 Mitigation Goals and Objectives

Based on the collaborative review and revision of the 2017 HMP mitigation goals and objectives, a list of five goals and twenty-two corresponding objectives were developed. The mitigation goals and objectives established for the 2022 HMP are shown in **Table 6-2.**

Table 6-2. 2022 Hazard Mitigation Goals and Objectives

Goal 1: Protect all life and reduce risks that exacerbate inequities in health safety.	
Objective 1.1	Develop and implement strategies to reduce Philadelphians' risk to natural and human-made hazards.
Objective 1.2	Prioritize mitigation actions that affect populations most at-risk[11] and that prioritize equity and accessibility.
Goal 2: Build the resilience of community assets, including property, infrastructure, and cultural resources.	
Objective 2.1	Implement projects and programs that protect property against flooding.
Objective 2.2	Assess vulnerability of infrastructure to identify where to prioritize mitigation actions.
Objective 2.3	Develop and implement mitigation programs and strategies that protect critical facilities and services.
Objective 2.4	Integrate hazard and risk information into land use planning decisions.
Objective 2.5	Promote post-disaster mitigation as part of restoration, recovery, and resilience building.
Objective 2.6	Repair, restore, and maintain existing infrastructure.
Objective 2.7	Identify, plan for, and protect historic properties and cultural resources.
Objective 2.8	Address historic drivers of vulnerability and invest in community assets.
Goal 3: Foster an economy that promotes mitigation and reduces impacts from hazards.	
Objective 3.1	Prioritize mitigation strategies that support the continuation of critical business operations during and following a disaster.
Objective 3.2	Sustain, promote, and enhance partnerships with external public and private entities to identify and share resources.
Objective 3.3	Form partnerships to leverage and share resources to address hazard risks today and projected from climate change.
Goal 4: Restore and enhance the natural ecology.	
Objective 4.1	Promote nature-based solutions to manage stormwater and reduce the impacts of flooding and SLR.
Objective 4.2	Support projects that address water holistically including water quality, stormwater management, dam safety, and flood mitigation.
Objective 4.3	Restore and enhance green spaces and prioritize communities overburdened by environmental hazards.
Objective 4.4	Support the transition away from fossil fuels and other greenhouse gases that impact health and safety and exacerbate climate change.
Objective 4.5	Improve air, water, and soil quality across the City starting with environmental justice communities.
Goal 5: Create awareness and demand for mitigation and adaptation as a standard of practice.	
Objective 5.1	Tailor mitigation training to public officials, businesses, organizations, and the public emphasizing equity and inclusion.
Objective 5.2	Improve existing and put in place necessary warning systems.
Objective 5.3	Increase public's awareness of hazards, mitigation, and other protective measures, including those related to the projected impacts of climate change.
Objective 5.4	Continue and expand coordination efforts to plan for cross-agency mitigation efforts.

[11] Please see the **2 Community Profile**, specifically **2.3.8 Social Vulnerability**, for more information on populations disproportionately impacted by disasters and **4 Risk Assessment** vulnerability assessment subsections for more information on geographic locations at greater risk.

6.3 Identification and Analysis of Mitigation Techniques

Mitigation actions include programs, plans, projects, and policies that help reduce or eliminate the long-term risk to human life and property from natural hazards. FEMA organizes mitigation actions into four categories. These categories allow similar types of mitigation actions to be compared and provide a standardized method for eliminating unsuitable actions.

1. **Local Plans and Regulations**: These actions include government authorities, policies or codes that influence the way land and buildings are developed and built.
2. **Structure and Infrastructure Projects**: These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
3. **Natural Systems Protection**: These actions aim to minimize damage and losses, preserve, or restore the functions of natural systems.
4. **Education and Awareness Programs**: These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

Table 6-3. summarizes Philadelphia's mitigation actions by hazard, mitigation action category, and goal/objective addressed.

Table 6-3. Summary of Mitigation Actions

Mitigation Actions by Hazard	
Hazard	**Total**
Natural	
Drought	12
Earthquake	1
Extreme Temperature	9
Flood, Flash flood, Ice Jam	75
Hurricane, Tropical Storm, Nor'easter	73
Pandemic and Infectious Disease	3
Subsidence, Sinkhole	6
Tornado, Windstorm	2
Winter Storm	12
Human-made	
Building and Structure Collapse	4
Civil Disturbance	3
Cyber Terrorism	3
Dam Failure	6
Hazardous Materials Release	13
Opioid Addiction Response	2
Urban Fire and Explosion	5
Terrorism	9
War and Criminal Activity	9
Multi-hazard	53

Mitigation Actions by FEMA Category	
Category	**Total**
Local planning and regulations	76
Structure and infrastructure projects	82
Natural systems protection	21
Education and awareness programs	30
Mitigation Actions by Goal	
Goal	**Total**
Goal 1: Protect all life and reduce risks that exacerbate inequities in health and safety.	12
Goal 2: Build the resilience of community assets, including property, infrastructure, and cultural resources.	71
Goal 3: Foster an economy that promotes mitigation and reduces impacts from hazards.	12
Goal 4: Restore and enhance the natural ecology.	50
Goal 5: Create awareness and demand for mitigation and adaptation as a standard of practice.	18

6.4 Mitigation Action Plan

This section presents mitigation actions for Philadelphia that reduce potential exposure and losses identified as concerns in chapter **4 Risk Assessment**. The City hosted two mitigation brainstorming sessions – one focused on infrastructure solutions, and another focused on nature-based solutions – and a Mitigation Strategy Workshop on November 19, 2021. During the workshop, the group reviewed a draft of the revised goals and objectives, discussed new mitigation actions, and considered what mitigation actions should be a priority for the 2022 HMP. Stakeholders submitted new mitigations actions for consideration after the workshop.

The final list of 163 actions is made up of actions from the existing 2017 HMP and new actions developed as a follow-up to the Mitigation Strategy Workshop. **Table 6-4.** lists all of the mitigation actions for the 2022 HMP. **Table 6-4.** includes a prioritization of each of the mitigation actions; the prioritization process is explained in the narrative and table following this table.

Table 6-4. 2022 Mitigation Strategy

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
1	**Goal 1: Protect all life and reduce risks that exacerbate inequities in health and safety.**						
1.1	**Objective 1.1 Develop and implement strategies to reduce Philadelphians' risk to natural and human-made hazards.**						
1.1.1	Continue to maintain and update the City's All-Hazard Mitigation Plan with a focus on plan integration and implementation.	OEM	Local Planning and Regulations; Education and Awareness	Multi-Hazard		Staff time, Agency operating budget, HMA	High
1.1.2	Develop and implement a drought contingency plan. PWD will update the existing Drought Contingency Plan with pertinent policy and regulatory updates, improved science and technical tools, and with a greater understanding of how Delaware Watershed policies can impact Philadelphia's water supply during critical drought conditions such as reduced water super availability.	PWD/OEM	Local Planning and Regulations	Drought		Bureau of Reclamation WaterSMART	High
1.1.3	Invest resources to plan and staff initiatives to reduce hazard risks citywide. This includes development of and coordination for Cybersecurity Incident Response and Recovery Plan and Training; a Philadelphia Economic Recovery Plan; a Regional Disaster Housing Plan, and pandemic response planning.	OEM	Local Planning and Regulations	Multi-Hazard		SLTT (FEMA cybersecurity grant)	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
1.1.4	PDPH Pandemic Planning and Implementation: Update and implement the Pandemic Response, Mass Prophylaxis and Immunization, and other plans to reflect best practices and lessons learned during the COVID-19 response. This includes identifying sites to administer vaccine and/or dispense medical countermeasures during public health emergencies; coordination with other human services partners to ensure inclusion of persons experiencing homelessness in pandemic response planning; and other preparations for outbreak related response activities.	PDPH	Local Planning and Regulations; Structure and Infrastructure	Pandemic & Infectious Disease		Grants	High
1.1.5	Expand lab capacity to rapidly identify and subtype organisms.	PDPH	Structure and Infrastructure	Pandemic & Infectious Disease	$10 million	HHS Grants, Capital Budget	Medium
1.1.6	Improve access to primary medical care city-wide and improve the quality of primary care by expanding the scope of services and building facility capacity for City Health Centers.	PDPH	Structure and Infrastructure	Pandemic & Infectious Disease; Multi-Hazard	$100,000,000	HHS Grants, Capital Budget	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
1.1.7	Improve environmental conditions to foster a sense of safety in neighborhoods, connectedness among neighbors, and reduce the locations where illegal guns are stored and where illegal activity occurs. Projects include addressing blighted buildings, cleaning abandoned lots, improving lighting, and other initiatives to improve environmental conditions.	Office of Policy and Strategic Initiatives for Criminal Justice and Public Safety, Community groups, PPD, L&I, Streets, Community Life Improvement Program, Pennsylvania Horticultural Society	Local Planning and Regulations; Structure and Infrastructure; Education and Awareness	Building & Structure Collapse; Hazmat Release; Urban Fire & Explosion; War &Criminal Activity	Varies based on project size	PA Redevelopment Assistance Capital Program, IIJA Healthy Streets, HMA	*Mitigation in Focus*
1.1.8	Implement Roadmap to Safer Communities programs including Group Violence Intervention, Community Crisis Intervention Program, and Operation Pinpoint.	Office of Policy and Strategic Initiatives for Criminal Justice and Public Safety	Education and Awareness	War &Criminal Activity	Varies based on project size	PA Redevelopment Assistance Capital Program, IIJA Healthy Streets	High
1.1.9	Identify and implement short-term flood proofing tools for at-risk communities.	OEM	Structure and Infrastructure	Flood; Hurricane	Varies based on project size	Agency Operating Budget	Medium
1.2	**Objective 1.2 Prioritize mitigation actions that affect populations most at-risk and that prioritize equity and accessibility.**						
1.2.1	Conduct outreach and coordinate personnel to keep the Philadelphia homeless population safe during extreme cold and extreme heat events.	OSH	Education and Awareness	Extreme Temperature	Staff time	Agency Operating Budget	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
1.2.2	Continue to deploy trauma kits to School District of Philadelphia facilities and buses, as well as conduct trainings with faculty and staff.	OEM	Structure and Infrastructure	Terrorism; War &Criminal Activity	$530,000	UASI	High
1.2.3	Reduce Opioid Overdose Deaths and the number of people Initiating Use of illicit opioids by increasing harm reduction and treatment resources.	PDPH/ ORU	Education and Awareness	Opioid Addiction; War &Criminal Activity		CDC Cooperative Agreement for Emergency Response and HHS Comprehensive Addiction and Recovery Act funding,	High
2	**Goal 2: Build the resilience of community assets, including property, infrastructure, and cultural resources.**						
2.1	**Objective 2.1 Implement projects and programs that protect property against flooding.**						
2.1.1	Assess properties that may benefit from elevation, acquisition, relocation, retrofitting, floodproofing, mitigation reconstruction, and additional adaptive/adaptation measures; and where feasible, implement recommended mitigation activities.	OEM, L&I, PCPC, PWD	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane;	Staff time, consultant time	Operating budgets, HMA	High
2.1.2	Elevate, acquire, relocate, retrofit, floodproof, complete mitigation reconstruction, and adapt properties that benefit from elevation, acquisition, relocation, retrofitting, floodproofing, completing mitigation reconstruction, or additional adaptive/adaptation measures.	OEM, L&I, DPD, PWD	Structure and Infrastructure	Flood; Hurricane	Staff time, consultant time	Staff time, HMA	High
2.1.3	Acquire properties that are prone to damage from flooding.	OEM, L&I, DPD, PWD	Structure and Infrastructure	Flood; Hurricane	Market value of properties	Operating budgets, HMA	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.1.4	Bartrams North and South Flood Mitigation: Examine and implement mitigation methods that protects buildings and access without providing any adverse impact to upstream or downstream properties along the western bank of the Schuylkill River.	PIDC	Structure and Infrastructure	Flood; Hurricane	TBD	PA Redevelopment Assistance Capital Program (RACP)	High
2.1.5	Demolish Philadelphia owned 4910 Botanic site structures, remediate known environmental contamination, and convey the riverfront portion of the site to PPR/Schuylkill River Trail/Bartram's Garden to decrease flood risks, risk of criminal activity, and risk of building collapse.	PIDC/ PPR, Schuylkill River Development Corporation, Bartram's Garden, PHA	Structure and Infrastructure	Flood; Hurricane; Building and Structure Collapse; War &Criminal Activity	$720,000	PA Redevelopment Assistance Capital Program (RACP)	High
2.1.6	Align reviews of City floodplain regulation and guidance with the International Code Council (ICC) tri-annual updates of the building codes. Follow and educate people in building profession on required and recommended strategies to mitigate hazards and increase resilience.	L&I/ PCPC	Local Planning and Regulations	Flood; Hurricane	Staff time	Agency Operating Budget, CAP-SSSE or CTP funding through PEMA	High
2.1.7	Complete outstanding follow-up items from the most recent Community Assistance Visit.	L&I/ FRMTF	Local Planning and Regulations	Flood; Hurricane	Staff time	Agency Operating Budget, CAP-SSSE or CTP funding through PEMA	High
2.1.8	Develop a software platform to share flooding event information across departments in real-time as well as historically.	Multiple Agencies	Local Planning and Regulations	Flood; Hurricane	N/A	Agency Operating Budget, USACE	Medium
2.1.9	Maintain enrollment in NFIP by implementing floodplain management initiatives, reducing the City's flood risk, and allowing residents to receive discounted flood insurance.	L&I/ FRMTF	Local Planning and Regulations	Flood	Staff time	Agency Operating Budget, CAP-SSSE or CTP funding through PEMA	High
2.2	**Objective 2.2 Assess vulnerability of infrastructure to identify where to prioritize mitigation actions.**						

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.2.1	Conduct a Mitigation Feasibility Study to determine the best approach for implementation of mitigation actions on private homes and businesses, including building elevations, retrofits, and acquisitions. Feasibility study will include a peer review of other large jurisdiction's approaches and will address Philadelphia specific challenges to implementation. Feasibility study will provide recommendations for next steps in implementation, and recommendations for how to make the process equitable and inclusive of population most at risk to hazards.	OEM, DPD, PCPC, Land Bank, PWD	Local Planning and Regulations	Flood; Hurricane; Subsidence & Sinkhole		PA Silverjackets, BRIC	High
2.2.2	Increase bridge inspection training and conduct bridge inspections.	Streets - Highway, PennDOT	Education and Awareness; Structure and Infrastructure	Building & Structure Collapse	Staff time	Agency Operating Budget; PennDOT	Medium
2.2.3	Analyze the impact of natural and human-caused hazards and threats on critical infrastructure that supports supply chain systems through the update of the Freight (Truck) Network.	OTIS, Streets	Local Planning and Regulations	Multi-Hazard		Staff time, Agency operating budget, HMA	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.2.4	Develop a Trail Resiliency Plan and identify flood mitigation strategies for Philadelphia's extensive trail network. Trails often follow streams and rivers in Philadelphia. Recreation and travel can be a suitable use of the floodplain. However, trail infrastructure represents a significant investment from City, State and Federal partners. OTIS would like to examine how trail infrastructure can be built resiliently to protect the investment while also protecting the ability of the floodplain to absorb water. The study will consider vulnerable assets, best practices in materials and construction suitable to a floodplain, and overall trail network resiliency. Trails provide a travel mechanism that does not contribute to climate change and provides healthy recreational options for residents.	OTIS/ PCPC, PPR, Streets	Local Planning and Regulations	Multi-Hazard	Unknown	FEMA BRIC, Transportation Alternatives Program (TAP) via PennDOT, Potentially new IIJA Healthy Streets program	*Mitigation in Focus*
2.2.5	Create a hazard event database to capture description, severity, location, impact, and potential loss/damage estimate from an event. This data will be used to update the hazard analysis and mitigation actions for Philadelphia, as well as allow the city to be better prepared for future events.	OEM	Local Planning and Regulations	Multi-Hazard	Staff time, $10,000	HSGP	Medium
2.2.6	Enhance THIRA process to identify gaps in mitigation capabilities, and to better align the THIRA with the HMP Planning Process.	OEM	Local Planning and Regulations	Multi-Hazard	Staff time	HSGP	Medium
2.2.7	Maintain Tier II Reporting and GIS program.	OEM/ PFD	Local Planning and Regulations	Hazmat Release; Terrorism; Urban Fire		HSGP	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.2.8	Update the Tier II emergency response plan process/template to provide more situational awareness on chemical inventories across the city for OEM/PFD and its partners.	OEM	Local Planning and Regulations; Education and Awareness	Hazmat Release; Urban Fire & Explosion	Staff time		Medium
2.2.9	Consider needs for improved floodplain mapping and analysis and apply for funding to support City initiated CLOMRs, LOMRs, improved flood studies for critical infrastructure and other inundation mapping.	L&I/FRMTF, PWD	Local Planning and Regulations	Flood; Hurricane	Staff time, Varies based on project	PA Silverjackets, CAP-SSSE or CTP funding through PEMA, Agency Operating Budget	Medium
2.2.10	Use damage assessment data to conduct in-depth GIS analysis of impacts from past flooding and storms events to better predict future impacts from similar storm events and inform severe weather preparedness planning, alert & warning messaging, and mitigation initiatives in those areas.	OEM, OIT	Local Planning and Regulations	Flood; Hurricane; Subsidence & Sinkhole		Agency Operating Budget	Medium
2.2.11	Utilize the results of the 2022 Hazus analysis to identify new mitigation projects.	OEM/ HM Steering Committee	Local Planning and Regulations	Flood; Hurricane; Earthquake	Staff time	Agency Operating Budget	Medium
2.3	**Objective 2.3 Develop and implement mitigation programs and strategies that protect critical facilities and services.**						
2.3.1	Conduct or update natural hazard vulnerability assessments for critical facilities throughout the Philadelphia.	OEM	Local Planning and Regulations	Multi-Hazard	Staff time	HSGP	Medium
2.3.2	Continue to enhance Citywide COOP-COG program to minimize disruptions and support continuation of essential City services during and following a disaster.	OEM/ Departmental COOP Owners, DPP, Fleet, OIT	Local Planning and Regulations; Structure and Infrastructure	Multi-Hazard	Staff time	Capital Budget, Urban Area Security Initiative, SLTT	*Mitigation in Focus*
2.3.3	Maintain and utilize early warning system.	PWD	Education and Awareness	Cyber Terrorism; Hazmat Release; Terrorism		EPA grant, industry user funding, PWD general fund	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.3.4	Procure and utilize long range drone(s) to assess areas of concern before and after hazardous events (and if possible during events).	SEPTA	Structure and Infrastructure	Multi-Hazard	$25,000		High
2.3.5	Purchase two VMS signs for deployment prior to and during emergencies and events to promote public safety and awareness.	OEM	Structure and Infrastructure	Multi-Hazard	$17,500.00	HSGP	Medium
2.3.6	Procure additional unites of level B PPE for surge operators.	PFD, PPD, OEM	Structure and Infrastructure	Hazmat Release	$90,000.00	HSGP	Medium
2.4	**Objective 2.4 Integrate hazard and risk information into land use planning decisions.**						
2.4.1	Planning and Land Use Regulation and Incentive Alignment: Align the City's comprehensive plan, district plans, zoning regulations, development incentives, and other land use related programs with the City's efforts to reduce flood risk, based on up-to-date flood risk projections. This may include designation of local flood zones and related permitting requirements.	PCPC, Commerce, L&I, OOS	Local Planning and Regulations	Multi-Hazard	Staff time, Varies based on project	PA Silverjackets, CAP-SSSE or CTP funding through PEMA, Agency Operating Budget	High
2.4.2	Resilient Design Guidelines: Collaborate with related City agencies on the creation of consistent, coordinated design guidelines documents to demonstrate possible strategies for resilience to current and future hazards for building design and the public realm. Build from existing base of guidelines created by various departments.	L&I, PCPC, OOS, PWD	Local Planning and Regulations	Multi-Hazard	Staff time; $200,000	PA Silverjackets, CAP-SSSE or CTP funding through PEMA, Agency Operating Budget	Medium
2.4.3	Include risk and resiliency considerations as comprehensive planning moves forward, including use of risk analysis by planning districts created for 2022 HMP update.	PCPC, OEM, Streets, PPR	Local Planning and Regulations; Education and Awareness	Multi-Hazard	Staff time	Agency operating budget, TCDI	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.2.4	Examine and evaluate the strategy of using rolling easements to assist in adapting to the potential consequences of sea level rise.	OOS	Local Planning and Regulations; Natural Systems Protection	Flood; Hurricane	Staff time	Agency operating budget	High
2.5	**Objective 2.5 Promote post-disaster mitigation as part of restoration, recovery, and resilience building.**						
2.5.1	Design and improve Eastwick drainage and flooding prevention infrastructure.	PWD	Structure and Infrastructure	Flood; Hurricane	TBD	PWD Operations/ Capital Budget/ Grant Funding	High
2.6	**Objective 2.6 Repair, restore, and maintain existing infrastructure.**						
2.6.1	Develop and implement the Climate Adaptation and Resiliency Plan (CARP). DOA is in the midst of evaluating its climate risks. Building on this baseline assessment, DOA will align findings with the Master Plan Update currently underway; identify and prioritize climate adaptation strategies; and implement the identified strategies and priority investments.	PHL-DOA	Local Planning and Regulations	Multi-Hazard	$201,510 (planning)	DOA Operating Budget (for planning); DOA Capital Budget and federal and state grants to support implementation	High
2.6.2	Assess, Design, Procure, and Construct Upgrades and Overhauls for Vent Wells, Emergency Exits, and Station Head Houses to protect and armor them against future flooding.	SEPTA	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane	$25-30,000,000	BRIC, IIJA Capital Investment Grants and State of Good Repair Grants	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.6.3	Conduct --and implement recommendations from--a *Philadelphia International Airport Hydrologic and Hydraulic Resiliency Study* to assess current and projected flood risk and identify resiliency strategies to address risks. Key steps include a review of existing conditions, coastal analysis, HECRAS analysis, development of preliminary adaptation study, determination of potential adaptation and mitigation measures, modeling of those potential measures, and a final technical report. DOA will then seek to implement recommended measures.	PHL-DOA	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane; Winter Storm	$204,000 (study)	DOA Operating Budget (for planning); DOA Capital Budget and federal and state grants to support implementation	Medium
2.6.4	Invest in transmission main condition assessments to improve understanding of probability of failure in the transmission system and install and/or upgrade priority transmission, water, and discharge mains to improve system redundancy, improve water flows, improve water quality, enhance capacity, and address other system needs.	PWD	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane; Winter Storm	$225,000,000	Capital budget, PWD Capital	High
2.6.5	Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	Streets	Structure and Infrastructure; Natural Systems Protection	Flood; Winter Storm	$100,000.00	HMA, IIJA PROTECT	Medium
2.6.6	Design, procure, and install electric switch heaters for priority sites.	SEPTA	Structure and Infrastructure	Extreme Temperature; Winter Storm	$10,000,000 - $15,000,000		High
2.6.7	Plan and implement waterproofing for all Railroad and Transit Tunnels within City Limits - Broad Street, MFSE, Trolley Tunnel, Railroad.	SEPTA	Local Planning and Regulations; Structure and Infrastructure	Multi-Hazard	$50-100,000,000 per tunnel		High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.6.8	Update the 2016 Wastewater Master Plan Update with a focus on PWD's Water Pollution Control Plants and Pumping Stations. As part of the update, PWD will: identify and develop a prioritized schedule of asset replacements based on condition and age; identify and prioritize current regulations and potential future regulations; develop scenarios to meet goals related to regulatory compliance; evaluate and develop solutions for reducing greenhouse gas emissions where possible; and evaluate and develop potential solutions for protecting wastewater infrastructure against climate change impacts. Based on these evaluations, PWD will develop a list of needs (projects) and then will develop and implement a 25-year Capital Improvement Plan.	PWD	Local Planning and Regulations; Structure and Infrastructure	Multi-Hazard	$1.4 million (planning)	PWD Operating and Capital Funding	Medium
2.6.9	Water & Wastewater Facility based Risk & Resiliency Assessments on Tidal Delaware and Lower Schuylkill Rivers: Evaluate water and wastewater facilities to identify mitigation activities and conduct flood risk assessment, flood resiliency assessment, stakeholder engagement and partnership building opportunities. Develop BRIC applications to fund selected mitigation activities.	PWD	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane	$203,520	Capital budget, PWD Capital, BRIC	High
2.6.10	Enlarge culverts of the Poquessing Creek tributaries to protect roadway and residences without providing any adverse impact to upstream or downstream properties.	Streets	Structure and Infrastructure	Flood; Hurricane	$300,000.00	Capital Budget	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.6.11	Ensure adequate material and equipment is available to repair and replace street lights and traffic poles & signs.	Streets	Structure and Infrastructure	Windstorm, Tornado	$10,000-$100,0000	Agency Operating Budget, Grants	Medium
2.6.12	Equip drawbridges with back-up generators.	Streets	Structure and Infrastructure	Multi-Hazard	$15,000.00	Grants	High
2.6.13	Implement emergency and non-emergency generator engine rehabilitation and electrical upgrades.	PHL-DOA	Structure and Infrastructure	Multi-Hazard	$950,000.00	Capital Budget	Medium
2.6.14	Install battery back-up traffic signal controllers (75,000 each) 10% of signals in City.	Streets	Structure and Infrastructure	Multi-Hazard	$50,000.00	Grants	Medium
2.6.15	Install electrical substation upgrades with flood control at A-East	PHL-DOA	Structure and Infrastructure	Flood; Hurricane	$1,000,000.00	Capital Budget	Medium
2.6.16	Maintain portable generators for key traffic intersections.	Streets	Structure and Infrastructure	Multi-Hazard	$1,000,000	Agency Operating Budget	Medium
2.6.17	Maintain safe roadways and bridges through roadway milling and paving capital projects.	Streets - Highway	Structure and Infrastructure	Building & Structure Collapse		Special gas tax	Medium
2.6.18	Procure wastewater system HME sensors	PWD, OEM	Structure and Infrastructure	Hazmat Release; Terrorism	$1,000,000.00	HSGP, EPA	Medium
2.6.19	Purchase and maintain hyper-local street-level weather stations to assist in salting, flooding, and plowing operations.	Streets	Structure and Infrastructure	Winter Storm		Capital Budget	Medium
2.6.20	Purchase and maintain drop-gates for known dangerous roads during emergency events, particularly along Cobbs Creek, for Bells Mill Road, and on Delaware Ave.	Streets	Structure and Infrastructure	Flood; Hurricane		Capital Budget	High
2.6.21	Redesign roadways and bridges to lesson occurrence/impact of flooding.	Streets	Structure and Infrastructure	Flood; Hurricane	$500,000	Grants	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.6.22	Replace the fence around the Upper Roxborough water facility to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	PWD	Structure and Infrastructure	Hazmat Release; Terrorism	$1,000,000.00	Capital Budget/ Grant Funding	High
2.6.23	Strengthen the traffic signals beyond the national standards in reference to wind tolerance.	Streets	Structure and Infrastructure	Hurricane; Tornado, Windstorm	$100,000	Grants	Medium
2.6.24	Upgrade equipment and resources necessary to respond to flooding, winter storms, and developing or unforeseen hazards.	Streets	Structure and Infrastructure	Multi-Hazard	Staff time	Agency Operating Budget	High
2.7	**Objective 2.7 Identify, plan for, and protect historic properties and cultural resources.**						
2.7.1	Develop and implement individual hazard management plans for city owned and operated historic structures and their surrounding landscapes. Plans should consider both natural hazards, climate change impacts, and human-caused hazards.; if necessary, consider moving the structure to a safer location. Build on Manayunk pilot for historic preservation.	Philadelphia Historical Commission (PHC), PHMC,), OEM, USACE, PPR	Local Planning and Regulations	Multi-Hazard		NPS	Medium
2.7.2	Implement various mitigation and resiliency measures identified in the Fairmount Water Works Resiliency Plan to prevent future repetitive losses from flood events.	The Fund for the Water Works/ PWD, PPR	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane	$850,000 (phase I)	HMA	High
2.7.3	Conduct city-wide survey to identify and document all historic properties in the City (private and City-owned) in order to assess risk, vulnerability, and mitigation strategies for properties. Study should take into account all hazards, including building collapse, urban conflagration, and other human-caused and natural hazards.	PHC; DPD, L&I, DPP	Local Planning and Regulations	Multi-Hazard		HMA	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.8	**Objective 2.8 Address historic drivers of vulnerability and invest in community assets.**						
2.8.1	Integrate equity and social vulnerability indicators more prominently into OEM's planning and operational products to better predict, prioritize, and support community needs during disasters and emergencies to reduce risk. Form and compensate a community panel making up a diverse group of public representatives to review, provide feedback on, and participate in OEM's planning processes including the Hazard Mitigation Plan.	OEM	Local Planning and Regulations	Multi-Hazard		Unknown	High
2.8.2	Public Health Climate Vulnerability Data and Assessments: Use data to identify populations at high risk of adverse outcomes during a public health emergency and allocate resources to address planning, communications, and service gaps as appropriate. This includes indices to identify communities that are at high risk of adverse health outcomes during a flooding and other climate hazards.	PDPH	Local Planning and Regulations	Multi-Hazard		Grants	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.8.3	Eastwick Place-Based Climate Risk, Adaption, and Resiliency Planning: Conduct community-based planning in one of the most vulnerable communities to climate change impacts, Eastwick. To support community resilience to flooding and other hazards, the planning efforts will focus on the identification of long-term mitigation efforts and development of mechanisms to implement them. This planning will build off the experience of a pilot community planning effort in Hunting Park, Beat the Heat, which addresses extreme heat. In Eastwick, the City will pilot a place-based flooding framework and seek funding to implement the planning process outcomes. The City also plans to expand the place-based extreme heat resiliency framework to other communities beyond Hunting Park.	OOS	Local Planning and Regulations; Structure and Infrastructure	Extreme Temperature; Flood; Hurricane; Subsidence & Sinkhole		Capital Budgeted, William Penn Foundation, OTF, HMA, IIJA Healthy Streets	*Mitigation in Focus*
2.8.4	Healthy Corridors Project: Expand cool roadways pilot program and stormwater management projects in heat and flood vulnerable neighborhoods.	Streets/ PWD/ OOS	Local Planning and Regulations; Structure and Infrastructure	Extreme Temperature; Flood		IIJA Healthy Streets	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.8.5	Lower South Infrastructure Resilience Roadmap and Implementation: A multi-departmental initiative focused on creating the strategic direction and tools needed to prepare the Lower Schuylkill area for present and future climate risks. The down-scaled understanding of specific climate risks and the potential solutions to address them will inform the master plans, building designs, and infrastructure plans currently underway or planned in this area, resulting in development that is more resilient to flooding and other risks.	OOS/ OTIS, PWD, PCPC	Local Planning and Regulations	Extreme Temperature; Flood; Hurricane		Capital Budget, HMA, PROTECT, USACE, NOAA Community-Based Restoration Project	*Mitigation in Focus*
2.8.6	Opioid Community Support: Launch multiple, intersectional programs that provide support to communities living with the direct and indirect consequences of the Opioid Overdoes Crisis, including targeting and expanded community engagement, services to families impacted by opioid misuse, and increased serve provisions and provision of city services at critical "hot spot" locations.	ORU/PDPH	Local Planning and Regulations; Structure and Infrastructure	Opioid Addiction		CDC Cooperative Agreement for Emergency Response and HHS Comprehensive Addiction and Recovery Act funding,	*Mitigation in Focus*
2.8.7	Bartrams Safety: Build sidewalks, curb cuts, and pedestrian crossings, and install new lighting, gateway treatments, and (potentially) cameras to improve safety and reduce short dumping and crime along the Woodland Avenue / Grays Avenue / Lindbergh Blvd corridor in Kingsessing, Philadelphia.	PIDC, SEPTA/ PHA and other community partners in SW Philadelphia	Structure and Infrastructure	War &Criminal Activity	$6,000,000 ($2,000,000 shortfall)	Hope Grant, PIDC, Capital Budget	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
2.8.8	Cohocksink Multi-hazard Mitigation Project: The final phase of a six-phase flood mitigation project proposes new sewer infrastructure and green stormwater infrastructure systems in the Northern Liberties and South Kensington commercial and residential neighborhoods.	PWD	Structure and Infrastructure	Flood; Hurricane	$31,200,000	Staff time, Agency operating budget, Capital Budget, private donations, HMA, IIJA Section 50204 and 50205	*Mitigation in Focus*
2.8.9	Compound fluvial-coastal flood modeling study in the Eastwick neighborhood of Philadelphia. The study is aimed at better understanding current and future flood risks and evaluating the effectiveness of potential flood mitigation solutions developed in coordination with Eastwick community members.	Stevens Institute of Technology/ PWD, Drexel University	Local Planning and Regulations	Flood; Hurricane	$299,683	Sectoral Applications Research Program (SARP), NOAA RISA Program (Consortium for Climate Risk in the Urban Northeast (CCRUN))	High
2.8.10	USACE is currently conducting a study of the Eastwick neighborhood to determine feasible flood mitigation alternatives. City agencies will work in collaboration with the community to determine next steps for implementation of flood mitigation initiatives upon completion of this study.	USACE/ PWD	Local Planning and Regulations	Flood; Hurricane		USACE	High
2.8.11	Continue the Philadelphia Fire Department's initiative to conduct education and outreach out fire prevention and provide and install free smoke alarms to Philadelphia home owners upon request. A number of adaptive alarms are made available to residents with hearing or vision loss.	PFD	Education and Awareness	Urban Fire		Agency operating budget	High
2.8.12	Evaluate the feasibility of and potential form for a Community Resilience HUB for Philadelphia.	HM Steering Committee, CCRUN	Local Planning and Regulations; Education and Awareness	Multi-hazard		Staff time, Agency operating budget, Private donations, HMA	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
3	**Goal 3: Foster an economy that promotes mitigation and reduces impacts from hazards.**						
3.1	**Objective 3.1 Prioritize mitigation strategies that support the continuation of critical business operations during and following a disaster.**						
3.1.1	Assess business risk to potential threats and hazards in Philadelphia and identify actionable solutions to support business response, recovery, and mitigation. This includes an analysis of past impacts to the business community and development of guidance on how businesses can leverage available mitigation funding and resources to be more prepared and resilient for the next disaster, including businesses that own or operate out of historic structures or historic districts.	OEM	Local Planning and Regulations; Education and Awareness	Multi-hazard		Staff time, Agency operating budget, HMA	*Mitigation in Focus*
3.1.2	Develop Regional Disaster Supply Chain Resilience Plan.	OEM	Local Planning and Regulations	Multi-Hazard	$350,000	Regional Catastrophic Preparedness Grant Program (RCPGP)	High
3.1.3	Establish open end contracts with construction companies for emergency bridge and road repairs.	Streets	Local Planning and Regulations	Multi-Hazard		Staff time	Medium
3.1.4	Citywide Streets Vulnerability Assessment: Document institutional knowledge of flood prone roadways and road closures from severe weather events. Develop system for tracking future storm impacts to inform mitigation actions, planning, and response related activities.	Streets/ OTIS, PWD, OEM	Local Planning and Regulations	Flood; Hurricane		PennDOT, FEMA HMA	High
3.1.5	Establish a smart detour plan for flooding of Wissahickon Creek, Schuylkill River, Cobbs Creek, and Delaware River (particularly along Delaware Avenue/Columbus Boulevard).	Streets	Local Planning and Regulations	Flood; Hurricane	$25,000.00	FEMA, UASI	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
3.1.6	Develop Cyber Security Incident Response and Recovery Plan, including education and outreach to stakeholders and the public.	OEM, OIT	Local Planning and Regulations	Cyber Terrorism			High
3.2	**Objective 3.2 Sustain, promote, and enhance partnerships with external public and private entities to identify and share resources.**						
3.2.1	Establish a Resilient Infrastructure Fund to fill in funding gaps for municipal capital projects to proactively implement best practice mitigation/adaptation measures for resilient infrastructure.	OOS	Local Planning and Regulations	Multi-Hazard	$200,000/year	Capital Budget	High
3.3	**Objective 3.3 Form partnerships to leverage and share resources to address hazard risks today and projected from climate change.**						
3.3.1	Create Community Resilience and Environmental Action Fund to direct funding to impacted communities to implement projects that draw upon their place-based knowledge of environmental hazards and community resilience.	OOS	Local Planning and Regulations	Extreme Temperature; Flood; Hurricane	$100,000/year	General Operating Budget	High
3.3.2	Study of Climate Change / Hazard Vulnerability of Police and Fire facilities, and potentially expand the study to include other key civic priority facilitates. DPP will release an RFP and contract for a climate vulnerability assessment and report with maps and recommendations. This assessment will be updated on a regular basis.	DPP	Local Planning and Regulations	Multi-Hazard	$50,000	Capital Budget	Medium
3.3.3	Maintaining relationships with universities and colleges within Philadelphia to support mitigation, emergency planning, training, and exercises between the City and higher educational facilities.	OEM	Local Planning and Regulations; Education and Awareness	Multi-Hazard	Staff time	Agency operating budget	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
3.3.4	Complete facility-based, asset-level coastal risk assessments for PWD's drinking water and wastewater infrastructure. Risk Assessment will directly inform future flood mitigation and adaptation strategies needed to protect these critical facilities from sea level rise and storm surge impacts.	PWD	Local Planning and Regulations	Flood; Hurricane		Staff time, Agency operating budget, private donations, HMA	High
3.3.5	Build collaborative opportunities with university programs interested in hazard mitigation planning. Collaboration could take the form of sharing research, students completing analysis and mapping for HMP plan updates, City presentations to classes, identifying university led mitigation actions, and internships.	OEM	Local Planning and Regulations; Education and Awareness	Multi-Hazard	Staff time from City and University	Agency operating budget	Medium
4	**Goal 4: Restore and enhance the natural ecology.**						
4.1	**Objective 4.1 Promote nature-based solutions to manage stormwater and reduce the impacts of flooding and SLR.**						
4.1.1	Mapping Stormwater Flooding Risk: Better define urban flood risk in areas not covered by FEMA floodplain mapping through more comprehensive mapping of sewer system flood risk in other areas of the city. PWD has already studied flash flooding risk in Wingohocking Sewershed but hopes to expand these efforts. Share results as appropriate online for community based planning.	PWD	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane		Staff time, Agency operating budget, private donations, HMA	Medium
4.1.2	Perform comprehensive study of the stormwater infrastructure of the Centennial District to identify necessary improvements in park infrastructure.	PPR, PWD/ Fairmount Park Conservancy	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane; Subsidence & Sinkhole		Grants, Capital Budget, Philanthropy	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.1.3	Complete stream restoration projects in West Fairmount Park whose impact is localized to discreet areas to eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PPR, PWD/ Fairmount Park Conservancy	Local Planning and Regulations; Natural Systems Protection	Flood; Hurricane		Grants, Capital Budget, Philanthropy	Medium
4.1.4	Advance the comprehensive planning, technical analyses, and stakeholder engagement in Germantown for a storm flood risk reduction and combined sewer overflow (CSO) mitigation project within the Wingohocking and the Tookany/Tacony-Frankford (TTF) Watersheds.	PWD	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane		Staff time, Agency operating budget, Capital Budget, private donations, HMA, IIJA Section 50204 and 50205	*Mitigation in Focus*
4.1.5	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Cobbs Creek Reaches 1 to 3 and Cobbs Creek Reaches 6 to 8 in Phase 2.	PWD	Natural Systems Protection	Flood; Hurricane	$1,000,000 (Reaches 1 to 3); $2,300,000 (Reaches 6 to 8)	PWD Operations/ Capital Budget/ Grant Funding	Medium
4.1.6	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Tacony Creek.	PWD	Natural Systems Protection	Flood; Hurricane	$11,500,000	PWD Operations/ Capital Budget/ Grant Funding	Medium
4.1.7	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Valley Green Road and Spring Lane.	PWD	Natural Systems Protection	Flood; Hurricane	$400,000	PWD Operations/ Capital Budget/ Grant Funding	Medium
4.1.8	Identify additional stream and creek restoration projects to aid in eliminating historic flooding hazards through area studies. Consider appropriate nature-based solutions (natural infrastructure, elevated berm/park space, living shoreline, etc.) to assist in adapting to flooding impacts today and from SLR.	PWD	Natural Systems Protection	Flood; Hurricane	$400,000-$12,000,000 per project	PWD Operations/ Capital Budget/ Grant Funding	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2	**Objective 4.2 Support projects that address water holistically including water quality, stormwater management, dam safety, and flood mitigation.**						
4.2.1	Conduct hydraulic modeling.	PWD	Local Planning and Regulations; Natural Systems Protection	Flood; Hurricane; Hazmat Release		PWD General Fund	Medium
4.2.2	Ongoing identification of larger infrastructure projects whose impact effects large areas of the city through PWD studies.	PWD	Local Planning and Regulations; Structure and Infrastructure	Drought; Flood; Hurricane; Dam Failure	$100,000-$40,000,000 per project	PWD Operations/ Capital Budget/ HMA and HHPD funding	High
4.2.3	Examine the impacts of all dams that are considered HHPD both in Philadelphia and that have inundation areas impacting Philadelphia, including the assets and populations at risk of dam inundation. Plan appropriate mitigation efforts and apply for FEMA HHPD funding.	OEM and PWD	Local Planning and Regulations; Structure and Infrastructure	Dam Failure	$100,000-$40,000,000 per project	PWD Operations/ Capital Budget/ FEMA HHPD funding	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2.4	Implement PWD's Drinking Water Master Plan (WMP) and related 25-year Capital Improvement Plan, which focuses on PWD's Drinking Water Treatment Plants, Pumping Stations, and Conveyance Systems. Implementation projects are planned projects to meet goals (in categories including system redundancy, resiliency, water quality, water quantity, and service pressure) and mitigate risks (i.e., aging infrastructure, current and future regulations, climate change, and environmental risks) identified in the WMP. WMP projects currently in Planning/Design phases include water treatment plant expansion, pumping station rehabilitation and construction, storage facility reconstruction, and transmission piping additions. All WMP projects are planned to mitigate risks on both the system and facility level.	PWD	Local Planning and Regulations; Structure and Infrastructure	Multi-Hazard	$2.5 billion	PWD Capital Funding, Capital Budget	High
4.2.5	Conduct study to identify stream restoration projects in West Fairmount Park along with the goal to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PPR/ Fairmount Park Conservancy	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane		Grants, Capital Budget, Philanthropy	Medium
4.2.6	Complete wetland creation projects in FDR Park to eliminate or reduce erosion issues, reduce swimming hazards, and reduce flooding damage to surrounding areas and connect park users to the water.	PPR, PWD/ Fairmount Park Conservancy	Structure and Infrastructure; Natural Systems Protection	Flood; Hurricane	$10,000,000	Capital budget, NFWF	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2.7	Perform Shedbrook Creek Stream Rehabilitation to aid in eliminating historic flooding hazards, improve safety of structure or surrounding areas, eliminate or reduce erosion issues, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PPR/ Fairmount Park Conservancy	Structure and Infrastructure; Natural Systems Protection	Flood; Hurricane	$250,000	Capital budget, NFWF	Medium
4.2.8	Perform structural repairs to dams and/ or removal of fishway structure at Fairmount Dam to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PWD	Structure and Infrastructure; Natural Systems Protection	Drought; Flood; Hurricane; Dam Failure	$100,000 - $250,000	Capital Budget	High
4.2.9	Perform structural repairs to dams and/ or removal of Flat Rock Dam, a HHPD to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PWD	Structure and Infrastructure; Natural Systems Protection	Drought; Flood; Hurricane; Dam Failure	$12,000,000 - $20,000,000	Capital Budget/ FEMA HHPD funding	High
4.2.10	Perform Tacony Creek Stream Rehabilitation Reaches 4 and 5 to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	PWD	Structure and Infrastructure; Natural Systems Protection	Drought; Flood; Hurricane; Dam Failure	$11,500,000	Capital Budget	Medium
4.2.11	Complete smaller sewer and green infrastructure projects whose impact is localized to discreet areas. Over one hundred are currently in design stages.	PWD	Structure and Infrastructure	Flood; Hurricane	$100,000- $4,000,000 per project	PWD Operations/ Capital Budget/ Grant Funding	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2.12	Addition of effluent and outfall pumping station to Northeast Water Pollution Control Plant Outfall and Effluent Pumping Station to pump treated water to the river during extreme wet weather events and high tide.	PWD	Structure and Infrastructure	Flood; Hurricane	$45,000,000 per project	Capital Budget/ Grant Funding	High
4.2.13	Addition of wastewater and stormwater pumps and storage in various locations throughout the system and facilities to send more water to the water pollution control plants during wet weather events.	PWD	Structure and Infrastructure	Drought; Flood; Hurricane; Winter Storm	$2,000,000 - $100,000,000 per project	Capital Budget/ Grant Funding	High
4.2.14	Build additional water mains to provide better system redundancy and resiliency.	PWD	Structure and Infrastructure	Drought; Flood; Hurricane; Winter Storm	$5,000,000 - $10,000,000 per project	Capital Budget/ Grant Funding	High
4.2.15	Design and construction of integrated flood and stormwater management systems in the Navy Yard's Historic District to protect critical energy infrastructure and public waterfront access, preserve historic structures, and minimize flood risks for employees, visitors, and residents.	PIDC/ Lower Schuylkill Collaboration, OOS and OTIS on Lower South Roadmap	Structure and Infrastructure	Flood; Hurricane; Subsidence & Sinkhole		PENNVEST, FEMA BRIC	High
4.2.16	Design and construction of integrated flood and stormwater management systems in the Navy Yard's Mustin District to protect critical energy infrastructure and public waterfront access, preserve historic structures, and minimize flood risks for employees, visitors, and residents.	PIDC/ Lower Schuylkill Collaboration, OOS and OTIS on Lower South Roadmap	Structure and Infrastructure	Flood; Hurricane; Subsidence & Sinkhole		PENNVEST, FEMA BRIC	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2.17	Improve and upgrade water security system to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure. Projects considered for 29th Street Complex Storage Units, Baxter and Belmont Water Treatment Plants, and Northeast and Southwest Water Pollution Control Plants.	PWD	Structure and Infrastructure	Cyber Terrorism; Hazmat Release; Terrorism	$15,000,000.00	Capital Budget/ Grant Funding	High
4.2.18	Install backup generators and switchgear at Queen Lane Raw Pump Station to ensure operations during power outages.	PWD	Structure and Infrastructure	Flood; Hurricane; Winter Storm	$2,300,000.00	Capital Budget/ Grant Funding	High
4.2.19	Install backup generators at West Oak Lane to ensure operations during power outages.	PWD	Structure and Infrastructure	Flood; Hurricane; Winter Storm	$1,500,000.00	Capital Budget/ Grant Funding	High
4.2.20	Make stormwater sewer improvements to reduce the combined sewer overflows affecting approximately 109 properties in the area between 1651 and 1851 Christopher Columbus Blvd during extreme rain events.	PWD	Structure and Infrastructure	Flood; Hurricane		Staff time, Capital budget, HMA	High
4.2.21	Moore St. drainage from Christopher Columbus to River infrastructure project to improve capabilities in the area.	PWD	Structure and Infrastructure	Flood; Hurricane	$7,000,000 - $10,000,000	PWD Operations/ Capital Budget/ HMA	High
4.2.22	Phase V of Northern Liberties infrastructure projects, which affects Northern Liberties and surrounding neighborhoods water drainage system capabilities.	PWD	Structure and Infrastructure	Flood; Hurricane	$8,200,000	PWD Operations/ Capital Budget/ HMA	High
4.2.23	Rehabilitate Queen Lane Raw Water Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	PWD	Structure and Infrastructure	Drought; Flood; Hurricane; Winter Storm	$35,000,000.00	Capital Budget/ HMA	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.2.24	Relocate Belmont Raw Water Pump Station Intake to ensure reliable source during droughts and winter storms.	PWD	Structure and Infrastructure	Drought; Flood; Hurricane; Winter Storm	$15,000,000.00	Capital Budget/ HMA	High
4.2.25	Restore approximately 12,000 linear feet of stream channel and 25-40 acres of wetlands on the Cobbs Creek Golf Course to maximize flood storage potential and create a stable, natural floodplain.	Cobbs Creek Foundation/ PWD, PPR	Structure and Infrastructure; Natural Systems Protection	Flood; Hurricane		Staff time, Capital Budget, private donations, HMA, PA DEP	High
4.2.26	Upgrade Lardner's Point Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	PWD	Structure and Infrastructure	Drought; Flood; Hurricane; Winter Storm	$55,000,000.00	Capital Budget/ HMA	High
4.2.27	Upgrade Mingo Creek Pumping Station to handle increased flows from wet weather events.	PWD	Structure and Infrastructure	Flood; Hurricane	$4,000,000.00	Capital Budget/ HMA	High
4.2.28	Upgrade of various wastewater and stormwater pump stations to handle increased flows from wet weather events.	PWD	Structure and Infrastructure	Flood; Hurricane	$400,000 - $4,000,000 per project	Capital Budget/ HMA	High
4.2.29	Upgrade P-796 at the Navy Yard Design to handle increased flows from wet weather events.	PWD	Structure and Infrastructure	Flood; Hurricane	$2,500,000.00	Capital Budget/ HMA	Medium
4.2.30	Coordinate with Pennsylvania DEP and Franklin Mills Limited Partnership on future plan updates regarding HHPD standards and planning.	OEM	Local Planning and Regulations	Dam Failure		Staff time, Capital Budget	High
4.3	**Objective 4.3 Restore and enhance green spaces and prioritize communities overburdened by environmental hazards.**						
4.3.1	Establish a policy based on need and funding availability for a regular pruning cycle for city trees.	PPR	Local Planning and Regulations; Natural Systems Protection	Multi-Hazard	Staff time	Capital Budget, NPS, DCNR	Medium
4.3.2	Complete sewer and green infrastructure projects whose impact is localized to discreet areas in West Fairmount Park.	PPR, PWD/ Fairmount Park Conservancy	Local Planning and Regulations; Structure and Infrastructure	Flood; Hurricane		Grants, Capital Budget, Philanthropy	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.3.3	Inspect trees within 100 ft. of walkways and roadways for signs of the emerald ash borer and treat affected trees every three years.	PPR	Natural Systems Protection	Multi-Hazard	$80,000	Capital Budget, NPS, DCNR	Medium
4.3.4	Monitor new tree watering contracts to ensure the trees have sufficient time to take root and establish themselves under warmer temperatures.	PPR	Natural Systems Protection	Drought; Extreme Temperature	Staff time	Capital Budget	Medium
4.3.5	Pilot study the growth of Southern plant species with sustainable planting practices in preparation for increasing temperatures over the next century.	PPR	Natural Systems Protection	Multi-Hazard	$50,000	Capital Budget	Medium
4.3.6	Utilize City Works Trees to track real-time response and management of downed trees and vegetation prior to, during, and following events.	PPR	Natural Systems Protection	Multi-Hazard	Staff time	Capital Budget	Medium
4.3.7	Decrease the backlog of 2,000+ tree maintenance and removal projects to reduce unpruned and dead trees falling on power lines during storm events.	PPR	Structure and Infrastructure; Natural Systems Protection	Multi-Hazard	$700 per tree removed	Capital Budget	Medium
4.4	**Objective 4.4 Support the transition away from fossil fuels and other greenhouse gases that impact health and safety and exacerbate climate change.**						
4.4.1	Develop a continuously updated Climate Data tool for screening infrastructure projects and planning processes against the best available climate projections for the city and region.	OOS	Local Planning and Regulations	Extreme Temperature; Flood; Hurricane		Capital Budget	High
4.4.2	Update a Indego Bike Share Comprehensive Hazard Mitigation Plan based on best practices for operational practices that mitigate identified hazards.	OTIS/ Bicycle Transit Systems (contractor)	Local Planning and Regulations	Multi-Hazard	$5,000	Staff time, Agency operating budget	Medium
4.5	**Objective 4.5 Improve air, water, and soil quality across the City starting with environmental justice communities.**						

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
4.5.1	Examine mitigation opportunities that address flooding and rising water tables from increased precipitation and sea level rise inundating brownfields and releasing hazardous materials into local waterways.	Brownfield Working Group	Local Planning and Regulations	Flood; Hurricane; Hazmat Release	Staff time	Agency operating budget	Medium
4.5.2	Construction of additional chemical dosing boosters and flushers throughout the city to maintain water quality.	PWD	Structure and Infrastructure	Drought; Extreme Temperature	$1,500,000-$5,300,000	Capital Budget/ Grant Funding	Medium
4.5.3	Secure intake booming materials.	PWD	Structure and Infrastructure; Natural Systems Protection	Hazmat Release	$500,000.00	Agency operating budget, EPA	Medium
4.5.4	Remove oil storage facility (tank farm).	PIDC	Structure and Infrastructure	Hazmat Release	Unknown	EPA's Brownfields Program	Low
5	**Goal 5: Create awareness and demand for mitigation and adaptation as a standard of practice.**						
5.1	**Objective 5.1 Tailor mitigation training to public officials, businesses, organizations, and the public emphasizing equity and inclusion.**						
5.1.1	Conduct active shooter training for city staff.	PPD, OEM	Education and Awareness	War &Criminal Activity	N/A	Staff time	Low
5.1.2	Employ a READYEmployee process to alert over 7,000 City employees that work in the Center City Quadplex buildings (City Hall, MSB, OPB, SCCJ) of emergencies and quickly gather an accountability report.	OEM	Education and Awareness	Multi-Hazard; Civil Disturbance	Staff time	UASI	High
5.1.3	Expand Multi-Assault, Counter Terrorism Action Capabilities (MACTAC) training program for patrol officers.	PPD	Education and Awareness	Terrorism; War &Criminal Activity	Staff time	HSGP	Low

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
5.1.4	Expand and continue training for all PPD personnel including, but not limited to: SPOT Training, Prevention and Deterrence of Terrorism Training, Advanced Trauma Training, Mass Casualty Awareness Training, Customized Alarm Response Training, Site Protection by Observational Techniques Training, Protest Awareness Training, Customized Alarm Response Training, Tourniquet Training, Field Force Operations Training, Field Force Extraction Training, Field Force Command Planning Training.	PPD	Education and Awareness	Civil Disturbance; Hazardous Materials Release; Terrorism; War &Criminal Activity	Staff time	HSGP	Low
5.1.5	Upkeep PFD Hazmat training and equipment.	PFD	Education and Awareness	Hazmat Release; Terrorism; Urban Fire		Agency Operating Budget	Medium
5.2	**Objective 5.2 Improve existing and put in place necessary warning systems.**						
5.2.1	Deploy a stream flood gauge on the Darby Creek near the Eastwick neighborhood.	OEM/ National Weather Service, Delaware County DES	Education and Awareness	Flood; Hurricane		NWS has in the past but funding has been cut recently	Medium

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
5.2.2	Inclusive and Equitable Public Health Notification, Engagement, Partnership and Awareness: Review, update, expand, and/or implement public health related notifications, educational programs, and planning process informed through inclusive stakeholder engagement processes to increase the reach of PDPH communications and promote more equitable outcomes. These include an expanded set of public notification strategies and protocols for health-related emergencies; a "Be a Buddy" program to empowering residents to support neighbors who may be at risk for adverse health outcomes; the Community Response Partner Network (CRPN); the Health Alert Network; resident education programs around extreme weather; community-based health bulletins; and a risk communication playbook for high priority public health hazards.	PDPH	Education and Awareness	Multi-Hazard; Civil Disturbance		HHS, CDC, HMA	High
5.2.3	Revamp and update Philadelphia OEM's Alert and Warning Plan for the City, along with associated frameworks and deliverables. Create a social, digital, and traditional media campaign focused on increasing the number of READYPhiladelphia subscribers including people with access and functional needs.	OEM	Local Planning and Regulations; Education and Awareness	Multi-Hazard		HMA, Homeland Security Grant Program, USAI	*Mitigation in Focus*
5.3	**Objective 5.3 Increase public's awareness of hazards, mitigation, and other protective measures, including those related to the projected impacts of climate change.**						

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
5.3.1	Create a Flood and Hurricane Preparedness Campaigns promoting mitigation efforts residents and businesses can take prior to flooding events, including print material and digital and social media content that focus on steps people can take to prepare for severe storms. This also includes development of new innovative messaging to promote in-person preparedness workshops to assist in preparing citizens for hurricane season and messaging to support the Community Outreach Team attracting participants to hurricane season at tabling events.	OEM	Education and Awareness	Flood; Hurricane		HMA	High
5.3.2	Provide public outreach throughout Philadelphia with READYHome, READYCommunity, and READYBusiness to increase community preparedness and mitigation.	OEM	Education and Awareness	Multi-Hazard	$5,000 - $100,000	Staff time; Agency operating budget; FEMA DHS and HMA funding potential for larger campaigns	High
5.3.3	Promote post disaster mitigation strategies throughout SEPA region, targeting communities that are most vulnerable. VOAD partner agencies may implement mitigation strategies.	OEM	Education and Awareness	Multi-Hazard	Staff time/ $15,000	HSGP	High
5.3.4	Update OEM's Ready programs, including READYBusiness to focus on COOP Planning and risk mitigation strategies for small to medium-size businesses, and READYKids in partnership with MDO Headstart & PFD Prevention Division.	OEM	Education and Awareness	Multi-Hazard	Staff time	HMA	High

	Mitigation Action and Description	Lead/ Support Agencies	FEMA Category	Hazard	Estimated Project Cost	Possible Funding Source(s)	Priority
5.3.5	Employ spatial data to inform OEM's community preparedness outreach to help OEM better understand where preparedness outreach is occurring and ultimately focus on areas most at risk.	OEM GIS	Local Planning and Regulations	Multi-Hazard	Staff time	Agency operating budget	Medium
5.4	**Objective 5.4 Continue and expand coordination efforts to plan for cross-agency mitigation efforts.**						
5.4.1	Bring in subject-matter experts to conduct trainings on benefit-cost analysis (BCA) for Philadelphia partners to support development of grant applications for mitigation projects.	OEM	Education and Awareness	Multi-Hazard		Partnership with PEMA and FEMA (CERC program might be utilized)	Medium
5.4.2	Develop and socialize guide and calendar of all available mitigation funding resources. Continue to develop and implement coordinated City approach to pursue mitigation funding.	OEM/ Mayor's Office of Recovery and Grants	Education and Awareness	Multi-Hazard	Staff time	Selected projects would be included in Capital Budget	High
5.4.3	Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder relationships pre-disaster.	OEM	Education and Awareness	Multi-Hazard	Staff time	Agency operating budget	Medium
5.4.4	Revitalize the Philadelphia Emergency Management Council from a 6+ year hiatus. This local council will consist of key city leadership and will focus on strategic emergency management issues including long-term risk reduction and risk/hazard education at a senior level	OEM	Local Planning and Regulations	Multi-Hazard	Staff time	Agency operating budget	Medium
5.4.5	Research and plan to increase the reach and timeliness of Regional Integration Center (RIC) research products (situational awareness reports, pre-event briefings, weather reports, etc.) before and during an event.	OEM	Local Planning and Regulations; Education and Awareness	Multi-Hazard		Funded - Regional Catastrophic grant program	High

The actions in the mitigation strategy are prioritized to assist with implementation. The project prioritization process outlined below aligns with the State Hazard Mitigation Plan project prioritization process. Equity has been added as an important factor for consideration in this process. A project's equity score was determined by looking at a variety of factors including, but not limited to:

- Does the project reduce risk to a geographic area with higher social vulnerability based on the CDC's Social Vulnerability Index?
- Does the project reduce risk to a geographic area with greater exposure to the hazard (ex: areas in a FEMA designated flood zone or areas experiencing higher heat due to the urban heat island effect)?
- Does the project reduce risk to a population more susceptible to negative impacts from the hazard due to intrinsic characteristics (ex: Individuals with disabilities, access and functional needs, or older adults)?
- Does the project reduce risk to a population or geographic location placed at greater risk to the hazard due to historic inequities or underinvestment?
- Does the project inadvertently increase risk to any of these populations or geographic locations?
- Has the principal of 'no adverse impact' been considered to ensure that a project that builds resiliency in one neighborhood does not increase risk for up or downstream neighbors?

After mitigation actions were developed, they were compared with one another to determine a ranking or priority using the Mitigation Action Prioritization Criteria listed below (**Table 6-5.**). For each action, scores of 0, 1, 2, or 3 was assigned for each of the criteria listed below with 0 indicating that the project did not meet the criteria and 3 indicating that the project overwhelmingly met the criteria. Values were given to each project based on the information provided by the lead agency. Members of the Steering Committee validated the scores assigned to each action.

Table 6-5. Mitigation Action Prioritization Criteria

Mitigation Action Ranking Criteria	Criteria Description	Weight Value
Effectiveness	The extent to which an action reduces risk to people and properties.	20%
Efficiency	The extent to which time, effort, and cost is well used as a means of reducing vulnerability both short and long term. Agency has demonstrated expertise and capacity to manage implementation of project.	25%
Multi-Hazard Mitigation	The action reduces risk to more than one hazard.	15%
Addresses High Risk Hazard	The action reduces risk to people and properties from a hazard(s) identified as highest risk. See **Table 6-6.**	10%
Addresses Critical Communications/Critical Facilities	The action pertains to the maintenance of critical functions and structures such as transportation, supply chain management, data circuits, etc.	15%
Equity	The action reduces risk to one or more populations more susceptible to the negative impacts of natural disaster due to environmental exposure, social vulnerability, or other factors (factors impacting exposures and vulnerability are described in more detail in Chapter 2: Community Profile and throughout Hazard Profiles, Chapter 4).	15%

Each project was given a priority (high priority, medium priority, or low priority) based on the cumulative, weighted score earned:

- High priority: 2.5-3.0
- Medium Priority: 1.9-2.4
- Low Priority: 0-1.8

Table 6-6 below outlines risk factor by hazard based on results from **Chapter 4 Risk Assessment**. This table was used to determine each project's score under the "Addresses High Hazard Risk" criteria. It also appears in **Section 4.4.2 Ranking Results** but is provided here as well for convenience in cross-referencing.

Table 6-6. Risk Factor Rankings

Hazard	0.3 Probability	0.3 Impact	0.2 Spatial Extent	0.1 Warning Time	0.1 Duration	Overall Risk
Flood, Flash Flood, Ice Jam	4	4	3	2	4	3.6
Opioid Addiction Response	4	4	3	1	4	3.5
Pandemic and Infectious Disease	3	4	4	1	4	3.4
Extreme Temperature	4	3	4	1	3	3.3
Hurricane, Tropical Storm, Nor'easter	3	4	4	1	3	3.3
Urban Fire and Explosion	4	3	3	4	1	3.2
War and Criminal Activity[12]	3	4	3	4	1	3.2
Hazardous Materials Release	3	3	2	4	4	3.0
Winter Storm	4	2	4	1	3	3.0
Tornado, Windstorm	4	3	2	2	1	2.8
Terrorism	1	4	2	4	1	2.4
Drought	2	1.5	4	1	4	2.4
Cyber Terrorism	3	1	2	4	3	2.3
Building and Structure Collapse	2	2	2	4	1	2.1
Dam Failure	1	3	2	2	3	2.1
Civil Disturbance	2	2	2	2	1	1.9
Earthquake	1	1	4	4	1	1.9
Subsidence, Sinkhole	2	2	1	2	3	1.9

The prioritization of each mitigation action is included below in **Table 6-7.** This table was reviewed by the Steering Committee and at the Draft Review Meeting. Stakeholders were encouraged to review and comment on draft prioritization.

[12] War and Criminal Activity includes the following human-caused hazards: Gun Violence and Active Assailant.

Table 6-7. Mitigation Strategy Prioritization

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
1	**Goal 1: Protect all life and reduce risks that exacerbate inequities in health and safety.**								
1.1	**Objective 1.1 Develop and implement strategies to reduce Philadelphians' risk to natural and human-made hazards.**								
1.1.1	Continue to maintain and update the City's All-Hazard Mitigation Plan with a focus on plan integration and implementation.	High	3	2	3	3	2	3	2.6
1.1.2	Develop and implement a drought contingency plan. PWD will update the existing Drought Contingency Plan with pertinent policy and regulatory updates, improved science and technical tools, and with a greater understanding of how Delaware Watershed policies can impact Philadelphia's water supply during critical drought conditions such as reduced water super availability.	High	3	3	1	2	3	3	2.6
1.1.3	Invest resources to plan and staff initiatives to reduce hazard risks citywide. This includes development of and coordination for Cybersecurity Incident Response and Recovery Plan and Training; a Philadelphia Economic Recovery Plan; a Regional Disaster Housing Plan, and pandemic response planning.	High	3	2	3	3	3	3	2.75

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
1.1.4	PDPH Pandemic Planning and Implementation: Update and implement the Pandemic Response, Mass Prophylaxis and Immunization, and other plans to reflect best practices and lessons learned during the COVID-19 response. This includes identifying sites to administer vaccine and/or dispense medical countermeasures during public health emergencies; coordination with other human services partners to ensure inclusion of persons experiencing homelessness in pandemic response planning; and other preparations for outbreak related response activities.	High	3	3	1	3	3	3	2.7
1.1.5	Expand lab capacity to rapidly identify and subtype organisms.	Medium	3	2	1	3	3	3	2.45
1.1.6	Improve access to primary medical care city-wide and improve the quality of primary care by expanding the scope of services and building facility capacity for City Health Centers.	High	3	3	2	3	3	3	2.85

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
1.1.7	Improve environmental conditions to foster a sense of safety in neighborhoods, connectedness among neighbors, and reduce the locations where illegal guns are stored and where illegal activity occurs. Projects include addressing blighted buildings, cleaning abandoned lots, improving lighting, and other initiatives to improve environmental conditions.	*Mitigation in Focus*	3	3	3	3	2	3	2.85
1.1.8	Implement Roadmap to Safer Communities programs including Group Violence Intervention, Community Crisis Intervention Program, and Operation Pinpoint.	High	3	3	1	3	2	3	2.55
1.1.9	Identify and implement short-term flood proofing tools for at-risk communities.	Medium	2	2	2	3	2	3	2.25
1.2	**Objective 1.2 Prioritize mitigation actions that affect populations most at-risk and that prioritize equity and accessibility.**								
1.2.1	Conduct outreach and coordinate personnel to keep the Philadelphia homeless population safe during extreme cold and extreme heat events.	Medium	2	2	2	3	1	3	2.1
1.2.2	Continue to deploy trauma kits to School District of Philadelphia facilities and buses, as well as conduct trainings with faculty and staff.	High	3	3	2	2	3	3	2.75

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
1.2.3	Reduce Opioid Overdose Deaths and the number of people Initiating Use of illicit opioids by increasing harm reduction and treatment resources.	High	3	3	2	3	1	3	2.55
2	**Goal 2: Build the resilience of community assets, including property, infrastructure, and cultural resources.**								
2.1	**Objective 2.1 Implement projects and programs that protect property against flooding.**								
2.1.1	Assess properties that may benefit from elevation, acquisition, relocation, retrofitting, floodproofing, mitigation reconstruction, and additional adaptive/adaptation measures; and where feasible, implement recommended mitigation activities.	High	3	3	2	3	3	3	2.85
2.1.2	Elevate, acquire, relocate, retrofit, floodproof, complete mitigation reconstruction, and adapt properties that benefit from elevation, acquisition, relocation, retrofitting, floodproofing, completing mitigation reconstruction, or additional adaptive/adaptation measures.	High	3	3	2	3	3	3	2.85
2.1.3	Acquire City properties that are prone to damage from flooding.	High	3	3	2	3	3	3	2.85

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.1.4	Bartrams North and South Flood Mitigation: Examine and implement mitigation methods that protects buildings and access without providing any adverse impact to upstream or downstream properties along the western bank of the Schuylkill River.	High	3	3	2	3	2	2	2.55
2.1.5	Demolish Philadelphia owned 4910 Botanic site structures, remediate known environmental contamination, and convey the riverfront portion of the site to PPR/Schuylkill River Trail/Bartram's Garden to decrease flood risks, risk of criminal activity, and risk of building collapse.	High	3	3	3	3	3	2	2.85
2.1.6	Align reviews of City floodplain regulation and guidance with the International Code Council (ICC) tri-annual updates of the building codes. Follow and educate people in building profession on required and recommended strategies to mitigate hazards and increase resilience.	High	3	3	2	3	2	3	2.7
2.1.7	Complete outstanding follow-up items from the most recent Community Assistance Visit.	High	3	3	2	3	2	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.1.8	Develop a software platform to share flooding event information across departments in real-time as well as historically.	Medium	2	2	2	3	1	3	2.1
2.1.9	Maintain enrollment in NFIP by implementing floodplain management initiatives, reducing the City's flood risk, and allowing residents to receive discounted flood insurance.	High	3	3	1	3	2	3	2.55
2.2	**Objective 2.2 Assess vulnerability of infrastructure to identify where to prioritize mitigation actions.**								
2.2.1	Conduct a Mitigation Feasibility Study to determine the best approach for implementation of mitigation actions on private homes and businesses, including building elevations, retrofits, and acquisitions. Feasibility study will include a peer review of other large jurisdiction's approaches and will address Philadelphia specific challenges to implementation. Feasibility study will provide recommendations for next steps in implementation, and recommendations for how to make the process equitable and inclusive of population most at risk to hazards.	High	3	3	2	3	2	3	2.7
2.2.2	Increase bridge inspection training and conduct bridge inspections.	Medium	2	2	1	2	3	2	2

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.2.3	Analyze the impact of natural and human-caused hazards and threats on critical infrastructure that supports supply chain systems through the update of the Freight (Truck) Network.	High	3	2	3	3	3	2	2.6
2.2.4	Develop a Trail Resiliency Plan and identify flood mitigation strategies for Philadelphia's extensive trail network. Trails often follow streams and rivers in Philadelphia. Recreation and travel can be a suitable use of the floodplain. However, trail infrastructure represents a significant investment from City, State and Federal partners. OTIS would like to examine how trail infrastructure can be built resiliently to protect the investment while also protecting the ability of the floodplain to absorb water. The study will consider vulnerable assets, best practices in materials and construction suitable to a floodplain, and overall trail network resiliency. Trails provide a travel mechanism that does not contribute to climate change and provides healthy recreational options for residents.	*Mitigation in Focus*	3	2	3	3	2	3	2.6

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.2.5	Create a hazard event database to capture description, severity, location, impact, and potential loss/damage estimate from an event. This data will be used to update the hazard analysis and mitigation actions for Philadelphia, as well as allow the city to be better prepared for future events.	Medium	2	2	3	3	1	3	2.25
2.2.6	Enhance THIRA process to identify gaps in mitigation capabilities, and to better align the THIRA with the HMP Planning Process.	Medium	2	2	3	3	3	2	2.4
2.2.7	Maintain Tier II Reporting and GIS program.	Medium	2	2	2	3	3	1	2.1
2.2.8	Update the Tier II emergency response plan process/template to provide more situational awareness on chemical inventories across the city for OEM/PFD and its partners.	Medium	2	2	2	3	2	2	2.1
2.2.9	Consider needs for improved floodplain mapping and analysis and apply for funding to support City initiated CLOMRs, LOMRs, improved flood studies for critical infrastructure and other inundation mapping.	Medium	2	2	2	3	3	2	2.25

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.2.10	Use damage assessment data to conduct in-depth GIS analysis of impacts from past flooding and storms events to better predict future impacts from similar storm events and inform severe weather preparedness planning, alert & warning messaging, and mitigation initiatives in those areas.	Medium	2	2	2	3	2	3	2.25
2.2.11	Utilize the results of the 2022 Hazus analysis to identify new mitigation projects.	Medium	2	2	2	3	2	3	2.25
2.3	**Objective 2.3 Develop and implement mitigation programs and strategies that protect critical facilities and services.**								
2.3.1	Conduct or update natural hazard vulnerability assessments for critical facilities throughout the Philadelphia.	Medium	2	2	3	3	3	2	2.4
2.3.2	Continue to enhance Citywide COOP-COG program to minimize disruptions and support continuation of essential City services during and following a disaster.	*Mitigation in Focus*	3	3	3	3	3	2	2.85
2.3.3	Maintain and utilize early warning system.	Medium	2	2	2	3	3	3	2.4
2.3.4	Procure and utilize long range drone(s) to assess areas of concern before and after hazardous events (and if possible during events).	High	2	3	3	3	3	2	2.65

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.3.5	Purchase two VMS signs for deployment prior to and during emergencies and events to promote public safety and awareness.	Medium	2	2	3	3	2	2	2.25
2.3.6	Procure additional unites of level B PPE for surge operators.	Medium	3	2	1	3	3	3	2.45
2.4	**Objective 2.4 Integrate hazard and risk information into land use planning decisions.**								
2.4.1	Planning and Land Use Regulation and Incentive Alignment: Align the City's comprehensive plan, district plans, zoning regulations, development incentives, and other land use related programs with the City's efforts to reduce flood risk, based on up-to-date flood risk projections. This may include designation of local flood zones and related permitting requirements.	High	3	3	3	3	3	2	2.85
2.4.2	Resilient Design Guidelines: Collaborate with related City agencies on the creation of consistent, coordinated design guidelines documents to demonstrate possible strategies for resilience to current and future hazards for building design and the public realm. Build from existing base of guidelines created by various departments.	Medium	2	2	3	3	3	2	2.4

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.4.3	Include risk and resiliency considerations as comprehensive planning moves forward, including use of risk analysis by planning districts created for 2022 HMP update.	High	3	3	3	3	2	3	2.85
2.2.4	Examine and evaluate the strategy of using rolling easements to assist in adapting to the potential consequences of sea level rise.	High	3	3	2	3	2	2	2.55
2.5	**Objective 2.5 Promote post-disaster mitigation as part of restoration, recovery, and resilience building.**								
2.5.1	Design and improve Eastwick drainage and flooding prevention infrastructure.	High	3	3	2	3	3	3	2.85
2.6	**Objective 2.6 Repair, restore, and maintain existing infrastructure.**								
2.6.1	Develop and implement the Climate Adaptation and Resiliency Plan (CARP). DOA is in the midst of evaluating its climate risks. Building on this baseline assessment, DOA will align findings with the Master Plan Update currently underway; identify and prioritize climate adaptation strategies; and implement the identified strategies and priority investments.	High	3	2	3	3	3	3	2.75

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.6.2	Assess, Design, Procure, and Construct Upgrades and Overhauls for Vent Wells, Emergency Exits, and Station Head Houses to protect and armor them against future flooding.	High	3	3	2	3	3	3	2.85
2.6.3	Conduct --and implement recommendations from--a *Philadelphia International Airport Hydrologic and Hydraulic Resiliency Study* to assess current and projected flood risk and identify resiliency strategies to address risks. Key steps include a review of existing conditions, coastal analysis, HECRAS analysis, development of preliminary adaptation study, determination of potential adaptation and mitigation measures, modeling of those potential measures, and a final technical report. DOA will then seek to implement recommended measures.	Medium	2	2	2	3	3	2	2.25

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.6.4	Invest in transmission main condition assessments to improve understanding of probability of failure in the transmission system and install and/or upgrade priority transmission, water, and discharge mains to improve system redundancy, improve water flows, improve water quality, enhance capacity, and address other system needs.	High	3	3	2	3	3	2	2.7
2.6.5	Construct ground water interceptors to capture water seeping from rock outcrops to prevent constant ice accumulation on Lincoln and Kelly Drives.	Medium	3	2	2	3	2	2	2.3
2.6.6	Design, procure, and install electric switch heaters for priority sites.	High	3	3	2	3	3	3	2.85
2.6.7	Plan and implement waterproofing for all Railroad and Transit Tunnels within City Limits - Broad Street, MFSE, Trolley Tunnel, Railroad.	High	3	2	3	3	3	3	2.75

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.6.8	Update the 2016 Wastewater Master Plan Update with a focus on PWD's Water Pollution Control Plants and Pumping Stations. As part of the update, PWD will: identify and develop a prioritized schedule of asset replacements based on condition and age; identify and prioritize current regulations and potential future regulations; develop scenarios to meet goals related to regulatory compliance; evaluate and develop solutions for reducing greenhouse gas emissions where possible; and evaluate and develop potential solutions for protecting wastewater infrastructure against climate change impacts. Based on these evaluations, PWD will develop a list of needs (projects) and then will develop and implement a 25-year Capital Improvement Plan.	Medium	2	2	3	3	3	2	2.4

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.6.9	Water & Wastewater Facility based Risk & Resiliency Assessments on Tidal Delaware and Lower Schuylkill Rivers: Evaluate water and wastewater facilities to identify mitigation activities and conduct flood risk assessment, flood resiliency assessment, stakeholder engagement and partnership building opportunities. Develop BRIC applications to fund selected mitigation activities.	High	3	3	2	3	3	3	2.85
2.6.10	Enlarge culverts of the Poquessing Creek tributaries to protect roadway and residences without providing any adverse impact to upstream or downstream properties.	High	3	3	2	3	2	3	2.7
2.6.11	Ensure adequate material and equipment is available to repair and replace street lights and traffic poles & signs.	Medium	2	2	1	3	3	2	2.1
2.6.12	Equip drawbridges with back-up generators.	High	3	2	3	3	3	2	2.6
2.6.13	Implement emergency and non-emergency generator engine rehabilitation and electrical upgrades.	Medium	3	2	3	3	3	1	2.45
2.6.14	Install battery back-up traffic signal controllers (75,000 each) 10% of signals in City.	Medium	2	2	3	3	3	2	2.4
2.6.15	Install electrical substation upgrades with flood control at A-East	Medium	3	2	2	3	3	1	2.3

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.6.16	Maintain portable generators for key traffic intersections.	Medium	2	2	3	3	3	2	2.4
2.6.17	Maintain safe roadways and bridges through roadway milling and paving capital projects.	Medium	2	2	2	2	3	2	2.15
2.6.18	Procure wastewater system HME sensors	Medium	2	2	2	3	3	3	2.4
2.6.19	Purchase and maintain hyper-local street-level weather stations to assist in salting, flooding, and plowing operations.	Medium	2	2	1	3	2	2	1.95
2.6.20	Purchase and maintain drop-gates for known dangerous roads during emergency events, particularly along Cobbs Creek, for Bells Mill Road, and on Delaware Ave.	High	3	3	2	3	3	3	2.85
2.6.21	Redesign roadways and bridges to lesson occurrence/impact of flooding.	High	3	3	2	3	3	2	2.7
2.6.22	Replace the fence around the Upper Roxborough water facility to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure.	High	3	2	2	3	3	3	2.6
2.6.23	Strengthen the traffic signals beyond the national standards in reference to wind tolerance.	Medium	3	2	2	3	2	2	2.3
2.6.24	Upgrade equipment and resources necessary to respond to flooding, winter storms, and developing or unforeseen hazards.	High	2	3	3	3	3	2	2.65

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.7	**Objective 2.7 Identify, plan for, and protect historic properties and cultural resources.**								
2.7.1	Develop and implement individual hazard management plans for city owned and operated historic structures and their surrounding landscapes. Plans should consider both natural hazards, climate change impacts, and human-caused hazards.; if necessary, consider moving the structure to a safer location. Build on Manayunk pilot for historic preservation.	Medium	2	2	3	3	2	2	2.25
2.7.2	Implement various mitigation and resiliency measures identified in the Fairmount Water Works Resiliency Plan to prevent future repetitive losses from flood events.	High	3	3	2	3	2	2	2.55
2.7.3	Conduct city-wide survey to identify and document all historic properties in the City (private and City-owned) in order to assess risk, vulnerability, and mitigation strategies for properties. Study should take into account all hazards, including building collapse, urban conflagration, and other human-caused and natural hazards.	High	3	2	3	3	3	2	2.6
2.8	**Objective 2.8 Address historic drivers of vulnerability and invest in community assets.**								

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.8.1	Integrate equity and social vulnerability indicators more prominently into OEM's planning and operational products to better predict, prioritize, and support community needs during disasters and emergencies to reduce risk. Form and compensate a community panel making up a diverse group of public representatives to review, provide feedback on, and participate in OEM's planning processes including the Hazard Mitigation Plan.	High	3	3	3	3	2	3	2.85
2.8.2	Public Health Climate Vulnerability Data and Assessments: Use data to identify populations at high risk of adverse outcomes during a public health emergency and allocate resources to address planning, communications, and service gaps as appropriate. This includes indices to identify communities that are at high risk of adverse health outcomes during a flooding and other climate hazards.	High	3	2	3	3	3	3	2.75

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.8.3	Eastwick Place-Based Climate Risk, Adaption, and Resiliency Planning: Conduct community-based planning in one of the most vulnerable communities to climate change impacts, Eastwick. To support community resilience to flooding and other hazards, the planning efforts will focus on the identification of long-term mitigation efforts and development of mechanisms to implement them. This planning will build off the experience of a pilot community planning effort in Hunting Park, Beat the Heat, which addresses extreme heat. In Eastwick, the City will pilot a place-based flooding framework and seek funding to implement the planning process outcomes. The City also plans to expand the place-based extreme heat resiliency framework to other communities beyond Hunting Park.	*Mitigation in Focus*	3	2	2	3	3	3	2.6
2.8.4	Healthy Corridors Project: Expand cool roadways pilot program and stormwater management projects in heat and flood vulnerable neighborhoods.	High	3	3	2	3	2	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.8.5	Lower South Infrastructure Resilience Roadmap and Implementation: A multi-departmental initiative focused on creating the strategic direction and tools needed to prepare the Lower Schuylkill area for present and future climate risks. The down-scaled understanding of specific climate risks and the potential solutions to address them will inform the master plans, building designs, and infrastructure plans currently underway or planned in this area, resulting in development that is more resilient to flooding and other risks.	*Mitigation in Focus*	3	3	2	3	3	3	2.85
2.8.6	Opioid Community Support: Launch multiple, intersectional programs that provide support to communities living with the direct and indirect consequences of the Opioid Overdoes Crisis, including targeting and expanded community engagement, services to families impacted by opioid misuse, and increased serve provisions and provision of city services at critical “hot spot” locations.	*Mitigation in Focus*	3	3	1	3	3	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.8.7	Bartrams Safety: Build sidewalks, curb cuts, and pedestrian crossings, and install new lighting, gateway treatments, and (potentially) cameras to improve safety and reduce short dumping and crime along the Woodland Avenue / Grays Avenue / Lindbergh Blvd corridor in Kingsessing, Philadelphia.	High	3	3	1	3	2	3	2.55
2.8.8	Cohocksink Multi-hazard Mitigation Project: The final phase of a six-phase flood mitigation project proposes new sewer infrastructure and green stormwater infrastructure systems in the Northern Liberties and South Kensington commercial and residential neighborhoods.	*Mitigation in Focus*	3	3	2	3	3	3	2.85
2.8.9	Compound fluvial-coastal flood modeling study in the Eastwick neighborhood of Philadelphia. The study is aimed at better understanding current and future flood risks and evaluating the effectiveness of potential flood mitigation solutions developed in coordination with Eastwick community members.	High	3	3	2	3	2	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
2.8.10	USACE is currently conducting a study of the Eastwick neighborhood to determine feasible flood mitigation alternatives. City agencies will work in collaboration with the community to determine next steps for implementation of flood mitigation initiatives upon completion of this study.	High	3	3	2	3	2	3	2.7
2.8.11	Continue the Philadelphia Fire Department's initiative to conduct education and outreach out fire prevention and provide and install free smoke alarms to Philadelphia home owners upon request. A number of adaptive alarms are made available to residents with hearing or vision loss.	High	3	3	2	3	2	3	2.7
2.8.12	Evaluate the feasibility of and potential form for a Community Resilience HUB for Philadelphia.	Medium	2	2	3	3	2	3	2.4
3	**Goal 3: Foster an economy that promotes mitigation and reduces impacts from hazards.**								
3.1	**Objective 3.1 Prioritize mitigation strategies that support the continuation of critical business operations during and following a disaster.**								

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
3.1.1	Assess business risk to potential threats and hazards in Philadelphia and identify actionable solutions to support business response, recovery, and mitigation. This includes an analysis of past impacts to the business community and development of guidance on how businesses can leverage available mitigation funding and resources to be more prepared and resilient for the next disaster, including businesses that own or operate out of historic structures or historic districts.	*Mitigation in Focus*	3	3	2	3	2	2	2.55
3.1.2	Develop Regional Disaster Supply Chain Resilience Plan.	High	3	2	3	3	3	3	2.75
3.1.3	Establish open end contracts with construction companies for emergency bridge and road repairs.	Medium	2	2	3	3	3	2	2.4
3.1.4	Citywide Streets Vulnerability Assessment: Document institutional knowledge of flood prone roadways and road closures from severe weather events. Develop system for tracking future storm impacts to inform mitigation actions, planning, and response related activities.	High	3	2	2	3	3	3	2.6

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
3.1.5	Establish a smart detour plan for flooding of Wissahickon Creek, Schuylkill River, Cobbs Creek, and Delaware River (particularly along Delaware Avenue/Columbus Boulevard).	Medium	2	2	2	3	3	2	2.25
3.1.6	Develop Cyber Security Incident Response and Recovery Plan, including education and outreach to stakeholders and the public.	High	3	3	2	2	3	2	2.6
3.2	**Objective 3.2 Sustain, promote, and enhance partnerships with external public and private entities to identify and share resources.**								
3.2.1	Establish a Resilient Infrastructure Fund to fill in funding gaps for municipal capital projects to proactively implement best practice mitigation/adaptation measures for resilient infrastructure.	High	3	3	3	3	3	2	2.85
3.3	**Objective 3.3 Form partnerships to leverage and share resources to address hazard risks today and projected from climate change.**								
3.3.1	Create Community Resilience and Environmental Action Fund to direct funding to impacted communities to implement projects that draw upon their place-based knowledge of environmental hazards and community resilience.	High	3	3	2	3	2	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
3.3.2	Study of Climate Change / Hazard Vulnerability of Police and Fire facilities, and potentially expand the study to include other key civic priority facilitates. DPP will release an RFP and contract for a climate vulnerability assessment and report with maps and recommendations. This assessment will be updated on a regular basis.	Medium	2	2	3	3	1	3	2.25
3.3.3	Maintaining relationships with universities and colleges within Philadelphia to support mitigation, emergency planning, training, and exercises between the City and higher educational facilities.	Medium	2	2	3	3	2	2	2.25
3.3.4	Complete facility-based, asset-level coastal risk assessments for PWD's drinking water and wastewater infrastructure. Risk Assessment will directly inform future flood mitigation and adaptation strategies needed to protect these critical facilities from sea level rise and storm surge impacts.	High	3	3	2	3	3	2	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
3.3.5	Build collaborative opportunities with university programs interested in hazard mitigation planning. Collaboration could take the form of sharing research, students completing analysis and mapping for HMP plan updates, City presentations to classes, identifying university led mitigation actions, and internships.	Medium	2	2	3	3	2	2	2.25
4	**Goal 4: Restore and enhance the natural ecology.**								
4.1	**Objective 4.1 Promote nature-based solutions to manage stormwater and reduce the impacts of flooding and SLR.**								
4.1.1	Mapping Stormwater Flooding Risk: Better define urban flood risk in areas not covered by FEMA floodplain mapping through more comprehensive mapping of sewer system flood risk in other areas of the city. PWD has already studied flash flooding risk in Wingohocking Sewershed but hopes to expand these efforts. Share results as appropriate online for community based planning.	Medium	2	2	2	3	3	2	2.25
4.1.2	Perform comprehensive study of the stormwater infrastructure of the Centennial District to identify necessary improvements in park infrastructure.	High	3	2	2	3	3	3	2.6

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.1.3	Complete stream restoration projects in West Fairmount Park whose impact is localized to discreet areas to eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	Medium	3	2	2	3	2	3	2.45
4.1.4	Advance the comprehensive planning, technical analyses, and stakeholder engagement in Germantown for a storm flood risk reduction and combined sewer overflow (CSO) mitigation project within the Wingohocking and the Tookany/Tacony-Frankford (TTF) Watersheds.	*Mitigation in Focus*	3	3	2	3	3	3	2.85
4.1.5	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Cobbs Creek Reaches 1 to 3 and Cobbs Creek Reaches 6 to 8 in Phase 2.	Medium	3	2	2	3	2	3	2.45
4.1.6	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Tacony Creek.	Medium	3	2	2	3	2	3	2.45

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.1.7	Complete stream and creek restoration projects to reduce impact of historic flooding hazards along Valley Green Road and Spring Lane.	Medium	3	2	2	3	2	2	2.3
4.1.8	Identify additional stream and creek restoration projects to aid in eliminating historic flooding hazards through area studies. Consider appropriate nature-based solutions (natural infrastructure, elevated berm/park space, living shoreline, etc.) to assist in adapting to flooding impacts today and from SLR.	High	3	3	2	3	2	2	2.55
4.2	**Objective 4.2 Support projects that address water holistically including water quality, stormwater management, dam safety, and flood mitigation.**								
4.2.1	Conduct hydraulic modeling.	Medium	2	2	2	3	2	2	2.1
4.2.2	Ongoing identification of larger infrastructure projects whose impact effects large areas of the city through PWD studies.	High	3	3	2	3	3	3	2.85
4.2.3	Examine the impacts of all dams that are considered HHPD both in Philadelphia and that have inundation areas impacting Philadelphia, including the assets and populations at risk of dam inundation. Plan appropriate mitigation efforts and apply for FEMA HHPD funding.	High	3	3	2	3	3	3	2.85

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.4	Implement PWD's Drinking Water Master Plan (WMP) and related 25-year Capital Improvement Plan, which focuses on PWD's Drinking Water Treatment Plants, Pumping Stations, and Conveyance Systems. Implementation projects are planned projects to meet goals (in categories including system redundancy, resiliency, water quality, water quantity, and service pressure) and mitigate risks (i.e., aging infrastructure, current and future regulations, climate change, and environmental risks) identified in the WMP. WMP projects currently in Planning/Design phases include water treatment plant expansion, pumping station rehabilitation and construction, storage facility reconstruction, and transmission piping additions. All WMP projects are planned to mitigate risks on both the system and facility level.	High	2	2	3	3	3	3	2.6

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.5	Conduct study to identify stream restoration projects in West Fairmount Park along with the goal to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	Medium	3	2	2	3	2	3	2.45
4.2.6	Complete wetland creation projects in FDR Park to eliminate or reduce erosion issues, reduce swimming hazards, and reduce flooding damage to surrounding areas and connect park users to the water.	High	3	3	2	3	2	3	2.7
4.2.7	Perform Shedbrook Creek Stream Rehabilitation to aid in eliminating historic flooding hazards, improve safety of structure or surrounding areas, eliminate or reduce erosion issues, reduce swimming hazards, and reduce flooding damage to surrounding areas.	Medium	3	2	2	3	2	3	2.45

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.8	Perform structural repairs to dams and/ or removal of fishway structure at Fairmount Dam to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	High	3	3	2	3	2	2	2.55
4.2.9	Perform structural repairs to dams and/ or removal of Flat Rock Dam, a HHPD to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	High	3	3	2	3	2	3	2.7
4.2.10	Perform Tacony Creek Stream Rehabilitation Reaches 4 and 5 to improve safety of structure or surrounding areas, eliminate or reduce erosion issues, help to regulate supply for drinking water intakes, reduce swimming hazards, and reduce flooding damage to surrounding areas.	Medium	3	2	2	3	2	3	2.45

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.11	Complete smaller sewer and green infrastructure projects whose impact is localized to discreet areas. Over one hundred are currently in design stages.	High	2	3	2	3	3	3	2.65
4.2.12	Addition of effluent and outfall pumping station to Northeast Water Pollution Control Plant Outfall and Effluent Pumping Station to pump treated water to the river during extreme wet weather events and high tide.	High	3	3	2	3	3	3	2.85
4.2.13	Addition of wastewater and stormwater pumps and storage in various locations throughout the system and facilities to send more water to the water pollution control plants during wet weather events.	High	3	3	2	3	3	2	2.7
4.2.14	Build additional water mains to provide better system redundancy and resiliency.	High	3	3	2	3	3	2	2.7
4.2.15	Design and construction of integrated flood and stormwater management systems in the Navy Yard's Historic District to protect critical energy infrastructure and public waterfront access, preserve historic structures, and minimize flood risks for employees, visitors, and residents.	High	3	3	2	3	3	1	2.55

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.16	Design and construction of integrated flood and stormwater management systems in the Navy Yard's Mustin District to protect critical energy infrastructure and public waterfront access, preserve historic structures, and minimize flood risks for employees, visitors, and residents.	High	3	3	2	3	3	1	2.55
4.2.17	Improve and upgrade water security system to prevent theft of chemicals, contamination of treated drinking water, and damage to critical infrastructure. Projects considered for 29th Street Complex Storage Units, Baxter and Belmont Water Treatment Plants, and Northeast and Southwest Water Pollution Control Plants.	High	3	2	2	3	3	3	2.6
4.2.18	Install backup generators and switchgear at Queen Lane Raw Pump Station to ensure operations during power outages.	High	3	2	2	3	3	3	2.6
4.2.19	Install backup generators at West Oak Lane to ensure operations during power outages.	High	3	2	2	3	3	3	2.6

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.20	Make stormwater sewer improvements to reduce the combined sewer overflows affecting approximately 109 properties in the area between 1651 and 1851 Christopher Columbus Blvd during extreme rain events.	High	3	3	2	3	3	2	2.7
4.2.21	Moore St. drainage from Christopher Columbus to River infrastructure project to improve capabilities in the area.	High	3	3	2	3	3	2	2.7
4.2.22	Phase V of Northern Liberties infrastructure projects, which affects Northern Liberties and surrounding neighborhoods water drainage system capabilities.	High	3	3	2	3	3	2	2.7
4.2.23	Rehabilitate Queen Lane Raw Water Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	High	3	3	2	3	3	3	2.85
4.2.24	Relocate Belmont Raw Water Pump Station Intake to ensure reliable source during droughts and winter storms.	High	3	3	2	3	3	3	2.85
4.2.25	Restore approximately 12,000 linear feet of stream channel and 25-40 acres of wetlands on the Cobbs Creek Golf Course to maximize flood storage potential and create a stable, natural floodplain.	High	3	3	2	3	2	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.2.26	Upgrade Lardner's Point Pumping Station to make the station more resilient in order to deliver water during extreme weather events.	High	3	3	2	3	3	3	2.85
4.2.27	Upgrade Mingo Creek Pumping Station to handle increased flows from wet weather events.	High	3	3	2	3	3	3	2.85
4.2.28	Upgrade of various wastewater and stormwater pump stations to handle increased flows from wet weather events.	High	3	3	2	3	3	2	2.7
4.2.29	Upgrade P-796 at the Navy Yard Design to handle increased flows from wet weather events.	Medium	3	2	2	3	3	1	2.3
4.2.30	Coordinate with Pennsylvania DEP and Franklin Mills Limited Partnership on future plan updates regarding HHPD standards and planning.	High	3	3	1	2	3	3	2.6
4.3	**Objective 4.3 Restore and enhance green spaces and prioritize communities overburdened by environmental hazards.**								
4.3.1	Establish a policy based on need and funding availability for a regular pruning cycle for city trees.	Medium	2	2	3	3	1	2	2.1
4.3.2	Complete sewer and green infrastructure projects whose impact is localized to discreet areas in West Fairmount Park.	High	3	3	2	3	3	3	2.85
4.3.3	Inspect trees within 100 ft. of walkways and roadways for signs of the emerald ash borer and treat affected trees every three years.	Medium	2	2	3	3	2	2	2.25

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.3.4	Monitor new tree watering contracts to ensure the trees have sufficient time to take root and establish themselves under warmer temperatures.	Medium	2	2	2	3	1	3	2.1
4.3.5	Pilot study the growth of Southern plant species with sustainable planting practices in preparation for increasing temperatures over the next century.	Medium	2	2	3	3	1	2	2.1
4.3.6	Utilize City Works Trees to track real-time response and management of downed trees and vegetation prior to, during, and following events.	Medium	2	2	3	3	1	3	2.25
4.3.7	Decrease the backlog of 2,000+ tree maintenance and removal projects to reduce unpruned and dead trees falling on power lines during storm events.	Medium	2	2	3	3	2	2	2.25
4.4	**Objective 4.4 Support the transition away from fossil fuels and other greenhouse gases that impact health and safety and exacerbate climate change.**								
4.4.1	Develop a continuously updated Climate Data tool for screening infrastructure projects and planning processes against the best available climate projections for the city and region.	High	3	2	2	3	3	3	2.6
4.4.2	Update a Indego Bike Share Comprehensive Hazard Mitigation Plan based on best practices for operational practices that mitigate identified hazards.	Medium	2	2	3	3	2	3	2.4

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
4.5	**Objective 4.5 Improve air, water, and soil quality across the City starting with environmental justice communities.**								
4.5.1	Examine mitigation opportunities that address flooding and rising water tables from increased precipitation and sea level rise inundating brownfields and releasing hazardous materials into local waterways.	Medium	2	2	2	3	2	3	2.25
4.5.2	Construction of additional chemical dosing boosters and flushers throughout the city to maintain water quality.	Medium	2	2	2	3	3	3	2.4
4.5.3	Secure intake booming materials.	Medium	2	2	1	3	3	3	2.25
4.5.4	Remove oil storage facility (tank farm).	Low	2	1	1	3	2	2	1.7
5	**Goal 5: Create awareness and demand for mitigation and adaptation as a standard of practice.**								
5.1	**Objective 5.1 Tailor mitigation training to public officials, businesses, organizations, and the public emphasizing equity and inclusion.**								
5.1.1	Conduct active shooter training for city staff.	Low	2	2	1	2	1	1	1.55
5.1.2	Employ a READYEmployee process to alert over 7,000 City employees that work in the Center City Quadplex buildings (City Hall, MSB, OPB, SCCJ) of emergencies and quickly gather an accountability report.	High	3	3	3	3	3	2	2.85
5.1.3	Expand Multi-Assault, Counter Terrorism Action Capabilities (MACTAC) training program for patrol officers.	Low	2	2	2	2	1	1	1.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
5.1.4	Expand and continue training for all PPD personnel including, but not limited to: SPOT Training, Prevention and Deterrence of Terrorism Training, Advanced Trauma Training, Mass Casualty Awareness Training, Customized Alarm Response Training, Site Protection by Observational Techniques Training, Protest Awareness Training, Customized Alarm Response Training, Tourniquet Training, Field Force Operations Training, Field Force Extraction Training, Field Force Command Planning Training.	Low	2	2	2	2	1	1	1.7
5.1.5	Upkeep PFD Hazmat training and equipment.	Medium	2	2	2	3	1	1	1.8
5.2	**Objective 5.2 Improve existing and put in place necessary warning systems.**								
5.2.1	Deploy a stream flood gauge on the Darby Creek near the Eastwick neighborhood.	Medium	2	2	2	3	3	3	2.4

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
5.2.2	Inclusive and Equitable Public Health Notification, Engagement, Partnership and Awareness: Review, update, expand, and/or implement public health related notifications, educational programs, and planning process informed through inclusive stakeholder engagement processes to increase the reach of PDPH communications and promote more equitable outcomes. These include an expanded set of public notification strategies and protocols for health-related emergencies; a "Be a Buddy" program to empowering residents to support neighbors who may be at risk for adverse health outcomes; the Community Response Partner Network (CRPN); the Health Alert Network; resident education programs around extreme weather; community-based health bulletins; and a risk communication playbook for high priority public health hazards.	High	3	3	3	3	1	3	2.7

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
5.2.3	Revamp and update Philadelphia OEM's Alert and Warning Plan for the City, along with associated frameworks and deliverables. Create a social, digital, and traditional media campaign focused on increasing the number of READYPhiladelphia subscribers including people with access and functional needs.	*Mitigation in Focus*	3	3	3	3	2	3	2.85
5.3	**Objective 5.3 Increase public's awareness of hazards, mitigation, and other protective measures, including those related to the projected impacts of climate change.**								
5.3.1	Create a Flood and Hurricane Preparedness Campaigns promoting mitigation efforts residents and businesses can take prior to flooding events, including print material and digital and social media content that focus on steps people can take to prepare for severe storms. This also includes development of new innovative messaging to promote in-person preparedness workshops to assist in preparing citizens for hurricane season and messaging to support the Community Outreach Team attracting participants to hurricane season at tabling events.	High	3	3	2	3	1	3	2.55

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
5.3.2	Provide public outreach throughout Philadelphia with READYHome, READYCommunity, and READYBusiness to increase community preparedness and mitigation.	High	3	3	3	3	2	3	2.85
5.3.3	Promote post disaster mitigation strategies throughout SEPA region, targeting communities that are most vulnerable. VOAD partner agencies may implement mitigation strategies.	High	3	2	3	3	2	3	2.6
5.3.4	Update OEM's Ready programs, including READYBusiness to focus on COOP Planning and risk mitigation strategies for small to medium-size businesses, and READYKids in partnership with MDO Headstart & PFD Prevention Division.	High	3	2	3	3	3	3	2.75
5.3.5	Employ spatial data to inform OEM's community preparedness outreach to help OEM better understand where preparedness outreach is occurring and ultimately focus on areas most at risk.	Medium	2	2	3	3	2	2	2.25
5.4	**Objective 5.4 Continue and expand coordination efforts to plan for cross-agency mitigation efforts.**								
5.4.1	Bring in subject-matter experts to conduct trainings on benefit-cost analysis (BCA) for Philadelphia partners to support development of grant	Medium	2	2	3	3	1	2	2.1

	Mitigation Action and Description	Priority	Effective	Efficient	Multi-Hazard	High Risk Hazard	Critical Facility	Equity	Score
	(continued 5.4.1) applications for mitigation projects.								
5.4.2	Develop and socialize guide and calendar of all available mitigation funding resources. Continue to develop and implement coordinated City approach to pursue mitigation funding.	High	3	3	3	3	2	2	2.7
5.4.3	Meet quarterly with VOAD partners to maintain preparedness, ensure situational awareness, identify resource capabilities, and build stakeholder relationships pre-disaster.	Medium	2	2	3	3	1	3	2.25
5.4.4	Revitalize the Philadelphia Emergency Management Council from a 6+ year hiatus. This local council will consist of key city leadership and will focus on strategic emergency management issues including long-term risk reduction and risk/hazard education at a senior level	Medium	2	2	3	3	3	2	2.4
5.4.5	Research and plan to increase the reach and timeliness of Regional Integration Center (RIC) research products (situational awareness reports, pre-event briefings, weather reports, etc.) before and during an event.	High	3	3	3	3	2	3	2.85

In addition to the prioritizing mitigation actions, the Steering Committee discussed and chose ten **Mitigation in Focus** actions. Additional information was gathered on these actions to assist with implementation. The implementation steps and funding information outlined below will assist in implementing these and other high priority actions. **Table 6-8.** summarizes the **Mitigation in Focus** actions.

Table 6-8. Mitigation in Focus Actions

Lead Agency	Project Name
OOS/Multi-Dept.	Lower South Infrastructure Resilience Roadmap and Implementation
OOS/Multi-Dept.	Eastwick Place-Based Climate Risk, Adaption, and Resiliency Planning
OEM	Continuity of Operations Program (COOP)
PWD	Tookany/Tacony-Frankford Watershed Flood Risk Reduction and Combined Sewer Overflow Mitigation
PWD	Cohocksink Multi-Hazard Mitigation Project
OEM	Alert and Warning
OTIS	Trails Resiliency Plans and Implementation
OEM/Commerce	Business Risk and Vulnerability Assessment
Multi-Dept.	Community Environmental Conditions and Safety
PDPH/ORU	Opioid Community Support

The worksheets for **Mitigation in Focus** actions provide additional detail on these high priority projects to support implementation=. The Equity and Resiliency Outcomes sections highlight equity impacts and include benefits from the Justice40 Initiative. The Justice40 Initiative is a priority from the US President for 40 percent of Federal investments flow to disadvantaged communities. A Presential Memo on the Justice40 Initiative describes benefits that are being prioritized for disadvantaged communities. These benefits are listed on the Mitigation in Focus sheets when applicable to support future grant applications and project implementation.

The following pages describe each of the Mitigation in Focus actions in more detail, including implementation steps.

Lower South Infrastructure Resilience Roadmap and Implementation

Project Description:
A multi-departmental initiative focused on creating the strategic direction and tools needed to prepare the Lower Schuylkill area for present and future climate risks. The down-scaled understanding of specific climate risks and the potential solutions to address them will inform the master plans, building designs, and infrastructure plans currently underway or planned in this area, resulting in development that is more resilient to flooding and other risks.

Action Steps:

1. Conduct baseline assessment of study area and its infrastructure systems through risk modeling, vulnerability assessments, and other analyses.
2. Identify a toolkit of solutions to address risks.
3. Narrow down strategies to create a roadmap through engagement and technical analyses.
4. Create the conditions to implement solutions, including governance structure and funding.

FEMA CATEGORY:
Local Planning and Regulations
Structure and Infrastructure

PROJECT LOCATION:
Lower South

PROJECT CHAMPIONS:
Office of Sustainability, OTIS, PWD, PCPC

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Equity and Resilience Outcomes:

- Action that addresses historical, existing, and projected risks that impact vulnerability to climate hazards in the Lower South, which includes Eastwick—one of the most vulnerable communities to climate change impacts.
- Establishment of the civic infrastructure for implementing equitable solutions to context-specific climate risk shared by institutions through a collaborative model focused on leveraging a diverse mix of existing funding sources and catalyzing additional investment.
- A co-created set of policy options and a strategic roadmap that addresses climate change risks to the real estate and infrastructure investment in the Lower South area upon which Philadelphia's economic competitiveness and long-term growth rely.
- Urban flood risk mapping addressing the distribution of socially vulnerable communities and risks.

Potential Resources: Capital Budget, HMA, Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) grant program from the USDOT, USACE, NOAA Community-Based Restoration Project

Eastwick Place-Based Climate Risk, Adaption, and Resiliency Planning

Project Description:
Conduct community-based planning in one of the most vulnerable communities to climate change impacts, Eastwick. To support community resilience to flooding and other hazards, the planning efforts will focus on the identification of long-term mitigation efforts and development of mechanisms to implement them. This planning will build off the experience of a pilot community planning effort in Hunting Park, Beat the Heat, which addresses extreme heat. In Eastwick, the City will pilot a place-based flooding framework and seek funding to implement the planning process outcomes. The City also plans to expand the place-based extreme heat resiliency framework to other communities beyond Hunting Park.

Action Steps:
1. Pilot place-based flooding framework in Eastwick
2. Expand place-based extreme heat resiliency framework, Beat the Heat

FEMA CATEGORY:
Local Planning and Regulations
Structure and Infrastructure

PROJECT LOCATION:
Eastwick neighborhood and other vulnerable communities with disproportionate climate impacts

PROJECT CHAMPION: OOS

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Equity and Resilience Outcomes:

- Creation of a community resilience plan for Eastwick that specifically includes addressing the needs of the Eastwick community.
- A proven, equitable approach to strengthen the climate resilience of disadvantaged communities that can be replicated for other communities vulnerable to the impacts of climate change**.**
- Increased technical assistance and community engagement of disadvantaged communities.
- Enhanced capacity of community-based leadership to define for themselves the solutions most relevant to the unique climate challenges they face.

Potential Resources:
Mixed: Philanthropic grant (William Penn Foundation ($250k/yr), City operation funds (OTF Grant Funds ($100k/yr)), General Fund ($50k yr towards staff time), HMA, and IIJA Healthy Streets.

Continuity of Operations Program (COOP)

Project Description:
Continue to enhance Citywide COOP-COG program to minimize disruptions and support continuation of essential City services during and following a disaster.

FEMA CATEGORY:
Local Planning and Regulations; Structure and Infrastructure

PROJECT LOCATION:
Citywide

PROJECT CHAMPIONS:
OEM
Departmental COOP Owners
DPP
Fleet
OIT

COST ESTIMATE: TBD

HAZARDS ADDRESSED:
Multi-hazard

Action Steps (include but not limited to)**:**

- Create a centralized notification process for all agencies to report COOP activations.
- Create a tracking system to accurately track COOP activations.
- Develop and maintain COOP documents and policies for key City agencies.
- Conduct facility assessments of potential, accessible, and safe shelter sites.
- Expand logistical capacities and COOP back-up facilities.
- Deploy the ESINet connecting the information networks of neighboring counties with Philadelphia Public Safety Answering Points (PSAPs).
- Implement redundancy measures for mission-critical equipment.
- Purchase a backup generator that can be used or deployed as a redundant power source for critical sites or facilities.
- Create a Cybersecurity Incident Response & Recovery Plan and create the conditions for implementation.

Equity and Resilience Outcomes:
Enhanced ability to respond to community needs during disasters and emergencies, especially under-resourced communities that disproportionally bear the burdens of inadequate housing quality, pollution, health disparities, and poverty.

Potential Resources:
Staff time, City Capital, Urban Area Security Initiative (UASI) funding, State, Local, Tribal, and Territorial (SLTT) grant program –FEMA cybersecurity assistance

PWD - Tookany/Tacony-Frankford Creek Watershed Flood Risk Reduction and Combined Sewer Overflow Mitigation

Project Description:

Advance the comprehensive planning, technical analyses, and stakeholder engagement in Germantown for a storm flood risk reduction and combined sewer overflow (CSO) mitigation project within the Wingohocking and the Tookany/Tacony-Frankford (TTF) Watersheds.

Action Steps:

1. Scope project
2. Conduct advanced planning /pre-design

Equity and Resilience Outcomes:

- Improved water quality within Tookany/Tacony-Frankford Creek and surrounding communities.
- Reduction of flooding risk
- Urban flood risk mapping addressing the distribution of socially vulnerable communities and risks

Potential Resources:

Staff time, Agency operating budget, private donations, HMA, IIJA provides funding particularly in Section 50204 and 50205 that could align with this and other PWD projects

FEMA CATEGORY:

Local Planning and Regulations; Structure and Infrastructure

PROJECT LOCATION:
Germantown

PROJECT CHAMPIONS: PWD

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Cohocksink Multi-hazard Mitigation Project:

Project description:

The final phase of a six-phase flood mitigation project proposes new sewer infrastructure and green stormwater infrastructure systems in the Northern Liberties and South Kensington commercial and residential neighborhoods. Cohocksink Creek is a historic stream that was covered over and integrated into Philadelphia's sewer system in the mid to late 1800s. The creek once flowed through the Kensington and Northern Liberties neighborhoods to the Delaware River. Today, the Cohocksink sewer system manages stormwater drainage from more than 1,000 acres of urban land. This project minimizes flooding on streets and properties by increasing the capacity of the sewer infrastructure that manages stormwater and wastewater in Northern Liberties and South Kensington. Once phase 6 is complete PWD will have doubled the capacity of the system.

FEMA CATEGORY:

Structure and Infrastructure

PROJECT LOCATION:
Northern Liberties and South Kensington

PROJECT CHAMPIONS:

PWD

COST ESTIMATE: $31,200,00.00

HAZARDS ADDRESSED:

Action Steps:

1. Continued coordination with neighbors and utilities.
2. Construction of final phase of project.
3. Planting of green stormwater elements.
4. Monitoring of new system in storm events.

Equity and Resilience Outcomes:

- Increased flood mitigation benefits through green stormwater infrastructure
- Reduction in the quantity of raw sewage discharged
- Increase in the number of community water systems that meet applicable health-based standards
- Increased bicycle and walking path – including installation of new ADA-compliant ramps and pavement

Potential Resources:

Staff time, Agency operating budget, private donations, HMA, IIJA provides funding particularly in Section 50204 and 50205 that could align with this and other PWD projects

Alert and Warning

Project description: Revamp and update Philadelphia OEM's Alert and Warning Plan for the City, along with associated frameworks and deliverables. Create a social, digital, and traditional media campaign focused on increasing the number of READYPhiladelphia subscribers including people with access and functional needs.

FEMA CATEGORY:
Local Plans and Regulations
Education and Awareness

PROJECT LOCATION: Citywide

PROJECT CHAMPIONS: OEM

COST ESTIMATE: TBD

HAZARDS ADDRESSED:
Multi-Hazard

Action Steps:

1. Update of the Alert & Warning Plan to reflect operations of Philadelphia's A&W equipment in 2021. Plan was last updated in 2011. Updated information on how to properly use the A&W systems will serve as a guide for leadership and decision-makers to properly implement timely messaging.
2. Work with OEM Public Information Programs to expand subscribers. Expanded distributions will mean more individuals are getting pre-event instructions, potentially reducing risk and impact from hazards.
3. Institute new pre-scripted templates built upon prior experiences with existing hazards. These templates will include scripted language with protective actions to identified areas of concern (e.g.: pre-flooding messaging built and ready to go for flood prone areas. . Having those tools ready to go and easily deliverable will increase use and reach of messages.

Equity and Resilience Outcomes:

- Increased access to and advancement of public safety warnings (weather and preparedness messages) translated into multiple languages.
- Expanded distributions will mean more individuals are getting pre-event instructions, potentially reducing risk and impact from hazards.

Potential Resources:

HMA, Homeland Security Grant Program, USAI

Trails Resiliency Plans and Implementation

Project description: Develop a Trail Resiliency Plan and identify flood mitigation strategies for Philadelphia's extensive trail network. Trails often follow streams and rivers in Philadelphia. Recreation and travel can be a suitable use of the floodplain. However, trail infrastructure represents a significant investment from City, State and Federal partners. OTIS would like to examine how trail infrastructure can be built resiliently to protect the investment while also protecting the ability of the floodplain to absorb water. The study will consider vulnerable assets, best practices in materials and construction suitable to a floodplain, and overall trail network resiliency. Trails provide a travel mechanism that does not contribute to climate change and provides healthy recreational options for residents.

FEMA CATEGORY:

Local plans and regulations

PROJECT LOCATION: Citywide

PROJECT CHAMPIONS: OTIS with support from PR

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Action Steps:

1. Identify project lead and convene planning team with representatives from various agencies to determine project scope.
2. Identify appropriate funding source/s to conduct a planning process.
3. Develop plan identifying potential resiliency strategies for trail network based on a risk & vulnerability analysis.
    a. Conduct risk and vulnerability analysis of trails to identify flood risk to trails systems and to inform development of resiliency strategies.
    b. Prioritize resiliency strategies and determine funding sources for implementation.
    c. Identify whether any special equipment is needed to address trail rehabilitation post disaster.
4. Implement resiliency strategies.
5. Embed resiliency strategies into plans for the trail network.

Equity and Resilience Outcomes:

- A trails system that is more resilient to flooding and storm events, which are growing more frequent and intense due to climate change
- Trail accessibility for more Philadelphians, allowing for more affordable and resilient mobility options—especially when other transportation systems are shut down.
- Increased access to fresh air, outdoor space, and natures.

Potential Resources: FEMA BRIC, Transportation Alternatives Program (TAP) via PennDOT, Potentially new IIJA Healthy Streets program

Business Risk and Vulnerability Assessment

Project description: Assess business risk to potential threats and hazards in Philadelphia and identify actionable solutions to support business response, recovery, and mitigation. This includes an analysis of past impacts to the business community and development of guidance on how businesses can leverage available mitigation funding and resources to be more prepared and resilient for the next disaster, including businesses that own or operate out of historic structures or historic districts.

Action Steps:

1. Identify disaster risk to businesses and commercial corridors through a risk and vulnerability assessment.
2. Develop mitigation and preparedness recommendation and guidance based off of the findings of the risk and vulnerability assessment.
3. Develop a business engagement strategy in partnership with Philadelphia Department of Commerce and other business support programs and initiatives to communicate findings with the business community.
4. Integrate findings into Economic Recovery Strategy with implementable public-private sector mitigation actions

FEMA CATEGORY:

Local Planning and Regulations; Education and Awareness

PROJECT LOCATION:

Citywide

PROJECT CHAMPIONS:

OEM

Commerce

COST ESTIMATE:
$100,000

HAZARDS ADDRESSED:

Multi-Hazard

Equity and Resilience Outcomes:

- Increased ability for Philadelphia's businesses, particularly small businesses, woman and minority owned businesses to survive, adapt, and grow no matter what type of chronic stresses and acute shocks they experience, including those related to extreme weather events, global pandemics, and other hazards.

Potential Resources:

Staff time, Agency operating budget, HMA

Community Environmental Conditions and Safety

Project description: Improve environmental conditions to foster a sense of safety in neighborhoods, connectedness among neighbors, and reduce the locations where illegal guns are stored and where illegal activity occurs. Projects include addressing blighted buildings, cleaning abandoned lots, improving lighting, and other initiatives to improve environmental conditions.

Action Steps:

1. Continue outreach to neighborhoods identified in Operation Pinpoint or where there have been recent incidents to collaborate on how to best link programs and resources to community members.
2. Continue outreach and implementation of Targeted Community Investment Grants program.
3. Continue efforts to clean properties and identify unsafe buildings for demolition or to be cleaned and sealed.
4. Consider new funding opportunities and apply for additional grants for further implementation.

Equity and Resilience Outcomes:

- Focused resources and other support for communities that disproportionally bear the burden of the impacts of poverty and disinvestment, rooted in the historical and social context of race, class position, and politics of place.
- Reduction in abandoned or vacant homes

Potential Resources: PA Redevelopment Assistance Capital Program, IIJA Healthy Streets

FEMA CATEGORIES:
Local Planning and Regulations; Structure and Infrastructure; Education and Awareness; Human-Caused Hazard Casualty Reduction

PROJECT LOCATION: Citywide

COST ESTIMATE:
Varies based on project size

PROJECT CHAMPIONS:
Office of Policy and Strategic Initiatives for Criminal Justice and Public Safety, Community groups, PPD, L&I, Streets, Community Life Improvement Program, Pennsylvania Horticultural Society

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Opioid Community Support

Project description: Launch multiple, intersectional programs that provide support to communities living with the direct and indirect consequences of the Opioid Overdoes Crisis, including targeting and expanded community engagement, services to families impacted by opioid misuse, and increased serve provisions and provision of city services at critical "hot spot" locations.

Action Steps:

- Develop and implement a Mobile Methadone Maintenance Treatment Program
- Develop holistic and trauma informed, healing-centered engagement
- Continue to support community organizations through the Kensington Community Resilience Fund
- Provide targeted, culturally competent substance use training and education
- Pursue permanent closure of drug corners and activation of community spaces in hotspot neighborhoods

FEMA CATEGORY:
Local Planning and Regulations; Structure and Infrastructure; Human-Caused Hazard Casualty Reduction

PROJECT LOCATION:
Kensington and other communities impacted by the Opioid Crisis.

PROJECT CHAMPIONS:
ORU/PDPH

COST ESTIMATE: TBD

HAZARDS ADDRESSED:

Equity and Resilience Outcomes:

- Prioritized resources to community-based organizations serving Black and Latinx neighborhoods.
- Accessible public education about risks of drug use and effective safety precautions.
- Targeted, culturally competent community engagement in Black and Latinx neighborhoods.
- Diversion of people arrested for low-level misdemeanors away from the Criminal Justice system.
- Permanent closure of drug corners and activation of community spaces in hotspot neighborhoods.
- Lower rates of trauma for families impacted by the opioid crisis.

Potential Resources: CDC Cooperative Agreement for Emergency Response and HHS Comprehensive Addiction and Recovery Act funding,

7 Plan Maintenance

7 Plan Maintenance

7.1 Update Process Summary

In accordance with state and federal guidelines, the HMP includes a plan maintenance process to ensure that the plan remains an active and relevant document. The maintenance process outlines a method and schedule for monitoring, evaluating, and updating the plan, and describes how, when and by whom the work will be done. This section also includes an explanation of how the City will incorporate mitigation actions into existing planning mechanisms, such as comprehensive plans and ordinances, and a description on the public's continued involvement.

7.2 Monitoring, Evaluating and Updating the Plan

7.2.1 Plan Reviews and updates

The Steering Committee intends to remain intact after the plan update and will be responsible for monitoring, evaluating, and updating Philadelphia's HMP. OEM will continue to act as the coordinating agency for the Steering Committee and will lead the review of the plan on an annual basis, as well as following major incidents or disasters. An approximate timeline for the annual review process is outlined in **Table 7-1** below. This timeline is subject to change based on stakeholder availability and any major, ongoing disaster responses.

All plan stakeholders, including those with mitigation actions identified in the 2022 plan, and those that wish to have a project added to the plan through a plan amendment, are encouraged to participate in the annual review process each February.

Table 7-1. Approximate Schedule for Annual Plan Reviews

Annual Review	Approximate Timeframe
2021	2022 Draft Plan Released for review and feedback
2022	February 2023
2023	February 2024
2024	February 2025
2025	February 2026
2026	2027 Draft Plan released for review and feedback

During each annual review, the following will be evaluated:

- Which mitigation actions have been started, completed, or are no longer feasible?
- Are there any new mitigation actions that should be added to the plan?
- Which mitigation actions should the City pursue FEMA Hazard Mitigation Assistance (HMA) funding for?
- Are there new hazards that should be added to the plan?
- Are projects changing priority based on the shifting physical, economic, or political landscape of the City?
- Are the goals, objectives, and mitigation actions relevant given changes in Philadelphia or changes to state or federal regulations or policy?

- Is there new data that affects the Risk Assessment, Capability Assessment, or Mitigation Strategy?
- What training, technical assistance, and resources are needed to implement remaining mitigation actions in the plan?

An annual report of findings from the review process will be sent to both PEMA and FEMA.

In addition to ongoing annual reviews, OEM will continue to do a full plan review and update of the Philadelphia HMP at least every five years as required by FEMA.

7.2.2 Plan Integration and Implementation

With OEM oversight, each organization identified as a mitigation action agency lead is responsible for implementing their specific mitigation actions identified in this plan. This includes incorporating these actions into other planning documents, such as comprehensive plans and zoning ordinances, as necessary.

Agencies are responsible for seeking out and obtaining funds from outside sources to implement the mitigation actions. The Hazard Mitigation Plan Steering Committee will decide which projects move forward in the State Application Process for FEMA's HMA funding, including the BRIC, FMA, and HMGP programs. OEM will continue to provide technical assistance to City agencies interested in applying for FEMA HMA funding. OEM will also monitor for additional mitigation funding sources beyond FEMA's HMA to support implementation of projects listed in this plan. City departments/offices and organizations listed as agency leads are ultimately responsible for applications, grant management, required cost-matches, and reporting procedures for grants.

The City had success during the 2022 update working with FEMA Region 3 and PEMA to host **G-318: Local Mitigation Planning Workshop Series** for hazard mitigation planning partners. Between plan updates and based on stakeholder interest Philadelphia OEM would like to host additional hazard mitigation planning trainings and expand the reach within the hazard mitigation stakeholder group.

7.2.3 Plan Amendment Process

To be eligible for FEMA's HMA grant programs, projects must be included in the City's All-Hazard Mitigation Plan. This verifies that the proposed mitigation project aligns with citywide mitigation goals and objectives. Projects not already included in the Hazard Mitigation Plan can be added through an amendment process approved by the City's Hazard Mitigation Plan Steering Committee, PEMA, and FEMA.

The Hazard Mitigation Plan Steering Committee will meet on an annual basis and review any newly proposed projects that are not already included in the 2022 Hazard Mitigation Plan. Projects that align with citywide mitigation goals and objectives will be approved by the Steering Committee for inclusion in a Hazard Mitigation Plan amendment request sent to PEMA and FEMA. **Agencies and organizations interested in adding a mitigation action to the 2022 plan through the plan amendment process are strongly encouraged to participate in the annual review process each February.**

7.2.4 Future Plan Updates

Potential areas for growth in future updates and annual reviews include:

- **Expanded outreach to reach underrepresented populations:** Philadelphia is a diverse City made up of 1.6 million people. Limited staff and funding, along with public outreach challenges due to the COVID-19 pandemic made equitable and inclusive community engagement for the 2022 plan update challenging. While we reached more members of the public through our 2022 outreach strategy than we did during our 2017 Hazard Mitigation Plan update, we may not have reached members of the public that were representative of the whole community. For the next plan update, Philadelphia would like to develop a more robust public outreach strategy and public participatory planning process with a focus on reaching populations underrepresented in the 2022 hazard mitigation planning process and populations placed at greater risk to hazards due to marginalization and systemic racism. The outreach strategy may include the formation of a public Steering Committee to guide and facilitate the plan update process.
- **Development of an equity screening tool for mitigation projects:** Equity was included in the project prioritization process for the 2022 Hazard Mitigation Plan, an improvement since the 2017 plan. However, a more defined tool for measuring equity is needed to better understand project impact and to prioritize projects.
- **Additional pre-disaster recovery planning:** One important benefit of a Hazard Mitigation Plan is that it provides a framework for both pre-disaster mitigation, and post-disaster mitigation and recovery. In the Mitigation Strategy, Philadelphia would like to identify additional mitigation actions that the City can take in the immediate hours, days, and weeks after a disaster to ensure the community can build back better and emerge from a disaster stronger and more resilient than before. This includes identifying projects eligible for Section 406 – Public Assistance mitigation funding.
- **Additional analysis of critical infrastructure/asset analysis vulnerability**: With every plan update, there is the opportunity to conduct a more thorough analysis of critical infrastructure and City assets vulnerable to the hazards in this plan. Additional analysis could include identification and prioritization of at-risk assets, such as utilities, especially those that provide services and functions to at-risk populations. Hazard risk data can also be more thoroughly analyzed alongside social vulnerability data to better understand populations most at risk, and their distribution across the City. This additional analysis will support future conversations with stakeholders regarding risk and will lead to more specific mitigation actions for at-risk assets and populations.
- **High Hazard Potential Dam Standards**: OEM will work with local partners, Philadelphia Water Department, and Pennsylvania Department of Environmental Protection (DEP), and the Franklin Mills Limited Partnership to meet HHPD standards future plan updates.

7.3 Continued Public Involvement

Philadelphia is committed to the continued involvement of the public in the hazard mitigation process. During all phases of plan maintenance, the public will have the opportunity to view and provide feedback on the HMP via OEM's website, OEM workshops, and by emailing OEM. The full plan and the plan's new, online executive summary (will be available Spring 2022) can be viewed online by members of the public at any time. This executive summary was designed to be accessible to all members of the public and will be updated to include additional information on the plan, hazard mitigation, and disaster preparedness over the next 5 years. A hard copy of the plan may be viewed in-person by request.

Philadelphia OEM received extensive feedback on the 2022 draft plan. All comments were addressed in the Feedback Matrix located in Appendix C. Feedback was incorporated into the final version when relevant and feasible. OEM will continue to collaborate with partner agencies across the City to implement additional recommended actions as available resources allow.

OEM will compile all comments and present them to the Hazard Mitigation Plan Steering Committee during the annual review process. The Steering Committee will consider these comments for incorporation in future plan amendments and updates.

OEM will continue to attend public meetings with partner agencies and community organizations to promote awareness and solicit useful feedback on the mitigation plan.

8 Plan Adoption

8 Plan Adoption

Adoption by the local governing bodies demonstrates the commitment of Philadelphia to fulfill the mitigation goals and objectives outlined in the HMP. Adoption legitimizes the HMP and authorizes responsible agencies to execute their responsibilities. The HMP was submitted to the Pennsylvania State Hazard Mitigation Officer for submission to FEMA on March 21, 2022. Philadelphia will proceed with formal adoption proceedings when FEMA provides Approval Pending Adoption (APA) of this HMP. Following adoption of the HMP, Philadelphia will submit a copy of the resolution showing formal adoption of the HMP to PEMA, who will then forward the acceptance to FEMA.

City of Philadelphia 2022 All Hazard Mitigation Plan Update

Municipal Adoption Resolution

Resolution No. _____

City of Philadelphia, Pennsylvania

WHEREAS, the City of Philadelphia, Pennsylvania is most vulnerable to natural and human-made hazards which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000) requires state and local governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, the City of Philadelphia, Pennsylvania acknowledges the requirements of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the City of Philadelphia 2022 All Hazard Mitigation Plan Update has been developed by the City of Philadelphia Office of Emergency Management and the Hazard Mitigation Steering Committee in cooperation with other county departments, and officials and citizens City of Philadelphia, Pennsylvania, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the City of Philadelphia 2022 All Hazard Mitigation Plan Update, and

WHEREAS, the City of Philadelphia 2022 All Hazard Mitigation Plan Update recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the City of Philadelphia:

- The City of Philadelphia 2022 All Hazard Mitigation Plan Update is hereby adopted as the official Hazard Mitigation Plan of the City of Philadelphia, and
- The respective officials and agencies identified in the implementation strategy of the City of Philadelphia 2022 All Hazard Mitigation Plan Update are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this _____ day of _____, 2022

ATTEST: **CITY OF PHILADELPHA**

_____ By _____

By _____

9 Appendices

A. Bibliography
B. Local Mitigation Plan Review Tool
C. Meeting and Other Participation Documentation
D. Dam Profile – For Official Use Only
E. Hazus Reports – For Official Use Only
F. Critical Facilities – For Official Use Only
G. Review of 2017 Mitigation Strategy